CANDY ETC

AUDIO

MARCH
1973 60¢

The Authoritative Magazine About High Fidelity ® A

23502

Omnidirectional Radiation / George Sioles

Quadraphony Requires Directional Sound / Ben Bauer

Spherical Sound Radiation / Winslow Burboe

"Omnidirectionality is Not a substitute for other high fidelity specifications; it cannot compensate for poor frequency response or high distortion."

". . . an unduly high percentage of reflected sound would never be a problem in a normal listening room."

"Quadraphony also benefits from properly positioned semi-directional and directional sound sources."

"Once the supporters of omni-directional speakers have admitted that they generally lose a lot of directional information and suffer from rather extreme distortions of lateral perspective, then I will admit that they may indeed prefer this sort of sound and that they have every right to."

"The response characteristics produced by a dipole loudspeaker is apt to be less affected by room acoustics than that produced by a omni-directional system."

"Omni-directional loudspeakers produce a relatively limited area of quadraphonic perception."

"The response from an omnidirectional loudspeaker is rather unpredictable near reflecting walls or corners."

eer's new nd

phase distortion, plus substantially better stability with four double tuned phase linear ceramic filters and four monolithic IC's in the IF section.

6-stage limiters

The IF section includes 6-stage limiter circuits. Used in conjunction with differential amplifiers in monolithic IC's, noise interference is completely eliminated with a signal to noise ratio of 75dB.

Exclusive Phase Lock Loop (PLL) IC circuitry in the TX-9100 multiplex section

Developed and used for the first time by Pioneer, the Phase Lock Loop (PLL) circuit is actually an electronic servomechanism. It maintains continuous and precise phasing between the pilot signal and the subcarrier, supplying optimum channel separation. Completely drift free, no alignment is ever required.

The PLL cannot be affected by humidity or temperature since there are no coils or capacitors to be detuned. This provides complete stability and reliability.

New pulse noise suppressor in the TX-9100 operates with computer control

This circuit operates automatically when it is switched on. It effectively blocks radiated noise from airplane and auto ignition systems, neon and traffic lights, etc. It does not interfere with frequency response and stereo separation. Whether the signal is weak or strong, this automatic 'brain' decides when the PNS gate circuit is to operate.

Unique muting control

A 2-position variable muting control uses electronic switching as well as reed relay switching. This eliminates interstation noise and the popping noise of tuning and detuning.

Complete command with a wide variety of controls

Whether it's for AM, FM or headset output levels, Pioneer provides greater operating precision with three independently operated output level controls. A headset may be used without a following power amplifier. Precision tuning is achieved with the aid of signal strength and tuning meters.

AM section highlights IC's

The entire AM section, following the front end, is a unitized IC. A monolithic IC replaces 84 individual components plus a ceramic filter. By using a differential amp circuit and a balanced mixing circuit, there are better spurious characteristics and special AGC amplification.

Great specs for great performance

	TX-9100	TX-8100	TX-7100
FM Sensitivity (IHF)	1.5uV	1.8uV	1.9uv
Selectivity	90dB	80dB	60dB
Capture Ratio	1dB	1dB	1dB
S/N Ratio	75dB	70dB	70dB
Image Rejection	110dB	100dB	85dB
Stereo Separation	40dB	40dB	40dB
Distortion (THD)			
Mono	0.2%	0.2%	0.2%
Stereo	0.3%	0.4%	0.4%
Spurious Response	110dB	100dB	100dB

The Amplifiers: SA-9100, SA-8100, SA-7100

Two separate power supplies utilize 30,000 uF total capacitance

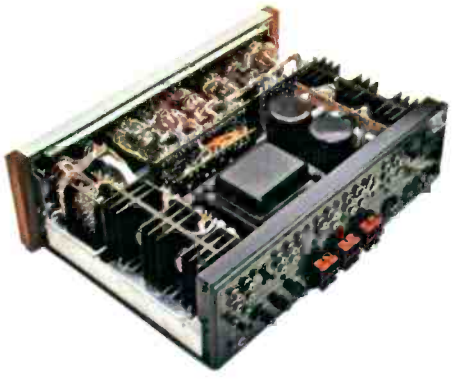
You read it right. The power supply in the SA-9100 uses a total capacitance of 30,000 uF. 15,000 uF each for the balanced positive and negative power supplies. This completely eclipses anything now available in integrated amplifiers. This super high capacitance results in an absolutely pure DC voltage supply. There's constant DC voltage regulation regardless

Two 15,000uF power supplies eclipse anything now available in integrated amplifiers.

of line voltage changes and signal input. Even at extremely low frequencies there's stable power output, excellent transient response and minimum distortion — only 0.1% at any frequency between 20-20,000Hz for 60 watts output per channel.

These positive and negative power supplies provide absolute stability in all stages, even in the equalizer amp and proceeding to the control and power amps. Therefore, the signal lines become zero potential to completely eliminate the usual (and annoying) click noise of operating controls and switches.

Stability is increased even further by the differential amplifier used in the first stages of the equalizer and control amplifiers (also the power amp.) 100% DC negative feedback supplies excellent stability and transient response; it also eliminates distortion. To further increase



Interior view. SA-9100

Introducing Pione series of tuners a amplifiers.

The time has come to completely re-evaluate the standard you now use to judge high fidelity performance.

With this new line of tuners and amplifiers, Pioneer presents many ingenious innovations in circuitry that are being used for the first time. However, this exclusiveness is only secondary. While each new circuit can be considered revolutionary by itself, what is even more important is that their combined capabilities achieve precision and performance heretofore unattainable.

The Tuners: TX-9100, TX-8100, TX-7100

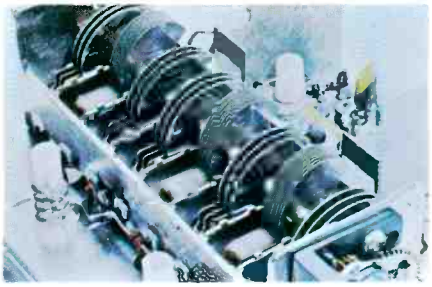
FM front end — an engineering triumph

The height of sophistication, the TX-9100's stabilized, drift-free front end replaces printed circuit boards with completely metallized construction. The same used in high precision communications equipment.

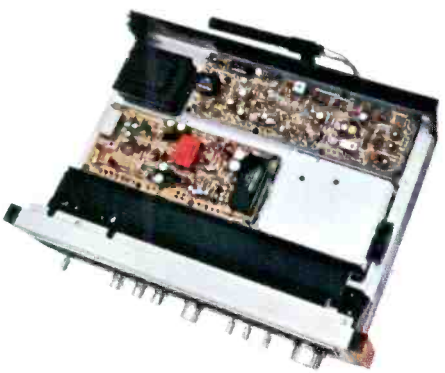
Employing three dual gate MOS FET's and a buffer circuit in the local oscillator, there's exceptionally high gain with extremely low noise. Two tuned RF stages with a 5-gang variable tuning capacitor contribute to the highest selectivity (90dB) and astonishing FM sensitivity (1.5uV). The exclusive use of a heavy gauge die cast aluminum housing assures uncanny stability.

IF section — the epitome of advanced research

In the pursuit of excellence, significant new IF section technology was developed. The result is optimum selectivity with minimum

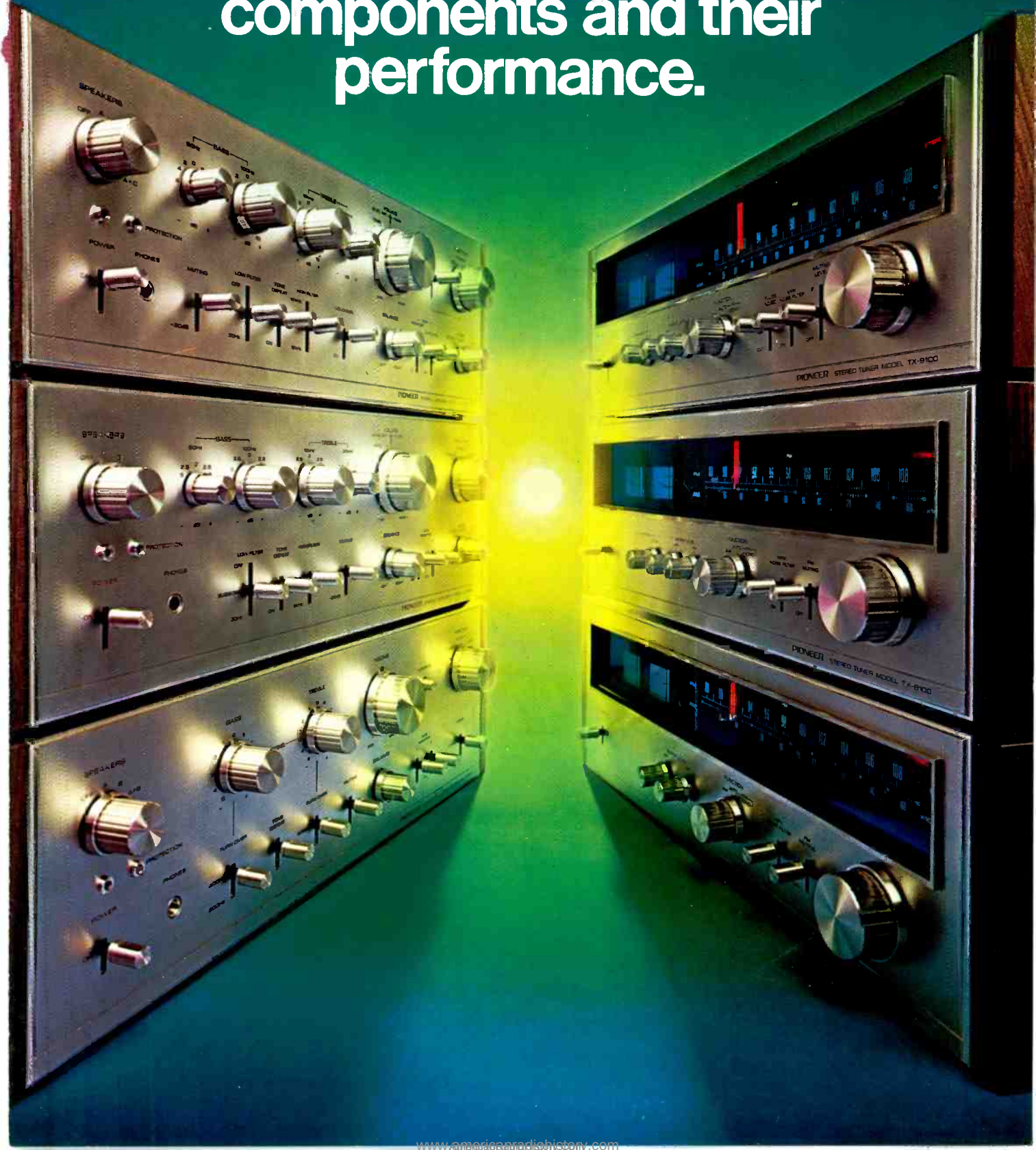


Exclusive heavy gauge die cast aluminum housing assures uncanny stability.



TX-9100 interior view. Chrome plated shielded front end housing and multiplex section.

Announcing a major breakthrough that will have universal impact on all future high fidelity components and their performance.



stabilization, special electronic regulator circuits are used. Transient response is also improved with a superb damping factor of 70.

The unique equalizer amplifier

To make certain that extraneous signals do not interfere with the input signal, the equalizer amp is totally enclosed and sealed to shield it against leakage.

There's also extra assurance of precision with special low noise metal film resistors and styrol capacitors. Both are manufactured under continuous computer control to highest laboratory test equipment tolerances: ±1% for resistors; ±2% for capacitors. Until now such precision has been unheard of in hi-fi equipment. Deviation from the ideal RIAA curve is only ±0.2dB.

Since a direct-coupled SEPP complementary circuit is used in the equalizer amplifier, virtually any dynamic phono cartridge can be accommodated without overloading or distortion. For example, with 2.5 mV sensitivity, the overload at 1KHz is an unbelievable 250mV, and 1200mV at 10KHz!

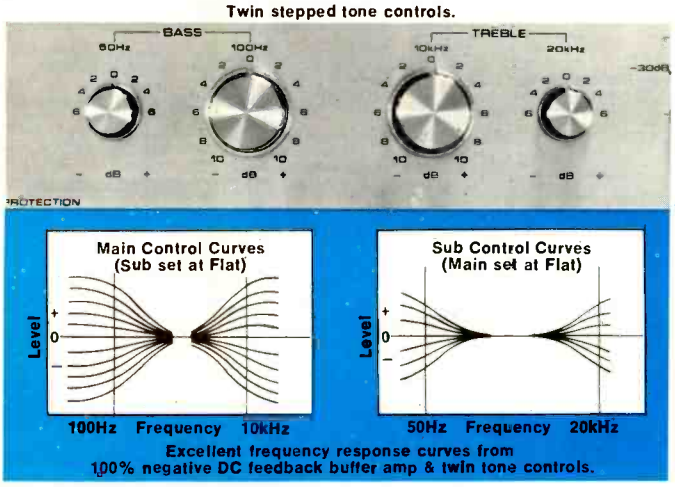
The power amplifier

To sustain the ultra sophistication of the equalizer and control amp sections, the power amp has a direct-coupled pure complementary SEPP circuit, double differential amplifiers and two constant current loads. The combined effect is the achievement of wide power frequency range and excellent transient response. 100% negative DC feedback is supplemented by 66dB dynamic negative feedback for minimum distortion and absolute stability. The pre and power amps can be used independently with a separation switch.

Exclusive direct-coupling in all stages

Until now direct-coupling has been used only with the power amplifier. Pioneer takes it a dramatic step further in the SA-9100 and SA-8100. Direct-coupling in all stages from the equalizer amp to the control amp to the power amp. More effective? Absolutely. It achieves the finest transient response, wider dynamic range, THD and IM distortion of only 0.04% (1 watt). It's an incredible achievement.

Twin stepped tone controls.



Excellent frequency response curves from 100% negative DC feedback buffer amp & twin tone controls.

Level set, volume and loudness contour controls adjust to listening preference

Three controls working together adjust to any degree of loudness. The level set control is the primary volume control. Its maximum loudness setting is 0dB.

Successive settings of −15dB and −30dB result in lower gain. Once the desired volume is obtained, the volume control is used for fine adjustments within the given range. While the loudness contour boosts bass and treble, it may also be used with the level set control. The more advanced the position of the level set control, the lower the effective range of the loudness contour.

The control amplifier: Twin stepped tone controls custom tailor your listening.

Now you can make the most critical bass and treble adjustments with supreme ease. In fact, there are 5,929 tonal combinations to suit your listening room acoustics and to compare or compensate for component frequency response.

On the SA-9100 and SA-8100 four tone controls (two for bass, two for treble) make 2dB (2.5dB with SA-8100) step adjustments for the entire audio spectrum. Working together with the tone controls is a buffer amplifier with 100% negative DC feedback. The main bass control governs ± 10 dB at 100 Hz; the sub-bass, ± 6dB at 50 Hz. The main treble control governs ±10 dB at 10KHz and the sub-treble, ± 6dB at 20 KHz. This, plus the tone defeat control (described in the next paragraph) makes the SA-9100 the most exciting-to-use amplifier that has ever powered any hi-fi system.

New tone defeat switch

Because of the extremely wide variety (5,929) of frequency adjustments made possible by the twin tone controls, the tone defeat switch adds extra flexibility. Adjusting the tone controls to your satisfaction, you can flip the tone defeat switch. Bass and treble responses instantly become flat. When it is switched off you return to the original tone control settings.

The original and positive speaker protector circuit

Since the signal is fed directly to the speakers because of direct-coupling, an automatic electronic trigger relay system is incorporated into the power amplifier. This protects the speakers against damage from DC leakage which can also cause distortion. It also prevents short circuits in the power transistors.

Maximum convenience for program source selection

While there is a multiple function rotary switch for microphone, phono 2 and two auxiliaries, Pioneer has included an additional convenience. A separate flip type lever control for instant switching between the more widely used tuner and phono 1 and any other single program source. Incidentally, both switches are shielded to protect the input against undesirable extraneous signal pickups.

Convenient program source selection switch & control lever.

Two-way tape duplicating and monitoring

There are two separate flip type switches on the front panel of the SA-9100 for tape-to-tape duplicating and monitoring. Two tape decks can be connected for recording, playback and duplicating in either direction, with simultaneous monitoring.

Level controls for phono 2, aux 2

In order to match the level of various inputs, individual level controls are provided for phono 2 and aux 2.

Speaker B control

This special control helps in the use of two pairs of speaker systems of different efficiencies. There is no sacrifice of damping or distortion when switching from one pair to the other.

Impedance selector for phono 2

An easy-to-use switch allows you to employ any phono cartridge input (25K, 50K, 100K ohms).

Two-position high & low filters

The low filter switch on the SA-9100 and SA-8100 has subsonic (below 8Hz) and 30Hz positions. The high filter switch has 12KHz and 8KHz positions.

Maximum versatility in program sources

	SA-9100	SA-8100	SA-7100
Inputs			
Tape monitor—S/N	2-90dB	2-90dB	2-90dB
Phono—S/N	2-80dB	2-80dB	2-80dB
Auxiliary—S/N	2-90dB	2-90dB	2-90dB
Microphone—S/N	2-70dB	2-70dB	1-70dB
Tuner—S/N	1-90dB	1-90dB	1-90dB
Outputs			
Speakers	3	2	2
Headsets	1	1	1
Tape Rec.	2	2	2

Consistent power for every requirement

	RMS power both channels driven 20-20KHz	RMS @ 8 ohms both channels driven @ 1KHz	RMS @ 4 ohms single channel driven @ 1KHz
SA-9100	60+60 watts	65+65 watts	100+100 watts
SA-8100	40+40 watts	44+44 watts	60+60 watts
SA-7100	20+20 watts	22+22 watts	36+36 watts

This new lineup of Pioneer tuners and amplifiers is unquestionably the most advanced available today. Yet despite this overwhelming sophistication, they're sensibly priced.

See your Pioneer dealer. He'll show you how this series of fine instruments can outperform any units in their price range. All prices include walnut cabinets.

SA-9100—$399.95; SA-8100—$299.95; SA-7100—$199.95.

TX-9100—$299.95; TX-8100—$229.95; TX-7100—$179.95.

While not discussed here, Pioneer is also introducing the SA-5200 stereo amplifier and the TX-6200 stereo tuner for high quality hi-fi on a low budget. Only $119.95 each, with walnut cabinet.

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

West: 13300 S. Estrella, Los Angeles 90248 / Midwest: 1500 Greenleaf, Elk Grove Village, Ill. 60007 / Canada: S. H. Parker Co., Ont.

PIONEER®

when you want something better

Number 93 in a series of discussions by Electro-Voice engineers

BASS IS BASIC

FRED NICHOLS
Manager,
Consumer Products

Creating truly fundamental bass with an acoustic suspension speaker system is often an exercise in frustration. It requires substantial power, plus a speaker that can move extreme distances without distortion. And as the woofer cone area is reduced the problem becomes more and more acute.

Luckily the typical distribution of energy in the lowest octaves for most music is usually modest, so that speakers are called upon to produce deep bass much less often than commonly supposed, even when reproducing organ and orchestral music. Nevertheless, the capability to accurately reproduce the lowest octaves is one greatly sought after and highly prized.

A re-examination of audio basics, primarily inspired by research by A. N. Thiele, has led E-V to develop new speakers based not on the ubiquitous sealed box concept, but rather on a sophisticated analysis of the vented enclosure. The first new system using this basic approach is the Interface: A. Unlike small sealed systems, the woofer excursion for this system actually diminishes as the system approaches resonance, thus permitting an extension of low frequency response without major penalties in efficiency or increased size.

To achieve the low frequency limit of 32 Hz (3 dB down point) from this 6th Order Butterworth-tuned system, research results suggested the use of an 8-inch woofer, matched to the enclosure volume with the equivalent of a 10-inch diameter, 20-foot long vent. But examination of the system reveals neither vent nor duct! Instead a vent-substitute is employed. This takes the form of a 12-inch cone assembly that is controlled in mass and compliance to be the mechanical analogue of the desired acoustic vent system. It has no voice coil or magnet but moves solely in response to the motion of the 8-inch woofer. It is fascinating to watch the 12-inch vent-substitute moving vigorously at 32 Hz in response to the woofer whose motion is barely detectable!

In combination with an active equalizer that adds a modest 6 dB boost at 35 Hz, Interface: A extends low frequency response well below that of a sealed system of equivalent size and efficiency, yet without increasing woofer excursion.

The same principles of vented system design have also been applied by Ray Newman, E-V Senior Product Engineer, in creating the new Sentry III monitor system. In this instance, high efficiency for studio use was a major design goal, and it is achieved with a larger enclosure, a 15-inch woofer and a "real" vent. The result is a system capable of low frequency performance uncommon in past high level monitor systems.

For reprints of other discussions in this series, or technical data on any E-V product, write:
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AUDIO

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FEATURE ARTICLES

EQUIPMENT PROFILES

RECORD AND TAPE REVIEWS

AUDIO IN GENERAL

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IMPROVE YOUR HEARING FOR $200.

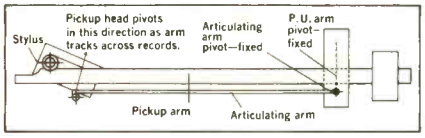
Sometimes high fidelity people lose sight of what it's all about: Sound.

The ultimate test of any piece of high fidelity equipment is what you hear.

That's why, of all the statements made by equipment reviewers about our Garrard Zero 100, the most significant were these:

"Using identical virgin records, and virgin styli in identical good cartridges, the Zero 100 on occasion sounded markedly 'crisper' than other turntables." *Rolling Stone.*

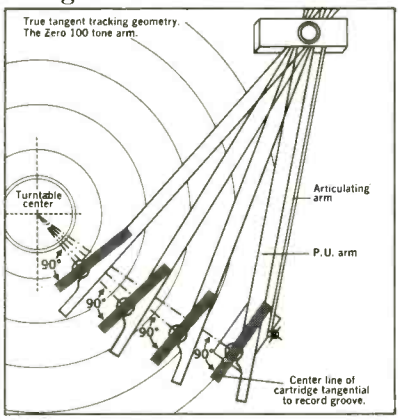
"A listening test proves to bring new life to many records, noticeably reducing distortion on the inner grooves." *Radio Electronics.*



"From about 7 in. diameter to runout, the Zero 100 delivers considerably less distortion and greater definition than with the same pickup mounted in a standard arm. The improvement in sound quality is notably impressive."
Elementary Electronics.

"The articulated arm of the Zero 100 produced less distortion, and therefore greater definition, on high-level, musically complex passages, from the inner grooves."
Hi-Fi Stereo Buyers' Guide.

That's what reviewers actually heard when they tested the first automatic turntable with Zero Tracking Error. This is, to our knowledge, the first time a turntable has been given credit for making records sound better.



Cartridges and other components, yes. But never a turntable — until the Zero 100.

By this time you probably know how we achieve Zero Tracking Error. The principle of the articulating arm, continually adjusting the angle of the cartridge so it is always at a 90° tangent to the grooves, is a simple one. But the ingenious engineering and the development of the precision pivots to make the principle work, took several years.

But enough from us. Let's go back to what the reviewers say about the Zero 100.

"It probably is the best arm yet offered as an integral part of an automatic player." *High Fidelity.*

"All of these features combined into one automatic turntable make news, even though some are found on other units. Only in the Zero 100 are they all put together." *Audio.*

When *Audio* talks about "all of these features" they're referring to such things as our magnetic anti-skating, variable speed control, illuminated strobe, viscous-damped cueing, 15° vertical tracking adjustment, patented Garrard Synchro-Lab synchronous motor and our exclusive two-point record support in automatic play.

But all of this gets back to our original point. It is the sound that makes the difference. After all, a $200 record player should give you a really meaningful difference. And the high fidelity experts agree that people who own a Zero 100 will hear better than people who don't.

If you'd like to read the reviews in full detail, we'll send them to you along with a complete brochure on the Zero 100 and the Garrard line. Write to: British Industries Company, Dept. K12, Westbury, N.Y. 11590.

GARRARD ZERO 100

The only automatic turntable with Zero Tracking Error.

Mfg. by Plessey Ltd. Dist. by British Industries Company

Check No. 2 on Reader Service Card

coming in April

Focus on open-reel tape recorders

Buyers Guide—a directory of 1973 two-channel stereo and quadraphonic open-reel recorders

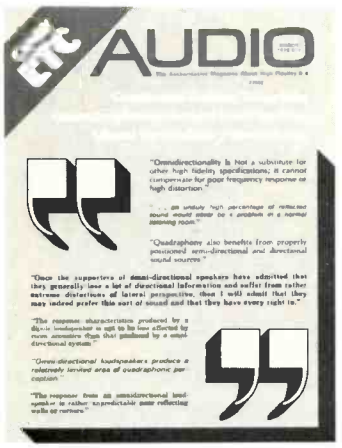
The Language of High Fidelity, Part 10 of Martin Clifford's Guide for Beginners

Equipment Reviews include:

Design Acoustics D-12 loudspeaker

Lafayette 4000 quadraphonic receiver

Infinity 1001 loudspeaker



About the cover: This is an attempt to highlight the different opinions on loudspeaker dispersion. Read all the articles and then buy the kind of loudspeaker *you* like best. Remember, we don't *all* like the front seat at a concert.

Tape Guide

Recording Stereo

Q. I recently bought a stereo tape deck and am very happy with it, except for the fact that I haven't figured out how to make stereo sound on sound recordings. The manual tells how to make mono sound on sound recordings, but not stereo ones. Can you make any suggestions for stereo sound on sound?—Michael R. Martin, APO, New York, N.Y.

A. To achieve stereo sound on sound, you would require an extra playback head mounted before the erase head. And you would need the capability for monitoring the signal produced by this head (Signal 1) and at the same time feeding Signal 1 along with Signal 2 to your record head (through your present mixing facilities). Alternatively, you could use a four-track (quadraphonic) set of heads, along with suitable switching, so that you simultaneously go from Track 1 to Track 2, and from Track 3 to Track 4; and then simultaneously from Track 2 to Track 1, and from Track 4 to Track 3; etc.

Mr. Martin further writes to present a solution to a problem encountered with plastic dust covers for turntables: "I have some information that may be of help to other owners of Dual and similar turntables with a plastic dust cover and a light-tracking cartridge. My Dual is equipped with a Shure M-91E that I operate at one-gram tracking pressure. I have found that on cold days when the humidity is low the plastic dust cover develops a static charge strong enough to lift the tone arm from the rest in off position or from the record during play. The problem is made worse if the dust cover is wiped with a dry cloth. The situation is easily remedied by taping a four or five inch strip of aluminum foil one-half inch wide to the dust cover so that as long as the cover is in place the foil contacts the metal of the turntable base. This prevents the tone arm from rising."

Transformerless TV Hook-Up

Q. I want to take the TV sound from the set's volume control. This, of course, means connecting the TV chassis to the receiver chassis and to the tape recorder chassis. The TV is transformerless. It receives its power through a polarized AC plug, thus grounding the TV chassis. If the polarity of the TV plug is not defeated, and if the AC wall receptacle wiring and polarity are compatible with that of the TV plug, would it be safe to make the sound connection described above?—J.H. Ruder, Oklahoma City, Oklahoma

A. If all your premises are met, it seems safe to connect your TV sound to your audio system in the manner your propose. But please do not accept my guarantee for safety. On general principles, I just don't like the idea of connecting a transformerless component to an audio system.

2- or 4-Channel Recorder

Q. I am considering the purchase of a Tandberg 14 mono tape recorder. My problem is in deciding whether to get this model in two- or four-track form. I have had experience with four-track mono recording, and the garbled rumble produced by bass notes on an adjacent track during silent passages is a plague. Tandberg specifies –60 db or more crosstalk. Would this be audible? Would I have this problem with a two-track machine? I understand that a two-track machine would put more signal on the tape, improving the signal to noise ratio about 2 db. Would this affect distortion?—Stephen L. Kasioras, Allston, Mass.

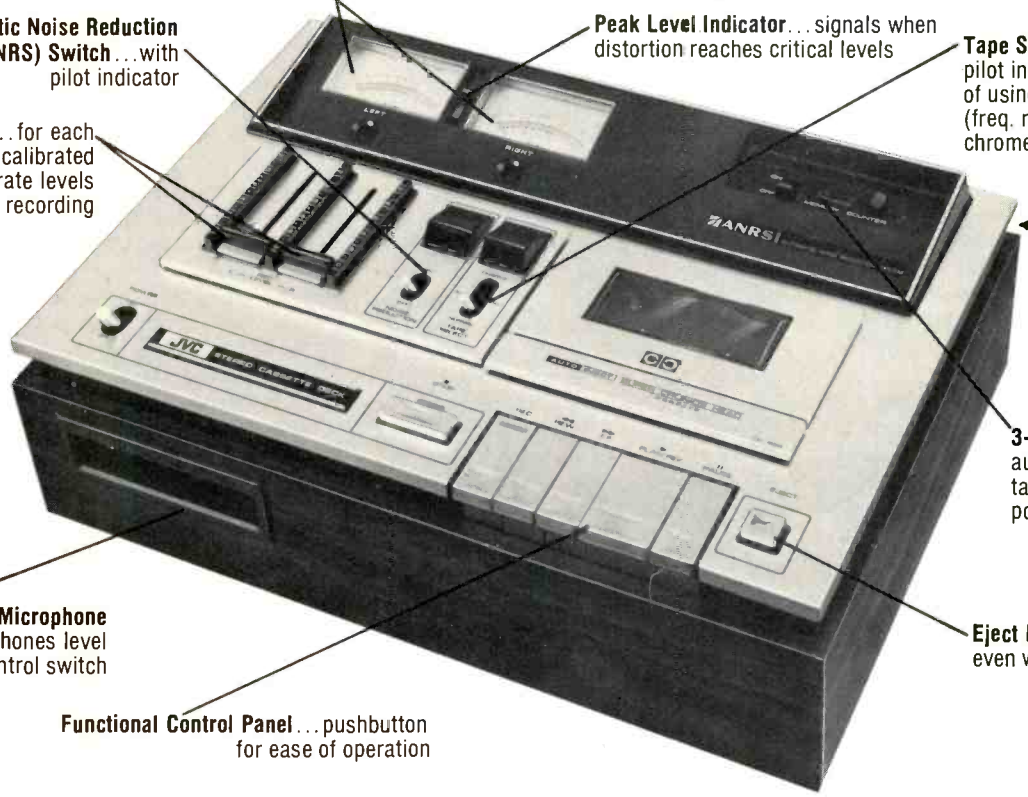
A. Crosstalk of –60 db would be inaudible in as much as other noise would be at most about –55 db below the maximum signal level. With good tape machines I have not run into the problem of "garbled rumble" that you describe.

Inasmuch as there is wider spacing between tracks in the case of a half-track machine than in the case of a quarter-track one, the former would be more free of crosstalk. Also, as you recognize, S/N would be higher for the half-track machine (about 3 or 4 db higher) inasmuch as this permits putting more signal on the tape. S/N is based on a given distortion level, so there would be no change in distortion. Another advantage of a half-track machine is that the wider track permits better averaging out of tape defects, such as those causing dropouts. On the other hand, the half-track recorder has the disadvantage that azimuth alignment is more critical. For a given degree of azimuth misalignment, treble loss is greater for a half-track unit than for a quarter-track one.

(Continued on page 79)

The JVC State-of-the-Art Stereo Cassette Deck with ANRS*

WHAT YOU SEE...



2 Studio-Type Vu Meters... accurate enough to be used for studio recordings

Automatic Noise Reduction System (ANRS) Switch... with pilot indicator

Peak Level Indicator... signals when distortion reaches critical levels

Tape Selector Switch... with pilot indicator. Gives you a choice of using chrome or normal tapes (freq. res.: 30-19,000 Hz with chrome tape)

Slide Level Controls... for each channel provides calibrated adjustments for accurate levels in recording

Dual Aux Inputs and Line Outputs... plus duplicate DIN connector allows hook-up of 2 sound sources

JVC MODEL CD-1668

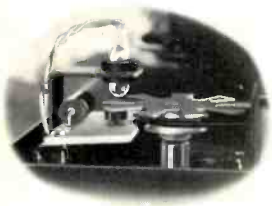
3-Digit Memory Counter... automatically stops the tape at a predetermined point when rewinding

Headphone and Microphone Jacks... with headphones level control switch

Eject Button... ejects anytime even when tape is in motion

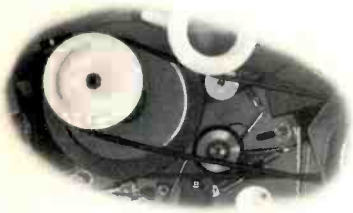
Functional Control Panel... pushbutton for ease of operation

WHAT YOU DON'T SEE...



Automatic Eject System With Photo-electric Cell... a photoelectric cell senses the end of the tape and automatically stops the tape and pops it up. It also eliminates any stretch inherent with tape tension type stop systems Another JVC unique feature!

Hysteresis Synchronous AC Motor... insures accurate rotation, reducing wow and flutter to 0.13% RMS



New Dual Drive Mechanism... capstan and reels are driven separately to optimize speed performance, maintain accuracy and reduce wow and flutter

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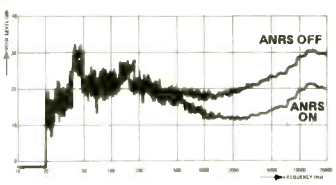

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Audioclinic

Joseph Giovanelli

Are Signals Too Strong?

Q. Can an FM signal be strong enough to cause distortion?

I have a Finco turnstile antenna on the terrace of my apartment. I get perfectly good reception of FM stations transmitting from New Jersey, Connecticut, Pennsylvania and surrounding regions. I get distortion and static only from those FM stations which transmit from the Empire State Building.

Can it be possible that the FM signals from the Empire State Building are so strong in my area (I live about eight miles from the building) that this causes the trouble? Is there anything I can do to reduce the distortion?—Salvatore A. Mele, Brooklyn, N.Y.

A. If an FM signal is too strong, this fact is USUALLY not manifested by distortion. (I have seen that happen, but so seldom that I have to think in other terms, as will be shown.) What usually happens is that the strong signal appears at more than one place on the dial or is heard as background to other, weaker stations.

I do not think, therefore, that your problem with FM stations broadcasting from the Empire State Building has anything to do with their signals being too strong. I think that you are either well shielded from such stations by other buildings or else you are getting multipath distortion. The fact that you hear "static" in addition to the distortion would lead me to believe that you may be a victim of both situations.

Your FM antenna is not suited to the elimination of these problems since it is omnidirectional. Therefore, it will pickup reflected signals as well as direct ones, with resulting distortion.

What is required is a directional and rotable antenna. If it is impractical to rotate the antenna, simply point it at the Empire State Building. If distortion is still present, reorient the antenna so that it is pointed in the direction of the reflected signals. It sometimes happens these reflected signals are stronger than the direct signals and produce significantly better audio quality than when the antenna is oriented to favor the direct signal. Because of the directional characteristics of the antenna, some of the weaker signals to which you have listened in the past may no longer be usable. This is because the antenna is not aimed at them. At such times as you wish to hear these stations, the antenna should be aimed toward them. They will once again be usable. In fact, they will be considerably stronger than they were at the time they were received by your turnstile antenna.

If your receiver has a signal strength meter, and if this meter is at nearly full scale—or perhaps pinning—you well may be the victim of severe overload. The directional antenna will add to this situation, but will reduce multipath distortion effects. Place an attenuator between the FM set and the lead-in cable; this should provide less signal and reduce or eliminate the overload.

FM Reception Problem

Q. Last year I bought a Kenwood TK-140 receiver. I had been using a little wire antenna that came with it until last week when I put up an outside antenna. Everything works fine except one thing. With the outside antenna I get a very annoying "frying" sound. Further, when listening to one particular station I get a "motorboating." When I disconnect the antenna, the noise stops. Therefore, the problem is not the receiver. What is my problem? What can I do about it?—Lloyd Luper, Inglewood, Calif.

A. I am not sure I know what is taking place in your receiver to bring about the "frying" and "motorboating." My best guess is that the increased signal strength provided by your new antenna is causing overload problems in your receiver.

The sole purpose your antenna serves is to increase signal strength; it does not produce noise of its own (at least not of the kind you have described; antenna noise could only be a factor with the most advanced possible circuitry when receiving very weak signals.) The only conclusion I can come to is that the receiver is to blame—in some way lacking the ability to handle strong signals.

This condition should not exist. The receiver should be checked.

"Motorboating" is generally associated with power or r.f. by-pass capacitor problems. It may be that yours is a marginal case, manifesting itself only under strong signal conditions.

"Frying" is often an indication of some stage breaking into oscillation—another indication of defective by-passing.

If you have background in servicing electronic equipment, I suggest that you shunt various r.f. and i.f. decoupling capacitors with new ones known to be good. Shunt them one at a time while the set is in operation WITH THE OUTSIDE ANTENNA CONNECTED. (Keep the leads as short as possible so the inductance in the leads won't minimize the by-passing action of the capacitor. This is most likely to be a factor when an r.f. stage is involved.) One capacitor probably will be found which will eliminate the "frying."

Intermittent FM Antenna Problem

Q. I am experiencing an intermittent problem in my FM antenna system. I am using a Finco FM-4G antenna, mounted on a rotator and supported on a 40-ft. telescoping pole. I use two antenna-mounted boosters; one is a Jerrold Powermate transistor booster of fairly recent manufacture which is designed for TV and/or FM use. The other is an older model Blonder-Tongue tube-type unit for FM only. The problem I have manifests itself when the wind blows. It is an intermittent popping sound in the speakers. At the same time the signal-strength meter jumps. Incidentally, the receiver is a brand-new Marantz Model 22.

I first changed the lead-in, thinking this was the obvious answer to the problem. No change. I then substituted the older booster for the transistor one. Still the same problem. I have double checked all connections. I am certain there are no loose ones. I am now completely puzzled. I do not know what to try next. —John F. Wieland, Liberal, Kansas

A. Because your problem with FM reception occurs only when the wind blows, the receiver cannot be the cause of the trouble. The receiver, after all, is not subject to wind. You are on the right track, therefore, when you think in terms of the antenna system.

You said that you changed the lead-in. Have you changed the cables which inter-connect the antenna mounters and the antenna? The cables must have slack in order for the rotator to turn. This slack loop may blow in the wind. If the conductors break under the insulation, you will not see the break. Nevertheless, the cables will become intermittent as the contact is made and broken with the cable's motion. The antenna itself can cause trouble. Check all rivets to see that they are tight. Loose rivets mean loose elements, which will result in poor contacts as the antenna is blown in the wind. It may well be that you have made the connections secure at the antenna terminals as far as the cables are concerned. Have you checked to see that the screws are snugged up against the driven elements? If the lock nuts for these screws are loose, this looseness will cause intermittent operation of the antenna.

I suggest that the mast be grounded. If this has already been done, check that the ground is intact, with no broken insulation and no wires broken under the insulation.

Check that the guy lines are tight and thus unlikely to make intermittent contacts with surrounding objects. AE

THE PROBLEM SOLVER

Say farewell to the grand old DC300, and welcome to THE PROBLEM SOLVER, the amp that is going to make your job easier and your customers happier. The original model DC300 was a great amp — the first super-power low distortion amp in the world, when Crown introduced it five years ago. Meanwhile, top sound systems designers have used it successfully in hundreds of demanding situations, and made some excellent recommendations for improvements. The response of the Crown design team was *not* an updated DC300, but a totally *new* and different amplifier, the DC300A. It is the *only* high power low distortion amp specifically *designed* for commercial sound applications. *(CAUTION: There are some large consumer-type amps attempting to sell in the commercial sound field without providing adequate continuous power for all load impedances.)*

Power You Can Count On

One of the DC300A's most outstanding features is that it has *double* the number of output transistors. This means effectively twice the muscle of the old DC300 — at the same price. Each channel has eight 150-watt devices for *1200 watts* of power dissipation *per channel*. The DC300A is rated at 150 watts per channel continuous into 8 ohms with both channels driven, 300 w/ch into 4 ohms or 500 w/ch into 2.5 ohms.

Two Amplifiers in One

As a dual-channel amplifier with separate level controls and circuitry for each channel, the DC300A is almost *two* amplifiers in one. This gives you additional flexibility in controlling your speaker load, as when driving separate front and back speaker systems in a large auditorium, or when bi-amping a system. For 600 watts continuous output at 8 ohms, the DC300A converts to a mono amp with two plug-in parts. This makes it possible to drive a 70-volt line directly without a matching transformer.

Superior Output Protection

The DC300A output protection circuitry is a radically new design which completely eliminates DC fuses and mode switches and further reduces service problems to the negligible level. It is superior in every way to the old VI-limiting circuit pioneered by Crown and now used by most other high power amplifiers, since it introduces *no* flyback pulses, spikes or thumps into the output signal, whether operating as a single-or dual-channel amp.

Gone too is the need to baby the amp by carefully juggling load configurations. The Problem Solver can drive *any* speaker load — resistive or even totally reactive — with *no* protection spikes! Parallel speakers with no deterioration of sound quality, since changing the load impedance only affects the maximum power available, not the ability of the amp to keep on producing clean sound.

Lowest Distortion and Noise

Also new is the DC300A's IC front end, which sets new world's records for low distortion and noise. At the 8-ohm rated output, IM and harmonic distortion is less than 0.05% full spectrum; hum and noise is 110db below. Servicing — if ever necessary — is a snap, since removing the front panel accesses the entire circuitry.

Although it is a completely redesigned model, the DC300A has inherited some characteristics from its predecessor:

PRICE - $685, the same as the 1968 introductory price, incredibly. As two amps in one, it will probably give you or your customers a welcome cost-break when you design your next multiple-amp system.

WARRANTY - three years, covering all costs of parts, labor and round-trip shipping.

COOLING - excellent heat dissipation provided by massive cooling fins and the entire chassis itself.

DEPENDABILITY - stringent pre- and post-inspection and testing proves every electronic component, every circuit module and every finished unit, to bring you one step closer to install-and-forget field dependability.

PEOPLE - the same innovative design team and careful craftsmen who made the DC300 such a sound success. And the same knowledgeable customer-service men ready to discuss your special application and send you detailed technical data. Phone 219 + 294-5571 or write Crown International, Box 1000, Elkhart, Indiana 46514.

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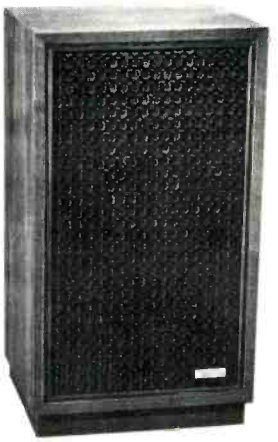
CR106-3

WHAT'S NEW IN AUDIO



4-Way Speaker System

Audioanalyst introduce Model A-200, a four-way speaker system using five direct radiators installed in a sealed enclosure. A 12 inch woofer with a low density cone, a 5 inch mid-range, a 3½ inch tweeter and two angled 2 inch super tweeters are said to provide a frequency response from 30 to 20,000 Hz with 180 degree dispersion. Level controls allow for adjustment of the output of the mid-range and tweeters. The oiled walnut enclosure measures 27 × 15 × 12¾ inches. Price: $225.00 East Coast; $239.00 West of the Mississippi

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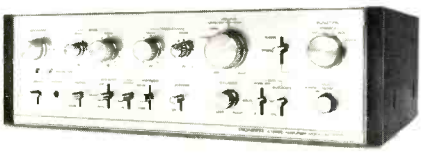

New Pioneer Amplifier

Pioneer have just announced a new integrated amplifier, model SA-9100. It is rated at 75 watts per channel into 8 ohms and 100 watts per channel at 4 ohms. Distortion is less than 0.1% and there are four tone controls—two for treble and two for bass. Turnover frequencies are 50 and 100 Hz, 10 kHz and 20 kHz. Other features include provision for two tape recorders, two phono pickups and two auxiliary inputs. Price: $399.95.

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4-Channel Amplifier

Heath announce the AA-2010, featuring four conservatively rated amplifiers and built-in decoder. Decoder circuitry decodes all currently available matrix encoded records and, with the flip of a mode switch, handles any discrete 4-channel material. The unit is said to enhance stereo material by feeding the out-of-phase ambience, common to 2-channel programming, to two rear speakers to produce a realistic 4-channel sound. Power rating is 260 (4x65) watts into 4 ohms, 200 (4x50) watts into 8 ohms and 120 (4x30) watts into 16 ohms. Heathkit mail-order price: $359.95.

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BSR 710X Turntable

Newest product from BSR is the 710X which is a 710 turntable complete with base, dustcover and Shure M91E cartridge. The 710 uses a similar mechanism to the 810 and has the same anti-magnetic platter, anti-skating adjustment and push-button controls. Price of the 710 is $129.95 and the 710X is available at a special package price.

Check No. 67 on Reader Service Card

Crown Amplifier

The Crown DC-300A features a new output protection circuit design for use with highly reactive speaker systems. The new output circuitry has allowed the elimination of the DC fuses and the protection mode switch, with a consequent simplifying of the operation of the amplifier. Power rating is 150 rms per channel. Price: $685.00 without optional walnut cabinet.

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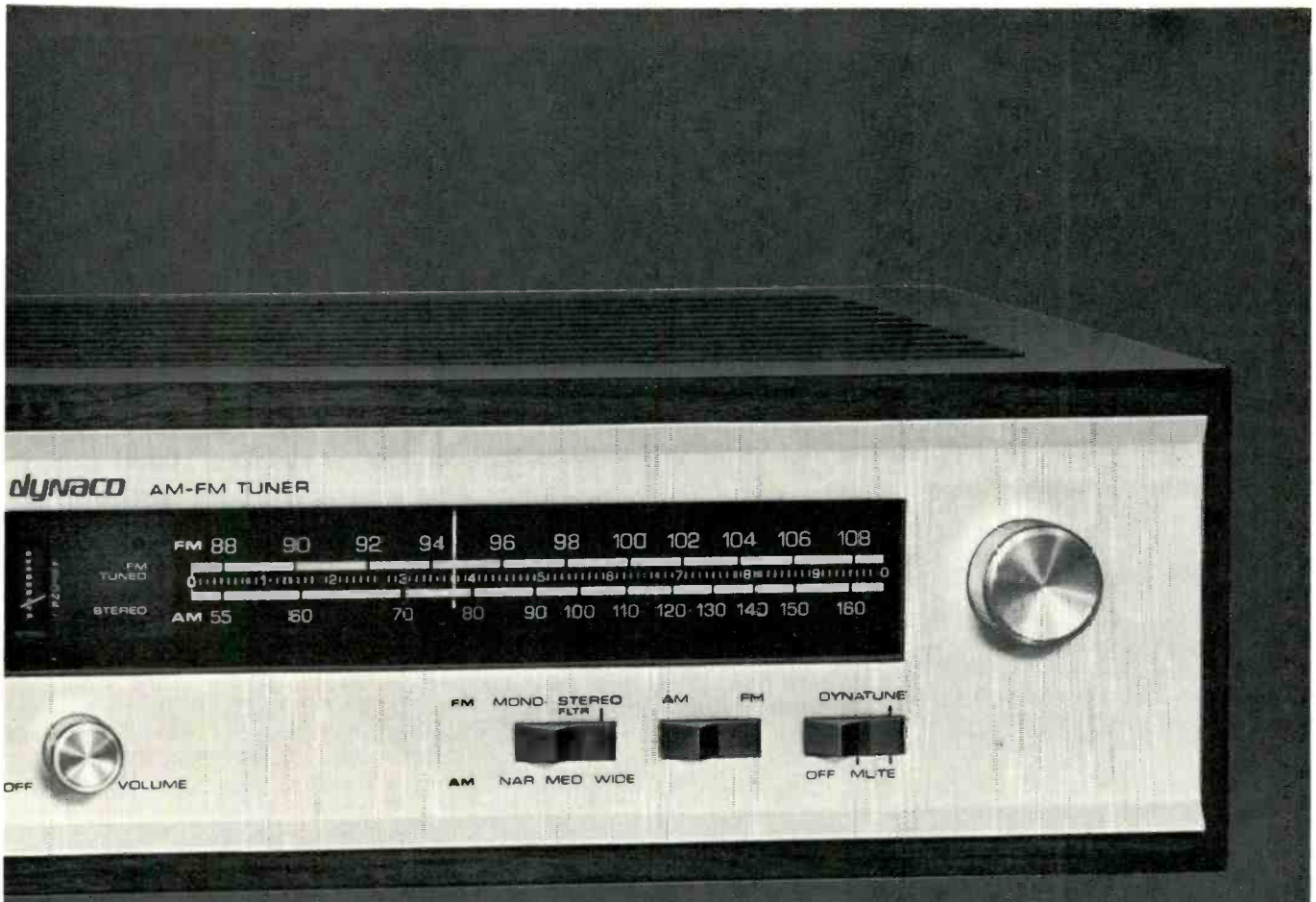
Behind The Scenes

Bert Whyte

THE YEAR OF 1973 is scarcely a week old and as I write, the advance parties of the various audio manufacturers are arriving in Chicago to set up their exhibits at the first Midwinter Consumer Electronic Show. Well, better them than me, friends. I used to live in Chicago, and I vividly remember those ice-pick winds sweeping in from Lake Michigan. The powers-that-be say they need this new CES at this frigid time of the year, because things are happening so fast in the industry, that the annual late spring shows are too far apart in time to adequately cover new developments. Perhaps they are right. I have heard many pro and con comments from manufacturers regarding the necessity of this new show. I must say however, that I am passing on this show because in my particular areas of interest, my spies tell me that nothing earthshaking is likely to happen.

There have been many pronunciamentos that 1973 will be the year that quadraphonic sound comes into full flower. Well, this is probably what should happen, but in my opinion, when we are nursing our 1974 New Year's hangovers, we will still not have arrived in this golden era. In spite of some ill-considered and premature statements in certain publications claiming that "the quadraphonic battle has been won", there is not at this moment any existing or officially recognized (in the sense of RIAA approval) standard for four-channel sound. Nor can any of the competing quadraphonic systems make any really valid claim to pre-eminence, or the status of an unofficial "standard." What *has* happened is a certain consolidation of resources in the EV/CBS, QS and CD-4 camps. Each has made advances to the extent that each treats the others with new respect. The battle lines are still drawn, but there are the beginnings of wary communication between the contenders. There have been overtures made with some interesting proposals advanced, even if none of them were given more than polite consideration. The combined discrete/matrix disc has been discussed anew, even though action on this is unlikely now or in the forseeable future. To top all this, there have been speculative, but nonetheless deeply probing looks at the various video disc systems, which with their very wide bandwidth as compared to audio discs offer interesting possibilities for multi-channel stereo recording. To most receiver manufacturers, alert to this situation, the name of the game is *non-obsolescence,* and the bolstering of consumer confidence in their products. Thus by the time the regular CES rolls around in May or June, you will almost certainly see receivers with built-in discrete and matrix four-channel facilities, or in some cases, at least built-in matrix quadraphonic with provision for discrete four-channel add-on units. In a nutshell . . . coexistence between the opposing camps is the order of the day, at least for the present. Fragile and tenuous though this situation may be, the action of the manufacturers in incorporating all the competing four-channel systems in their units cannot but help to offer some degree of stability to the presently confused situation in the merchandising of quadraphonic products. It is true of course, that consumers who want to use the CD-4 facility built into their units will still have to buy a special phono cartridge for that purpose. As far as the music dealer is concerned, even if this is an interim situation, he is not too badly off. Today a dealer often carries the same recording as a stereo disc, an open reel tape (sometimes as a discrete four-channel tape), an eight-track cartridge, a four-channel cartridge, and a cassette. If matrix stereo discs and CD-4 discrete stereo discs are added to his inventory, this should not be a particular burden. After all, Columbia and RCA have their own exclusive artists and they rarely interchange talent. If



New! dynaco AF-6 am-fm tuner

The closest approach to high fidelity AM!

Wide-band, low distortion AM with the impeccable specifications you'd expect from Dynaco. An exclusive audio bandwidth circuit extends the audio range when the signal quality warrants it for the best AM you've ever heard: yet it retains sharp 55 dB selectivity with a 12 section LC design IF filter. Switch to normal reception for weaker signals, or to a narrow bandwidth for high interference conditions. Coupled with all the superlative performance and features of the FM-5 (test reports on request), the AF-6 kit takes just two evenings to build. Now you can enjoy the unmatched convenience of Dynatune™ automatic FM tuning with sound which is "entirely a function of the FM program quality" according to Stereo Review, plus AM that may fool you into thinking it is FM.

$199.95 kit; $299.95 assembled
Walnut cabinet shown $17.95

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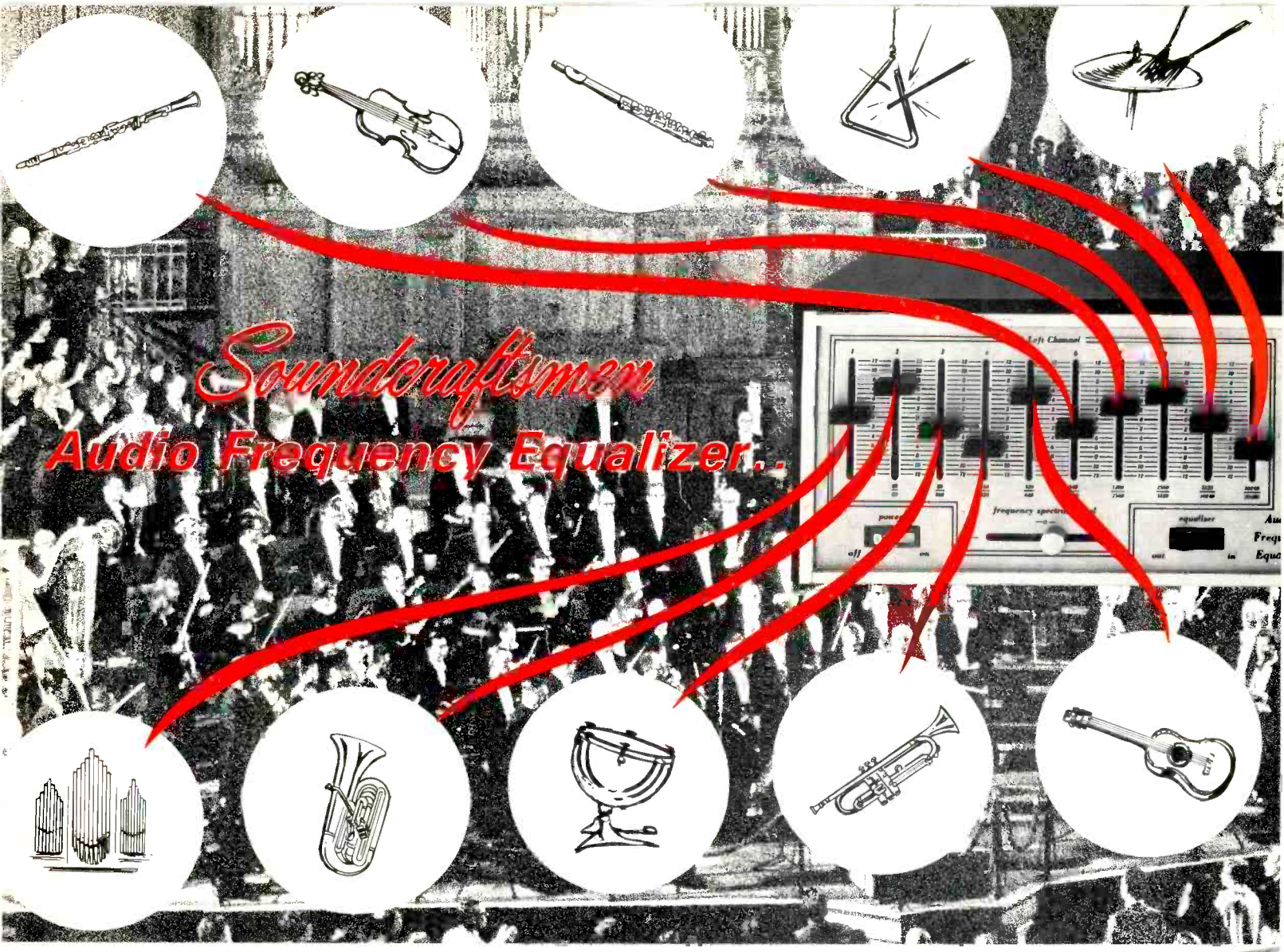
you want an Elvis Presley recording, you buy it from RCA. If you want Streisand, you buy it from Columbia. Whether the recording is discrete or matrix quadraphonic is of little consequence to the consumer. His present stereo phono cartridge will playback either kind of disc. At a later time if he is so inclined, he can acquire the means for quadraphonic playback of the discs. Everything considered, one must say that the four-channel stereo situation is improving, to the extent that those dealers who have been hesitant about making a vigorous sales effort on quadraphonic sound, can now undertake such a campaign without compromising their integrity, or shortchanging their customers.

Whether one advocates the EV/CBS, QS, or CD-4 quadraphonic systems, there is no argument on the basic root choice of format for source material. This is of course, a four-channel, in-line discrete stereo tape. It makes no difference whether the tape was mixed down from an eight or sixteen or even 24 track recording, or was the minimal straight four-channels . . . it is the final discrete four-channel stereo music source that is used to make whatever format of quadraphonic disc. Needless to say, it has long been acknowledged that as far as home listening to quadraphonic sound is concerned, the discrete four-channel stereo tape is the tops in quality.

In every field of endeavor, and with almost every kind of product, there always is a super deluxe model . . . the ne plus ultra . . . the cat's meow! Recently Vanguard Records has come out with a strictly Rolls Royce quality open reel discrete four-channel stereo tape. This 7½ ips tape is recorded with Dolby B Type noise reduction in both the front and the rear channels. Quite obviously you need two Dolby B outboard boxes of the type manufactured by Advent, Teac, Concord and similar units. To save on cost, you might want to use the least expensive units made by these companies. For example, two of the Advent 101 units can be had for the price of their Model 100. They do an excellent job, albeit without the conveniences of the higher priced unit. It is equally obvious that even this expedient is still a fairly expensive proposition. The real answer to the playback of these fore and aft Dolby B Vanguard tapes, is in the IC chip of the Dolby B circuit being made by the Signetics Company. Presumably, with the introduction of this type of tape, there would be those manufacturers venturesome enough to incorporate two of these chips into an inexpensive four-channel stereo Dolby B Type noise reduction unit. I should emphasize that these Vanguard Dolby B tapes are not experimental. They are commercially available, and I have been told that most of the stores that had the tapes have already re-ordered. Thus encouraged, I think we can look for more of this type of tape from Vanguard. Among titles of the "double Dolby" Vanguard tapes available are . . . VSS-15 Tchaikovsky 4th Symphony, Stokowski conducting, VSS-16 Excerpts from Handel's *Messiah*, VSS-20 A Bach Organ Program, VSS-19 *Aquarius* (broadway show tunes), some Joan Baez and Buffy St. Marie material, and two demo tapes with a few sound effects and some Japanese rock! Listening to these fore and aft Dolby B recordings is a revelation, especially rewarding with the classical works, although the Broadway show tunes reel has enough dynamic range to make the use of Dolby worthwhile. What a pleasure it is to listen to the Tchaikovsky 4th and the *Messiah* tapes, with virtually no tape hiss from the front speakers, nor from the rear. These are true four-channel stereo recordings with the rear channels carrying ambient information. Heretofore, in recordings of this type, the rear tape hiss was not only very distracting, but in some cases was enough to swamp the ambient information! The Bach organ works, which includes the inevitable D minor tocatta and fugue, as well as the Fantasia and fugue in G, is interesting inasmuch as it was recorded in Japan. The organ seems to be along the style of the bigger Aeolian-Skinner installations in this country. In any case it is a fine sounding instrument, and the recording is very well done with a judicious balance between organ definition and hall reverberation. Stokowski's interpretation of the Tchaikovsky 4th is highly individualistic, which will be praised by some and damned by others with equal fervor! Clean, powerful, strongly detailed sound in an acoustic perspective that seems a mite cramped for such a large ensemble. The Messiah excerpts are outstanding for their cleanness and the ethereal quality of the lovely pianissmos free from the tyranny of tape hiss. All in all, really a memorable listening experience. If you can afford it, discrete four-channel stereo tape with fore and aft Dolby B is the only way to fly! AE



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(Following quotes from 20-12 owners' Warranty cards on file at Soundcraftsmen)

"One of the best investments I ever made!!" . . . "Even made a believer out of my wife" . . . "I thought my system was the best sounding system going, but this equipment makes it sound un-real" . . . "Incredible! Every system should have one" . . . "Excellent — superb improvement of system" . . . "One Hell of an improvement to what I thought was a good sounding system" . . . "It would be a very great boon to anyone's stereo system — I love it" . . . "Has made a big improvement in the sound of my system" . . . "Great improvement to my system!!!" . . . This is a very fine piece of equipment. It tremendously improves the sound of my system" . . . "Can't believe how good it makes my set-up sound" . . . "WOW!!! What a change in my system!".

SPECIFICATIONS and SPECIAL FEATURES

TOROIDAL and ferrite-core inductors, ten octave-bands per channel.
FREQUENCY response: ± ½ db from 20-20, 480 Hz at zero setting.
HARMONIC DISTORTION: Less than .1% THD @ 2 v., Typ: .05% @ 1 v.
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SIGNAL-TO-NOISE RATIO: Better than 90 db @ 2v. input.
INPUT IMPEDANCE: Operable from any source 100K ohms or less — (any Hi-Fi Pre-amp. Receiver or Tape Recorder.)
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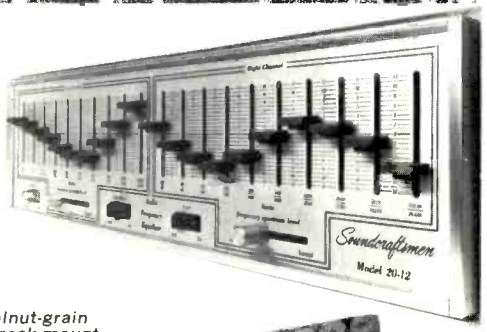
RESISTORS: Low-noise selected carbon-film.
RANGE: 12 db boost and 12 db cut, each octave.
MASTER OUTPUT LEVEL: "Frequency-spectrum-level" controls for left and right channels, continuously variable 18 db range, for unity gain compensation from minus 12 db to plus 6 db.
MAXIMUM OUTPUT SIGNAL: variable Master "frequency spectrum level" Controls allow adjustment of optimum output voltage for each channel, to exactly match amplifier capability, up to 7 v.
SIZE: designed to coordinate with receivers, comes installed in handsome walnut-grained wood receiver-size case, 5¼" x 18" x 11", or rack mount.
WARRANTY: 2-year parts and labor.



$299.50
includes walnut-grain cabinet, or rack-mount.

FREE!

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Editor's Review

Focus is on loudspeakers for this issue and we usually publish a Directory listing the various models and specifications. However, this time we decided to use the space for articles on design and performance—particularly regarding the advantages and disadvantages of omni-directional sound propagation. Opinions differ widely—partly because of the compromises involved with the reproduction of stereo sound, partly because of limitations of loudspeakers themselves and partly because of indefinable personal preferences.

AM Hi Fi

Recently, a number of letters have been received extolling the virtues of AM and pleading for better AM receivers. AM is not inherently inferior to FM and there are several stations in the broadcast band radiating wide bandwidth, clean signals. But they are in a minority and the quality of most AM stations is incredibly bad. It would be an over-simplification to say that the reason is a mercenary one but the desire to rope in the maximum number of listeners to hear the advertiser's message is certainly a factor. So all kinds of limiters, compressors and equalizers are used to get the loudest possible signal. It is also true that many station operators believe some signal processing is necessary because of the poor quality of many AM receivers—especially car radios. Some of the techniques were outlined by Irwin Fust, formerly Chief Engineer of several radio stations, in the November issue of Broadcast Management Engineering—known to its loyal readers as BME. Mr. Fust says, "It may be desirable to allow music to be broadcast with small limitations of dynamic range, but for most material *some processing is necessary.*" After dealing with automatic gain control, asymmetric limiting and compression systems, Mr. Fust goes on to say, "Restricting the bandwidth of the transmitted signal will allow a considerable increase in the total audio power received by the listener while retaining the overall quality of the signal . . . a high-pass filter cuts off any frequency below 100 Hz and a low-pass filter cuts off any frequency above 7.5 kHz. These filters are commercially available." Some equalizers peaking at 5 kHz and 300 Hz were described and then there was the following brainwave, "A little trick that can be done with some turntables it to increase the speed ever so slightly in order to give the recorded sound a 'brighter' quality. Increasing the speed increases the pitch of the music and can produce a subliminal effect." Quite so, but the effect of all this processing is to alienate the music-lover and so there is no real demand for top-quality AM tuners or receivers. I have forgotten which prominent TV executive said, "The purpose of Television is to Sell," but AM radio reached that stage a long time ago . . . .

Men of Hi Fi

Looking at the Men of Hi Fi transcript in the February issue, I suddenly thought, well, this is a nice photograph of Ray Dolby but I ought to have included one of Adrian Horne, so here it is. Adrian is Licensing Manager for the Dolby Company.

Setting the Record Straight

Percy Wilson's article on record care aroused a great deal of interest and we have been inundated with letters. One was received from Agnes Watts (widow of Cecil Watts) who says, "The Dust Bug was the first of our maintenance family of cleaners and it has never been claimed that this could deal with other than the dust in the groove being traversed by the Bug. Our Preener and Parastats were developed later and have been coping with dirty discs and maintaining clean ones successfully for many years. The disc washing machines on the market depend entirely on our Parastat brushes for their efficiency as no other brush has been manufactured with such delicate skill which enables the most stubborn dirt to be removed without damage." *G.W.T.*

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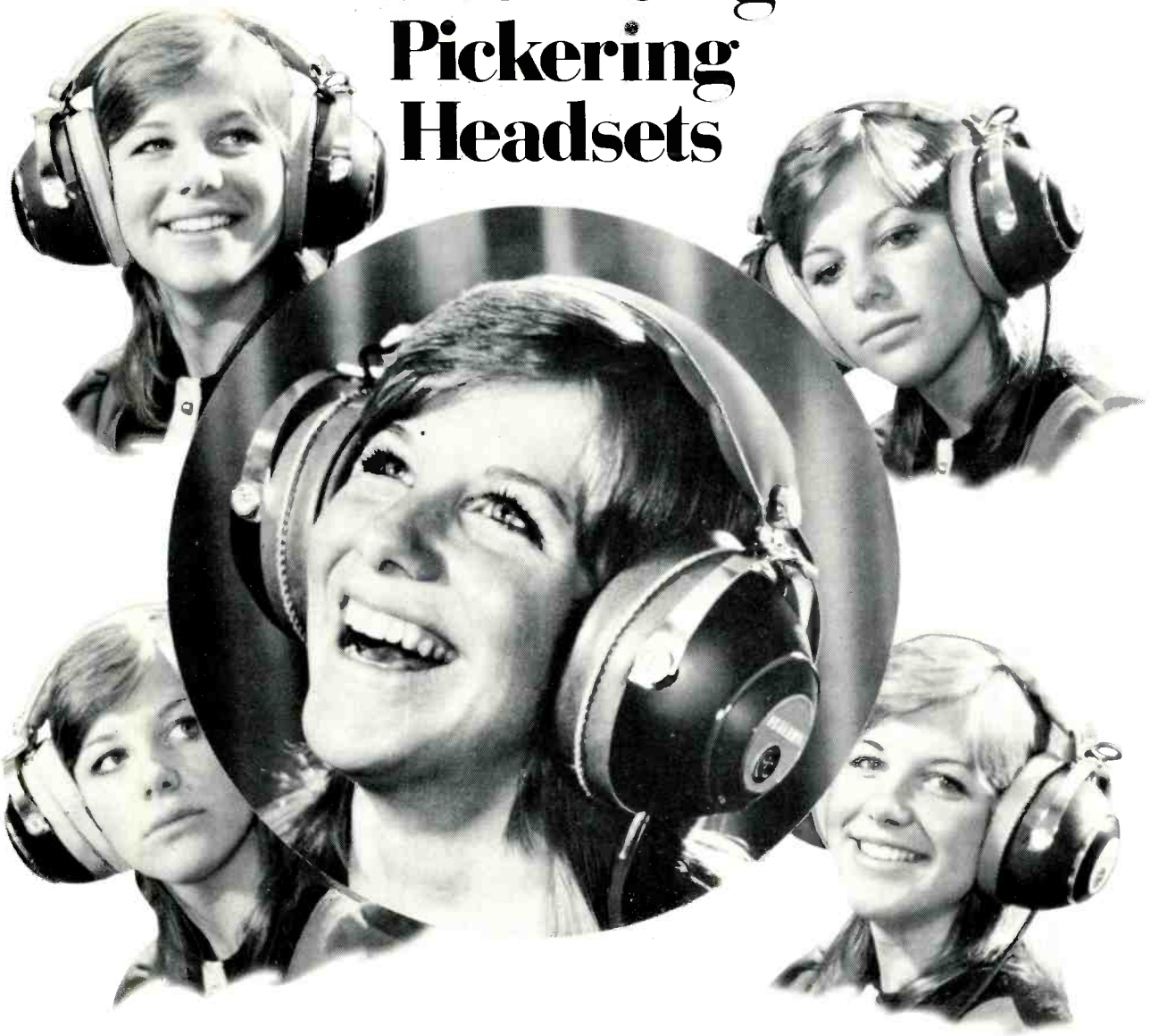

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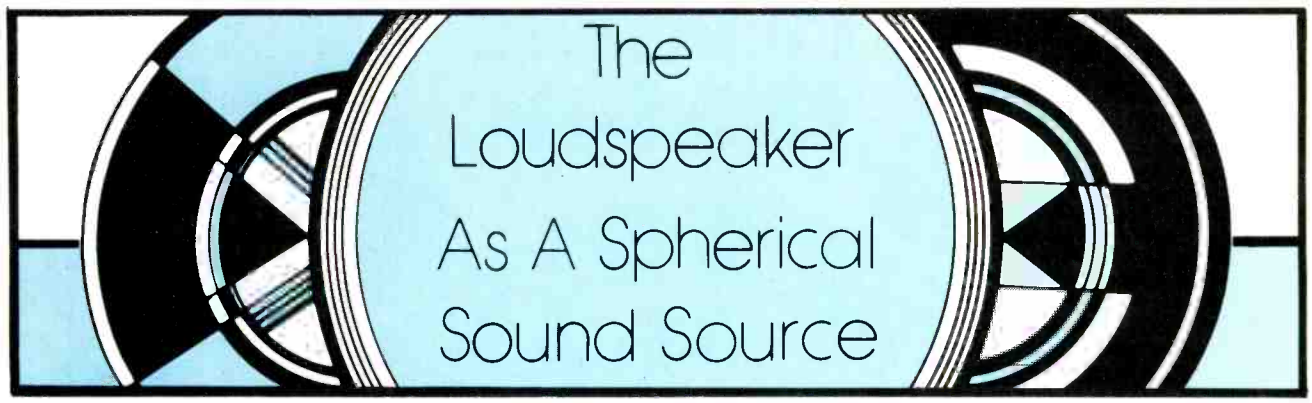

***Winslow N. Burhoe**

It has long been known to physicists and audiophiles that the ideal loudspeaker would radiate sound equally in all directions, at all frequencies without any distortion. The usual visual image which is called to mind is that of a small pulsating sphere, perhaps the size of a tennis ball. As this imaginary ball expands and contracts, it transmits a pressure wave to the air which then expands as a spherical wave of sound. Unlike wave motion in strings or on the surface of water, sound waves are three dimensional.

The term "omnidirectional" applies to the three dimensional spherical wave pattern this ideal sound source would generate. This term has been abused in recent years by being applied to speakers that do not technically qualify as omnidirectional. Some have been omnidirectional only over a very narrow frequency bandwidth and most are not omnidirectional at any frequency. As a consequence, there has been little industry or consumer excitement over speakers which have been introduced and labelled "omnidirectional".

It is essential for true and valid omnidirectionality that two conditions be met: (1) Omnidirectionality at all frequencies, and (2) equal energy radiation in *all* directions—up, down, left, right, forward and backward. Omnidirectionality is NOT a substitute for other high fidelity specifications; it cannot compensate for poor frequency response or high distortion. It is of no advantage unless applied to wide frequency bandwidth. However, when the traditional high fidelity values of flat frequency response, low distortion, and wide bandwidth are embodied in a truly omnidirectional speaker, a major improvement in sound reproduction is achieved; the close approximation of the mythical ideal speaker, a Spherical Sound Source.

Like all other historical advances in the art of high fidelity, true omnidirectionality provides a greater degree of musical realism and increases the aural perception of the listener. The psycho-acoustic effects of a stereo pair of true Spherical Sound Sources requires many hours of acclimatization, but once the listener's ear has accepted the more complicated aural impulses, the result is the most realistic perception of sound reproduction possible.

It has become a well known fact in recent years, even among audio consumers, that a speaker providing the listener with a combination of direct and reverberant sound imparts a greater sense of spaciousness and realism to the listening room. A truly omnidirectional speaker carries this concept many steps further by providing the maximum possible reverberant field effect, ie., the ratio of reflected energy from an omnidirectional speaker arriving at the ear from all directions, milli-seconds after the direct input, imparts an ambience and realism to the reproduced signal unequalled by any direct or partially reflective speaker.

*EPI Inc.

The amount of reverberant field effect of any speaker is determined by the amount of dispersion, especially of mid and high frequency energy, the amount of reflective versus absorbant surfaces in a listening room, and the speaker's position in relation to those reflective surfaces. In order to effectively utilize the maximum effect of reverberant field in an acceptable listening environment, a speaker must be able to accurately supply the listener's ear with two distinctly different and separately perceived aural inputs: the transient information and the tonal information.

The transient wave form provides the brain with bits of purely digital information. The time of first arrival of the transient at each ear is compared and the difference between these two arrival times provides a directional analysis and the greater part of the stereo image. Without proper transient information the stereo image becomes distorted, possibly through exaggeration of the size of the image, possibly through a minimization of the difference between channels.

The tonal information provides the brain with the actual musical overtones. The ear has the ability to act as a Fourier Analyzer and to separate all the complex tonal input into its actual frequency content. Even the most complicated harmonic structures and overtones are individually analyzed and then transmitted separately to the proper information processing sections of the brain, where the listener enjoyment of the reproduced musical signal occurs.

As long as a speaker provides transient information that can be accurately identified by the ear, the presence of a reverberant field effect serves to multiply and enhance the tonal input from the original musical signal allowing the brain a longer period to identify and enjoy the complexities of the musical overtones. Therefore, the greater the reverberant field, the greater the psycho-acoustic pleasure becomes.

The lack of accurate transient response from the speaker, or an unusual listening environment that would provide an extreme saturation of reflected sounds (the opposite of an anechoic chamber) could result in a muddy or blurred sound. The problem of transient information can be overcome with proper speaker design and an unduly high percentage of reflected sound would never be a problem in a normal listening room.

In a closed acoustical environment such as a normal listening room, an additional benefit of a spherical sound source is its ability to produce a field of sound, in much the same way that the earth produces a gravitational field. Because of the reverberant or reflective characteristics of a room and the psycho-acoustic effects of reverberation, the acoustic field produced is equivalent to a uniform field. In other words, there is no apparent source and no apparent change

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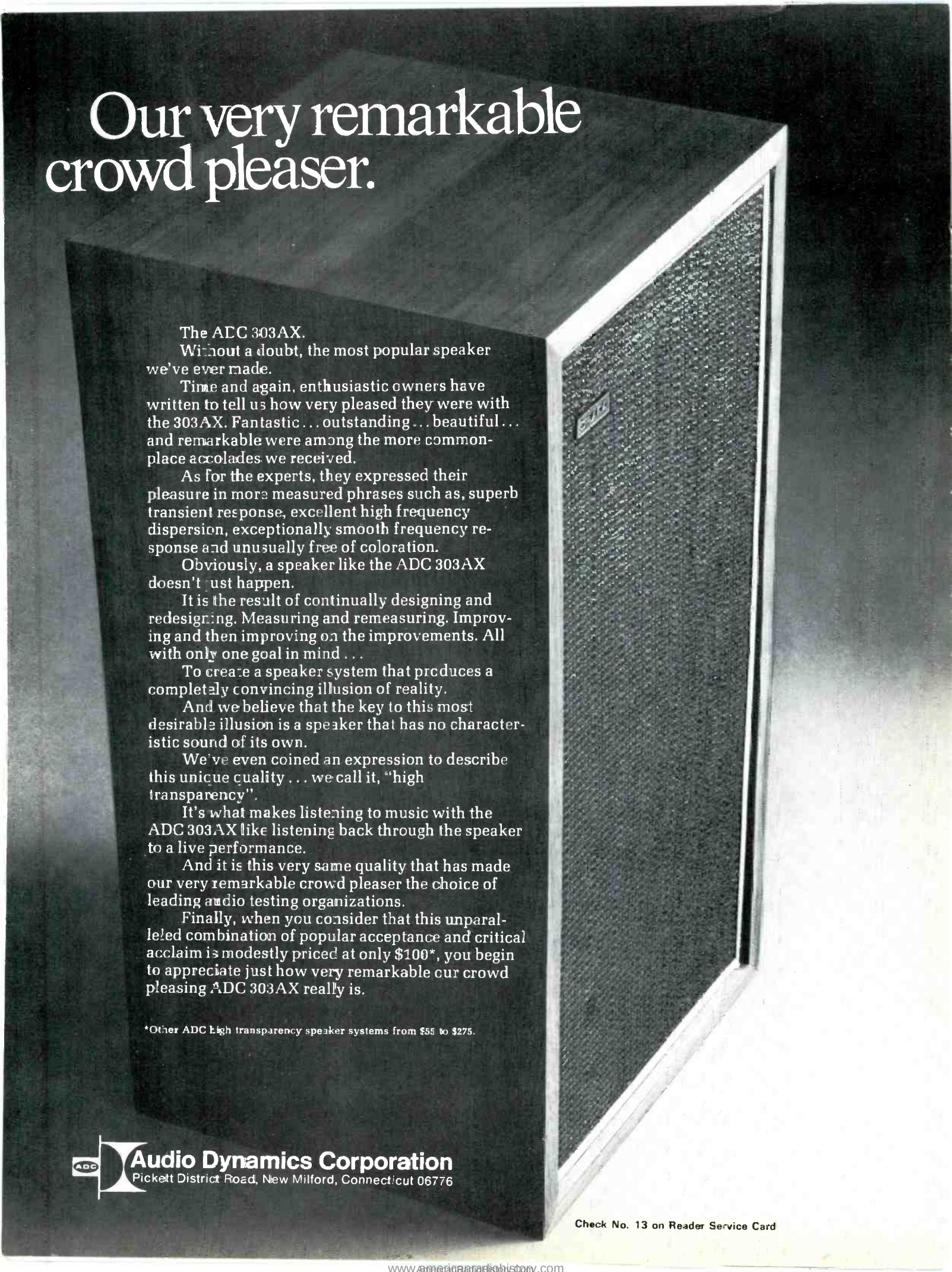

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Omnidirectional Radiation

*G Sioles

Science and technology as well as the arts have been characterized by controversy, and audio is no exception with such arguments as "pentodes vs. triodes" in amplifiers, the relative importance of measurements vs. listening tests in evaluating loudspeakers being typical. Sometimes the controversy is more imagined than real and derives its substance from insufficient knowledge, or over-simplification. It is the purpose of this article to discuss a recent "controversy" over the relative merits of omni-directional and "conventional" speakers.

Ideally, the performance specification sheet for a loudspeaker should look the same as one for an amplifier, with the exception of a few physical descriptors of one that do not have an easily definable counterpart in the other (e.g. output impedance). A loudspeaker, however, propagates sound in a three-dimensional continuum, whereas the signals processed by the amplifier are propagated in one, a pair of wires. Because of this, an additional important set of data is needed to show how the acoustic power is radiated in the various directions. It is a statement which is not generally discussed in any great detail because representation of the data is cumbersome (imagine looking at sixteen frequency response curves depicting the performance as it varies with direction from the source). But, we would like to discuss this difference between the loudspeaker and other elements in the audio reproduction chain because it is basic.

It is possible to argue, because of the variety of available room placements, that a loudspeaker should radiate uniformly over a solid angle of between π and 4π steradians. Further, the *power* output in free space (not simply axial pressure vs. frequency response) may have a special form to account for the increase in output at low frequencies resulting from wall reflections. It is not acceptable to have a uniform radiation pattern over 4π steradians at low frequencies, becoming directional at middle and high frequencies in such a manner that the net result is a non-uniform pressure vs. frequency characteristic in the reverberant field of the listening room. And yet, this is not uncommon.

Since non-directional behavior or controlled broad directivity is nominally desirable, from where derives the prejudice in some quarters against omnidirectional speakers? First, some speakers considered to be omnidirectional are not, but instead are directed-reflected type radiators. Second, those who feel that omni's are deficient in certain areas may be making generalizations from a very few poor examples. We are not aware, prior to now, of the existence of true omnidirectional speakers as serious contenders in the high performance speaker race. It would seem that omni's are put down in absentia—despite the fact that designers of conventional speakers generally strive to make speakers non-directional over as much of the frequency range as they can manage.

The question more properly may be, are there any true omni speakers? The answer is no. It is exceedingly difficult to produce a speaker that has uniform radiation over a spherical surface in the near field. What happens in the reverberant field (where people normally listen) is another matter. It is possible to produce a speaker which is essentially a true omnidirectional source, as heard in the reverberant field. It does not suffice, however, to place a number of driver units of individually indifferent frequency responses on the surface of a sphere and hope to get good results. True, omni behavior will result but at some cost in frequency response. Suppose we assume a good design—are there problems uniquely associated with omni's, and are they inherent? I do not think so, but a discussion of potential difficulties is worthwhile.

A true omnidirectional source must be either a point source (not possible) or a finite pulsating sphere (not practicable). In practice, an omnidirectional speaker comprises sources so small as to be non-directional as a consequence of their smallness, or sources of known directivity occupying a fraction of a "spherical" surface and equalized so that they radiate constant power vs. frequency, or some combination of the two. If there is any faulting of this approach it may be in the requirement for a multiplicity of sources. What happens is this:

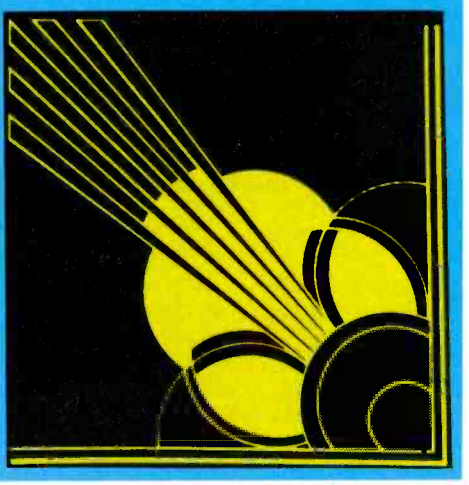
In the frequency range where a number of sources are radiating, the pressure vs. frequency response characteristic will be a function of the microphone position and, in general, will not be "flat". But this is not what we hear. We hear the integrated power output as modified by the listening room characteristics. This poses no problem, if the integrated power output is constant with frequency. There is a possible unlooked-for effect, however, with regard to stereophonic localization. If two multiple driver speakers are so placed with respect to the listener that he does not receive the same "free field" response from both, the stereo images will be imprecise. This may appear to be a significant flaw until one thinks more about the whole process of localization.

Obviously, the problem is potentially most severe if the entire range is covered by a number of drivers, since then the non-uniform response with direction will extend to relatively low frequencies and have more of an effect on the stereo information received by the listener, *if* the speakers are not symmetrically positioned. (If only part of the spectrum is covered by multiple units, it is only the stereo information in this range that may be affected). But, this can be prevented by symmetrical speaker placement. Indeed, symmetry of the listener himself with respect to the two sources is essential to preserve the accuracy of the stereo images, since the process of stereo localization depends on the perception of time and intensity differences between the two channels. These intensity differences are in large measure vitiated by the movement off the axis of symmetry by the listener of approximately one foot. This is because a time of arrival difference of approximately 1 msec. makes necessary an increase of almost 10 db for the later source to be perceived as existing—lacking in this, the sound will appear to come entirely from the near source. Such constraint on the listener is more restrictive than the requirement of symmetrical orientation of speakers. In fact, with omni-directional speakers the tendency to lose the stereo effect is less when the listener moves away from the axis of symmetry—a significant advantage.

Finally, the acoustic characteristics of the listening room are far more important than most people realize. Because the ratio of reverberant to direct sound from omnidirectional speakers is higher than that from more directional types, the effect of the room is correspondingly greater. Since many listening environments (e.g. some audio dealers' showrooms) are less than good acoustically, an omni speaker may come off second best in an A-B listening test with a more directional type. However, for one who does not wish to be fixed in space for his listening enjoyment, and can provide a reasonably good acoustic environment, an omni-directional speaker system is definitely advantageous. AE

* Design Acoustics

Quadraphony Needs Directional Loud-speakers



***Benjamin B. Bauer**

When stereo began its spectacular rise in popularity more than a dozen years ago I presented a paper before the Audio Engineering Society demonstrating that Stereophonic Perspective could be improved significantly, regardless of listener position by proper design of the directional characteristics of loudspeakers and their placement with respect to the listening area. The improvement is explainable in terms of semi-directional polar patterns of conventional (e.g. "bookshelf-type") loudspeakers; it can further be enhanced with more strongly directional (e.g. "dipole" or "gradient") radiators[2]. A similar analytical and experimental process leads us to conclude that quadraphony also benefits from properly positioned semi-directional and directional sound sources.

What about the role of "omnidirectional" loudspeakers we hear so much about? It turns out that true omnidirectional radiation at all frequencies is difficult to achieve in practice; "semi-omnidirectional" performance, however, can be attained with relative ease. Omnidirectional loudspeakers obviously do not require directional orientation to cover a quadraphonic listening area reasonably well and, therefore, often are able to provide quadraphonic performance superior to that obtained with improperly oriented semi-directional loudspeakers; this is a very commendable attribute of systems intended for use by the lay public. On the other hand, omnidirectional loudspeakers can result in nasty wall reflection problems, and furthermore, any knowledgeable Hi-Fi enthusiast, or one who takes a bit of trouble to optimize loudspeaker placement, is apt to gain more satisfaction and improved quadraphonic performance with well designed semi-directional loudspeakers; or, if he is fortunate enough to obtain them or skillful enough to devise them—with properly designed dipole units.

To provide a better understanding of the principles involved in applying directionality to quadraphonic loudspeaker arrays we discuss first the physics of omnidirectional or semi-omnidirectional, semi-directional, and directional loudspeakers.

Omnidirectional Loudspeakers

At first blush, it would appear easy to design an omnidirectional loudspeaker; actually the task is rather formidable. A truly omni-directional radiator is defined by a spherical surface which expands and contracts radially equally and inphase. There are not many practical ways in which such a transducer can be fabricated. One approach is to use a hollow sphere (or two abutting hemispheres) of suitably polarized piezoelectric material (e.g. polycristalline lead zirconium titanate ceramic), including suitable internal and external electrodes to receive the electrical signals. Such a ball vibrates uniformly radiating equal amounts of sound intensity in all directions. Unfortunately such a transducer does not perform efficiently in air, (albeit it works fine underwater).

To improve efficiency we can place a large number of small moving-coil loudspeakers on the surface of a sphere; but since the radiation characteristics of all the units must properly overlap, this approach turns out to be quite complex and expensive. Another possibility is to install a ring of small loudspeakers around a cylindrical drum, or even to place a single transducer on the end of the drum and to confront it with a reflector adapted to direct the medium and high-frequency sounds equally all around into the horizontal plane. Thus, from the truly omni-directional ceramic ball loudspeaker we progress in steps to various practical "semi-omnidirectional" designs which radiate sound relatively uniformly only in the horizontal plane.

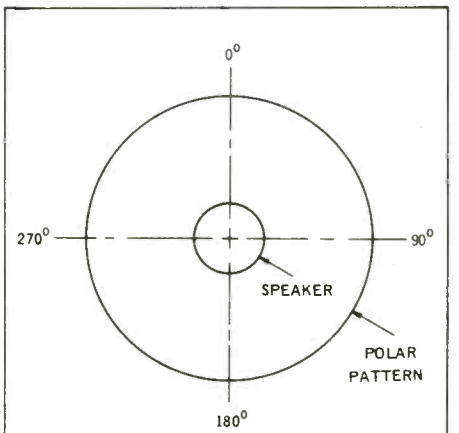


Fig. 1—Polar pattern of an omnidirectional speaker in free space.

Graphically we show this uniform radiation in Fig. 1 by a circular "polar pattern," which signifies that the sound pressure radiated at a given distance in a 360° compass is constant.

Next, we consider briefly what happens when an omnidirectional loudspeaker is placed near a reflecting wall or corner. In this circumstance its performance can best be analyzed by the method of virtual images. For example, in Fig. 2(a) the loudspeaker center is placed at 1 ft. from a reflecting wall. Because sound travels at a speed of 34,400 cm/sec, the wavelength at a low frequency, say 50 Hz, is 34,400/50 = 688 cm (22.6 ft.)—much greater than

1. "Broadening the Area of Stereophonic Perception" *Tenth Annual Convention of the A.E.S.*, N.Y., Sept. 29, 1958.
2. B.B.Bauer, *Jour. A.E.S.*, 8, 2, 91-94 (April 1960).

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the distance between the loudspeaker and its image (2 ft.). Both the real and the virtual source may be assumed to radiate inphase resulting in the doubling of sound pressure, with the polar radiation characteristic remaining nearly circular, as shown by the pattern

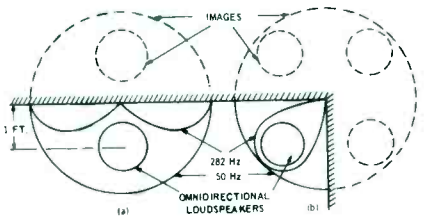

Fig. 2—Polar pattern of omnidirectional loudspeakers placed (a) near a wall (b) near a corner.

labeled "50 Hz" in Fig. 2(a). In reality, real radiation is only outside the wall P shown in solid line. The virtual source and radiation being shown in dash-line. (The presence of this virtual source accounts for increased bass when a loudspeaker is placed near the wall). At higher frequencies, the wavelength λ becomes comparable with the distance between the loudspeaker and its image, resulting in interference patterns. For example, at 282 Hz the distance is precisely $\frac{1}{2}\lambda$ resulting in total cancellation of radiation in a direction perpendicular to the wall, as shown by the polar pattern labeled "282 Hz." At other frequencies, different patterns will be generated. Placed in a corner, again at 1 ft. from both walls, as shown in Fig. 2(b), three virtual images are formed. Again, at 50 Hz the pattern is nearly circular, and the radiated sound pressure is increased four-fold. At 282 Hz, the radiation near the walls drops to zero, but the radiation along the diagonal is a maximum, resulting in a rather narrow polar radiation pattern. Again, at other frequencies different patterns will be formed.

Therefore, the response from an omnidirectional loudspeaker is rather unpredictable near reflecting walls or corners, suggesting that the presence of acoustical absorption on or near the walls may be desired to avoid the higher-frequency reflection modes.

Semi-Directional Loudspeakers

The majority of "bookshelf-type" and similar loudspeakers are semidirectional. This is to say, they are omnidirectional at low frequencies becoming relatively directional at high frequencies. This is illustrated by the way of example in Fig. 3 where at (a) is portrayed a loudspeaker consisting of a sealed box (popularly known as "infinite baffle") say 12 × 20 in. in cross-section, enclosing a driver with a piston width W = 8" or approximately 20 cm. In actual practice the piston is circular or elliptical; but to make our example as simple as possible we assume it to be rectangular with the long dimension perpendicular to the paper.

At a low frequency, say 50 Hz, where the wavelength is much greater than the dimensions of the box, the particles of air displaced by motions of the piston move to-and-fro together in imaginary channels—much like water flowing from an opening, as illustrated by the streamlines in Fig. 3(a). At a distance from the box, it becomes possible to strike a circular surface along which all the streamlines are distributed with a near equal density of flow, corresponding to equal sound pressure which expands in concentric circles away from the loudspeaker. Under this circumstance the loudspeaker behaves like an omnidirectional radiator.

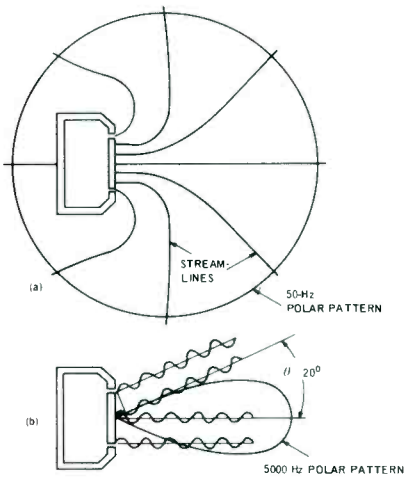

Fig. 3—Polar patterns for a piston in closed box for (a) low frequency (50 Hz) and (b) moderately high frequency (5000 Hz)

As the frequency increases the wavelength becomes progressively shorter with the consequence that sounds from various portions of the piston are no longer inphase causing the radiation off the principal axis to be diminished or even to become completely cancelled. For example, consider the situation at 5000 Hz where λ is but 34,400/5000 = 6.88 cm (2.7 in.). As may be seen in Fig. 3 (b), the wavelets from the center and edge of the piston in the direction parallel with the axis are in additive phase resulting in intense sound radiation forward of the piston; but at some angle, θ, the wavelets are found to be in phase-opposition causing complete cancellation. In the example given, θ is readily found as follows:

$$\sin\theta = (\lambda/2)/(W/2) = \lambda/W \quad (1)$$

or, since λ = 6.88 cm, and W = 20 cm, $\sin\theta = 6.88/20 = 0.344$; or $\theta = 20°$. From its on-axis maximum, the radiated sound pressure progressively diminishes to zero as shown by the polar-pattern in heavy line in 2(b). It is obvious that, in this last example, we are dealing with a narrow directional pattern which is unsuitable for high-quality sound reproduction at widely spaced positions in the room. To "broaden" the directional pattern sufficiently to obtain reasonably good coverage, we must restrict the upper frequency at which a piston is allowed to radiate. A workable rule of thumb for *circular* pistons is that the wavelength should not be less than the diameter of the piston. For an 8-inch piston this corresponds to 1720 Hz. To provide a satisfactory radiation pattern to 20,000 Hz the diameter of the piston should no exceed approximately 34,400/20,000 = 1.7 cm (0.68 in.).

At this point the reader might wonder why not use the small piston for all frequencies simply by making it work that much harder at low frequencies. This approach is counter-productive because the sound pressure generated at any given frequency at any point in space is related to the volume of air displaced by the motion of the piston, i.e. by its area multiplied by its linear vibration amplitude. Thus, an 8-inch diameter circular piston vibrating with a ¼-inch motion is apt to provide adequate bass sound; a 1.7-cm diameter piston which has $\frac{1}{22}$ the area of an 8-inch piston would have to have a 22-times longer stroke for the same sound output. —or 5½ in. which obviously is impractical.

Thus, the designer is caught between the limitations of maximum allowable piston amplitude, at one end of the frequency scale, with the directional radiation problems at the other, and he has to allocate the range covered by each piston to a relatively limited band of frequencies. This explains why a superior loudspeaker system usually will employ several drivers of different diameters interconnected electrically with dividing networks to convey to each its proper portion of the spectrum. Typically, the response pattern of a good semi-directional loudspeaker is omnidirectional (circular) at low frequency narrowing down to a 90°-60° included angle at about 1000 Hz and remaining within this range up to the highest frequency of interest, as various radiators of progressively smaller size

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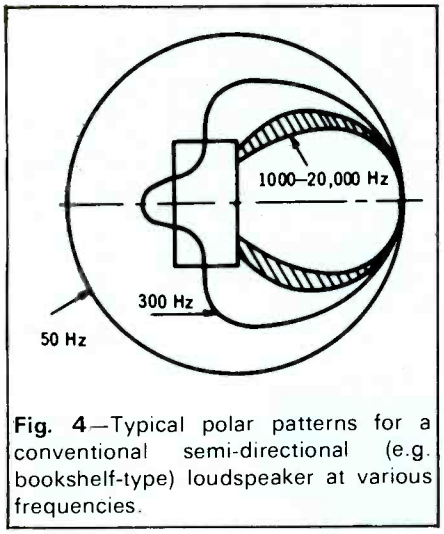

Fig. 4—Typical polar patterns for a conventional semi-directional (e.g. bookshelf-type) loudspeaker at various frequencies.

come into play, as shown in Fig. 4. Because the baffle box diminishes the radiation toward the back at mid-frequencies, such a semidirectional loudspeaker is less bothered by reflections from the walls or corners, than an omnidirectional unit. Without pretense of offering a treatise on loudspeaker design, it should be noted that the polar pattern of a loudspeaker cone can be modified by shaping, adjusting compliance, adding acoustical lenses etc.

Dipole Loudspeakers

A dipole loudspeaker is simply a piston (e.g. loudspeaker mechanism) vibrating in open air without an enclosure to confine the back radiation. The efficiency of such a device is a function of frequency because the radiations emerging from each side of the piston tend progressively to cancel each other as the wavelength increases. Efficiency may be improved by adding to the piston a baffle, as shown in Fig. 5, which increases the distance between the front and the back of the piston. It is easy from Fig. 5 to visualize that, in the perpendicular front, or zero degree direction, the back sound radiation has to travel an added distance D before it can proceed to the front; the added distance giving rise to a phase differential between the two waves producing a net sound pressure at a given point in space designated as P_0. As we move in a circle to the 90° direction, the radiations from both sides become equal and in antiphase; thus there is a zone of silence at all points on a surface S perpendicular to the axis. As one travels to the back, or 180° direction, the distance D comes again into play (except that this time, from front-to-back) resulting in a maximum sound pressure at P_{180}. It is not difficult to prove mathematically that as one moves around the circle, the pressure function follows a cosine law, the polar pattern taking on the form of two circles at both sides of the piston. To avoid an excessive loss of efficiency the dimension of the baffle should be no less than approximately ⅛th the wavelength of the lowest frequency of interest. At high frequency the radiation from the piston narrows down in a manner similar to that described in Fig. 3. Therefore, the highest operating frequency for any one piston should be that corresponding to a wavelength equal to its dimensions. An 8-inch diameter loudspeaker installed in a 13-14-inch baffle, has a satisfactory operating range between 250 and 1700 Hz. A second, correspondingly smaller gradient loudspeaker would be needed to cover a range between 1700 Hz and 10,000 Hz, etc. The polar pattern obtained with a composite gradient loudspeaker would then be approximated by the broadened circular outlines in Fig. 5.

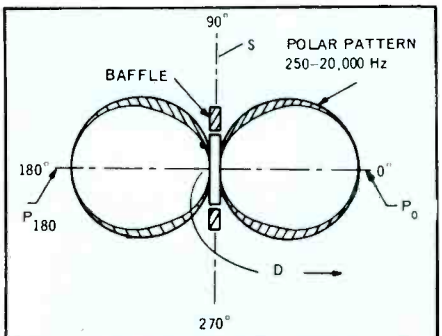

Fig. 5—Theoretical polar pattern of a dipole loudspeaker composed of progressively smaller dipole elements to cover the full frequency range between 250-20,000 Hz. (Below 250 Hz, an omni-directional loudspeaker is used).

Experience has shown that response below 250 Hz can readily be provided with a conventional (omnidirectional) loudspeaker in an infinite baffle, without greatly influencing the aurally perceived directional characteristic of the gradient array.

Thus, a practical dipole loudspeaker generally is omnidirectional below about 250 Hz, and exhibits a figure-eight pattern above 250 Hz, as shown by the heavy outline in Fig. 5. The frequency response of the combination must be carefully tailored to be "flat" overall. The biggest advantage offered by the dipole loudspeaker array is that it retains its cosine-law directional pattern over that portion of frequency which conveys the major part of directional information i.e. between 250-20,000 Hz.

A few dipole loudspeakers are available commercially. Usually they employ electrostatic high frequency sections and a moving coil bass section. For the present, however, the majority of high fidelity enthusiasts will have to be content with semi-directional loudspeakers to obtain the improved area coverage described below.

Application of Directional Loudspeaker to Stereophonic Arrays

The wrong and the right way of placing conventional semi-directional loudspeakers (e.g. bookshelf loudspeakers) for stereophonic listening is shown in Figs. 6 and 7, reproduced here from the paper referred to previously[2] with the kind permission of the Audio Engineering Society. In the first case, the loudspeakers are placed parallel to the front wall of the room. A listener at position P is at a greater distance from loudspeaker A than from the loudspeaker B. Also, the radiation strength of loudspeaker A in the direction P, represented by the vector AQ, is smaller than the radiation strength of loudspeaker B in the direction BP, as portrayed by the longer vector BR. Thus, the loudspeaker B has two advantages: The listener hears predominantly the sound of B and very little or no sound from the loudspeaker A. Furthermore, any sounds panned in between the two channels appear to move strongly towards B, because the Haas or "precedence" effect tends to credit the nearest loudspeaker with being the source of sound.

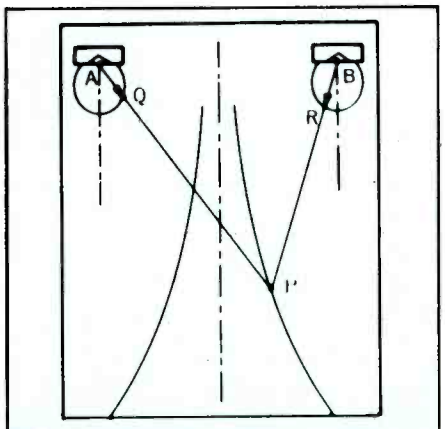

Fig. 6—Relatively narrow stereophonic listening area is obtained with directional loudspeakers placed parallel to the wall (*Courtesy AES.*)

Next, we examine the operation of the improved placement method in Fig. 7. Here the listener at point P again is at a greater distance from A than from B. However, because the loudspeakers are at an appropriate angle with respect to each other and with respect to the listener at P, the radiation vector AQ in the direction AP is greater than the radiation vector BR in the direction BP. Thus, the dis-

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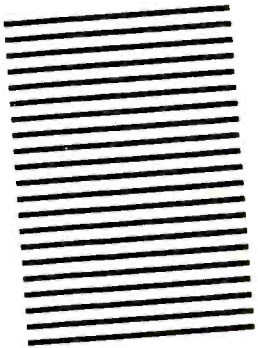

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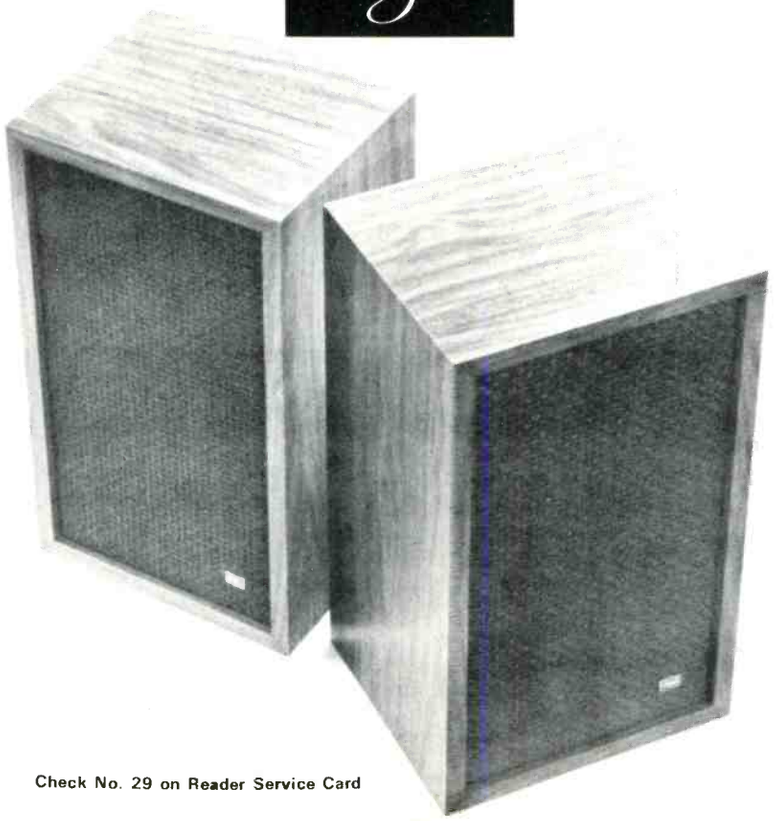

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tance effect is, in part, compensated by the directional effect. The sounds arriving from the two loudspeakers remain in balance over a considerably broader area than is possible with the arrangement in Fig. 6. Also, the added

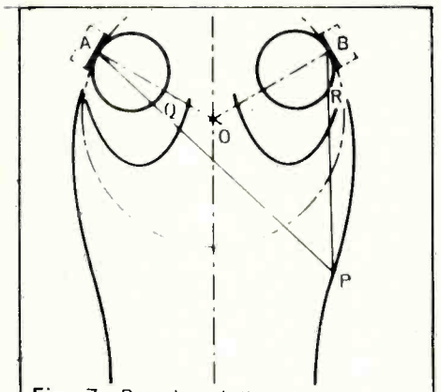

Fig. 7—Broadened listening area obtained with directional loudspeakers angled towards the center (*Courtesy AES.*)

signal strength from the farthest loudspeaker tends, in part, to compensate for the Haas effect thereby allowing a significant amount of common sounds to appear in between the loudspeakers avoiding the so-called "hole in the middle" effect.

The solid line contours in Figs. 6 and 7 represent the listening area within which the signal strengths from loudspeakers having radiation pattern as described remain within 3 dB of balance relative to each other. The advantage of the inclined orientation is evident. For an average bookshelf-type loudspeaker, the included angle between the loudspeaker axes, for proper orientation, turns out to be approximately 120-130 degrees.

Wall Reflections with Dipole Loudspeakers

We have shown, in a previous section, that omnidirectional loudspeakers under certain circumstances are significantly affected by reflections from the walls. Dipole loudspeakers, by contrast, are relatively free of this problem.

It has been seen from one of the preceding sections that directional loudspeakers normally are placed at an angle to the walls enclosing the listening area. Fig. 8(a) represents the polar pattern of a dipole loudspeaker placed, say, at 45° to a wall. It will be noted that a listener at P is subjected to its maximum output. This same listener is in a near-null orientation with respect to the virtual image caused by wall reflection. Furthermore, with the dipole loudspeaker placed in a corner, as shown in Fig. 8(b), two of three virtual images are oriented with the null planes toward the listener, thus contributing relatively little to the sound pressure at P. Thus, the response characteristic produced by a dipole loudspeaker is apt to be less affected by room acoustics than that produced by an omnidirectional unit. It should be noted, however, that the "back" radiation of the gradient loudspeaker does exist, and while it may not be significant on first reflection, it may become so for subsequent, later, reflections helping to create a desirable "ambiance" effect.

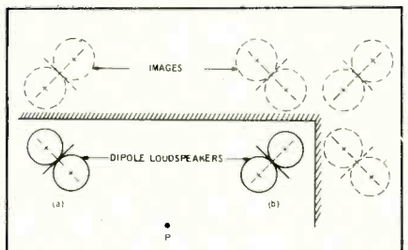

Fig. 8—Angled dipole units (a) near wall and (b) near corner.

Quadraphonic Arrays

Following the example given previously in connection with stereophonic arrays, the benefits of directional loudspeakers in quadraphonic listening will now be demonstrated. Fig. 9 portrays a quadraphonic listening area with 4 omnidirectional loudspeakers placed in the corners. For the sake of simplicity we assume for the moment that there are no walls to cause directional cancellation and reinforcement problems. Thus, the polar patterns of the loudspeakers are shown as four circles concentric with the corners of the listening area (which forms a dash-line perimeter). That portion of the listening area where the sound pressure from any of the four loudspeakers varies no more than ±3 dB is shown by the diamond-shaped outline.

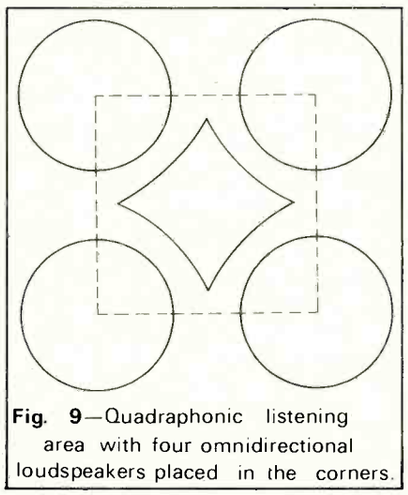

Fig. 9—Quadraphonic listening area with four omnidirectional loudspeakers placed in the corners.

In Fig. 10, dipole loudspeakers are used. The ±3 dB contour is now increased substantially, reaching all the way to the edge of the square; thus

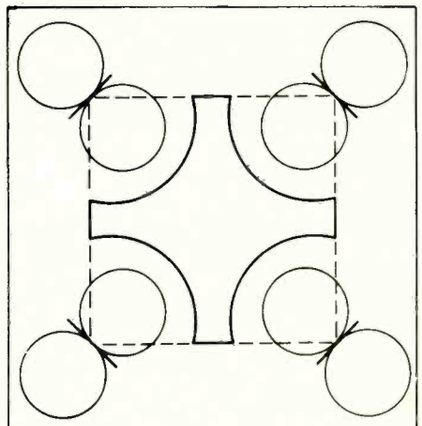

Fig. 10—Quadraphonic listening area with four dipole loudspeakers.

greatly increasing the positional freedom of the listeners. Similar, but perhaps not quite as dramatic improvement is obtained with semi-directional loudspeakers in the corners facing the center of the area. On the other hand, if these semi-directional loudspeakers were to be placed squarely against a wall (instead of being angled), their directional patterns would tend to augment the effect of the inverse distance law causing the optimum listening area further to be restricted.

The aforementioned analysis holds true even in conventional semi-reverberant listening rooms because directional localization depends principally on the sounds of first arrival.

Conclusion

Much remains to be learned about optimum design and placement of quadraphonic loudspeaker arrays. Omnidirectional loudspeakers in vogue today are a partial answer to this problem —albeit one troubled by excessive dependence upon the acoustical characteristics of the room boundaries. Also, omnidirectional loudspeakers produce a relatively limited area of quadraphonic perception. Directional loudspeakers—e.g. semi-directional or "bookshelf" types, and especially the dipole types, are apt to result in a more balanced sound field over a broader listening area, but usually require some experimentation with orientation and seating arrangements. AE

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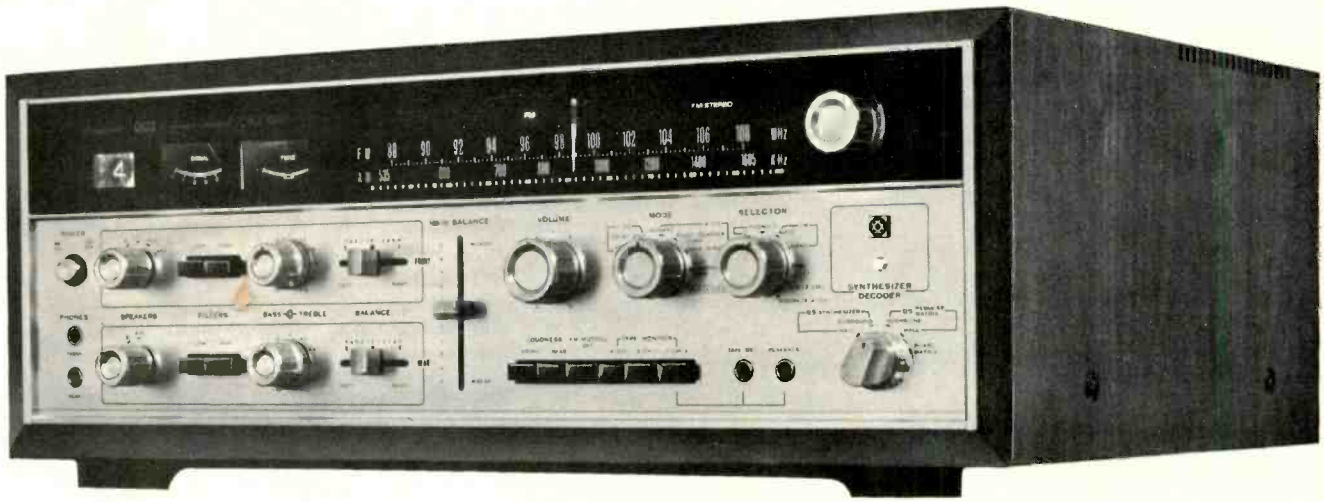

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In All Directions

*John Crabbe

A proper understanding of the mechanism of stereo perception requires extended reading, in general terms or at greater depth for those with a mathematical bent[1], but for my present purpose it can be safely stated that the accuracy with which stereo images may be localised by the listener depends on four factors:

(i) Clearly differentiated electrical information in the stereo signal, given either by Blumlein-inspired coincident microphone techniques, or by unambiguous amplitude pan-potting of discrete signals on to the soundstage.

(ii) Use of identical or near-identical loudspeakers.

(iii) An unobstructed sound path between each loudspeaker and the listener's ears.

(iv) Either an equal path length from the listener's head to both loudspeakers *or*, if the listener is placed to one side, a radiation pattern from the speakers which compensates subjectively for the resulting time differential.

We must assume that the first condition is satisfied, which is reasonable at least for the direct instrumental sounds in most modern recordings (almost invariably pan-potted), though not for the reverberation, which tends to be anomalous. Most good loudspeakers should satisfy the second point except for laboratory measurements, and the third requirement is a matter of common-sense usage.

With perfect two-channel stereo reproduction the full panoply of sound-sources is heard accurately displayed between and beyond the loudspeakers. This accuracy applies not only to the direction of individual instruments or voices, but also to their apparent widths. Now it so happens that in any system that is well balanced and has adequate electrical separation between signal paths, the performance with a central (double-mono) signal is a reliable indication of overall stereo accuracy. If a left-only signal produces a narrow sound image from the left-hand speaker, a right-only signal likewise from the RH speaker, and a double-mono signal produces a narrow image centrally placed between the speakers, then it follows automatically that a stereo signal will be reproduced accurately right across the soundstage. Unfortunately, this perfect stereo can normally only be obtained if the listener is equidistant from both speakers —that is, if he is in the 'stereo set' placed on the apex of an isosceles triangle subtended by the speakers.

Any reader who doubts this can try it for himself: it will be found that there is a precise listening line along which a double-mono signal is heard as a very narrow and clearly detached sound-source. If this elementary first-step fails there is something faulty somewhere—either in the speakers, the room or the ears! Movement to one side from this ideal position normally causes two things to happen: (i) the image shifts more or less with the listener, and (ii) it broadens and is therefore less precisely located. In any system, insofar as mono does *not* sound as if it were coming from a separate central speaker, there is some falsification of stereo signals—an element of pseudo-stereophony. A major problem in domestic sound reproduction is to minimise this effect over a reasonable listening area, thus providing good stereo for practical use in the home.

The normal approach to this stabilisation of stereo images is to employ to best advantage any directional characteristics possessed by the speakers. Essentially, the central image (and everything else with it) becomes distorted when listening away from the bisecting line because one is then nearer to one speaker than the other, which gives its signals a time-lead. Because of Haas-effect (precedence-effect), this lead in time produces a subjective boost in loudness from that channel, which shifts and broadens the apparent sound-source in that direction. Now, if movement to one side resulted in a *lower* acoustic level at the listener's ears from the speaker on that side (and/or a higher level from the other side), the image-shift due to a time differential could be cancelled by a contrary shift due to the loudness change. This is the basis of the well-known Hugh Brittain loudspeaker placing[2], pursued more fully to overcome certain anomalies by Joseph Enock.

Practical loudspeakers vary enormously in the shape and frequency-dependence of their forward radiation patterns, and since an ideal 'Enock' speaker would have one particular lobe shape and no tendency at all to extra beaming at high frequencies, it is evident that the whole business is full of compromise. However, with patience most conventional speakers can be made to perform quite satisfactorily in most rooms. Setting up may be a tedious business[3], and it may sometimes involve very curious angling as advocated from time to time by Ralph West in his speaker reviews. But my experience is that if one is prepared to sit fairly well back from the speakers and not unreasonably out to the left or right extremities, it is possible to obtain good stereo over a sensible listening area. By 'good stereo' I don't mean the pin-pointed accuracy heard from the stereo seat, but a fairly consistent and well defined sound-stage of the sort associated with a double-mono signal that never shifts more than a third of the way towards one side or broadens to an angular width of more than about five degrees.

What has all this to do with omni-directional speakers or their advertising? Taking the second point first, it is extremely relevant, for we have been shown families of seven people ridiculously huddled around one chair in the middle of a room whose only other contents are a pair of conventional speakers, an amplifier and a player. This is a gross falsification of the domestic listening situation, attempting to create a myth that until recently it has been necessary to upset one's living arrangements in this manner in order to enjoy the benefits of stereophony. Even a hi-fi dealer wrote to me in support of this extremist position, conceding that 'there is a place for the lone listener in his throne the stereo seat' who can 'choose from a mass of direct sound speakers . . . but there are many more readers with a family and friends who like to sit round the fire-side', etc. Now it is true that sitting in a semi-circle around a fire does create difficulties for desiderata (iii) and (iv) listed earlier, but I suggest that this is only one special case among endless domestic possibilities, and that it is unfair to adopt such an extreme 'either—or' attitude about those who listen to music in their homes.

---

1. *Stereophony* by N. V. Franssen. (Philips Technical Library).
2. *Two-channel Stereophonic Sound Systems* by F. H. Brittain and D. M. Leakey. 'Wireless World', May/July 1956.
3. *Installation: Loudspeakers*—pp. 223-229. 'Hi-Fi in the Home' by John Crabbe (Blandford Press).
4. *Two Channel Quadraphony* by David Hafler. 'Hi-Fi News', August 1970.
   (See also 'A New Quadraphonic System' David Hafler, 'Audio' July 1970.)

*Editor, *British Hi Fi News*,

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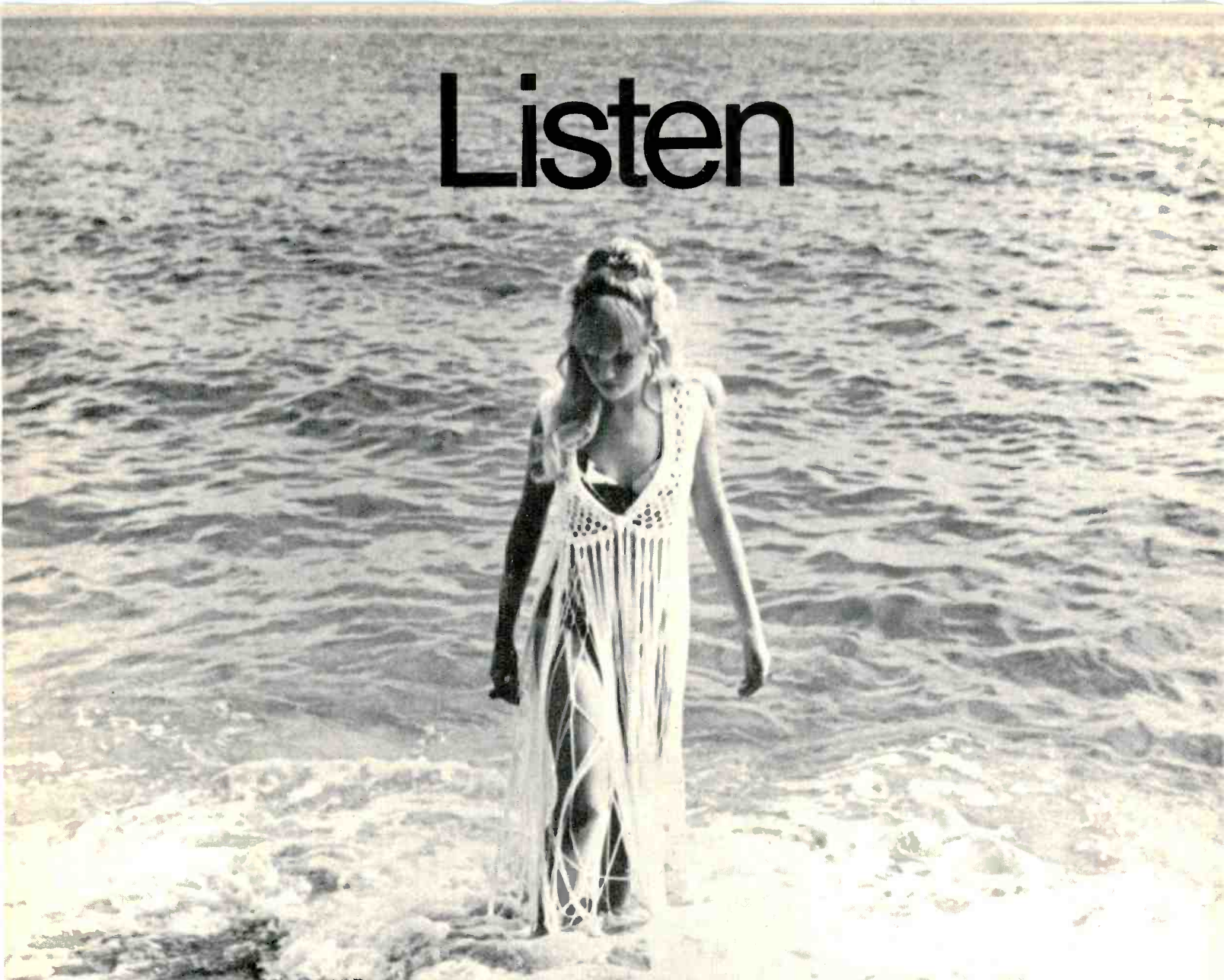

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In any case, stereo is really a fairly subtle business and can only be appreciated fully by those who *listen* to music—it is hardly necessary for background while sitting around the fire!

The other important point about the adverts is their claim that omnis surround the listener with stereo sound wherever he or she is in the room, obviating the supposed need for 'stereo seat' listening and implying that the type of stereo obtained on the bisecting line with conventional speakers is achieved everywhere with omnis. This is where my earlier remarks about stereo perception come into the argument, for it can be shown both theoretically and practically that omni-directional loudspeakers distort the stereo sound picture more or less severely.

Firstly, they cannot by definition offer a sound intensity pattern that compensates for precedence-effect because they radiate equally in all directions; thus even in an anechoic room there would be considerable shifting and broadening of a centre-stage image as heard by an off-centre listener. Secondly, in a normal room there is relatively little direct sound from omnis of the Sonab type (without *any* forward radiating unit) so that the ears are presented with a very complex series of confusing reflected wavefronts which upset the localising faculty. This means that even in the stereo seat a nominally central sound-source seems vague and broad in most rooms, the only really precise directional information (if the room permits any at all) arising from extreme left or right sounds. In my own sitting room, which is acoustically rather 'dead' compared with most and therefore relatively disinclined to scatter the stereo sound-picture, a pair of Sonab OA-5s was quite incapable of producing anything remotely approaching a narrow sound-source from a double-mono signal. On a stereo recording of a harpsichord concerto on which a seemingly small solo instrument is contrasted nicely with a broad orchestral backcloth, the harpsichord stubbornly occupied the full space between the speakers as heard from any point in the normal listening area.

This is not good stereo—it is hardly stereo at all—and I must beg to differ most strongly with critics who state that omnis 'do provide a good stereo image virtually anywhere in the room'. They do not and they cannot. Neither can they provide a satisfactory and reasonably consistent frequency response from sample to sample, depending as they do entirely on the environment in which they are used; this is contrary to all good loudspeaker design criteria. Despite all this there are bound to be a few freak rooms in which it is impossible to obtain a satisfactory listening area with conventional speakers but which reflect the sound from omnis in a manner that happens to provide some compensation for Haas-effect in a pseudo-Brittain fashion. Any readers with such rooms (one was amongst my correspondents) may ignore the bulk of this article—but my general thesis stands.

Some people not in this special category may nevertheless *like* the sounds produced and many will welcome the fairly constant type of sound pattern throughout the listening room that was mentioned and praised by Donald Aldous in his review of the Sonab in November. Some have referred to this review as if it vindicated their viewpoint, apparently failing to notice that Donald did not claim that the relatively stable sound-field represented good stereophony. Indeed, he scattered a fair number of serious doubts, stating that 'there is loss of definition and precise images', that it is 'true that stereo is often anomalous . . . and this may prove disconcerting, especially to the more experienced listener', and that 'it is essential that the reader should be aware that the contention concerning directionality, at least, is fallacious when related to sound *reproduction*'. It is a case of distortion that remains equally distorted from all points of view!

I think that covers the objective side of the matter and explains why we commented so adversely on the Sonab advertising—though I see that more recently we have been asked to believe that these loudspeakers have some curious extra property enabling them to reproduce the quarter tone scale of Indian music that is 'too much for most systems'. It's certainly too much for me—I give up!

On the musical and subjective side there is much more room for argument and maneuvre. Once the supporters of omni-directional speakers have admitted that they generally lose a lot of directional information and suffer from rather extreme distortions of lateral perspective, then I will admit that they may indeed actually prefer this sort of sound and that they have every right to. But it must be understood that in terms of sound *reproduction,* of producing an accurate acoustic equivalent of the signals passing through the stereo amplifier, omni-directional loudspeakers represent a firm step backwards. Musically, this may not seem to be the case but if so this can only be due to other limitations of two-channel stereo which are receiving partial compensation via the loudspeakers. This indeed is part of the Sonab philosophy, emanating from Stig Carlsson, the argument being that in real life most of the sound energy arriving at our ears in the concert hall comes via reflections. This was outlined in the November review and is a point that has been made on many occasions when discussing the philosophy of stereo reproduction. It is basic also to the Bose loudspeaker, though this is in a rather different category to the Sonab, without the latter's flimsy construction and rather obvious colorations, and with at least one forward-facing drive unit. However, developments in quadraphony or pseudo-quadraphony promise a more satisfactory type of solution, taking us much closer to a live concert-hall atmosphere than the rather unreliable use of multiple short room reflections via omni speakers.

I am sure that it is this missing sense of all-round atmosphere that leads people to look beyond conventional stereo, with its sound-stage at one end of the room and no reverberation from around or behind the listener. But things are now on the move, and even limited experiments with 'difference' signals[3,4] can be a revelation in added spaciousness compared with the effects achieved by omni speakers. And there is no penalty to pay in the accuracy of spatial reproduction on the forward sound-stage.

Several of my correspondents were slightly offended by the phrase 'undifferentiated wodge of sound' used to describe the omni type stereo picture. The dealer whom I mentioned earlier pointed out that in his view this is just what many people want and that it gives a great deal of musical pleasure. Well, that may be so for some stereo beginners, especially if their taste is for big, lush orchestral music—Strauss tone-poems for instance—just as upward-facing column speakers were all the rage for a while when stereo recordings were first introduced. We have been through all this great debate before; but gradually, as people listened more carefully and became more critical, they came to realise that what they thought was stereo was really little more than mono thrown around somewhat by two speakers—in fact an undifferentiated wodge.

One reader claimed in a letter that omni speakers are 'as great an improvement over ordinary stereo speakers as stereo itself is over mono'. Well now, if this is so it would follow that to switch a pair of omnis from mono to stereo would be at least as revealing or dramatic as a similar switch using conventional speakers. But it is generally a good deal *less* revealing, for the simple reason that omnis dilute the stereo image and inflate a mono signal to the point where they are rather similar.

Finally, a few words in favour of the

"Most impressive range and power...

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CONSUMER COMMENTS: **R. A., Portsmouth, N. H.,** *The rich true sound of stereo* • **W. S., Canoga Park, Calif.,** *The style for my wife . . . the sound for me* • **J. A., Hyattsville, Md.,** *Superior sound over anything near it in price* • **D. O., Vallejo, Calif.,** *That's good sound* • **T. F., St. Louis, Mo.,** *Fantastic sound and the fine quality in the design* • **R. G., New York, N. Y.,** *I love it; you made it!* • **D. D., Honeybrook, P. A.,** *Fantastically good fidelity* • **J. F., Vancouver, B. C.,** *This speaker is truly a work of art!*

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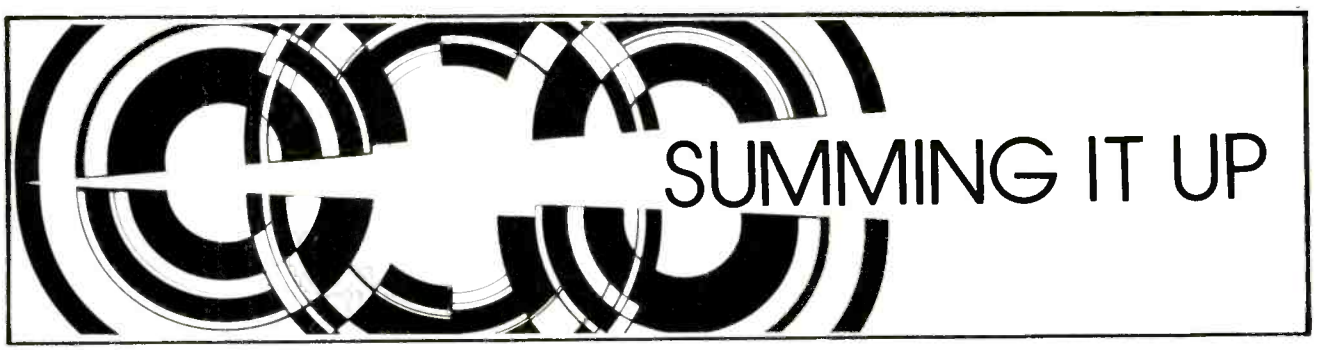
musical subtleties of conventional stereo, subtleties not demanding bisecting-line listening accuracy, but simply ordinary loudspeakers and ordinary seating sensibly arranged in an ordinary room.

This was exactly what happened when I played the aforementioned harpsichord concerto recording: on conventional speakers in mono the whole orchestra and solo instrument appeared to occupy a fairly narrow band in the centre of the speaker wall, while in stereo the orchestra spread out correctly and grandly in its various sections with the harpsichord remaining of slender proportions at front-centre; on omni speakers in mono both harpsichord and orchestra appeared to occupy the whole wall, and in stereo the only change was a suspicion of upper strings more prominent on the left. The moral of this story is that if you want a stereo recording to make an impression on omni speakers you must exaggerate the left/right instrumental separation and minimise centrally placed sources for all you are worth—a thoroughly unmusical and reprehensible business, yet my same correspondent goes on to say that he 'looks forward to the record industry catching up with the equipment manufacturers by producing records suitable for reproduction on these omni-directional speakers'. God forbid! listen to the sound first from the stereo seat and then from a point far enough to one side to shift and stretch the sound image unreasonably. My ears register a change of tonal quality which seems to be independent of HF beaming effects. Tone-colours are part of music, so this sort of thing must affect musical pleasure at some level.

Much music demands, and some conductors use, spatially separated 1st and 2nd violins. Done discreetly, as on many recordings, the two string groups are placed to left and right of stage-centre, but not pulled apart ridiculously. A lot of delightful antiphonal effects are there for the hearing, but they are certainly less easily distinguished in a 'wodge' of sound. Solo instruments set against an orchestral backcloth sound quite unnatural if stretched out in the manner of the harpsichord already mentioned; in violin concertos, particularly, some of the musical drama is dissipated if the instrument's physical smallness is lost. This applies also to voices, especially in opera where both subtlety of movement or placing, and moments of high drama, may be lost or even contradicted in the proverbial sonic wodge.

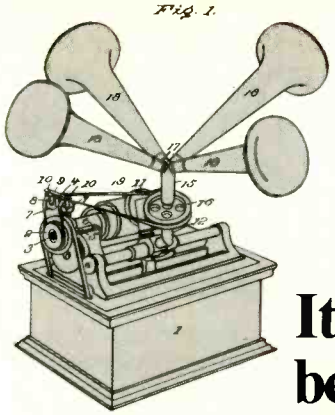
Complex many-stranded counterpoint is sometimes difficult to follow without the aid of a score, especially when the music is for multiple divided strings and therefore unsignposted by a variety of instrumental timbres. Such music benefits from good stereo because of the audible but often subtle separation in space. Finally, chamber music, and particularly the string quartet, which can sound so very convincing when well reproduced but quite vague and silly when distorted by omni loudspeakers. Anyone with experience of listening to a real quartet at fairly close quarters soon realises the absurdity of the freakish quasi-stereo offered even by a moderately differentiated 'wodge'.

This all means that sooner or later people will get fed up with omni-directional loudspeakers—just as most people eventually abandoned their column speaker about ten years ago. (There is a possible analogy here with headphone listening, the present popularity of which—due to its consistently accurate stereo—could be a reaction against the vague stereo heard even from improperly used conventional loudspeakers.) Singers' mouths or solo violins several feet wide which cannot be placed at all certainly in an particular direction are tiring and irritating to live with. They will come home to roost. This I know from personal experience, having been a keen advocate of reflected sound not many years ago! Æ



Summing up: there is no doubt that omni-directional speakers or systems that specifically use walls for reflection do give a more spacious kind of sound. Under the right circumstances, one is less aware that one is listening to two loudspeakers. It is also true that this effect is achieved at the cost of definition. On the other hand, very directional loudspeakers give a sharp stereo image but the listening area is restricted. In the early days of stereo (two channel) I maintained that the optimum dispersion angle was 120 degrees but in these days of 16-channel mixers and multi-mic techniques I cannot be so dogmatic. Stereo itself is an illusion and the program material goes through many processes of mixing, dubbing, equalising and so on. Some producers exaggerate separation, some transport the listeners to the conductor's podium and others try and give him the impression of being in the middle of the 10th row back. Then again, most of today's music is recorded in the studios—not the concert hall at all! Finally, there is the question of room acoustics. The room must be considered acoustically as an extension of the loudspeakers and what sounds superb in one room can be incredibly bad in another.

Perhaps the best answer to some if not all of these problems lies with the intelligent use of the quadraphonic medium. This can give us a better sound image without relying on random room reflections or being so affected by room acoustics—especially standing waves. Moreover, as Jim Long stated in his recent article on microphones, "Four mic/four channel recording reduces the need for accent microphones. The ability of four-channel stereo to sort out a single event amidst complex aural confusion—if the recording is properly handled—can be downright uncanny!" The big question will be: What kind of loudspeaker radiation pattern will give best results with quadraphonic sound? My own tests indicate a dispersion of 90 degrees but I am reserving judgment for the moment. *G.W.T.*



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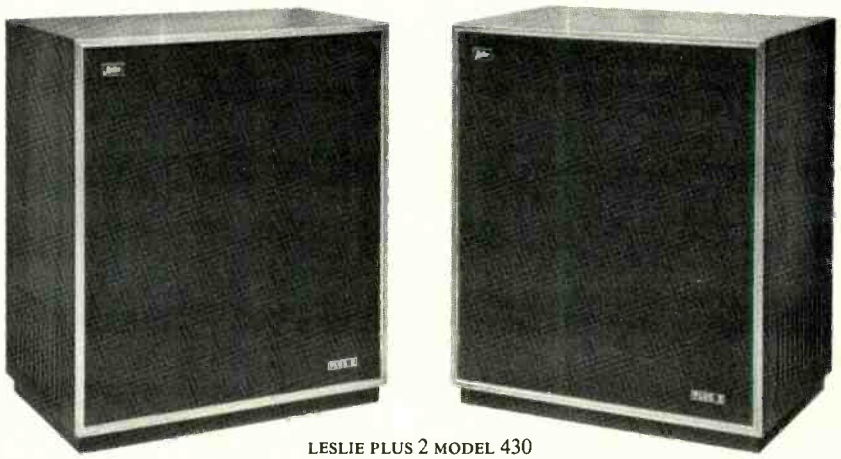

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Binaural sound for headphones is on the air! You have read about it in Billy G. Brant's article in our November issue (p. 34) and, earlier, in my own "Midwest Safari" last July (p. 56). In large areas of the country you may now crank up your FM tuner, plug in your phones and hear broadcast sound specifically intended for headphones—*not* stereo. Binaural. But before we go much further there is a whale of a pile of confusion to sort out as to what binaural is and isn't. Moreover, we have a problem of *compatibility*, if we are to broadcast binaural software.

Compatibility? Not in the equipment. In the software requirements, for loudspeakers and for phones. They are very different. True binaural sound, designed for headphone listening, is a law unto itself. You can take down and reproduce sonic situations in binaural that are utterly impractical in the loudspeaker mode. In fact the astonishing power of good binaural is right there—its extra impact in "impossible" situations where normal recording and broadcast techniques flounder. There's no end to the recording discoveries you can make when you set up your own pair of mics and listen back via phones to what you get.

But on the air, this creates its own increasing problem. Because for every FM multiplex listener with phones on his head you will find another, or maybe a half dozen, sitting in front of loudspeakers waiting for something to happen. They aren't aware of the difference. Or they have no phones—yet.

So every binaural broadcast, now and for a long time to come, must be profitably listenable both on phones *and* on loudspeakers. That is a contradiction that seems to deny binaural its very best virtues. Oh, so you thought we already had headphone listening, with all those stereo broadcasts and tapes and discs we've been hearing on phones? They call them stereophones, don't they? Ah yes. Confusion upon confusion. Not that stereo via phones isn't an attractive proposition to many listeners. Why else would they be buying phones? Even so, stereo heard in this fashion is only accidentally and in part binaural. (Some of the earliest stereo recordings, done with two mics only, make very good binaural.) The sound of stereo, in all its present complexity, has been specifically developed for loudspeakers. The whole principle is different. You listen in a different way, and it is not merely the physical difference between phones on the head and speakers in the living room.

Via loudspeakers, *both* your ears hear *both* channels, as reproduced out there in front by the speakers. The resulting dual-point "fix" in space, to your left and right, sets up the well known stereo phenomenon whereby you seem to hear a smooth spread of sound extending between the speakers and even out beyond to each side (and to the rear in quadraphonic stereo). It's a marvelously useful illusion and a highly satisfactory way of listening.

But binaural is a different alternative. Inside those phones, each of your ears receives one channel, *exclusively*, and not a trace of the other. No fixed sources out in front. You are in on the scene itself, hearing directly through surrogate ears, the microphones. If these mics were set up *like* ears (more or less—we are flexible in perception), a pair of mics ear-close, with maybe a surrogate head in between them, then *you are there*. With certain important and interesting reservations, you can hear precisely what your ears would hear on the spot. Any spot. Anywhere. In the most unlikely places. Once you have experienced true binaural reproduction, you will not ever forget it.

Yes, normal stereo does give a partially binaural effect through phones, which is enough to account for much of its appeal, over and above considerations of privacy and "surrounded sound". But the whole elaborate stereo recording technique is designed for maximum effectiveness in the loudspeaker mode of listening. Via phones, one channel exclusively to each ear, the effects are both exaggerated and subtly false—out of focus, out of register, confusing. Like looking through wavy glass. You can't pull it all together, it won't quite fuse. The middle is vague and lacking, the sides pull outward, your music threatens to split in two. Individual sounds in the stereo mixdown appear too close, losing contact with the whole. Some sounds, in one channel alone (for one speaker), are heard in one ear and not in the other, and thus are rendered spaceless, drifting unattached inside the head. Like a fly speck on your spectacles. Very annoying.

The more you listen to stereo via phones, the more you will notice these inconsistencies though, admittedly, many of us are not going to let ourselves be unduly bothered by them. Headphones are fun. Nevertheless—they are there, and for good reason.

It follows that if you are out for binaural sound via broadcast, a stereo mic pickup is out of the question. Why bother to call it binaural, if it isn't? Binaural mic pickup uses a single pair of mic "ears" (though more complex techniques are possible). With them, you capture whatever sounds interesting to *your* ears, anywhere. No special close-up mic technique. No worry about interference noises, excess reverb, overly great distance. Binaural doesn't mind, if you don't. *Anything* whatsoever that is interesting to hear in the flesh, can be taken down for binaural reproduction. You will not understand how utterly different this microphone technique is until you have tried it out, until you have pushed it to extremes—say recording a conversation in a noisy and crowded cafeteria, or taking down a lecture at a distance of 100 feet or so—just to see how far you can go.

But the further you go, the less possible it is to broadcast your results, where loudspeakers may do some of the reproducing. That is the incompatibility.

Fortunately—if you have begun to digest these somewhat alarming thoughts—there *are* areas of overlap, where binaural for phones and standard sound for loudspeakers can both be served satisfactorily. It is my intention to analyze these very tricky areas for our mutual gratification. I've done a lot of experimenting and a lot of interested worrying on this score. I've been in binaural myself, off and on, for over twenty years and I am of course delighted that this essentially personal, private, individual way of listening should find a method of simultaneous distribution to a mass audience. That, after all, is basically what broadcasting is all about, even in its normal mode.

My own visit to NCAE (National Center for Audio Experimentation) in Madison brought me squarely up against these questions. NCAE is in business,

already producing a line of finished binaural software directly intended for radio. My first thought was—*do they know?* Are they even aware of the difficulties of compatible binaural? Had they tackled the problem and found a solution? Or was this just a public-relations gadget? An old cynic, me! Plenty of people have barged into binaural feet first, all thumbs and no head.

I'm glad to be affirmative. The answer is yes—NCAE knows what it is doing, even if their people don't talk about compatibility. Why should they? They have a product. If they've found a workable procedure to their own satisfaction (they have), allowing for reasonably good loudspeaker playback and yet providing plenty of genuine binaural punch, then why lecture? Get the product out. (The lecturing seems to be my job, and I'm always willin'.) But do not think it is a cinch, this compatible sort of technique for a useful broadcast binaural. They are other approaches quite different from NCAE's. Yours may work just as well. But if you don't know your binaural fundamentals, you won't get far. Or, as I say, you will barge in feet first, and Heaven help you! What, then, are the favorable areas for an overlapping technique, taking in both phones and speakers, within which you must work to develop your own compatible binaural? Here are guidelines.

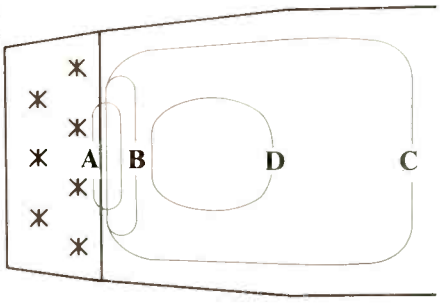

Fig 1—Favorable mic distances

A Favorable mono mic area

B Favorable stereo mic area

C Favorable binaural mic area

D Optimum binaural mic area

1. FAVORABLE MIC DISTANCES FROM SOUND SOURCE. My Fig. 1 shows an idealized conventional indoor

source, on a stage. You may extrapolate to your own situation. A and B, sausage-like areas, represent areas of conventional mic placement (simplified) for mono and stereo, the stereo a bit further out. C, encompassing virtually the entire space and overrunning A and B, is the favorable binaural mic area for headphone reproduction. D is the optimum binaural, out beyond the loudspeaker mic placement and, perhaps, in one of the "best seats in the hall".

What this says is, first, that true binaural reproduction will be acceptable from virtually anywhere in the hall (or other area) where the sound itself is acceptable to living ears. You get what you hear. And, second, that the optimum "best seat" is where it ought to be, well out from the normal loudspeaker mic location. Third: a *compatible* pickup may thus be made from a position at the extreme outer fringe of the loudspeaker-favorable area or a trace beyond. The binaural sound will then be OK. By manipulation of other factors (below), it can even be quite dramatic—and compatible, too.

II. DIRECTIONAL AREAS OF PRIMARY LISTENING INTEREST. Another and different factor. Here there is an astonishing disparity between the loudspeaker areas of favorable directionality and those for headphone binaural. Yet you still may have your cake and eat it.

In Fig. 2, A (mono) and B (stereo)

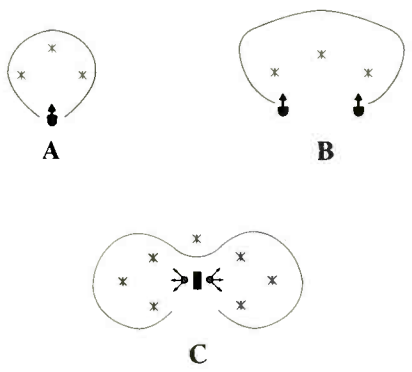

Fig 2—Areas of primary listening interest
A Primary mono interest—frontal
B Primary stereo interest—frontal
C Primary binaural interest—to the sides

indicate the idealized normal frontal directionality of interest for loudspeaker sound, and the means for microphoning it, again simplified. Via speakers, program material is *always* frontal in playback. (Most quadraphonic sound is, too, though by no means all.) And this even though you may actually set up your mics in all sorts of directions, before specially-placed sound sources. Whatever you do, the playback always comes out frontal.

C in Fig. 2 indicated, in contrast, the very peculiar areas of primary interest in headphone listening. They are not to the front, but *to the sides*. Indeed, front (and rear) directionality, while perfectly clear in the sound, tends to be perceived curiously as overhead, or indefinitely nowhere in particular. Anywhere *but* out in front. It is extremely difficult to place a binaural sound squarely in front. On the other hand, it is easy—and effective—to place it on either side.

This immutable fact of binaural reproduction is still not too well understood though it has been the subject of massive research. The effect is not appreciably altered by a between-mics "head", like NCAE's "Herman", nor for that matter, by "Oscar", a painstakingly realistic German research model head with tiny mics buried inside ear canals. You still hear best to the sides; you are vague as to frontal placement. Even with no "head" at all, just the two mics, your perception is not appreciably different in this respect. To my knowledge, no practical way has yet been devised to bring accurate front placement of sound to headphones. It doesn't really matter, for us at least. You will not notice the lack, if the material is well presented. You *will* notice the dramatic realism of any sound off to one side of you. So—we program for the sides, as well as we can.

Directional compatibility, for phones and loudspeakers, is thus a matter of providing multiple directionalities. Not difficult, once you get the idea. First, your main information must be up front but may be spread out between the normal stereo angles, approximately 45 degrees, though with emphasis on the angled sources, to please stereo listeners. (A correct mic *distance* is here taken for granted, as per I. above.) Second, other sounds, preferably incidental and small, are added to *extreme* right and left, beyond 45 degrees. (But never in one channel only!) They should be light enough not to impede loudspeaker listening, which requires low incidental noise, but definite enough to register, dramatically, at the sides of the headphone listening space.

These sounds serve to frame, or set off, the main up-front material, which will be vague in direction in the phones. You have a wide choice—deliberate faint coughts, throat-clearings, rustling of paper, shifting feet, squeaks, scrapes, clinking of ice in glasses, even breathing sounds. Startling, via

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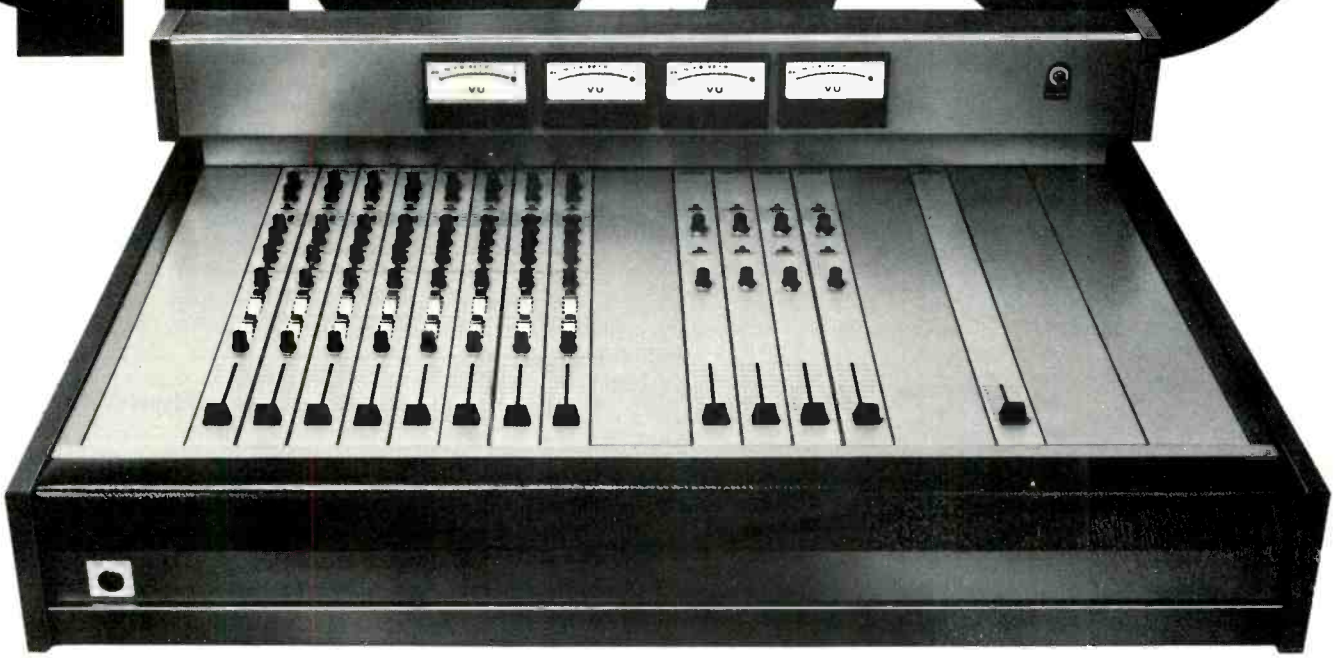

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binaural! Yet, if low in volume, they are not an impediment to communication in the loudspeaker mode. You must use your judgement, experiment. It depends on the needs of the moment. Just remember (a) to keep your incidental sound effects highly directional, to the sides, (b) adequately low in level, and (c) preferably close at hand. Tiny noises close to one side are absolutely startling in binaural playback.

Directionalities of this sort are normally set up in real time and space, an "instantaneous" recording or broadcast. They may, again, be alternatively mixed down via pan pot techniques and the like. NCAE's prerecorded "sound beds" should be very useful for such situations—but they must be used with extreme care, as NCAE will tell you. Binaural does not like blends. They don't blend, unless very carefully matched.

Note that a wide sound-spread of directional sources is obviously best served by omni mics. For binaural, I use nothing else. They pick up the side information that I want. You may need to use cardioids, to reduce excess ambience (for loudspeakers) or to increase channel separation. Don't expect them to get side information. You may have to mic the sides separately. But note again that multi-mic, multi-layer techniques are very chancy in binaural, as of present knowhow. You will be wise to stick to two mics, omni, until you have found out better tricks by experience.

III. OPTIMUM MIC SEPARATION. Here is an interesting third factor, optional in use, which can be immensely helpful for compatible recording/broadcast of indoor staged events such as concerts. It cannot be used, of course, if your two mics are fixed in their separation by some kind of permanent mount, as in NCAE's "Herman" with the oblong head between. You will have to eliminate the head—no great loss, aesthetically speaking, especially for music with ambience. (The head serves in part to cut down ambience.) Your ears will be satisfied merely by the fact of two channels and a binaural separation.

How far apart? How close? The minimum mic separation for binaural effect is astonishingly small. Mics set only an inch or two apart still produce a decided binaural effect in phones. More practically, you may stretch the separation beyond ear-distance. I have found that in an average indoor hall a distance of three or four feet between mics still produces binaural fusion. Beyond that, the channels separate, you begin to "hear double" and listening becomes tiring. A real stereo spread—twenty feet or more—is thus out of the question.

But at around four feet, you will find, you may have a very acceptable loudspeaker stereo (assuming good mic distance again) and binaural too. While at ear distance, around eight inches of separation, your stereo on loudspeakers is nil, and might as well be mono. So—try "enhanced binaural" as I call it. The binaural effect is of course exaggerated. You are listening, so to speak, with a very swelled head. But we should all know that exaggeration is the spice of drama! Your "enhanced" binaural will be hi-powered and you will keep your loudspeaker listeners happy, too.

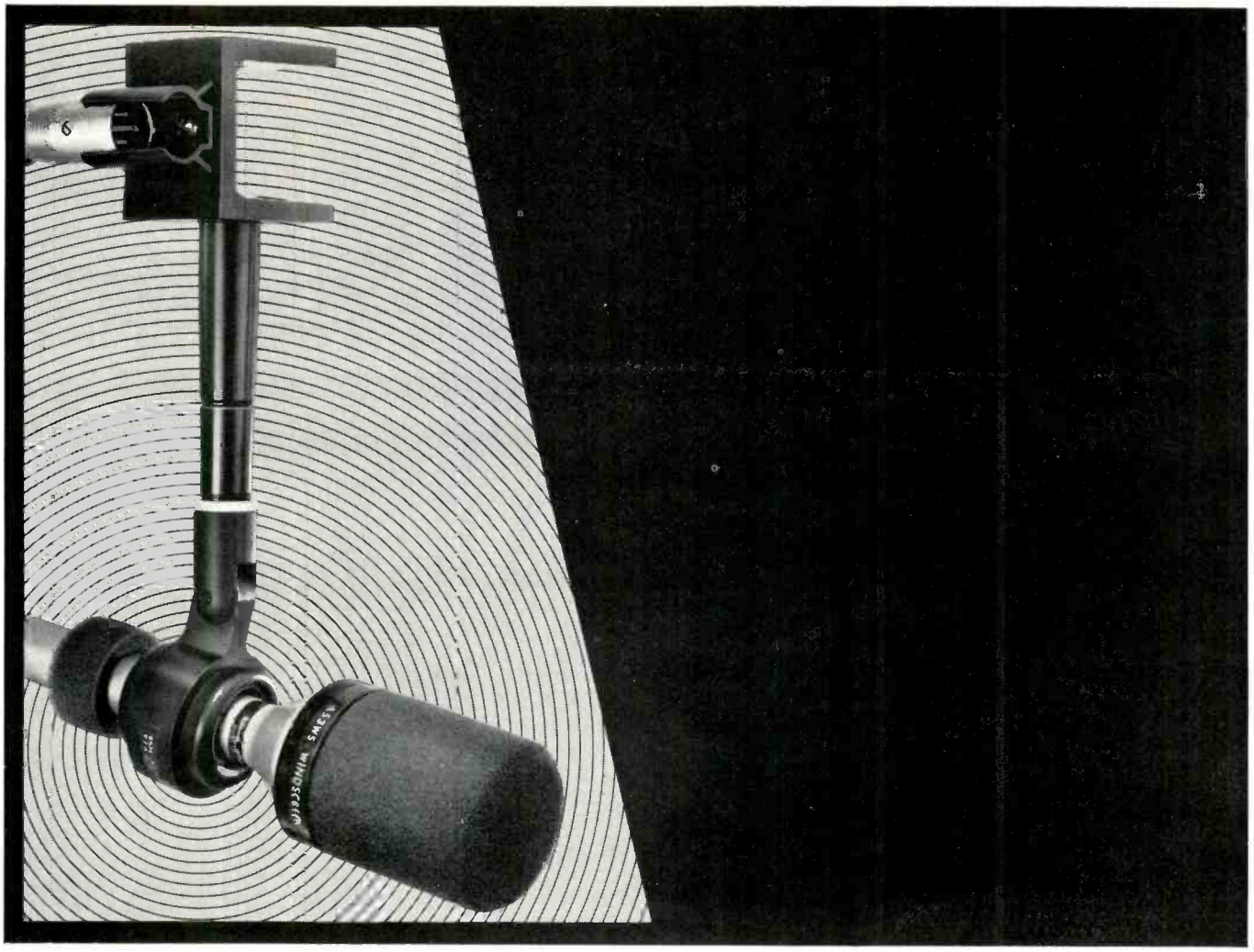
With *much* circumspection, you may try accent or solo mics, to help the loudspeakers where soloists are too distant. (They are OK anywhere in binaural.) Close mics are a familiar device in loudspeaker-intended sound. But you are likely to get violently unnatural effects in your phones. Your solo singer may suddenly be dangling directly over your head at about three feet distance, bellowing at you as though suspended from wires. That's the sort of thing that happens when you miscalculate your binaural. (Well, if you *like* it that way, it's all right with me. Just be forewarned . . .)

* * *

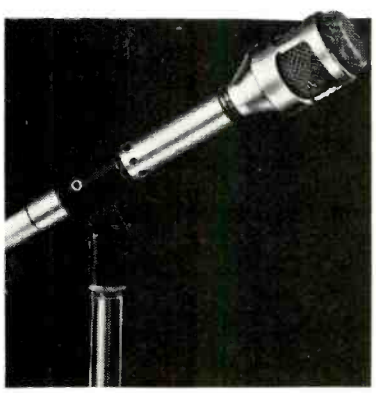
There you have three discrete variables to play with, Mic distance, Source Directionality, Mic Separation. Each can be manipulated for good compatibility. But the pay off is in their simultaneous use. If all three are optimum, you can have strikingly effective headphone sound and good loudspeaker sound too, with no seeming compromise whatsoever. Most good art, remember, is a matter of canny accomodation—using what you have to maximum effect.

I once made a tape of a choral rehearsal which I throw at you (in words) as a helpful example. There were some hundred singers, sopranos, altos, tenors, basses, seated in a large half circle around the conductor, a piano off behind. The music was Bach's B Minor Mass, and the conductor stopped often to exhort and explain. He has *persona*, as they say. I wanted him, too, as well as Bach. So I set myself up (that is, my mics) directly to his left, only a few feet from his podium. Here is how I met the conditions I've mentioned for optimum compatibility, though in fact this wasn't my intention at the time. Just experiment.

(Continued on page 55)



Boom Boon.



We've taken our most versatile, best-performing unidirectional studio microphone, the *Shure SM53,* and made it even more versatile by developing a complete boom accessory system that equips the SM53 for every conceivable boom and "fish-pole" application! Shure design engineers started with a major breakthrough in design: a small, lightweight, extremely effective isolation mount. They developed a super-flexible isolation cable, a pair of highly-efficient front-and-rear windscreens, and a 20" boom extension pipe. Finally, they developed a complete boom assembly that combines unusually small size with superb control and noise isolation. Result: an accessory lineup that makes every Shure SM53 studio microphone a complete microphone system! Write:

Shure Brothers Inc.,
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SHURE

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THE LANGUAGE OF HIGH FIDELITY
Part IX Record Players

Martin Clifford

Thomas Alva Edison has been credited with many inventions, but he gathers no plaudits for being one of the progenitors of a portion of today's hi-fi systems. And yet, almost 100 years ago (1877 to be exact) he had the idea that sound waves could be represented by the displacement of a stylus. This concept isn't at all outrageous if you consider that sound waves comprise rarefactions and compressions of air molecules. The amount of sound (its volume or intensity) is the deciding factor in determining the total movement of the stylus. Edison used tinfoil wrapped around a cylinder as his recording medium (Fig. 1). The number of indentations in the foil, and their depth, produced by a cutting stylus riding progressively on top of it, was determined by two factors—pitch and sound intensity. A reverse process was followed to recover the sound. A stylus riding in the grooves produced by the cutting stylus would wiggle in a somewhat reasonable approximation of the shimmies of the original recording cutter. We can't afford to be patronizing about it, for despite the fact that it preceded radio and television by many decades, it is still the same system we use today—with some changes, of course. A little humble pie is good for the hi fi soul.

Edison's recording cylinder concept digressed into office machine recording equipment, while spirally grooved flat discs or records were used for home entertainment purposes. However, those early phones were purely mechanical, operated by spring-wound motors, with everything in a happy state of resonance. The stylus, referred to as a needle and made of steel, reproduced the music and so did the device that held the stylus. There were no amplifiers for the entire mechanical assembly supplied music. Some of the sound was also conducted to a box or chamber faced by a pair of wooden doors mounted on hinges with the amount of door opening constituting the volume control. Life was simpler in those days provided you understand that simplicity is not a synonym for better. The sole criterion in making a phonograph purchase was loudness.

The basic difference between those yesteryear reproducers and today's is that the mechanical movement of the stylus is converted, not directly into sound, but rather into an electrically equivalent signal. The signal is then amplified by a voltage amplifier or pre-amp followed by a power amp and into a speaker system. Modern units, then, are transducers, changing the mechanical energy of the moving stylus into electrical energy.

The Record

On a stereo disc the sound information is contained in the two walls of the microscopic grooves. One of these, the inner wall or the wall closer to the center hole of the record, carries information for the left stereo channel. The other or outer wall is used for the right channel, with the two walls forming an angle of 90° (Fig. 2).

The Record Playing System

A record playing system consists of a turntable, a motor to rotate it, a stylus, a cartridge and a tonearm for holding the cartridge. These are the basic elements and that is what you get when you buy a record player. But, as in the case of automobiles, there are all sorts of options: speed changing components, mechanisms for raising and lowering the tone arm, and supplementary devices working as aids in tracking and stylus pressure.

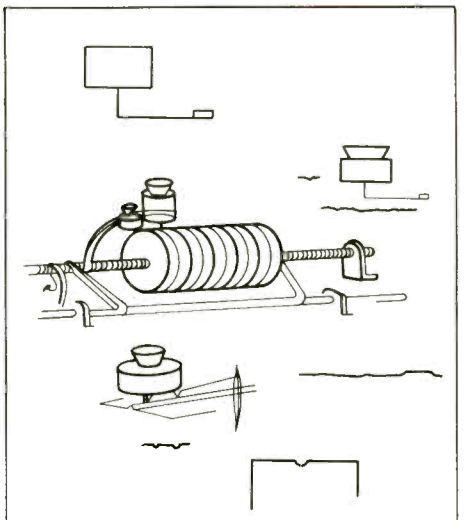


Fig. 1. First sketch by Thomas A. Edison of the phonograph.

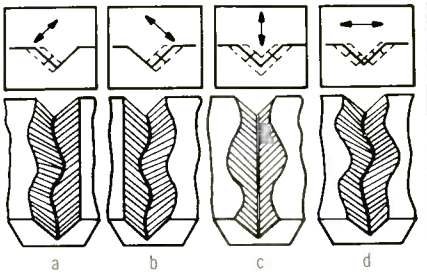
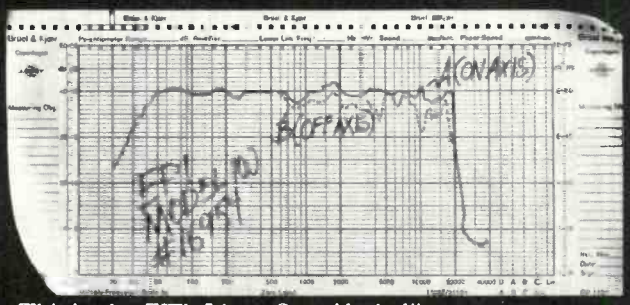


Fig. 2. Stereo grooves and stylus movement.

Motor and Drive System

The job of the motor sounds simple and that alone should make us suspicious. Simply rotate the turntable platter at a constant speed, usually 33-1/3 and 45 rpm, preferably not simultaneously. But the motor/platter combination isn't electronic; it's electromechanical, and so, like any other moving mechanical system, there is always the possibility of wobble, inaccurate speed, drifting speed, and slow starting. A motor, operated by AC, is comparable to turning a large wheel by hitting it along the side at regular intervals, and so running a motor on AC is equivalent to using a pulsating torque process. This sort of torque can cause the turntable speed to change rapidly. The unhappy result is a form of frequency modulation of the reproduced sound known as flutter.

EPI'S LINEAR SOUND. YOU HAVE TO SEE IT TO BELIEVE IT.



This is what EPI's Linear Sound looks like.

Everybody talks about linear sound.

But only EPI has EPI's Linear Sound. And there's a difference.

CURVE "A"

See the curve marked "A" on our linear response graph? We recorded curve "A" in the usual manner, placing our microphone (a B&K Model 4133) directly in front of our EPI speaker.

That's a remarkable thing, that curve "A". From way down on the bass end all the way up to the high treble end, it's practically a straight line.

What you see is what you hear: a pure, uncolored, natural sound from top to bottom. With no artificial boosting of the bass to impress the innocent. And all the nuances and overtones at the treble end that, on ordinary speakers, just fade away.

CURVE "B"

Now look at curve "B", and you'll see something even more remarkable: another virtually straight line.

What's remarkable about this is that curve "B" was recorded by placing our mike at a point 60 degrees off axis. So EPI's speakers disperse Linear Sound not just straight ahead, but in all directions, and at all frequencies.

In fact, up to 15KHz, the off-axis dispersion is down only an average of 3db. This is the result of EPI's unique one-inch linear air spring tweeter.

What does that mean?

It means that when you're listening to music, you can sit anywhere in the room, and you'll be hearing that big, full, natural sound you've just seen on our graph.

EPI's Linear Sound. It comes out of eight great speakers, from $55 to $1000, made only by Epicure Products Inc., Newburyport, Mass. 01950.

LINEAR SOUND IS FROM EPI.

This is what EPI's Linear Sound dispersion looks like.

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Manufacturers specify flutter in terms of percentage. Good units will have a flutter of less than 0.1% with many down to below 0.05%.

The motor isn't the only flutter villain in this drama. It can be caused by such less obvious things as a record with a slightly eccentric hole, or some minor defect in the drive system, or a turntable that isn't perfectly flat. To check whether it's the system or the record, try a number of different records. They can't all be bad.

Flutter is actually a signal generated by a record reproducing system and imposed on the sound recorded in the disc. And as such it can have a number of different pitches—that is, frequencies. Flutter having a very low frequency is called wow because this was the exclamation of the individual back in recorded history who first heard this form of distortion, and because that is the word that closest describes the sound. To minimize flutter, manufacturers use heavy platters with some form of drive isolation between the motor and the platter. Manufacturers also specify the weight of the platter, but this in itself isn't enough. A more meaningful figure is the ratio of the mass of the turntable to the motor. And so a heavy platter isn't necessarily a guarantee of minimum flutter. There are brighter ideas than that of using a VW engine to drive a 10-ton truck.

Nevertheless, there is a good argument for making the turntable platter as large and heavy as the motor torque will permit. Once in motion such a platter serves as a flywheel and keeps the speed constant by its own inertia. Turntable platters are made of pressed steel plate or die-cast aluminum alloys. The aluminum alloy platter is preferable since it will not become magnetized by the motor's magnetic field. And manufacturers like it because it is easier to machine than steel. However, if the heavy platter is to take advantage of fly-wheel effect, it must be accurately balanced, comparable to the idea of balancing an automobile wheel.

The Motor's Code of Behavior

The motor must meet six conditions. It must rotate at a specific constant speed; this speed must remain constant for varying line voltage conditions and for varying load conditions (that is, whether the tonearm is resting on the record or not); it must not vibrate; it must have sufficiently powerful torque (rotational force) so that it maintains its speed at the precise moment the stylus makes contact with the record grooves; it must not produce any magnetic flux leakage as this can induce hum in the pickup system; and it must be able to work for hour after hour, if required. There are also some incidental conditions. The motor must not overheat. It must be absolutely quiet. It must be able to get the platter from a condition of zero rotation to required speed in the minimum amount of time. It must be troublefree for as long a time as possible. The motor represents the guts of a record player and like its human counterpart, must never intrude. At least not in polite society.

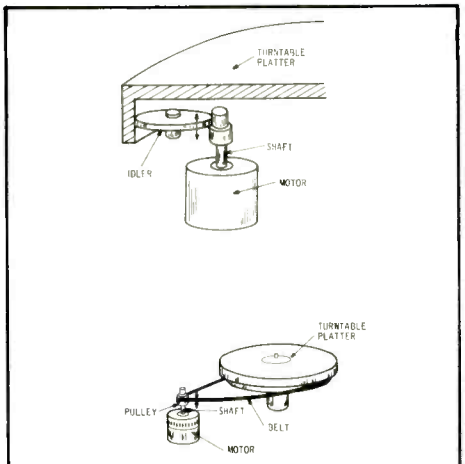

Fig. 3. Idler drive system (above) and belt drive system (below).

The absolute speed of a turntable platter is the unchanging speed at which it rotates over a period of time. If this speed is a constant 33 rpm when it should be 33-1/3 rpm, it is unlikely you would notice the difference. What is more serious is the short term speed stability. If a platter has an operating speed of 33-1/3 rpm with this speed representing an average, with a variation above and below this figure, then the platter is speed wobbling with 33-1/3 rpm as its rotational average, not a good situation at all, either for the motor, or for the listener.

Only two types of AC motors can fulfill all the motor requirement conditions for record players—the induction motor and the synchronous motor. Of these, the induction motor is used mainly for low-priced turntables since its speed can fluctuate with load variations, but this can be overcome with some kind of regulatory mechanism. The synchronous motor has its speed locked in to the AC line frequency and therefore is constant, even if the line voltage fluctuates. Power line frequency can shift, but deviations are small and the average is excellent. Looking at an electric clock is equivalent to an expression of faith in the frequency stability of your local power company's generators.

A special—and substitute *expensive* for special—variation of the synchronous motor is the hysteresis synchronous. Its features include freedom from vibration and noise-free operation. A more recent motor design is the brushless DC servo Hall motor, using Hall elements, a kind of semiconductor. DC motors for turntables require switching devices, such as a mechanical commutator, but the DC servo Hall motor uses Hall elements instead. The Hall motor has large torque, causes no electrical or mechanical noise. The advantage of a DC motor is that it is free of the torque pulsations associated with induction and synchronous motors.

The operating speed of the motor is another important consideration. Many motors turn at 1800 RPM, but there are some available that work at 600 RPM, 300 RPM, and at still slower speeds. The lower the speed, the less opportunity for such hazards as wow and rumble. Rumble is a low-frequency noise heard in the reproduced sound, caused by the motor, or parts associated with it. In operation, the motor can vibrate at a low-frequency rate, a vibration that can be transmitted to the platter, and thence to the stylus, producing a form of sound modulation.

Not all manufacturers indicate amount of rumble in their spec sheets, but when they do it is in the form of dB. The larger the dB figure, the better. A quality record player will be −35 dB, or more. The frequency of rumble is a submultiple of the motor's operating speed, and can go down to 30 Hz. Since the second harmonic is 60 Hz it is quite easy to confuse rumble with hum. A simple way to check is to lift the tonearm. If the disturbing sound remains it is hum-caused, but if it appears only when the stylus is tracking, then the problem is rumble.

The Drive System

Since motors run at higher speeds than 33-1/3 and 45 RPM, they must be coupled to the turntable by some type of reducing linkage, usually accomplished in any of several ways. In one system, known as rim or idler drive, one or more idler wheels (Fig. 3) transfer rotational power from the motor pulley to the turntable platter through friction drive of their rims. Advantages are relatively low cost, easy speed changes, and the opportunity (for the manufacturer) of using motors having lower torque. The difficulty with this method is that as the rubber drives wear a certain amount of slippage is bound to occur. Further, if the wear isn't uniform, drive may become uneven.

Some of the reasons why other turntables don't perform quite like a Dual.

Because of the wide acceptance and acclaim Dual has earned over the years, especially among audio experts, many Dual features inevitably appear on competitive turntables.

To copy a Dual feature is one thing: to achieve Dual performance and reliability is quite another matter. The true measure of a turntable's quality is not its features alone, but how well the entire unit is designed and manufactured.

Following are just some of the ways in which Duals differ from other automatic turntables.

Gyroscopic gimbal suspension.

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 the tonearms of the 1218 and 1229 are suspended in true, twin-ring gimbals.

Every Dual gimbal is hand-assembled and individually checked with gauges especially developed by Dual for this purpose. This assures that the horizontal bearing friction of the 1229 for example, will be no greater than 0.015 gram, and vertical friction no greater than 0.007.

True single-play automatic tonearm.

A turntable of the 1229's caliber is used primarily in its single play mode, so the tonearm is designed to parallel a single record on the platter. For multiple-play, the entire tonearm base is moved up to parallel the tonearm to the center of the stack.

The 1218 tonearm provides the single-play adjustment within the cartridge housing, and the cartridge pivots around the stylus tip to maintain the correct overhang.

Stylus pressure around pivot.

Today's finest cartridges, designed to track at around one gram, have little margin for error. In the 1229, therefore, the tracking pressure scale is calibrated within 0.10 gram from 0 to 1.5 grams.

To maintain perfect balance on every Dual tonearm, stylus pressure is applied internally and around the pivot. This is accomplished by a very long spring coiled around the pivot. Only a small portion of the spring's length is needed to apply the required pressure, thus contributing greatly to the accuracy of the calibrations.

Avoiding sounds that weren't recorded.

The rotor of every Dual motor is dynamically balanced in all planes of motion. Each motor pulley and drive wheel is also individually examined with special instruments to assure perfect concentricity.

Any residual vibration within the motor is isolated from the chassis by a three-point damped suspension. Finally, every assembled Dual chassis is "tuned" to a resonance frequency below 10 Hz.

The best guarantee.

All these precision features and refinements don't mean that a Dual turntable must be handled with undue care. So we're not being rash when we include a full year guarantee covering both parts and labor for every Dual. That's up to four times the guarantee you'll find on other automatic units.

Now, if you'd like to know what several independent test labs say about Dual, we'll send you complete reprints of their reports.

Better yet, just visit your franchised United Audio dealer. You'll see for yourself that only a Dual performs precisely like a Dual.

Dual®

Dual 1215S, $109.50

Dual 1218, $155.00

Dual 1229, $199.50

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Exclusive U.S. Distribution Agency for Dual.

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The other common drive system uses a rubber or plastic belt (Fig. 3), such as polyurethane. Polyurethane is preferable since it can be made impervious to aging, heat or oil, and has low elasticity. Rubber is a vegetable product, tending to become brittle as it gets older. It is also subject to stretch deformation.

Speed changes are made by guiding the belt around either of two motor pulley sections with different diameters. The belt prevents motor vibrations from reaching the turntable, reducing noise and rumble. Some turntables with slow speed motors (Fig. 4) are coupled directly to the turntable platter—the motor's shaft is also the turntable axle. Speeds are controlled by electronic servo mechanisms.

The Pickup System

The basic elements of the pickup system (Fig. 5) consist of the stylus, cartridge, head shell, tonearm, balance rest, and a balance weight. It sounds straightforward, but the technology of the pickup system is rather complex. Books could be written just on this subject alone if for no other reason than the presence of so many conflicting requirements. In many cases, a quality pickup system represents a compromise, an attempt to reach an armistice between the hostile demands of each of the parts of the pickup system.

The Stylus

The usual stylus is a diamond, preferable because of its longer service life contrasted with other materials, with some 400 to 800 hours of operating life. Its durability depends largely on the tracking force—that is, the weight with which the stylus is pushed against the walls of the record grooves. The tip of the stylus is machined to extreme precision. It can be spherical, with a tip radius of about 0.5 mil to 0.7 mil, or elliptical. Elliptical styli usually deliver better response to high audio frequencies, that is, they track the high notes better. (Not all authorities are convinced of the superiority of elliptical styli. One thing is certain: if an elliptical stylus is not made accurately and mounted correctly in a properly aligned arm it can cause more distortion and record wear than a conical type—Ed.)

Mono records can be played with a 1 mil stylus, but the smaller spherical stylus designed for stereo recordings can also be used on mono discs. The elliptical stylus has a radius of about 0.2 mil, or less, for contacting the undulations in the record walls. The larger radius of the elliptical stylus is about 0.7 to 0.9 mil and keeps the stylus from running along the bottom of the groove. There is no signal impressed here and so the only result would be unnecessary

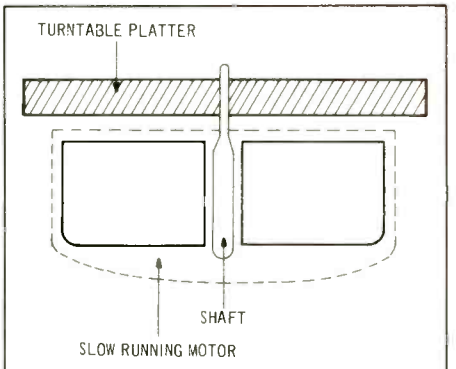

Fig. 4. Direct drive system.

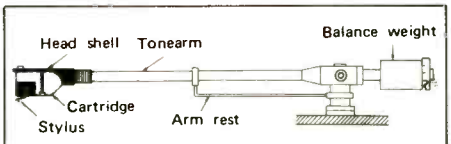

Fig. 5. The pickup system.

Shakespeare. Dickens. Stevenson. Poe. Sony. Balzac.

Add another classic to your library from Sony/Superscope ...the bookshelf-size Sony Model TC-640B three-motor three-head stereo tape deck.

Get all of these outstanding Sony features in the most beautifully compact, beautifully priced ($399.95) three-motor tape deck on the market today.

Three Motors. One precisely controls tape speed and two provide extremely fast rewind and fast-forward modes for optimum tape handling ease.

Three Heads. Separate erase, record and play heads give better frequency response and also provide for tape/source monitoring, allowing you to check the quality of recording while in progress.

Built-In Sound-On-Sound and Echo. Switching networks on the front panel facilitate professional echo and multiple sound-on-sound recording without requiring external patch cords and mixer.

Mic/Line Mixing. Dual concentric level controls regulate the record levels of microphone and line inputs independently, also allowing simultaneous mix and record.

Two Large Illuminated VU Meters – calibrated to NAB standards.

Plus Lever Action Solenoid Controls and Locking Pause Control.

Also ask about the Sony TC-353D ($229.95), TC-580 ($499.95), TC-850 ($895.00) at your Sony/Superscope dealer. After all, when it comes to tape recorders Sony wrote the book.

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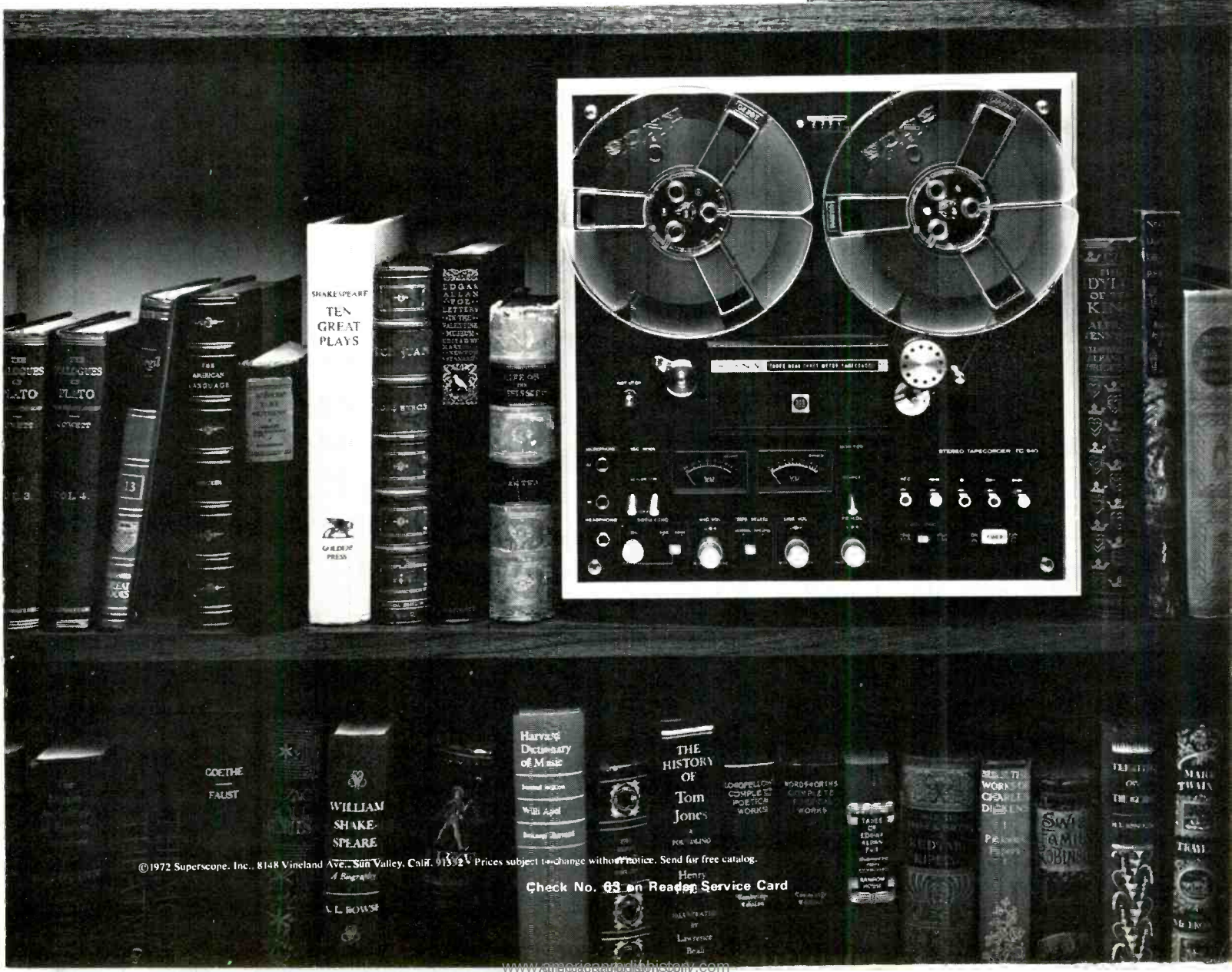

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wear of the stylus, and, what is worse, the production of distortion. The disadvantage of the conical stylus is that its shape will not prevent it from riding along the groove bottom, something that can happen if the stylus diameter happens to be very small.

Most styli today are the elliptical type. The changeover from a conical to elliptical stylus isn't just a matter of doing some switching. The elliptical has a smaller region of contact between the stylus and the grooves and so the tracking pressure should be less. The elliptical stylus can be used to play both stereo and mono records. The motion of the stylus is generally transmitted by means of a cantilever strut to a transducer inside the cartridge—with the transducer converting the mechanical motion of the stylus to an electrical signal.

The Phono Cartridge

The stylus fits into the cartridge, which, in turn, is mounted in a shell at the tip of the tonearm. As the stylus tracks in the rotating grooves, it is deflected laterally and vertically, depending on the modulations inscribed in the groove walls. In theory this sounds easy enough, but if the stylus is to track well, it must follow the complicated meanderings of the groove instantly and it must do so without bottoming (that is, without hitting the bottom of the grooves), without losing contact with the walls, yet not pressing unduly hard against them, and without jumping out of the grooves. Further, its contact or pressure must be the same against both walls—inner and outer—despite the fact that the very motion of the stylus makes such an equilibrium very difficult. To be able to do all this, the mass of the stylus and moving parts must be kept as little as possible, since the greater the moving mass, the greater its inertia—that is, the greater its resistance to quick changes in motion. And so the conditions for good tracking are quite difficult. But these aren't the only requirements. There must be a sufficient downward force, known as tracking force, on the stylus, to keep it in the grooves. Too much will cause stylus and records to wear out more quickly than necessary.

The stylus assembly must have freedom of movement—technically called trackability of compliance. The greater the compliance, the smaller the tracking force required. And since the stylus is going to wiggle around thousands of times a second as the record rotates beneath it, it becomes obvious that with high compliance we are permitting the stylus to do its job, to follow even the most delicate tracings in the groove walls.

(To be continued)

Presenting the perfected iron-oxide tape:

Capitol 2.

Other companies aren't getting the kind of performance out of iron-oxide that we are. No wonder they've switched to different materials.

We at Capitol, on the other hand, have found a way to perfect iron-oxide tape.

And when we say perfected, we mean perfect. A tape that outperforms chromium dioxide and cobalt-energized tapes in many ways, yet retains all the inherent advantages of iron-oxide formulations.

What has Capitol done differently?

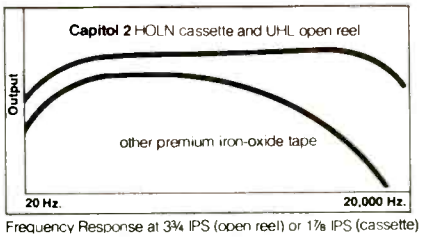
Capitol makes more efficient use of iron-oxide particles than anyone else. We get more energy from each iron-oxide particle by keeping the particles from touching one another (which would cause them to lose some of their energy). The process we use is secret, but the results aren't secret.

Capitol 2 is the world's highest-output iron-oxide tape.

The new high-output, low-noise tape, both cassette and reel, works harder than other iron-oxide tapes. You can record them at a higher record-level without distortion.

Capitol 2 has the world's best dynamic range, bar none.

Efficient use of oxide particles and smooth tape surfaces all but eliminate the three most annoying forms of noise: bias, modulation, and DC. So Capitol 2 has the world's highest dynamic range. You can record both louder and softer signals than ever before.



Frequency Response at 3¾ IPS (open reel) or 1⅞ IPS (cassette)

Capitol 2 is the world's first low-print, high-output, low-noise tape.

Print-through is a problem in high-output tape (both cassettes and reels) that Capitol 2 is really the first to solve. The uniform particle size, combined with a secret processing technique, reduces print-through to inaudibility.

Capitol 2 high-output, low-noise is a tape of a different color.

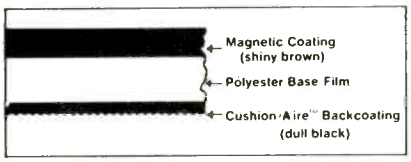
The side of the new tape that faces the heads is a shiny brown, and not as dark as most tapes. The shiny mirror-smooth tape finish improves high-frequency response by improving head-to-tape contact.

The light color is the result of taking the carbon out of the oxide side of the tape. Carbon doesn't help the recording properties of tape in any way. But other manufacturers are forced to use it in order to achieve good static properties. Capital 2 solves that problem differently:

The backcoating.

Just as the side of the tape that touches the heads should be smooth, the texture of the back of the tape should have a controlled roughness that improves handling characteristics.

So Capitol puts the carbon into its new Cushion-Aire™ backcoating. The new black backcoating not only prevents electrostatic charges from building up, but improves the handling



characteristics of our reels, helps make our cassettes jamproof, and extends the tape life considerably.

Presenting the world's best open-reel tape: Capitol 2 Ultra-High-Output, Low-Noise (UHL).

Capitol 2 UHL is the perfected reel tape. At 15,000 Hz (at 3¾ ips) the new tape is, on the average, 4.5 dB more sensitive than the top tape made by the best known brand.

Presenting the perfected iron-oxide cassette: Capitol 2 High-Output, Low-Noise (HOLN).

Capitol 2 cassettes aren't just the best iron-oxide cassettes you can buy (at least 6 dB more sensitive than conventional premium tapes at high frequencies, where it really counts). For many reasons, they're the best *cassettes* you can buy.

Capitol 2 HOLN cassettes are compatible.

Say you bought a good cassette recorder two years ago. You can't use chromium-dioxide cassettes. But you can use Capitol 2. With the kind of results chromium-dioxide users have been bragging about ever since it came out. The new iron-oxide cassettes will improve the sound of any cassette recorder in the house, from the old one you gave to your kid, to the new Dolby-ized one you bought yesterday.

Capitol 2 HOLN cassettes are jamproof.

The Cushion-Aire™ backcoating not only improves cassette winding, it makes cassettes jamproof.

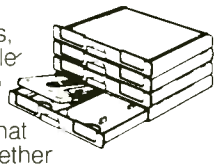
The texture of the backcoating assures that the tape will always wind smoothly with no steps, protruding layers, and other pack irregularities that cause, among other things, jamming.

So Capitol 2 HOLN cassettes just don't jam.

The perfect cassette package: the Stak-Pak.™

If you've ever tried to locate a cassette in a hurry, or pick one from the bottom of a pile, or put one away in an orderly fashion, you'll appreciate the Stak-Pak.

It's modeled after something you find around the house: the chest of drawers.



The Stak-Pak is, very simply, a double drawer. It holds two cassettes. But the unique part of it is that Stak-Paks slide together and interlock to form a chest of drawers. The more you have, the higher your chest of drawers. Each cassette is neatly filed away in its own drawer.

The world's most acclaimed cartridge.

The Capitol 2 Audiopak® is the world's most popular cartridge, long a favorite not just with consumers, but with broadcast studios and duplicators. The cartridge tape is a special formulation of iron oxide, different from the new Capitol 2 cassettes and reels. It is specially lubricated (that's why it's often called 'lube tape').

Capitol 2 Audiopak cartridges are the standard against which all other cartridges are measured.

The price, perfected.

Your dealer will sell you four Capitol 2 cassettes, 60's or 90's, your choice, packaged in two Stak-Paks, for the price of three cassettes alone.

How to find Capitol 2.

Capitol 2 is new. Not all stores stock it yet. If you can't find it, ask your dealer to order it for you.

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Capitol 2 is the family name that includes Ultra-High-Output, Low-Noise reel tapes, High-Output, Low-Noise cassettes, Audiopak® professional 8-track cartridges, and High-Performance, All-Purpose reel tapes

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Loudspeaker Damping

*Nelson Pass

To an engineer designing a loudspeaker system, one of the most important performance criteria is the transient response of the system. Good transient response requires that the speaker radiate sound as soon as a signal is applied, and stop radiating when the signal ends. The amount of time the speaker requires to reach 90% of its steady state amplitude for a given sinusoidal signal is called the attack time, and the time required to drop to 10% of that steady state amplitude can be called the decay time (Fig. 1). Since the attack time is primarily a function

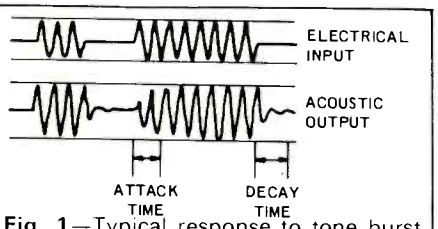


Fig. 1—Typical response to tone burst at 40 Hz.

of the frequency response of the speaker and not very dependent on damping, we will be concerned with the effect of damping on the decay time. Obviously, for good transient response we want the decay time to be minimized. The speaker continues to radiate sound after the signal has ended because it has leftover energy—kinetic energy in the mass of the moving cone, potential energy stored in the speaker's suspension, and acoustic energy still bouncing around in the enclosure. To reduce the decay time it is necessary to drain off that leftover energy, and this is what damping does. Damping for loudspeakers is directly analogous to the use of shock absorbers in a car, which keep the suspension from oscillating after a bump. There are several ways to dampen the response of a loudspeaker—electrical, mechanical, and acoustical, and each has particular advantages and disadvantages.

Electrical damping works by letting the speaker behave as an electrical generator. Because the dynamic loudspeaker is essentially a motor, motion of its diaphragm can generate electrical currents. By draining off the energy in these electrical currents, we can reduce the decay time and help smooth out resonances in the loudspeaker and enclosure. For a simple demonstration of this technique, compare the resistance of a woofer to a light push on the cone when the terminals of the woofer are not connected to anything, and when the terminals are short-circuited. When the terminals are shorted, the cone becomes harder to move because the energy is being rapidly dissipated in the electrical circuit of the voice coil. The less resistance in that circuit, the more energy will be dissipated at a time. Damping factor, often quoted in amplifier specifications, is the ratio of the impedance of the voice coil of the loudspeaker to the output impedance of the amplifier. When the speaker is connected directly to an amplifier having a high damping factor, the speaker will be damped as if its terminals were shorted. An amplifier with a damping factor of 20 or greater will serve such a purpose, and because the limiting factor is the resistance of the voice coil, there is no significant difference in damping between an amplifier having a damping factor of 20 and one with a factor of 200. It should be remembered that to make use of the damping factor of the amplifier, cables should be as short as possible and coils in the crossover network should have as little resistance as possible. There are two other ways of increasing the damping beyond the limit set by the resistance of the voice coil. One is to increase the strength of the magnetic field in the voice coil gap, and another is to increase the amount of wire exposed to the magnetic field at one time in the voice coil. Both of these measures make the speaker a more efficient generator, allowing more energy to be drained off quickly. The energy is dissipated in the resistive elements of the circuit—mainly in the voice coil—as heat energy.

Electrical damping does have some disadvantages. It often requires the use of iron core coils in the crossover instead of air core coils, and unless properly designed they can become non-linear at high power levels. Also, some loudspeaker systems depend on the woofer's fundamental resonance for boosted bass output, and as noted before, damping will reduce such response peaks, and also the overall efficiency of the speaker.

Mechanical damping occurs basically in two places in a loudspeaker, in the suspension and in the cone. Motion in the suspension dissipates some energy as heat, as demonstrated by the heating that occurs in a rubber band stretched rapidly several times. This type of damping is occasionally found in midrange and high frequency speakers, where the suspension soaks up some of the energy and converts it to heat.

Damping can also be found in the cone material itself, put there to

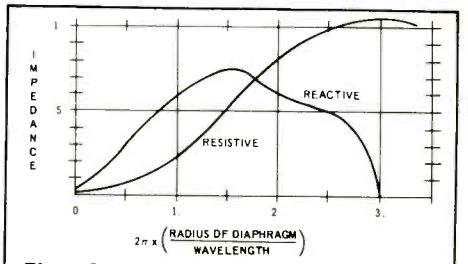


Fig. 2—Relative values of resistive impedance and reactive impedance for diaphragm mounted in a large flat baffle.

dampen out vibrational modes occurring in the diaphragm. Often at higher frequencies, the cone ceases to behave as a piston and the motion varies over different parts of the cone. This can be valuable if the design of the speaker makes use of it, as in the decoupling rings found in some cones, but if the speaker was not designed that way, then the undampened vibrational modes will result in response irregularities due to phase cancellation and other factors.

Acoustic damping can be used to reduce resonances and decay time in a loudspeaker by increasing the resistivity and decreasing the reactance of the load of air the speaker is pushing against. If the acoustic load on the speaker is resistive, then the energy is efficiently dissipated into the air as sound. If the acoustic load is reactive, then the motion of the cone does little work—dissipating less unwanted energy and lowering the efficiency of the speaker. The impedance of the air for a given size diaphragm is dependent

*Electrostatic Sound Systems, Inc.

Meet the creator.

Today, the musical artist has a new instrument at his command—the recording studio. It's an instrument that can capture sound, manipulate and mold it, stack it and scramble it, equalize and echo it—a contemporary creative tool with possibilities confined only by the borders of imagination.

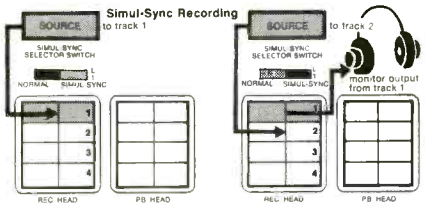
Some might call this musical soundfoolery, an adulteration of the pure musical art form. But throughout history, the truly creative artist has always used whatever instruments were available to reproduce the music he heard in his mind. The artist is no different today—but the instruments he uses are. And this has resulted in a dynamic new range of musical experiences for us all.

The creator—a 4-channel studio that fits on a shelf

With the needs of the contemporary artist in mind, TEAC tape technologists set out to design a precision musical instrument that would provide studio electronic flexibility and studio performance accuracy—yet be compact enough for home use and priced within the bounds of reason. The result: the creator, TEAC's amazing Model 3340 4-Channel Simul-Sync™ Tape Deck—a recording studio that fits on a shelf.

The 3340, backed by TEAC's exclusive two-year Warranty of Confidence,* is carefully crafted in the TEAC tradition of professional quality. 10½" studio reels; a quick and gentle three-motor transport; four studio-calibrated VU meters; eight input controls for complete mic/line mixing; dual bias selection; 7½ and 15 ips studio-accurate speeds. And Simul-Sync.

Simul-Sync: what it does and how it works



Overdubbing has become a familiar term to every knowledgeable musician. Simply, it means a) recording a voice or instrument on one track of a multi-track tape machine, b) adding another voice or instrument to a different track at a different time, and c) matching the two tracks so it sounds as if they were recorded simultaneously when played back. To overdub properly, the artist recording on the second track has to listen to the material recorded on the first track while performing in perfect synchronization to it.

That's where the problem occurs with most tape recorders. Conventional record/playback monitoring systems only let you listen to the previously recorded material off the playback head. That means a time delay between the track being recorded and the track being monitored. A small delay, to be sure, but large enough to make perfect synchronization virtually impossible.

TEAC engineers solved the problem with Simul-Sync. They designed a studio-tolerance 4-channel record head, then added electronics that allow each track on that head to be switched independently to either record or playback modes. By doing so, they completely eliminated the time lag and permitted the artist to add track after track—all in absolute synchronization with each other.

The TEAC Simul-Sync head, operating in conjunction with a 4-channel erase head and a hyperbolic playback head capable of reproducing either stereo or 4-channel material, served as the foundation for the TEAC 3340 concept. It also opened the door to a whole new realm of musical creativity and enjoyment.

Exploring the realm

Here are just a few of the sonic effects possible with the TEAC 3340:

1. Unlimited overdubbing. Up to nine individual instruments or voices can be recorded at different times without any track being used beyond second generation. Sensational signal-to-noise ratio is the result.

2. Professional quality mixdown. All four channels to a single track or ¼-track stereo masters. The optional TEAC AX-20 Mixdown Panel makes it a quick and easy process. Individual controls also allow for desired mixing level for each channel.

3. Special effects. Enter the world of psycho-acoustic phenomenon where the creative juices can really start flowing. Things like echo, cross echo, 4-channel rotating echo and pan pot effects (with AX-20 Mixdown Panels). You can put echo on some instruments and not on others. One-man group arrangements, with a single artist playing all instruments and singing all vocal parts. Backwards recording, an effect that gives any instrument a totally new sound. Dual speed recording, mixed down in perfect sync. With all these effects at his disposal, the professional musician can quickly save the cost of a 3340 in reduced studio experimental time alone.

4. Pseudo-quad recording through ambient delay to the rear channels. And, of course, full discrete 4-channel record and playback.

5. Are you creatively curious? If so drop TEAC a line, and ask for the "Meet the creator" booklet. It describes all of the 3340 effects in detail and explains how each is done. And it's free.

If creative involvement is what you're after, meet the creator—the TEAC 3340 4-Channel Simul-Sync Tape Deck. (or the 7" reel, 3¾—7½ ips version, the 2340).

When it comes to creative recording, they perform miracles.

*TEAC or one of its authorized service stations will make all necessary repairs to any TEAC tape deck resulting from defects in workmanship or material for two full years from the date of purchase, free of charge to the original purchaser. This warranty applies only to TEAC products sold in the United States.

The TEAC 2340 and 3340 are priced at $759.50 and $849.50, respectively. For complete information, please write to TEAC, 7733 Telegraph Road, Montebello, California 90640. In Canada: White Electronic Development Corp., Ltd., Toronto. TEAC Corporation, 1-8-1 Nishi-shinjuku-ku, Shinjuku, Tokyo, Japan. TEAC EUROPE N.V., Kabelweg 45-47, Amsterdam-W.2, Holland. Hi-Fi, S.A. Alta Fidelidad Hidalgo 1679, Guadalajara, Jal., Mexico.

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upon the frequency—as the frequency goes higher, the load becomes more resistive. If the cone size is increased, then the load will be more resistive at a given frequency (Fig. 2). When the diameter of the diaphragm is greater than ⅓ of the wavelength at a particular frequency, then the load starts becoming primarily resistive[1]. As an example, the acoustic load on a twelve inch woofer is mostly resistive above 500 Hertz, but is very reactive below that frequency, and it becomes necessary to depend on other types of damping. Considering the need for

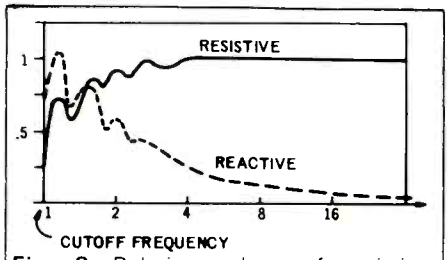


Fig. 3—Relative values of resistive and reactive load for speaker in an exponential horn.

a resistive load to reduce cone excursion and dampen response, it is easy to see why woofers must have large cones and why the speaker will have better bass output placed against a flat surface where the impedance is more resistive, but there are yet other ways to insure good acoustical damping. Exponential and other types of horns can be used effectively to give a small speaker a resistive load down to a cutoff frequency determined by the

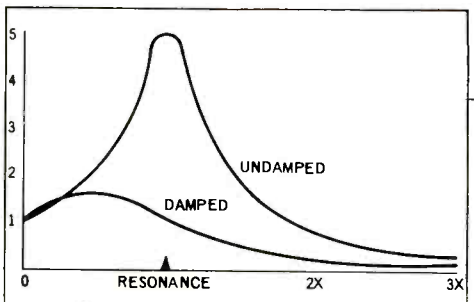


Fig. 4—Cone excursion at resonant frequency for two typical cases.

flare rate of the horn and the size of the mouth[2] (Fig. 3). A loudspeaker operating into a horn at a frequency higher than the cutoff frequency of the horn will experience good acoustic damping and high efficiency. It is also this high resistive load that allows horns to have very high acoustic output for very small excursion of the diaphragm, thus lowering the distortion caused by suspension nonlinearity. It is possible to reduce the necessary mouth area of a horn and still retain the resistive load through the use of resistive materials placed

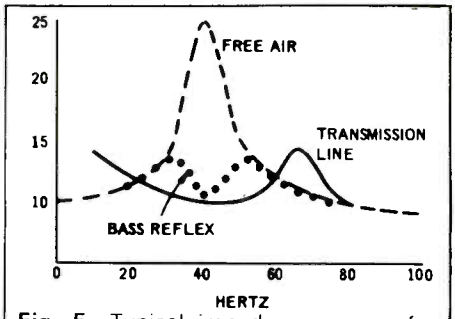


Fig. 5—Typical impedance curves for two enclosures.

in the horn such as fiberglass or dacron[3].

Other types of enclosures have been designed to load down the speaker while increasing the acoustic output at the speaker's resonant frequency. At resonance, the speaker's undamped excursion becomes very large, causing harmonic distortion (Fig. 4). Enclosure designs such as the bass reflex or transmission line act to load down the speaker as resistively as possible at its resonance so that the acoustic output remains strong and the system is well damped while the cone excursion is nearly halved or more. The bass reflex accomplishes this loading by tuning the Helmholtz resonance of the enclosure to use the back wave off the rear of the diaphragm to boost the output off the front of the diaphragm at resonance. This loads down the woofer and works to dampen the spurious response at that frequency. A somewhat similar approach to acoustic damping is found in the transmission line, or acoustic labyrinth where a tubular pathway having a specific length guides the back wave until it comes out in phase with the

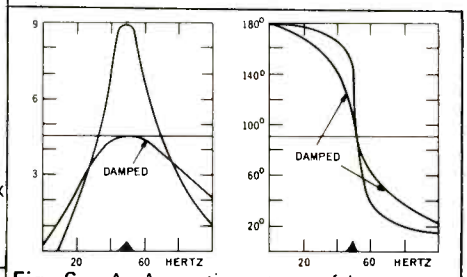


Fig. 6— A. Acoustic output of bass reflex port versus frequency.
B. Phase shift in output of port relative to directly radiated output.

front wave off the diaphragm. The tube is lined with a resistive material, and its length should be longer than ¼ the wavelength of the speaker's resonant frequency.

The cone velocities reflect excursion in the speaker's impedance curve, and by examining the curve one can get an idea of the load on the woofer at resonance due to the action of the enclosure (Fig. 5). Additional resistive loading can be found in the use of fiberglass or dacron fiber in the port or duct of a bass reflex or placed tightly behind the diaphragm of the loudspeaker. The use of resistive material in the port of a bass reflex dampens out the enclosure resonance, smoothing the port output, and lowering the rate of phase shift of the output of the port (Fig. 6).

Still another type of acoustic damping exists where the interior of an enclosure is lined or stuffed with a resistive (absorptive) material to reduce the vibrational modes of the enclosure due to standing waves, the simplest of which consists of a sound bouncing back and forth between two parallel

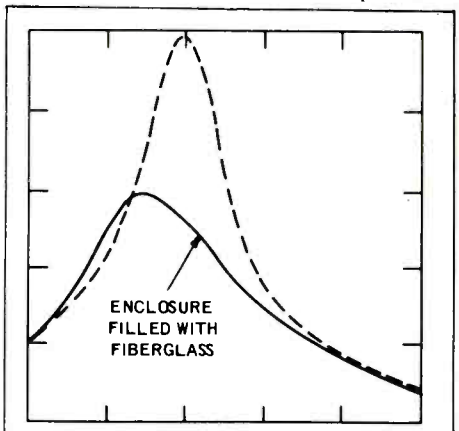


Fig. 7—Typical excursion of woofer at resonance in a sealed enclosure.

surfaces where the wavelength is equal to the distance between the surfaces divided by multiples of ½. These vibrational modes must be damped out or they will cause response irregularities in the output of the speaker. In acoustic suspension or infinite baffle designs, the amount of stuffing is increased in the enclosure to make it behave as if it were 1.4 times larger in volume by slowing down the sound, so to speak. With that much acoustic resistance, the air compression becomes isothermal instead of adiabatic, and it dissipates much more energy, further dampening the system and lowering the resonance of the enclosure and speaker (Fig. 7).

In designing a loudspeaker system, the amount of damping occurring both in the speakers and in the enclosure is an important factor which can only be tested properly by comparing tests of frequency response, transient re-

1. Leo L. Beranek, *Acoustics*, Chapter 2, McGraw-Hill, 1954.
2. C. R. Hanna and J. Slepian, "The Function and Design of Horns", Transactions A.I.E.E., presented Feb., 1924.
3. W. E. Glenn, "Terminated Horn Enclosures", I.R.E. Transactions on Audio, 1956.

sponse, distortion, and impedance against different amounts of electrical and acoustical damping. A peak in the response or impedance curves is indicative of an undamped resonance, but the most effective test is made with the use of tone bursts and waveform photographs. These quantitative methods will yield good results, but in the final analysis, the quality of sound as judged by listeners is the most important criterion. Æ

(Continued from page 42)

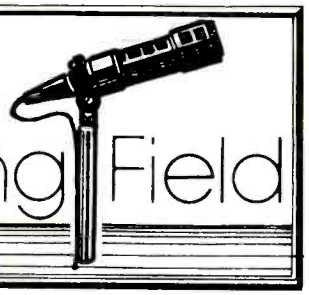
First, I was about fifteen feet away from the front rows of singers, a perfect distance, in a fairly live big room, for mono/stereo loudspeaker pickup. A happenstance but a good one. It was also an interesting binaural distance, with plenty of detail sound as well as an over-all blend. As for the conductor, at a few feet he is very much "on mic" for loudspeakers and his remarks are nicely spotlighted. Via phones, at my extreme right, he is overwhelming—he breathes right down your neck. The piano? Nicely background, as an accompaniment.

Second, the singers surrounded me for a full 180 degrees. Thus I had extreme side information, smoothly blended (at equal distance) from one side around to the other. With omni mics, the sopranos were clearly picked up to my extreme left, the basses to the extreme right, the others in between. (You can "tie down" that illusive binaural front area, thus, by hitching it smoothly to the sides.) Between musical numbers, the small rustle of many sounds from the singers all around is superb via phones, reasonably natural via speakers.

Third and most significant, I set my two mics *three feet apart.* No head between. With such a wide spread of sources, this gave me a very workable loudspeaker stereo, the sopranos easily located to the left, the basses to the right, the conductor just right of center. In the phones via this "enhanced binaural" mic separation, old Bach really jumps. It is musically one of the most exciting binaural recordings I have ever heard, even though made on relatively primitive equipment. Good for phones *and* good for speakers.

There's one approach to combined compatibility, NCAE's is another and quite different, in a different area of programming. Yours may be a third, or an n^{th} if you will use these guidelines, listen with your two good ears, and perhaps discover other areas where compatibility can be enhanced. For compatibility we *must* have, if binaural is to exert its drama on the FM air. Æ

Entering The Recording Field



Joseph Giovanelli

Judging from the numerous letters I have received over a short period of time, there is a considerable interest and fascination surrounding the area of sound recording. Many of the readers who have written me have asked what is involved in entering into the field of sound recording as a vocation. It is in response to this reader interest that I have prepared the following information.

Those of us who entered the field of sound recording did so because of tremendous personal interest and enthusiasm for this fascinating area.

At the time we became interested in this field, a typical studio was comprised of a couple of microphones, a mixer, and a disc recorder.

In contrast, today's recording studio can include 30 microphones, a console, tape recorders capable of recording up to 24 individual tracts, synchronizing equipment, reverberation and echo systems, limiting amplifiers, equalizers, programmers for automatic mix-downs, automated disc mastering equipment, and an arrangement by which all of this equipment can be interconnected.

The early recording studio procedures required a relatively short time to understand. Even then, however, the recording technician did need to know basic electronics theory and did need to have a knowledge of the mechanical work required to maintain disc-cutting equipment. With these basics, a little "feel" for music and with customers, the studio was in operation.

The complicated electronic equipment of the recording studio today requires more knowledge than did the earlier studio. Hence, more time is needed to achieve proficiency. Most modern studios cannot afford the time to teach a new-comer this necessary information.

The novice cannot expect to begin his career by mixing for the "Rolling Stones" or the Boston Symphony. He can expect to start as a messenger, an office worker or even as a floor sweeper. If he demonstrates enthusiasm for the "action" in the studio and shows his great interest in practical ways, someone will notice and he will eventually get a chance to get into the studio work.

Somehow the knowledge required by the modern studio must be gained. Observation of repair sessions, and actual recording sessions, is invaluable. Learn to listen and you will find out why a technician rejected one "take" during a session and accepted another.

A studio cannot teach the basics in electronics. This material can sometimes be learned through extensive reading. A formal education, however, will probably prove a time-saver in the long run. Fundamentals of electronics can be secured as part of a general college program. This is not always practical. In many communities, however, there are technical schools which offer courses in electronic theory. A course of this type should include laboratory work. It is one thing to have a theoretical understanding. (Under actual studio conditions it is often more necessary to have skill in handling a soldering iron than in handling a slide rule.) If your community does not have such a school, there are correspondence courses available.

Neither *AUDIO* nor I recommend any particular school. The names and addresses of a few schools which appear to offer the kind of electronics background applicable to the needs of today's recording studios appear at the end of this article.*

Although an electronics background is important in keeping a recording studio in operation or in planning future expansion of its facilities, the art of actually making recordings is a completely different process, requiring different skills. These skills can be acquired in various ways. One excellent way to learn many of the basic elements of that art is to use your tape recorder. Another way is to observe recording at a recording studio in operation. A third way is to obtain formal training. It is best to combine all three of these methods.

Using Your Tape Recorder

The only way to learn to use a tape recorder is to acquire one and start working with it. Preferably, it should be a stereo machine. Start by recording from phonograph records or from FM. Classical music generally has a wide dynamic range which poses problems which will be understood after you have gained some experience in recording this material. (By "dynamics" I refer to the variation between the loudest and softest musical passages.) Get to know the recorder so well that you learn to keep distortion as low as possible, and still maintain as good a signal-to-noise ratio as possible. You will make mistakes which will lead to distortion. It will be your task to learn how to correct such errors. Clues can sometimes be found by reading the instruction manuals which you received with your recorder.

There are some recorders which have automatic means by which level can be controlled. Do not use such a tape machine; lots of the things you must learn will go by you by so doing.

When these techniques are mastered, use your microphone with the tape machine. Record anything at all: children playing, conversations over dinner, a babbling brook, moving traffic outside your window, etc. Try to record a rock group or other music event for the fun of it and for the experience.

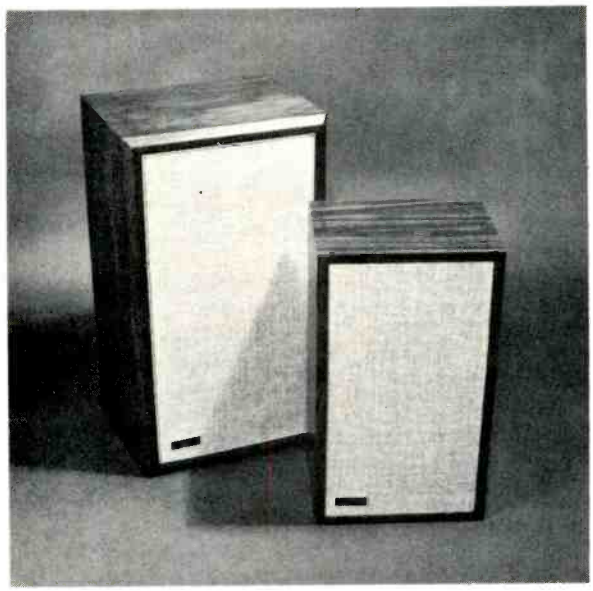
You must listen to all of your recordings *critically*, not just with amazement that anything at all was reproduced. Many of your recordings will be terrible. It is up to you to determine why and to correct the situation in future attempts.

As in any skill, recording requires time to master, even when working at it every day; there is no way to reduce this time.

A companion to tape recording is tape editing. I suggest that you obtain a good splicing block. The better ones are complete with basic instructions dealing with the procedures by which good splices are made, plus some helpful hints as to the kinds of edits which can be successful, plus those which cannot. Try editing a conversation leaving out portions and see if the content is still sensible. Try to edit a piece of music, leaving out a chorus. See if you can do this without any listener being able to detect the point where the section was removed. Practice inserting what is known as "leader tape" between pieces of music or between sections of your tape. What would occur if you had a quarter track machine with selections on both sides of the tape, and if you edited one side

If You Would Like Nothing Less Than the Best in Loudspeakers, But Doubt That You Can Afford Them, Please Read This Ad.

Both the loudspeakers shown—the original Advent Loudspeaker and The Smaller Advent Loudspeaker—are intended to be compared in audible performance, including frequency bandwidth, with the most elaborate and expensive speakers available. That may be difficult to



accept, we realize, but it is true and verifiable in the listening.

Both Advent speakers were designed after more than fifteen years of experience in designing and manufacturing high-performance speaker systems, including some of those of other brands still held in highest regard by critical listeners. They were designed simply, out of knowledge that most complex, multi-speaker systems are the result of long-outdated notions that got their start when the first high-fidelity speakers for the home were adapted from the theater speakers of the 1940's. And they were designed to take advantage of new manufacturing techniques that had been developed over many years of experimentation.

Over-engineering—needless elaboration of design in imitation of what has existed so far—is a common problem in audio equipment, and one for which the customer often pays heavily in many ways. Good design to us is represented by the simplest approach that permits reaching a design objective without compromise.

Both Advent speakers are two-way systems. A single speaker would be a more "ideal" device, but in practice has to give up either the frequency range or the power-handling needed for a no-compromise speaker. The use of several "full-range" speakers of any size doesn't preserve the theoretical advantage of a single speaker. And three-way and four-way systems are not only unnecessarily expensive and elaborate, but often inferior-sounding because of interference effects and abrupt electrical cut-off of drivers in different operating ranges. The two-way design is simple and effective, and both Advent systems exploit it more thoroughly than any previous speakers. No more elaborate design is capable of wider range or subtler characteristics.

Both Advent systems were also designed to waste nothing in imitation of theater speakers. They are intended for use—heavy and hard use—in a home, not an auditorium or laboratory, and they include nothing but what is needed for the best possible performance in a home.

The original Advent Loudspeaker, which costs between $105 and $125 depending on its cabinet finish and the part of the country we have to ship it to, can withstand absolute, no-holds-barred comparison with any speaker of any price, and sounds obviously and dramatically better than many far more expensive speakers. The Smaller Advent Loudspeaker ($70-$75) sounds the same as the original, but will not play quite as loud as the original in as big a living room.

We will be happy to send you a full explanation of the design of both Advent speakers. Please write us at the address below and ask for our Speaker Packet, which includes reprints of reviews.

Thank you.

Advent Corporation, 195 Albany Street, Cambridge, Massachusetts 02139.

of the tape? Listen to the second side. If you discovered any problems, how could you solve them? (You won't find the answers to these questions here.)

If the studio in which you hope to work has disc equipment, it is a good idea to follow the same procedures as for tape recording. Try putting your tapes onto discs.

Sometimes it is possible to locate used, inexpensive disc recording equipment. Such a recorder will really show you what disc making is all about. The machine will not have any of the refinements found on studio mastering equipment. It will produce rumble and the nature of the head may be such that you cannot obtain as high a signal level as might be desirable. It may be so old a machine that even if it does cut at 33⅓ RPM, the groove spacing will be wide, not microgroove. However, you can see all its parts and can gain a real insight into the operation of a recording lathe. It would be nice if you could obtain a small, over-head lathe, but this is not really necessary. In this connection, however, I must tell you that even if the machine came to you inexpensively, it is not cheap to make records. Styli are perhaps $5.00 each, but this varies, depending on the requirements of the head. A mistake will cause the stylus to chip and it will be ruined. 12-inch blanks are about $2.00 each, and you will have to buy them 25 at a time. Smaller sizes are proportionately less expensive. Discs, however, cannot be reused as tapes can. By the time you have mastered the art of this machine and understand all of its peculiarities, you will have gone through a great many discs and considerable money, especially if you break a few styli along the way. Along the way you learn about groove depth, and about the maximum permissible levels found on recordings.

Search through your local library to discover any possible books on the subjects of tape and disc recording. These books will supplement your practical experience.

Observing Studio Operation

Even if you have not begun your work in a studio as a floor sweeper, perhaps you can get to know someone in a recording studio who can, from time to time, let you in as an observer of the "goings on." There is probably much which can be said regarding what you should look for except that, under the pressure of a session which can, in larger setups, run into thousands of dollars per hour, this is not the time to ask the engineers questions about the work they are doing. The time for this is after the session has been concluded. What you have observed during the session can form the basis for what will probably be better questions than those you might have asked earlier. Many of those original questions would be answered merely by watching the session as it proceeds.

Some of the things you might watch for could include: how the engineer went about setting up his microphones; why the engineer rejected some of his own work; how the engineer edited a reel of tape. There are, of course, countless other details, and there is insufficient space to "run them down." About all I can say, therefore, is for you to keep your eyes and ears open.

Formal Training

Unfortunately there are almost no schools with instruction related to studio operation. The only schools I have been able to find are listed at the end of this article.* The student able to attend any of these schools will receive invaluable training. What this training will do is to give the student an entree when applying for a position in a recording studio. It can also shorten the time required to learn the operation of the studio which hires you.

In any case, no studio of any size will employ you as a mixer on the first day of your new position.

Part of formal training should include courses in music, including how to read an orchestral score. The primary work done in any studio is that of recording music, therefore, a "feel" for it is essential. With an understanding of what the musicians are attempting to do, you will have a better idea of how to produce a "mix" which will satisfy their requirements. Your understanding of music also helps to create a rapport with the performer. He will know that you understand what he is doing, and, therefore, he is likely to be more ready to listen to any suggestions as to mixing or what have you, that you may offer.

There is another element in working in a recording studio that is of the utmost importance. No amount of formal training can help you learn it either. This element is *the ability to get along with people.* The artists who keep a recording studio in business range from the easy-going to the very temperamental. It well may be your sometimes unwritten, difficult assignment to keep friction down between members of a musical group or between the group and yourself.

From a reading of the foregoing it is hoped that you do understand that there is more to working in a recording studio than rubbing shoulders with famous people. What is involved is hard work, often done under great pressure. Therefore, you must enjoy the work for its own sake.

Our basic discussion so far has been slanted toward the large studio which has facilities to do virtually anything. There are other types of studios which specialize in a certain kind of sound recording. One type of studio is set up to produce master tapes but not discs. Modern disc recording often involves a fantastic investment in equipment, and it is an art in itself. Therefore, a studio of this kind "farms out" its disc work to studios which specialize in that area.

When applying for work in a studio you may wish to specialize in a particular aspect of recording work. Keep in mind that there are only a limited number of studios. These studios have little turn-over of personnel. In order to get into a studio, therefore, you might have to do some other work than you hoped for, just so you get "your foot in the door." As a result of the limited number of positions available, the owner of a studio is in a position to select the "cream" from all of those applying. Patience and enthusiasm on your part are essential. Any resume must be neat and well thought out. Those resumes written on wrapping paper or with crayons or the like will not be read. (I'm not making that up; I've seen such professional summaries.) A studio is looking for, not necessarily the highest qualifications, but for clues as to your interest in the work, your overall background and willingness and ability to learn.

Many of you reading this may ask why all this formal work, when most people started out knowing little about the work. As I said at the beginning of the article, lots of us got started at a time when things were less complex, when the pace was less frantic. As new things came along, we had the time to absorb them. Any one starting out now must learn a lot rather quickly. I think some of this "pioneering spirit" can still work for those who are really "sharp". Training, however, helps to get you started.

Working in a studio is not the only way to operate in the sound recording industry. There are successful technicians in business for themselves, who specialize in such fields as the recording of weddings, recording and transcribing business and other con-

(Continued on page 87)

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EQUIPMENT PROFILES

JVC Model CD-1667 Cassette Deck

MANUFACTURER'S SPECIFICATIONS:
Frequency Response: CrO2, 30 to 16,000 Hz ± 3 dB. Normal Tape: 30 to 13,000 Hz ± 3 dB. **Signal to Noise:** 50 dB at 1 kHz, with ANRS: 55 dB at 1 kHz, 60 dB at 10 kHz. **Wow and Flutter:** 0.15% rms. **Cross Talk:** 60 dB at 1 kHz. **Channel Separation:** 35 dB at 1 kHz. **Bias Frequency:** 95 kHz. **Motor:** Servo-controlled d.c. **Rewind Time:** 100 seconds, C60. **Dimensions:** 15 by 15 by 10½ inches deep. **Weight:** 10.1 lbs. **Price:** $199.95

The JVC 1667 is a similar model to the 1668 which was included in our capsule reviews published in the October issue. It does not have a Memory switch, an indicator for CrO2-normal tape, peak indicator and some other refinements but it *does* have the ANRS noise reduction systems and the basic performance is almost identical. The main functions are controlled by six piano keys with a separate button for Eject on the extreme right. The on/off lever switch is on the left, and above that are the input level slide controls. Next to these are the ANRS noise limiter and Tape Select switches. At the top, on an angled panel, are the two VU meters with the record indicator light and to the right is a three-digit counter. Right at the front, under the on/off switch, is a recessed panel containing the microphone and headphone sockets together with a two-position headphone sensitivity switch. At the rear are the input and output sockets, a DIN connector and two preset input controls.

The complete top panel is mounted a little above the wooden base—a nice styling feature.

Measurements

Figure 1 shows the record-playback responses with CrO2 and TDK ED low-noise tapes as well as the response with a standard playback tape. It will be seen that the CrO2 measurements are well within the specified 30 to 16 kHz figures. The 3 dB point for "normal" tape is given as 13 kHz but our measurements with TDK ED tape were considerably better and came quite close to the CrO2 tape performance. The noise reduction system operates by boosting low-level frequencies from 500 Hz in the recording mode and then reducing them on playback. Figure 2 shows how the boost is dependent on level. Playback characteristics form a mirror image and actual tests showed that the deviations are insignificant. Signal/noise was 50 dB without ANRS and 55 dB with—an improvement of 5 dB. At 10 kHz the noise reduction increases another 5 dB. Distortion at 0 VU was just over 1% as shown in figure 3. At +3 VU the distortion was only 2.5%—which is excellent. Wow and

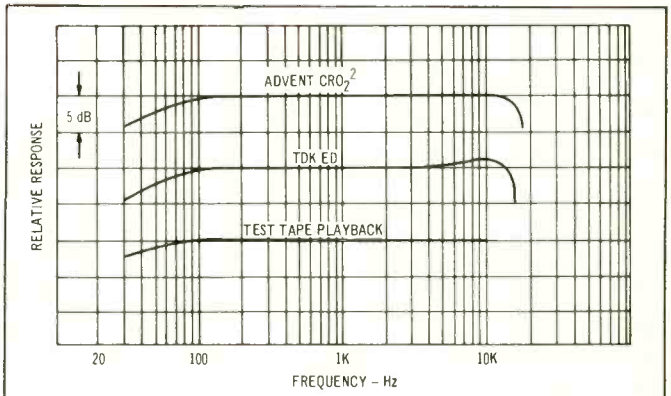

Fig. 1—Frequency response

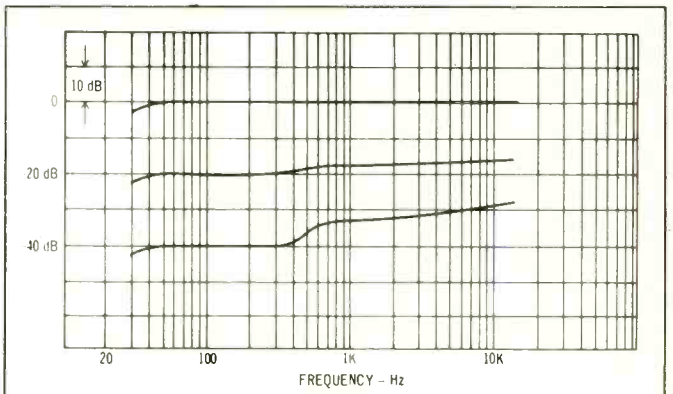

Fig. 2—ANRS recording characteristics at two levels

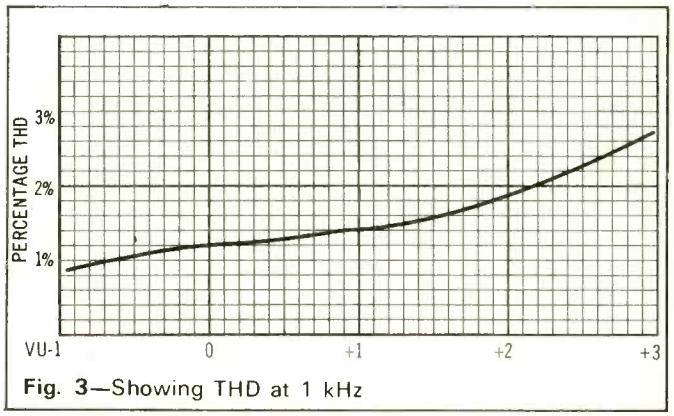

Fig. 3—Showing THD at 1 kHz

Bill Wertz, VP of WQLR, checks the chronometer, as Dennis Weidler is poised to put the station on the air. Pat Dyszkiewicz and Eric Toll watch.

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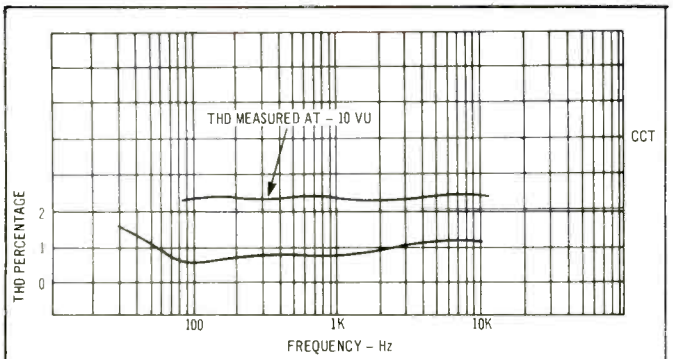

Fig. 4—Frequency v distortion at –10 VU

flutter measured 0.14% and speed was found to be 0.7% fast. Erase with CrO2 tape was 49dB. Input sensitivity was 72 mV for 0 VU and line output was 1.2 volts. Microphone sensitivity measured 0.30 mV. Finally, rewind time was 140 seconds for a C90 tape and just under 100 seconds for C60. So much for the figures.

Listening Tests

The first impression of the 1667 was a *smoothnes,* an ease of handling unusual for a recorder in this price class. The push-buttons need a very light, almost a feather-light touch but are quite positive in action, and the automatic stop device works without fuss. As the end of the tape is reached, the player stops and the cassette just pops up and sits there—it doesn't fly out into the room! The motor itself is quiet and the machine as a whole is very well made. As the figures indicate, the ANRS feature is well worthwhile—you can certainly hear the difference. Records were taped without the noise reduction system and the tape hiss clearly showed which was tape and which was the record on a comparison test. However, when the ANRS was switched in it was quite difficult to tell which was which! The obvious question is—how compatible is the JVC ANRS system with Dolby? In our review of the JVC 1667, we said it was *reasonably compatible:* in other words Dolby tapes could be played back with little difference in overall sound. There were some exceptions—piano music for instance sometimes showed a slight breathing kind of distortion which was absent when played through a Dolby deck. But for orchestral music it was difficult to hear the difference so we will stick with our original opinion—the systems are reasonably compatible.

TEAC 3340

MANUFACTURERS SPECIFICATIONS

Tape speed: 7½ and 15 ips. **Reel Size**: 10½ and 7 inches. **Motors**: 1 dual-speed hysteresis synchronous, 2 eddy current capstan. **Heads**: 3 four-track and two channel. **Wow and flutter**: 0.04% at 15 ips, 0.06% at 7½ ips. **Frequency response**: 30 to 20,000 Hz ±3 dB at 15 ips, 30 to 18,000 Hz ±3 dB at 7½ ips. **Signal to noise**: 60 dB. **THD**: 1% at 0 VU. **Crosstalk**: 60 dB at 1000 Hz. **Inputs**: Mic: 0.25 mV, Line 0.1 v at 50,000 ohms or higher. **Outputs**: 0.3 v at 10,000 ohms. **Headphones**: 8 ohms. **Dimensions**: 20½ by 17¼ by 8. Price: $849.

The TEAC 3340 is primarily a quadraphonic recorder, a semi-professional machine with a high standard of performance. However, it can be used for 2-channel record-playback, ½-track playback, mono record-playback as well as 4-channel record-playback. The main feature of the 3340 is probably the Simul-Sync facility-about which more later.

Looking at the photograph, it will be seen that there is a group of eight controls on the left side. These are the output level controls and dual-concentric input controls for microphone and line. Above these is the tape speed knob with slide switch for small or large tape reels. The Simul-Sync unit is in the center and tape source-tape monitor switches are located between the VU meters. Underneath are the four microphone input jacks and a headphone socket. A slide switch allows the phones to be connected to the front or rear channels or F + R. At the right is the stop control, tape direction lever, record push-button, on/off switch, bias switch and record mode switches. The input and output sockets, plus a fuse and a power input socket are all located at the rear.

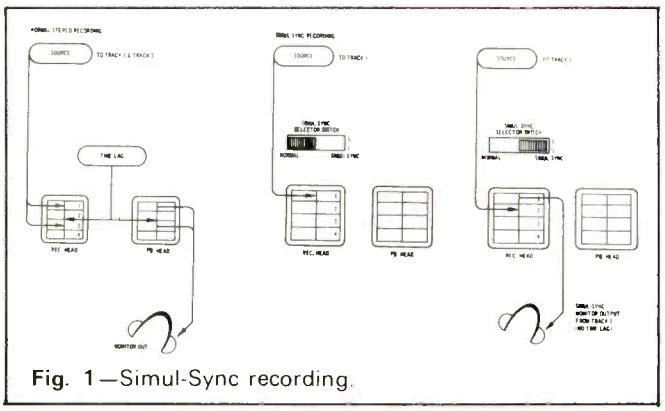

Fig. 1—Simul-Sync recording.

Simul-Sync Recording

This is a technique which allows you to play back and monitor one track without time delay while recording a second, third or fourth track in perfect synchronization. The head function switch provides this feature by changing the record head to playback when the switch is in the Simul-Sync position, thereby eliminating the time delay which is inevitable with conventional monitoring systems. See figure 1. Thus, a rhythm section could be recorded on track 1, brass on track 2, piano on 3. A vocalist can then dub in later and the complete sound mix can be created by the independent level controls. Figure 2 shows the view underneath. The main motor is a dual-speed hysteresis type and the reel motors are eddy current induction types. Figure 3 shows the heads and capstan assembly. Note the heavy, rigid base plate which is necessary to

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maintain correct alignment. Permalloy shielding is employed and then a hyperbolic shape is used which TEAC claim gives minimum head contact for reduced tape wear and increased head life. Other features of the 3340 include independent

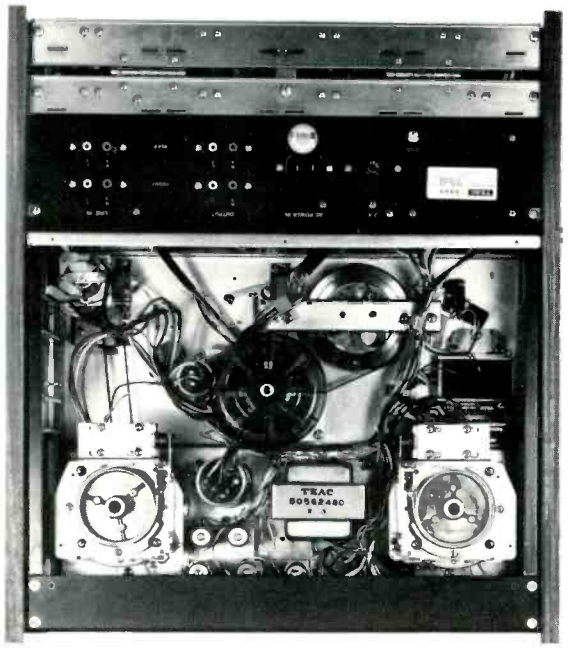

Fig. 2—Showing the view underneath

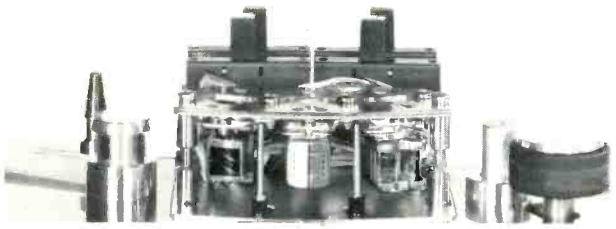

Fig. 3—Heads and capstan assembly

record and relay amplifiers, expanded scale VU meters, oil damped tension arm, "Quick Lok" reel holders, automatic tape lifters and provision for manual cueing.

Measurement

The frequency response at 7½ and 15 ips is shown in figure 4 and it will be seen that the upper 3 dB roll-offs are 26 kHz and 35 kHz with Maxell low-noise tape. Signal/noise was 60 dB (at 0 VU) at 7½ ips and 63 dB at 15 ips. Distortion at 1 kHz, 0 VU measured 0.55%—better than the modest claim of 1%. Wow and flutter was 0.03% at 15 ips and 0.05% at 7½ ips. Input for 0 VU was 30 mV for line and 0.20 for mic. Maximum output at the line terminals was 1.2v at 0 VU. Fast winding time was 90 seconds for 1200 ft. and 120 seconds for 1800 ft.

Listening Tests

The 3340 was on test for a period of just over a month and gave every satisfaction. The controls were exceptionally easy to operate—in particular the stop button was absolutely positive, yet I never succeeded in breaking any tape not even 1 mil! Some 4-channel recordings were made using EV-RE 55 microphones and it was just possible to detect a difference between 15 ips and 7½ ips but it was very slight. The Simul-Sync facility worked beautifully and so did the monitor switches. These perform three functions, they allow you to monitor either the source signal before it is recorded, or the signal from the tape and in addition they select the signal to be displayed on the VU meters and routed to the headphone jack. This recorder is particularly suitable for the semi-professional user, small rock groups or studio use but it is also recommended to any enthusiast who requires a 4-channel machine with top performance. At $849 it is not cheap but in our opinion, well worth the money. *T.A.*

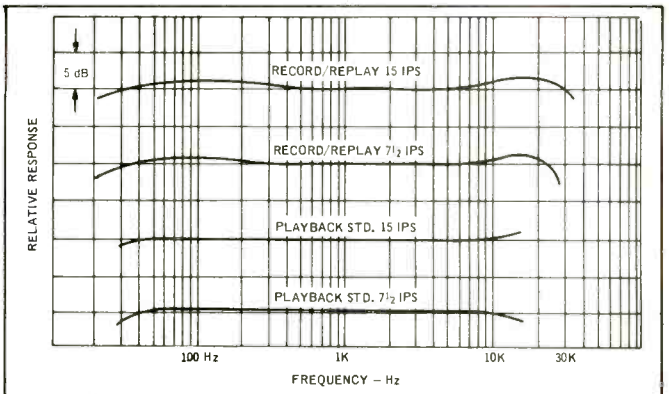

Fig. 4—Record/replay response using Maxell low-noise tape and playback response with standard tapes.

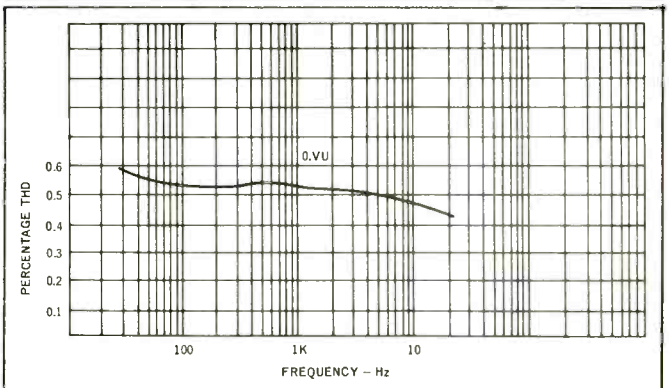

Fig. 5—THD v frequency

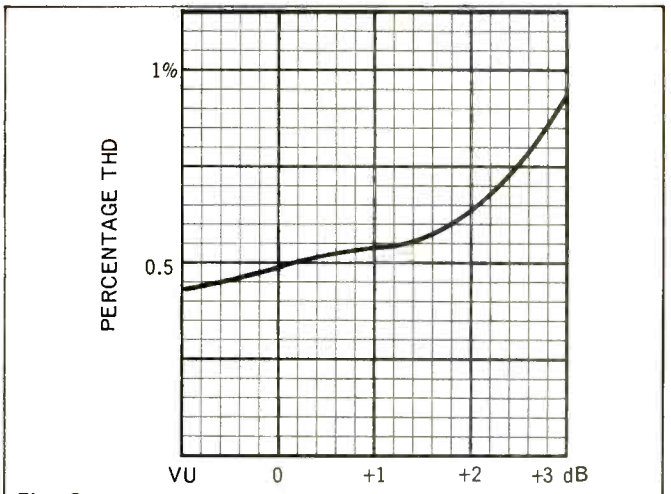

Fig. 6—THD at 1000 Hz

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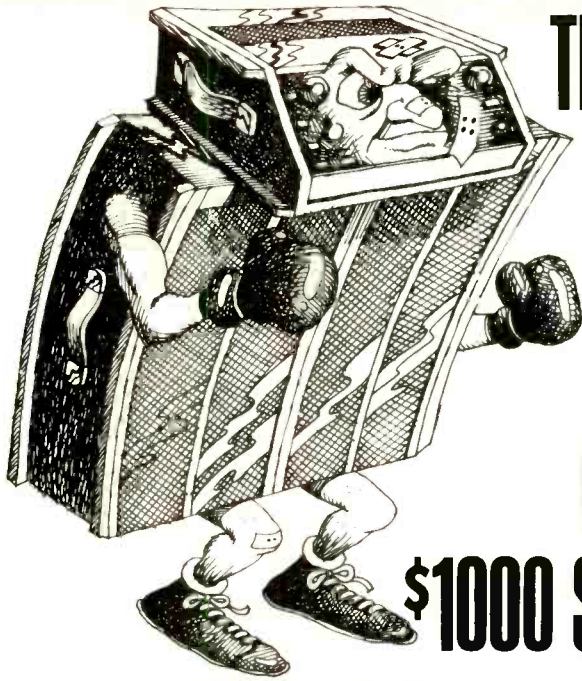

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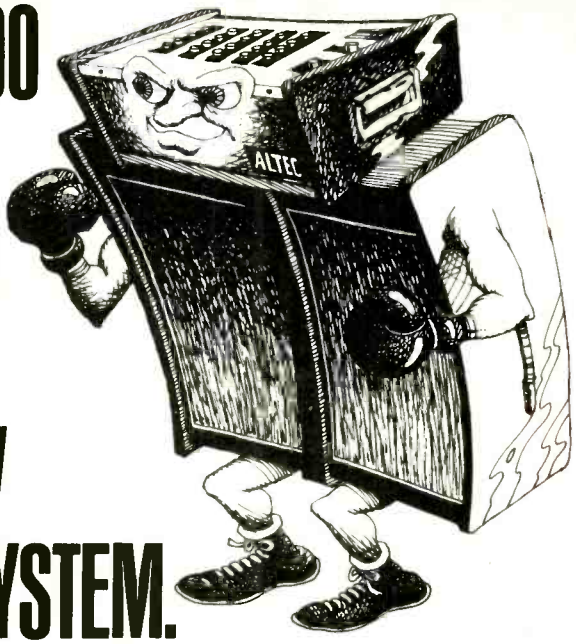

If you're into music, you and your group know there is one good $1000 sound system you can buy. That's the one we're going to call "theirs." Because we've just come out with "ours." We thought they should have a little competition. So we built our brand new $1000 Altec A-112 system. We think it makes theirs obsolete. Sorry about that.

START BY COMPARING THEIR 5 PERCENT DISTORTION VS. OUR 2 PERCENT DISTORTION. Their system is rated at less than 5 percent distortion. Our system is rated at less than 2 percent distortion. And you know what less distortion can do for you. It keeps the mud out of your sound.

COMPARE THEIR HAND WIRING VS. OUR MODULAR PRINTED CIRCUIT BOARDS. There's no comparison. Our modular plug-in printed circuit boards make for faster servicing and exchanges. It's that simple. Simple.

WHEN IT COMES TO REVERB, OURS OUT-REVERBS THEIRS BY A MILE. Theirs has a standard on-off reverb switch. So reverb is either on or off. Ours has individual reverb controls on each channel. So you can control the exact amount of reverb channel-by-channel. Ours also has an exclusive reverb lock that protects the reverb spring. So you can travel without boinging all the way to your next gig.

One more thing, ours has Altec's exclusive Shockcheck that eliminates ever getting zapped from a mike or amplifier. And Altec's exclusive Acoustic Feedback Control (with 3 position switches instead of 2 like theirs) that lets you compensate for room acoustics—and increase total gain before feedback.

TO BE HONEST ABOUT IT, THEIR SYSTEM HAS SOME THINGS THAT ARE AS GOOD AS OURS—WELL ALMOST AS GOOD. When it comes to the control consoles' input channels, theirs has 6 and ours has 6. But ours has an additional 7th auxiliary input for plugging in another mike or mixer or any newfangled thing you want.

NOW, LOOK AT THE COLUMN SPEAKERS FOR A MINUTE. In our new 1207B column speakers (the ones you get in our A-112 system), you know what kind of speakers you're getting. Standard Altec 8-inch, sweet-sounding 403A speakers. Six in each. A grand total of 12 Altec 403A's and a lot of sweet sounds. You see, we've been in the speaker business for more than 30 years. And we believe when you buy an Altec sound system you should get Altec speakers. And you do.

TO OURS, YOU CAN ADD-ON POWERED SPEAKERS—ALL THE WAY UP TO 20 OF THEM. You can start off with our new A-112 system (just as you buy it) and get 100 watts of RMS continuous power. Then anytime you want, you can add on up to 20 Altec powered speakers. ZOW. And at the same time, you can use your original columns for on-stage monitors. There's even a special monitor speaker volume control on the back. (Just part of our campaign against planned obsolescence.)

NOW FOR OUR FINAL POINT. THE ALTEC A-112 SOUND SYSTEM WAS DESIGNED BY THE SAME SOUND ENGINEERS THAT DESIGNED THE BIG, HIGH-POWERED, ALTEC SOUND SYSTEMS. It just makes more sense to us to have big designers design little things than little designers try to design a big thing. We hope that makes sense to you.

Write for our new musical sound equipment catalog that's right off the press. Altec Musical Sound, Department A, 1515 S. Manchester Avenue, Anaheim, Calif. 92803.

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Fisher Sound Panels (Model PL 6)

MANUFACTURER'S SPECIFICATIONS

Frequency response: 40 Hz-18,000 Hz. **Maximum music power**: 50 watts. **Maximum rms power**: 25 watts. **High frequency driver voice coil**: 1 inch. **Low frequency driver voice coil**: 1 inch. **Magnet structure**: 2.64 lbs. **Impedance**: 8 ohms. **Weight**: 21 lbs. **Dimensions**: 29¾ by 23¾ by 2⅞ inches deep. **Price**: $138.

Loudspeakers with flat diaphragms are not new and we well remember a British unit called the Midgely-Harmer which appeared on the market around 1936. It used a dural diaphragm with the voice coil mounted off-center to reduce resonances. The diaphragm was very thin and it was protected by a heavy chromium plated grille which looked so elegant that many manufacturers mounted the unit with the grille on the outside of the cabinet. This was a mistake because people were so intrigued by the metal diaphragm that they poked at it through the grille with pencils and knitting needles—with disastrous results! The sound had a metallic coloration and, all-in-all the MH system was not a resounding success!

Electrostatic systems use flat diaphragms—and then there is the Orthophase and the Audio Research Magnaplanar. But cones have many advantages for dynamic speakers in regard to rigidity, mass to strength ratio and so on. Expanded polystyrene seemed to be an ideal material for flat speaker diaphragms but it was soon discovered that this material had problems too. Internal friction was high and the transverse resonances caused severe irregularities in the response. Resin impregnation and aluminum skins helped to solve these problems and among the speakers using flat polystyrene diaphragms are those made by the British KEF. These units have a linear response up to 1 kHz and are used by a number of manufacturers here including Infinity, ESS and IMF. Another speaker using a flat plastic diaphragm is the Yamaha which, for some reason, is shaped like a human ear. The diaphragm is clamped at the edges and vibrates rather than moves in a conventional manner. Recent developments in quadraphonic sound have inspired speaker designers to take another look at flat speakers which might help to overcome some domestic objections to 4 speakers in a room. If two at least could be made inconspicuous, fine; but if they could be disguised as pictures that could even add to the decor—better still. And so Fisher have brought out the PL 6 Sound Panels with a wide choice in artistic design—contemporary, abstract or representational. They can be hung on the wall, built into room dividers or stood on the floor. The back is partially open so the sound pattern is roughly dipolar (Omni-directional at some frequencies). Two dynamic drivers are used, one mounted off-center for bass, crossing over at 2 kHz to a HF unit which is located at one corner. The diaphragm is made of expanded polystyrene clamped at the edges so the system is highly efficient. This diaphragm has

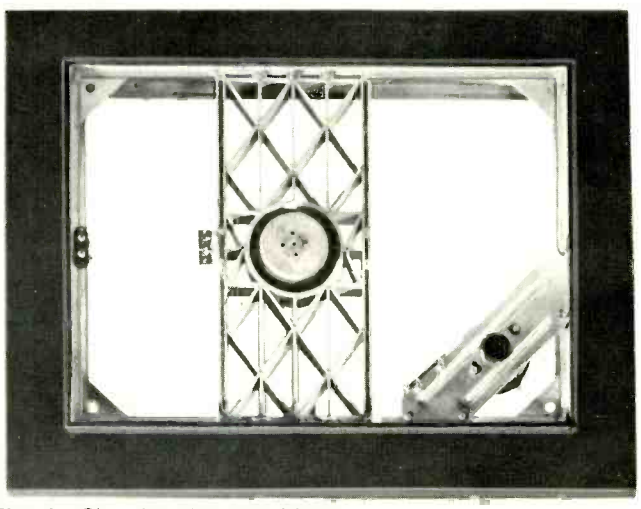

Fig. 1—Showing the two drivers

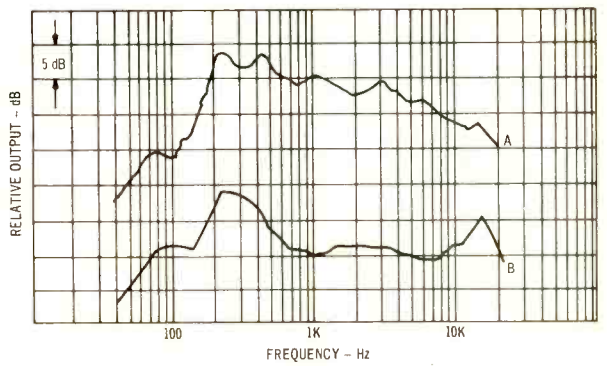

Fig. 2—Response measured with one-third octave pink noise. A was taken with the speaker 3 inches from a wall and B at 6 inches.

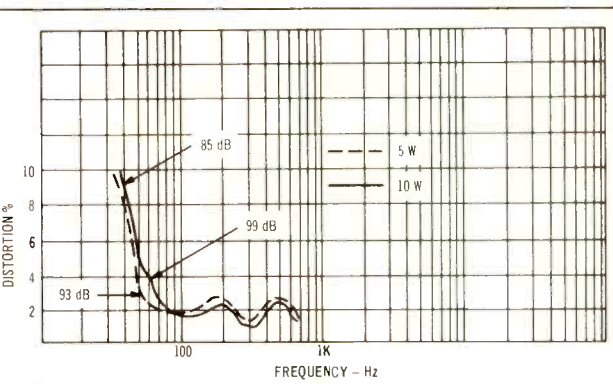

Fig. 3—Response measured with the speaker in the middle of a room. A on axis B at 30 degrees and C at 60 degrees off-axis.

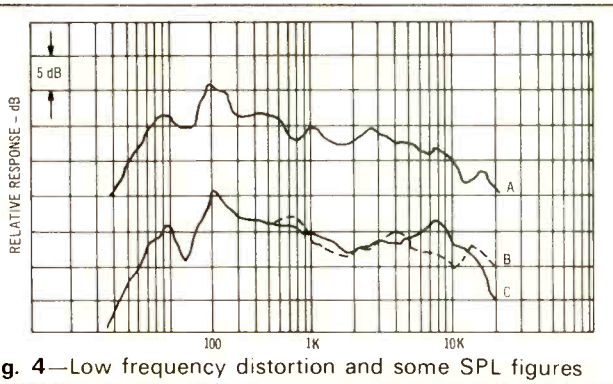

Fig. 4—Low frequency distortion and some SPL figures

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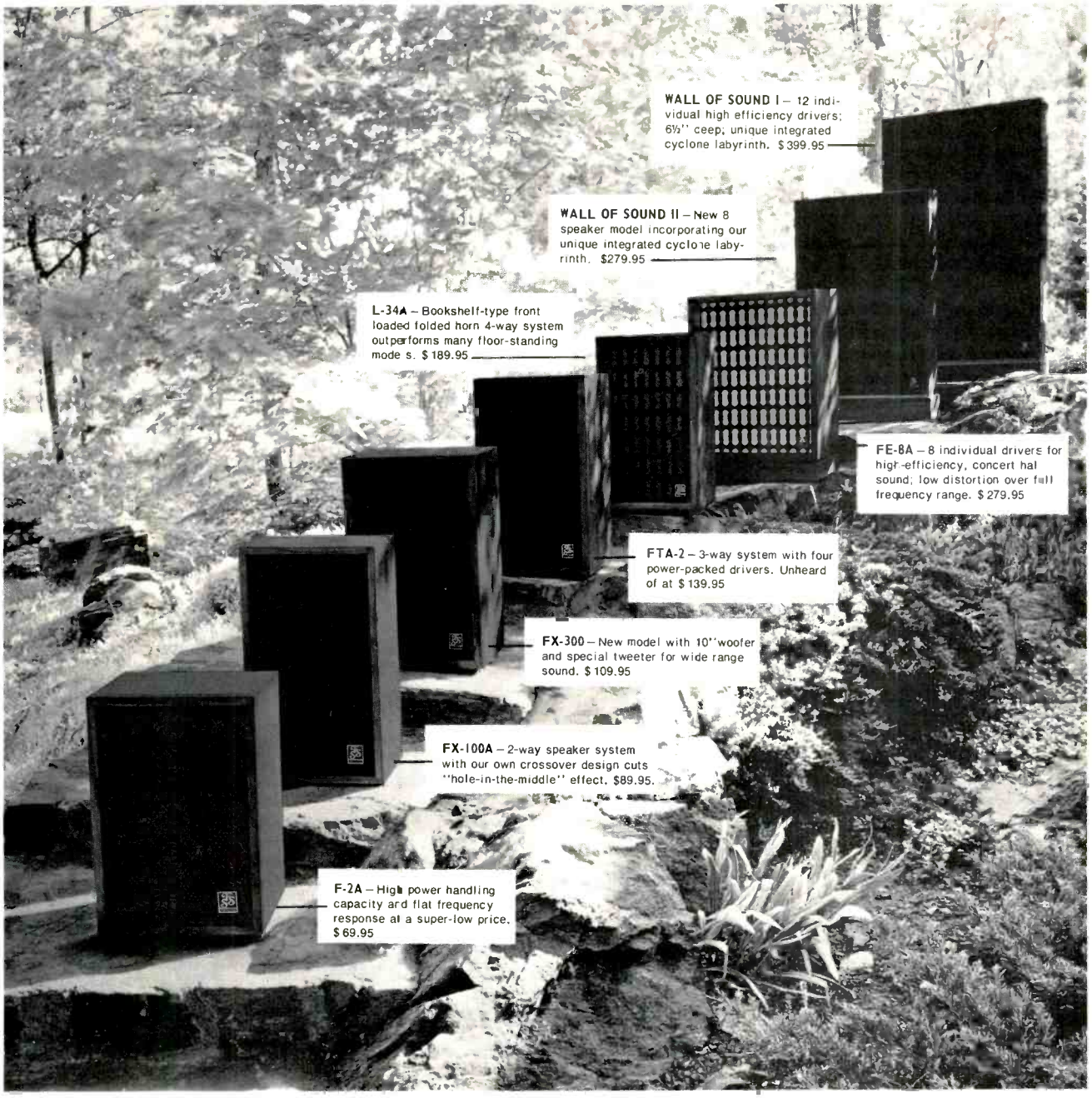

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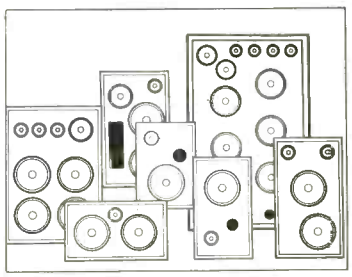

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Pittsburgh, Joseph Horne Music Ctr., 510 Market St.
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Pittsburgh, House of Audio, 929 Liberty Ave.
Pittsburgh, House of Audio, 2967 W. Liberty Ave.
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West Virginia
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Wheeling, James W. Black & Sons, 1206 Chapline St.

Wisconsin
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Janesville, TV Hi Fi Center, 117 W. Milwaukee St.
Milwaukee, Discount Records, 434 W. Wisconsin Ave.
Milwaukee, Hi Fi Fo Fum, 2532 W. Wisconsin Ave.
Milwaukee, Hi Fi Salon, 7204 W. Greenfield
Whitewater, The Golden Ear, 112 First St.

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The Stereo Set, 1737 Wisconsin Ave. NW

variable density and thickness but the secret, or shall we say piece de resistance of the PL 6 is the use of a non-linear compliance between the voice coils and diaphragm. It is made of a co-polymer in the form of a ¼ inch disc, slightly larger than the voice coil and its function is to equalise the response. Figure 1 shows the rear view before the diaphragm is mounted; both voice coils are four-layer and the diaphragm area near the treble unit is treated to improve the HF response.

Measurements

Figure 2 shows the frequency response taken with one-third octave pink noise. A was taken on-axis with the unit mounted 3 inches from a wall and B with the space increased to 6 inches. Figure 3 shows the response with the speakers in the middle of the room and 3A shows the radiation at 30 and 60 degrees off-axis. Low-frequency distortion and SPL measurements are given in the graphs at Figure 4 and the impedance curves are shown in Figure 5. It will be seen that the system resonance is just under 60 Hz. Tone-burst characteristics at 100 Hz, 500 Hz and 5 kHz are shown in Figure 6. White noise showed some mid-range coloration, not judged too serious.

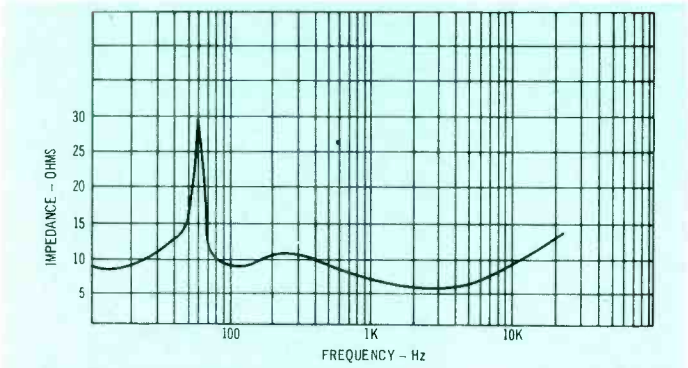

Fig. 5—Impedance characteristics

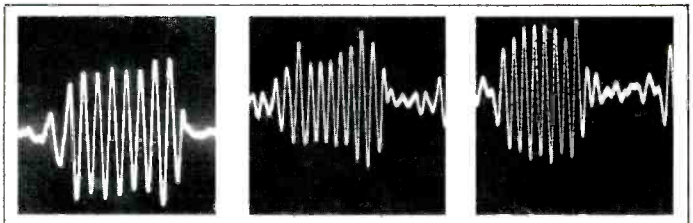

Fig. 6—Tone-burst characteristics at 100, 500, and 5000 Hz

Listening Tests

Having had considerable experience with thin, flat speakers over a long period, we were well aware of the difficulties. For one thing, it is not easy to get a reasonable bass response due to the inevitable cancellation. True, a large radiating area helps but it would have to be very big indeed to produce a good output below 100 Hz. So we thought—but we were wrong. When we first heard the Sound Panels we knew about the flexible coupling but, well—we were somewhat skeptical. And so we were amazed at the healthy bass response—the coupling gadget really works! In fact, if the unit is placed in a corner, some people would find the bass too prominent. A useful output was obtained down to 38 Hz and the system would handle 62 watts at 40 Hz and 75 watts at 100 Hz without audible signs of distress. Instructions call for a spacing of at least 3 inches from a wall and under these conditions there was an appreciable loss of low frequencies (see Figure 7). This could be compensated for by judicious use of the tone controls. Better balance was obtained with the units standing on the floor (suitable feet are provided) although some treble lift might be desirable in some rooms. Sensitivity was 3 to 5 dB higher than average so they could be used in a quadraphonic system or conversion, with a small amplifier for rear channels.

How does it compare with conventional systems in the same price class? Well, at low levels many listeners thought the PL 6's had a more open quality but at high power levels the cabinet systems were clearly superior. On the other hand, the Sound Panels do have considerable advantages and they only need 6 to 8 watts for quite large rooms. *T.A., G.T.*

P.S. You might ask, "How about those wires running up the wall?" Fisher have thought about that too and they can supply flat conductors that can be painted to make them "invisible".

Magnavox 8898

MANUFACTURER'S SPECIFICATIONS

FM TUNER SECTION

IHF Sensitivity: 3.0 μV. **S/N Ratio**: 50 dB. **THD (Mono)**: 1.0%. **Selectivity**: 60 dB. **Capture Ratio**: 4 dB. **Image Rejection**: 75 dB. **I.F. Rejection**: 100 dB. **Spurious Response**: 75 dB. **AM Rejection**: 35 dB. **Stereo FM Separation**: (1 kHz) 35 dB.

AM TUNER SECTION

IHF Sensitivity: 400 μV/M. **Image Rejection**: 40 dB. **I.F. Rejection**: 30 dB. **Selectivity**: 20 dB.

AMPLIFIER SECTION

Continuous Power Output: 50 watts/channel. **Rated THD**: 0.5%. **Rated IM**: 1.0%. **Power Bandwidth**: 15 Hz to 20 kHz. **Damping Factor**: 30. **Hum and Noise**: Phono, 60 dB; Aux, 75 dB; Tape Monitor, 75 dB. **Input Sensitivity**: Mag. Phono, 2 mV; Ceramic, 150 mV; Aux, 150 mV; Tape Monitor, 400 mV. **Frequency Response**: 20 Hz –25 kHz ±1 dB.

GENERAL

Dimensions: 18 in. W. x 5¼ in. H. x 14½ in. D. **Maximum Power Consumption**: 300 VA. **Price**: $479.95 (minimum retail price, applicable in fair trade states).

The Magnavox 8898 Receiver is the first entry in the component high fidelity field by a firm that had, since its inception, steered clear of this segment of the home entertainment market. We must admit, at the outset, that the mere name suggested "console" design philosophy and compromises all too familiar to the knowledgeable audio enthusiast. After objectively measuring and testing this first unit, however, our fears were dispelled.

Evidently determined to enter the component world with a bang and not with a whimper, Magnavox has come up with a handsomely styled, amply dimensioned receiver that sports by far the largest digital readout system we have thus far encountered. The upper portion of the front panel is "blacked out" until power is applied; when *either* AM or FM is se-

"Leave it to Radio Shack to make a 4-channel receiver with a remote control that's really useful! Pre-set your 6 favorite FM stations, control tuning AND volume from your easy chair. And it's wireless too!"

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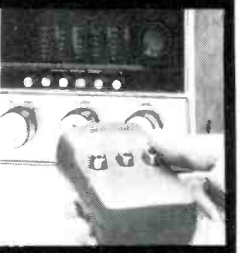

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The most powerful, most innovative receiver we've EVER offered! Accepts every kind of source — reproduces every kind of sound. Has power and plugs for 8 separate speakers — enough for stereo or 4-channel anywhere you want it! The Accu-Balance™ slide controls balance left, right, front and rear just the way you like, the Perfect Loudness™ adds the right amount of bass for any listening level. There are front panel jacks for stereo or 4-channel headphones; bass, treble AND midrange tone controls, more! Our wireless remote control is a "miracle" of space-age design. Stop in, see it and hear it at any of our over 1600 stores in all 50 states!

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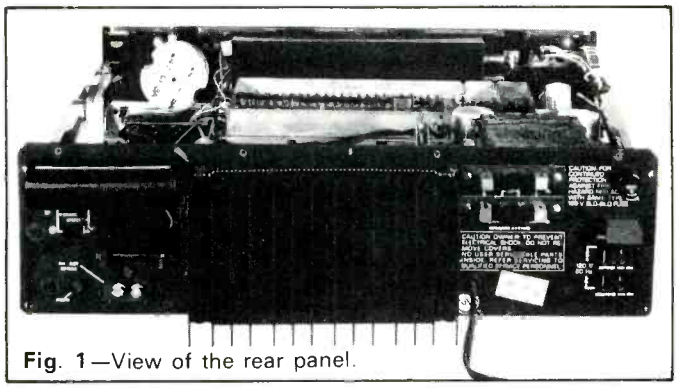

Fig. 1—View of the rear panel.

lected, red numerals measuring over one inch in height appear, denoting the frequency to which the receiver is tuned. Tuning is accomplished by a massive 1½ in. knob at the right which is coupled to a flywheel. In the FM mode, the letters FM-MHz also appear alongside the numeric readout, while in AM, the letters AM-KHz appear alongside the numbers. The upper portion of the panel also contains a pair of speaker push-button switches of the push-push variety, enabling sole use of the headphone jack, located just below, when neither the "A" or "B" speaker switch is depressed.

The lower portion of the panel has a walnut-finish decorative inset section. At the left are six chrome plated "piano key" switches governing such functions as TAPE MONITOR, STEREO/MONO Mode, MUTE, LOUDNESS, and HI CUT and LO CUT Filters. As these switches are depressed, appropriate illuminated words appear in an otherwise blacked-out area above them. The four rotary controls which follow are for adjustment of BALANCE, VOLUME, TREBLE and BASS. Finally, at the lower right, there are five more "piano-key" switches. The first, colored red, applies power to the unit while the others (again chrome plated) select program sources. These last four are of the interlocking type so that only one can be depressed at a time.

The rear panel, shown in Fig. 1, is equipped with the usual input and tape monitor in and out jacks. A switch located below the phono input jacks selects the proper pair of jacks for either magnetic or ceramic cartridges. Below the pivotable AM loopstick antenna are a pair of screw terminals for connection of a 300 ohm FM antenna transmission line. The entire center section of the rear panel is occupied by a large, ribbed heat sink while to the right are color coded, spring-loaded terminals which make speaker cable connection easy and short-circuit-proof, since the stripped ends of the speaker wires are simply inserted in holes which are exposed when the terminals are depressed. A line fuse is located just above the convenience a.c. outlets, one of which is switched—the other unswitched. Finally, borrowing from one of the good design points in "console" manufacture, Magnavox has included a "changer power" receptacle. Changers equipped with a matching three-terminal plug (and Magnavox changers are so-equipped) can be connected to this receptacle instead of to the usual standard a.c. receptacle. When so connected, the record changer's automatic shut-off switch also shuts off power to the receiver after the last record has been played. As supplied, the receiver is fitted with a shorting plug so that normal operation of the front panel power on-off switch takes place even if such specially equipped record changers are not used with this receiver.

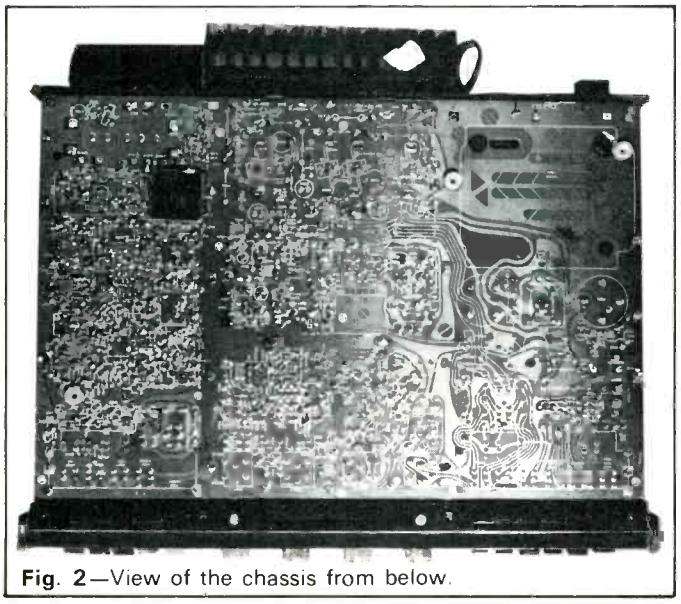

Fig. 2—View of the chassis from below.

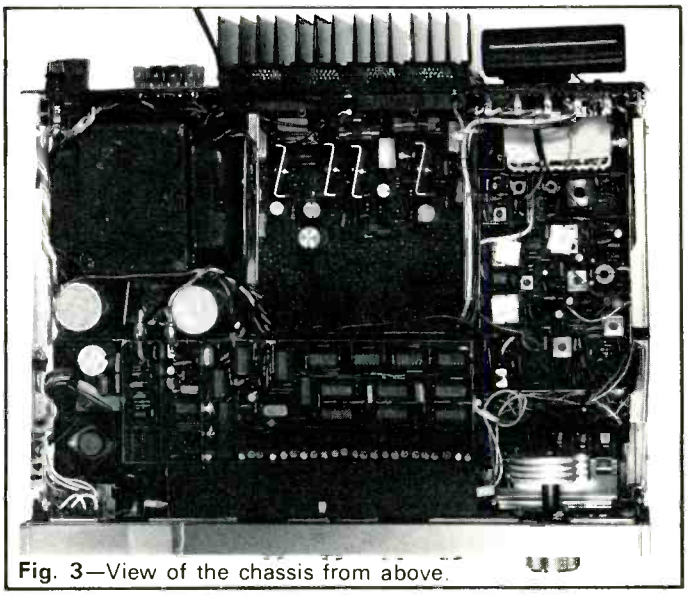

Fig. 3—View of the chassis from above.

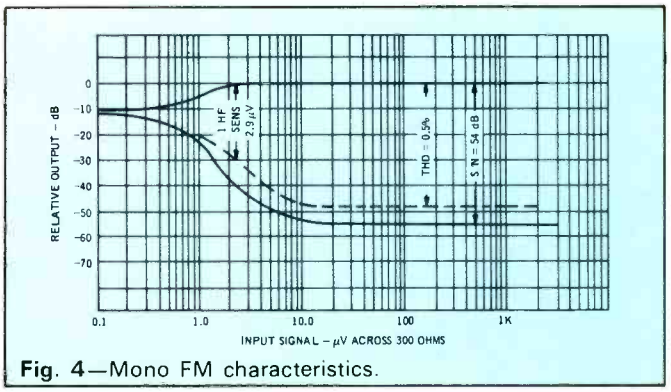

Fig. 4—Mono FM characteristics.

Circuitry and Layout

The Magnavox 8898 receiver is built on a foundation of what is probably the largest single p.c. board we have yet seen, as shown in Fig. 2. Despite its size, however, there seems little danger of breakage, since the board is well "anchored" to its supporting chassis frame. As can be seen in the top view of Fig. 3, an additional p.c. board, equipped with a variety of IC's, is mounted "piggy back" above the main board and takes care of the digital readout functions.

R.f. circuitry includes a MOSFET r.f. amplifier stage and four tuning sections in a conventional variable capacitor arrangement. Thus, the local oscillator is quite conventional and unrelated to the digital readout system. The digital circuits

merely "read" the frequency of the oscillator and, in effect, subtract 10.7 MHz from that reading to give a display which corresponds to the incoming r.f. frequency. In short, all the extra IC's and the read-out tubes simply replace a conventional dial pointer and calibrated dial scale. This nicety is not to be confused with other digital systems which control oscillator frequency through the use of phase-lock-loop circuits, etc.

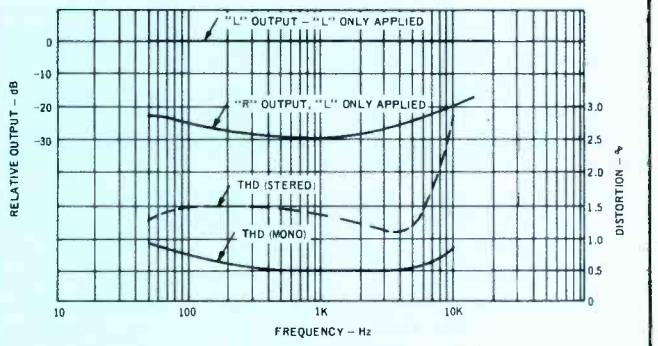

Fig. 5—Stereo separation and distortion characteristics.

IC's are used in the FM and AM i.f. circuitry, as well as in the stereo multiplex circuits and the phono preamplifiers. Output circuitry is direct coupled and of the quasi-complementary type. Output transistors are fused and there is a thermal cut-out switch on the main heat sink and a current limiting circuit for the output stages.

Electrical Measurements

The manufacturer's specifications listed above are said to be "minimum" specifications and in most cases this turned out to be ture. Nevertheless, examination of them will disclose that they do not represent the kind of "state of the art" numbers that we have been accustomed to seeing lately. For example, the ultimate S/N in FM is stated as a minimum of 50 dB. Our actual measurements gave a reading of 54 dB, as shown in Fig. 4. While this is certainly a quiet enough signal for ordinary FM listening, it falls short of the "critical listening" kinds of readings we have been observing on other recently designed receivers. Some 60 dB or better has been the norm, with exceptional units often producing 65 or even 70 dB of ultimate S/N. It should be pointed out that the residual content at –54 dB observed on this unit consisted primarily of power supply hum components rather than wide-band noise. THD in mono FM on the other hand was a very respectable 0.5% as claimed and, as shown in Fig. 5, the THD in mono never exceeds 1.0% at any audio frequency of listening significance. IHF sensitivity measured 2.9 μV, a bit better than claimed.

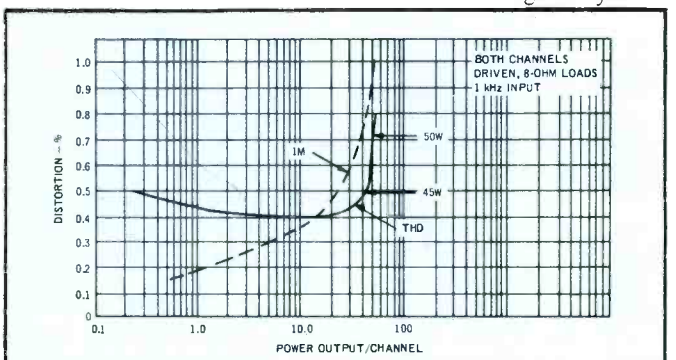

Fig. 6—THD and IM characteristics.

Stereo FM separation fell a bit short of claims, measuring 30 dB at mid-band and decreasing to 20 dB at 10 kHz and

about 23 dB at 50 Hz. THD in stereo FM was also quite acceptable, remaining under 1.5% from 50 Hz to about 6 kHz. One thing that can be said for the digital readout scheme as used in this and other receivers we have tested is that "calibration" is perfectly accurate. Because of the crystal "clock" reference used in these counting circuits, when the readout reads 103.5 you can be certain that that is the exact frequency to which you are tuned. Of course, the readout is given in increments of 100 kHz (0.1 MHz) so, in theory, you could be off by as much as 50 kHz in either direction, but we found that as you approach the next tenth of a MHz there is a tendency for the last digit to pulsate between the two alternate tenths, giving you the clue that you are perhaps too close to the next tenth of a MHz. With this type of readout method, however, we still feel that a center-of-channel meter or some other center-tune indicator would be useful and competitive receivers in this price category usually offer such a meter.

With both channels driven, we were able to obtain 46 watts continuous output per channel at 1 kHz before reaching 0.5% rated distortion. Rated power output of 50 watts per channel was reached with a THD of 0.7%, as shown in Fig. 6. At all power levels tested below 46 watts per channel, THD never exceeded rated values of 0.5%. IM distortion, also plotted in Fig. 6, was quite low at nominal listening levels but tended to rise a bit sharply above 20 watts, reaching the 1.0% rated value at exactly 50 watts per channel.

At half-power and one-watt levels, THD remains below 0.5% for all audible frequencies, as shown in Fig. 7, while power bandwidth extends from 20 Hz to just above 25 kHz, as claimed and as plotted in Fig. 7. Fifty watts per channel was used as the "0 dB" reference in these measurements.

Tone control, loudness and filter characteristics for the Model 8898 are plotted in Fig. 8. Both filters have a slope of 6 dB per octave, but since the cross-over points are at about 100 Hz and 4 kHz their effectiveness is greater than that which might be obtained by simply rotating both tone controls clockwise to get rid of rumble and/or record scratch and noise. The loudness compensation characteristic for a –30 dB setting of the volume control is also plotted in Fig. 8 and Magnavox has elected to compensate slightly at the high end, in addition to the usual boosting of the low end.

Listening Tests And Additional Operating Features

The Magnavox 8898 receiver was subjected to approximately two weeks of normal use and performed well during that time. For our low efficiency speakers, power was ample and sound was generally clean. We found station tuning to be a bit critical, particularly on AM, where even slight rotation of the tuning knob results in a shift of frequency of several kHz (one full turn of the knob moves the frequency over 100 kHz, which means that resolution accuracy of 1 kHz in AM tuning requires being able to resolve 1/100 of a full rotation of the knob).

When the mute and stereo switches are actuated together, the receiver will allow only stereo signals to be heard while in the mono mode, the mute switch performs as strictly an inter-station noise supressing circuit. Mute settings are not adjustable by the customer and, in our model, muting was overcome at just under 10 microvolts of signal strength. Tuning drift was minimal and did not shift frequency enough to cause audible distortion in either AM or FM after a few minutes warm-up.

We logged 42 acceptable FM signals with the aid of our out-door antenna aimed westward (towards New York City). Of these, 21 were stereo transmissions. AM reception was average, with sensitivity a bit lower than expected, though bandwidth seemed adequate.

We examined the instruction booklet in some detail and found it easy to follow and well organized. We did discover another feature which had escaped our attention when we measured the receiver on the test bench. Just under the stereo indicator light, in the right-hand section of the blacked-out dial area is a second indicator identified in the instruction booklet as the OVERHEAT INDICATOR. This lamp is associated with the thermal cut-out switch near the output transistors and, of course, it did not become illuminated during our normal tests. In order to see it work (and to confirm its effectiveness), we took the unit back to the test bench, hooked up 8-ohm loads and fed a moderate signal to the receiver while at the same time short-circuiting the speaker output terminals. After a few minutes—sure enough the front panel indicator did become illuminated and the current drive was removed from the output stages—protecting the output transistors from accidental failure. The presence of the light is a good indicator to the consumer that something is wrong, even though no permanent damage has been done.

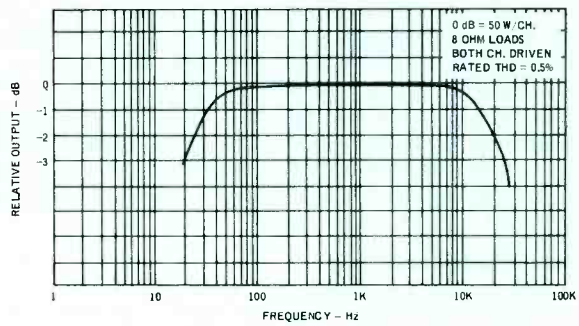

Fig. 7—THD vs. frequency at various power levels.

Summary

As a first effort, this Magnavox unit certainly qualifies as a high-fidelity stereo component receiver. While the digital readout feature adds to the cost while providing no real audible benefit, this is probably off-set in part by Magnavox's ability to produce large runs of a product efficiently and economically. Specifications, both published and confirmed, are good though not spectacular, particularly in the FM section. From a listening point of view, however, the unit performs quite well. We would like to see future products with lower overall distortion in the audio section and better quieting characteristics in the FM portion. *Leonard Feldman*

Check No. 73 on Reader Service Card

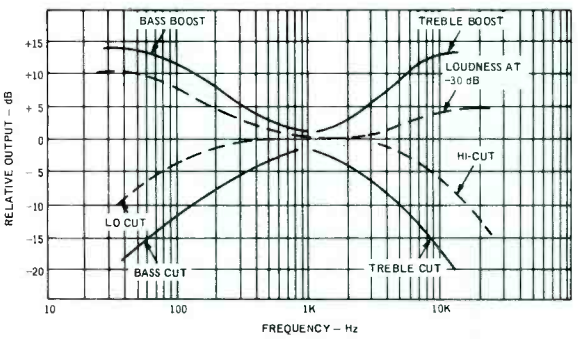

Fig. 8—Tone control characteristics.

Correction

The price of the ESS Mk VII Speaker System is $229.00, not $299.00 as stated in January Audio which makes it an even better buy for the money.

(Continued from page 4)

Equalization Standard

Q. I own a Uher 4400 Report stereo portable tape recorder. This machine was purchased overseas, and I have a feeling that the equalization curves may conform to the European (CCIR) rather than the U.S. NAB standard. I note that, particularly at the 3¾ ips speed, the machine tends to attenuate the highs and slightly boost the bass. Although less evident, the same problem occurs at 7½ ips. I have discovered that tapes recorded on this machine do not display the same imbalance when played on other machines. Can you tell me whether it is possible to adjust either the equalization or bias frequency in order to correct this problem.—David R. Kidd Jr., Lenox, Mass.

A. Regardless what equalization is used, a properly designed and adjusted tape machine should give you flat record-playback response. Inasmuch as tapes recorded on your machine sound O.K. when played on other machines, the problem appears to lie in the playback equalization of your machine. Changing the tape you use would be of no appreciable help now would change of bias level (nor frequency). I suggest that you take your machine to an authorized service dealer and have him check and adjust the playback equalization. Of course, all this is based on the assumption (per your letter) that tapes recorded on your machine do play back correctly on other machines.

Applying Equalization

Q. I have recorded about 60 LP's at 7½ ips directly from the magnetic cartridge into the microphone inputs of my tape recorder, without any phono equalization between the cartridge and recorder. Can I equalize this material by playing my recorder at a low level into the phono input of a preamp?—Robert Colvin, Hayward, Calif.

A. Yes, you can apply phono-equalization to the output of your tape recorder's playback preamp and come out with proper frequency response. However, the ultimate playback signal may contain excessive distortion. Substantial treble cut should have been applied to the output of the phono cartridge. In the absence of such cut, the excessive signal level at treble frequencies may have overloaded the record amplifier of the tape machine and/or the tape. Keep in mind that in recording, a substantial amount of treble boost is applied to the audio signal.

(Continued on page 92)

Stravinsky: Le Sacre du Printemps. London Symphony Orch., Bernstein. **Columbia MQ 31520** quadraphonic $6.98.

Tchaikowsky: Swan Lake Ballet Suite. New York Philharmonic, Bernstein. **Columbia MQ 30056,** quadraphonic, $6.98.

I sometimes wonder, as I listen to matrix quadraphonic of this classical sort via Columbia's full-logic SQ (which at this moment I am giving an extended listen-to over a long period of time) whether the creative experts who combine their immense talents to put forth these discs are really able to envision the public's primitive reaction to their finished product. There is so much talk of technicalities, not to mention spirited argument and even corporate battles, that—on the inside—one can quickly bog down in quadrants, j factors, f'—f' and a thousand more such, quite aside from the merits of matrix vs. discrete. What the public hears, we *must* remember, is music. If the trumpet shrieks and the horns blat rightly in *Sacre*, if the sound is vivid and the liveness spacious, then who cares which quadrant they come from! It really doesn't matter.

Odd, because Columbia has produced a kind of benign contradiction here. *Le Sacre*, if I am right, was done as a deliberate revolutionary experiment in multi-track surround recording, à la pop music, though simultaneously performed. The conductor was in the middle, the instruments ranged in big families all *around* him, both front and back, and the music was taken down in eight tracks for later remix into four (and presumably two for stereo). On the other hand, *Swan Lake* was, if I guess correctly, done more conventionally—if I may use that term. That is, the intention, whatever the actual instrumental set-up, was to create a sense of front spread, with the sound all around, in terms of reverb (as in many live situations) but *not* the instruments themselves. I.e., you are supposed to hear the orchestra out in front and the concert hall all around you. Big difference.

OK—so what do we hear?

What I heard first of all, on direct AB comparison, was simply a big difference in liveness. *Le Sacre* is recorded in one of those swimming pool or arena-type halls, an enormous resonant space in which the sound goes 'round and 'round. *Swan Lake* has a more conventional and lesser liveness, standard classical style.

Now I ask you, in an indoor swimming pool can you tell from which direction a joyful child's shriek comes, among dozens of others? You cannot. Yes, I get a sense of contrasting placement in *Le Sacre* and it is good. But in this vast reverberation I really can't spot the quadrants! Nor do I care one way or the other. There's just enough separation of brass, strings, winds, so you hear them dramatically differentiated—but where they come from isn't important. The sound IS, however, all around you and marvelously so. You can face any old direction. You are immersed in the great orchestral battering ram, if I may mix an improbable metaphor. That's good. I loved every minute of it. I have never heard *Le Sacre* with such an immediate and dramatic living-room impact. Even though I felt that Bernstein flagged a bit towards the end; and that last little musical dribble, before the final explosion, didn't come off at all. Low voltage.

In *Swan Lake* the liveness is less extreme; therefore the separation is more concrete. Yes, the music is out in front. You will do better (if you try) by facing forward than by turning around to face the rear speakers. (One is vaguely conscious of the out-of-phase element in the SQ rear, which merely makes it sound more like the back of a hall. Quite proper and musical.) Yes, in normal fashion the omnipresent higher strings are off to the left and you hear them in front, though they are loud in the back speakers too, if you try separately. Yes, the hall sound is very much all around you. Not surround-*instruments*. Surround-*hall*.

Now what strikes me as significant is that, for the average well trained stereo listener, these two discs do not sound radically different. Instruments all in front? Instruments lined up around the four walls of your room? You aren't even going to notice. The *visual* contrast would of course be enormous—just imagine it. But in pure sonic listening, it dissolves away and is no more than a contributing factor to more forward impressions.

In both recordings what you hear first of all is surround sound. Even though, of course, that impact *is* a product of the recording technique. Other things follow along—liveness, clarity of the fi, instrumental balances and—bless us!—the performance and the music itself, all as primary conscious listening factors. Exact instrumental placement, I am quite certain, is last on the list. Not unimportant! But it rates as an unconscious influence, vital in the recording technique but not to be noticed *as such* in the listening. In other words, an art.

Columbia doesn't say a word on the records about specific recording techniques. Right. Let the music speak for itself, via four loudspeakers in one living room. Let the quadraphonic experience *define itself*, in its own terms. Ably assisted, of course, by us

record critics. How we do go on . . .

I'd like to hear an alternative *Le Sacre* in a much drier recording place, with this same all-around instrumental placement. Then you would more consciously notice it, which would be interesting. After all, this piece isn't a classical golden oldie. It can, and should, take a harder, drier modern studio sound as an alternative to the swimming pool treatment.

Performances: B; A– Sound: A–; A–

Shostakovitch: Symphony No. 15 (1971). Philadelphia Orchestra, Ormandy. **RCA ARD1-0014,** quadradisc, $5.98.

Fifteenth! Will the man never stop? Haydn wrote more than a hundred, but his were short and precise. Shostakovitch goes on and on.

This one has plenty of virtues. First, it is one of the shorter ones, relative to, say, the mammoth Seventh (Leningrad). Second, it definitely marks a returning point, a kinship with his First, that wonderfully snazzy, dry opus that launched the very young Shostakovitch's world career back in the thirties. This Fifteenth is a bit like Beethoven's Eighth, also a concise work that referred back to earlier styles but in a more complex and concentrated fashion. I like this aspect. I like the dry, early-thirties sound here, refreshing in Shostakovitch's always expert orchestration.

Third, curiously, this is a quote piece. Right away we hear the Lone Ranger —that is, the theme of Rossini's familiar *William Tell Overture.* Then a bit from Shostakovitch's Seventh and other quotes from a whole galaxy of earlier Shostakovitch works, or allusions to them. In the later stages there is a remarkable series of references to, of all composers, Wagner: more than one, including the tell-tale rising interval of the beginning of Tristan.

Fourth, this is very much a solo, or concertante symphony, sparely scored, full of small groups of instruments and solos. Excellent, especially on disc.

It's not really very short, only relatively so. Don't expect this composer to write briefly! But the length here is, shall I say, palatable. I like the music, though I do not think it is world-beating masterpiece. Bartók can say more in ten measures than S. in a thousand.

Quadradisc? Well, at least it sounds fine on standard two-channel stereo. Also via Columbia SQ matrix decoding. Why not! RCA has done very well in approaching conventional LP standards here, after a not very auspicious beginning in the early prototype CD-4

Edward Tatnall Canby

CANBY'S CAPSULES

Miracles. Yma Sumac. Prod. by Les Baxter. **London XPS 608,** stereo, $5.98.

Remember Yma Sumac? No—not a shrub, a singer. Peruvian gal with voice that goes from low tenor growl to top soprano squeak. Five-octave. Nobody ever wrote much of interest for same—so Les Baxter et al. "produced" stuff for her debut in 1950; she is still growling, squeaking. Here, she is updated with rock-style commercial background, carloads of reverb; she goes lala, whee, doo-doo-doo, wow-wow, in all four registers, sings duet with self. Unutterably boring. Too bad—a nice instrument and she doesn't know what to do with it.

Ives: Symphony #2. London Symphony, Hermann. **London SPC 21086,** stereo, $5.98.

Bernard Hermann has been an Ives champion, an excellent hardworking conductor (remember, on radio?)—this is a persuasive version, the Britishers really getting into it. Early Ives, a bit warmed-over Brahms and Franck (sometimes *two* Brahms at once in different keys) plus beginnings of famed Gospel/band stuff that Ives mixed into his "classical". Ill-digested music, but warm and honest as well as skillfully scored. Fun.

An Evening with Scott Joplin. Assorted artists. **(Concert, N.Y. Publ. Lib. Available via the Library)**

Scott Joplin, "King of Ragtime" from turn of the century, was a highly musical black composer, all right—but such an elegant fuss here! Full-dress concert, *very* high brow; ragtime in deadly earnest, sounding like rarified Chopin, on a vast grand piano. If Joplin played like *this,* I'll eat my ancient hat! The unperformed 1911 opera, *Treemonisha,* comes off a lot better, in excerpts, thanks to a very lively chorus. It isn't "legendary" at all—much nicer than that: clean, simple, friendly little tunes, the solos rather G & S, the choruses loosening into Stephen Fosterish, with a bit of light Brahms added, and a lot of "doo-dah"—type clapping. Good! An early Porgy & Bess, it got tragically nowhere. But let's not make it heavyweight! Done rightly, it would make a splendid stage show now.

Arthur Berger: Three Pieces for Two Pianos (1962); Chamber Music for 13 Players (1956). Richard Donovan: Music for Six (1961); Five Elizabethan Lyrics (1932-57). P. Jacobs, G. Kalish, pfs.; Instrs. cond. Gunther Schuller; Adele Addison, sopr., Galimir Str. Quartet. **CRI SD 290,** stereo, $5.98.

A former Columbia release, this beautifully done disc features two mild-mannered older men (I met both!) whose musical bite is *much* less mild than their bark! Wow. Berger's pianos sound as tho played by power-steel fingers—crrrash bang! But nice, tho startling, with bits of John-Cage-like prepared piano noises mixed in. A gorgeous piano sound—no less. His Chamber Music is a mathematical marvel, retro-played, finely tuned in bleeps and blats. Donovan's gentler "Music for Six" is dry and blatty, too, but humorous, with vulgar U.S. tunes mixed in for fun, a pleasingly desicated spoof, very skillfully written. Addison sings the very high lyrics in little-girl tiny voice, beautifully in tune; but top notes are a struggle. Quite lovely songs. A fun-shock record, this.

Arnold Elston: String Quartet (1961). Gordon Binkerd: Cello Sonata (1952?). Pro Arte Quartet; Rog. Drinkall, cello, Rich. Corbett, pf. **CRI SD 289,** stereo, $5.98.

These two older Americans offer sterner, more academic stuff—but I like both works, and enjoyed them even more the second time. Elston's quartet is American-style Schoenberg, wholly atonal (tho not without "theme" ideas), yet much more solidly feet-on-ground than the frenetic Schoenberg himself. A very polished quartet technique, beautifully written out for string sonorities. The Cello Sonata (Binkerd can't remember just when he wrote it) is "tonal", begins, ends, emphasizes key tones, uses tonal-suggestive figures (lots of thirds) but is otherwise dissonant-lyric. A splendidly musical performance—best cello I've heard in a long time, and excellent piano too.

The New Messiah by George Frideric Handel. Revelation Philharmonic Orch., One Experience Choir, et al. **Columbia KC 31713,** stereo, $6.98.

Well, well—a psychedelic (or something) "Messiah!" All the old tunes (quite a few, anyhow), with rock beat added, plus extra segments *not* envisioned by Handel. It would be just awful, if it weren't done with such verve and excitement; I do believe these kids (mostly) have *discovered* "Messiah"—the music that Handel wrote, that is—and have given it their highest compliment, conversion to Jesus Superstar. Well (cynic, you), maybe it is just a commercial try on a big scale. But they do sing with fervor, and quite a lot of it *is* Handel, rock or no. I got all the way through both sides. And I'm a *(sigh)* purist!

Man of La Mancha. All-Star Cast from Broadway, Hollywood and Opera. **Columbia SQ 31237,** quadraphonic, $6.98.

I was especially sent this by BB (the originator of SQ) as his favorite example of the SQ art, and I so recommend it to you, from the horse's mouth. Not from personal experience. Sorry, but this is one kind of music I just cannot listen to. No offense—those as likes it likes it! Plenty of you do, and it should be great in quadra—I almost said quad.

(When will the Quad amplifier people break down and let us use that obvious one-syllable term! It should join kodak and victrola and coke, if they'll be nice and let it.)

quadradisc demonstrators. This makes a perfectly good stereo disc, very compatible. As for discrete four-way playback, I wouldn't know. Nobody has yet told me of a decoder I might use, to listen discretely. I'm waiting. While I try one matrix decoder after another, all floating in my direction without the slightest effort on my part. Very curious—for we all would *like* to hear RCA's best four-way sound, you may be sure. (Maybe by the time this appears in print I will be hearing it. Who knows?)

Performance: A—Sound: B (2-channel)

Schumann: Davidsbündlertänze. Brahms: Sonata No. 1. William Masselos, piano. **RCA LSC 3291**, stereo, $5.98.

William Masselos is one of those young pianists (he is now getting on towards middle age) who are just "around", year after year, doing excellent and workmanlike jobs but not exactly hitting the big time. It is startling, then, to find this man a real powerhouse genius on records. RCA obviously thinks so. Why isn't he "celebrated"? Probably, I would say, because there are pianists who are modest in everything *but* their music itself, without fancy charisma, and he is apparently one of them. Other pianists have the gift of big show and these are the ones who grab the spotlight. But on records, all is equality! Masselos comes into his own.

His Schumann is astonishingly good, and his Brahms is just as good. Schumann is really tough for any pianist these days, not the notes but the expression. The middle generation pounds him out drily, and fails; the very young go all moony and romantic, and also fail, for Schumann is not as soft as they think. Masselos has an edge of modern hardness to him, entirely approproiate to his age and training. But his Schumann is big, dramatic, imaginative, beautifully shaped with never a false emotional tone—some feat, and few can do it. Often, he is as suddenly powerful as Rachmaninoff himself, but with the intelligence of a Schnabel. Great man! He really grabs at you. His Brahms, that youthful, exuberant Brahms aged 19 or 20, is perfectly proportioned too, full of reckless youthful spirit and yet as disciplined as Brahms himself already was in his playing. The Schubert and Brahms go marvelously well together, and RCA's recording is as good as it always is.

Performances: A— Sound: B+

Cherubini: Missa Solemnis in D Minor. Wells, Forester, Shirley, Diaz, Chorus and Orch. the Clarion Concerts, Newell Jenkins. **Vanguard VCS 10110/11**, two discs, stereo, $7.96.

Cherubini was a remarkable figure, an Italian-born musician who became a Frenchman (like Rossini) and survived in France from before the Revolution straight through until 1842, very nearly to the Second Empire. He was a conservative in outward style—his late music still has the ring of Mozart and Haydn—but in more profound ways he was solidly up to date. This vast Mass, composed in 1811, is even larger than the later Missa Solemnis of Beethoven and, similarly, was composed in the new manner, not on commission but simply as a work of art. It is hardly Beethoven in scope, but it has a grandeur and breadth and dignity that are very much of its day, out of the Eroica.

The Mass is a specialty of Newell Jenkins and thus it gets a fine performance here, with his own polished little orchestra and a brace of top soloists including the fabulous Maureen Forrester. The chorus is typical Jenkins—a gaggle of New York roving pro singers, all full of brassy wobbles and unblend, yet musically alive and intelligent. The orchestra, oddly, is quite different—Jenkins has imported a very Italian style of string playing to New York (he had an orchestra in Italy for some years after the war) which features precisely the opposite, a very smooth, non-vibrato tone with exquisite blend. Too bad that Jenkins can't dig up singers who can produce the same sort of tone! They only exist, around our parts, among the amateurs, and the amateurs aren't able to learn the music fast enough for the New York pro tempo, nor with enough strength and accuracy for a big work like this.

Performance: A— Sound: B+

Robert Casadesus: Piano Sonata No. 2. Alban Berg: Sonata, Op. 1 Hanns Eisler: 4 Klavierstücke. Carol Colburn, piano. **Orion ORS 7298**, stereo, $5.98.

This young lady pianist has a most interesting repertory, and a persuasive presentation. (Her earlier Orion disc offered two very early piano works by Richard Strauss.) Robert Casadesus is one of those composers about whom everybody says, Oh, I didn't know he *composed*—as though it were crazy for a famous traveling virtuoso pianist to do any such thing! Others of the recent breed were Ignace Jan Paderewski (premier of revived Poland after WW I) and Arthur Schnabel. Schnabel's modern sounding music, indeed, is a shock to all who think that if *he* composed, it would have to be in the manner of Beethoven, now, wouldn't it? It isn't!

The Casadesus Sonata—dare I say it—pleases me a lot more than the Casadesus rendering of such as Beethoven. I was not one of his big fans; I liked his colleague Gaby Casadesus better. His own music, though, is really charming and subtle in a highly French way—which perhaps explains why I did not like his (enforced) concert Beethoven and the like. He was, after all, French. This music is all shimmering harmonic color, old fashioned in a way, seemingly out of the first decade or so of the century though composed in the U.S. in 1941 and 1942. It has a lot of Ravel in it, but minus that Ravel violence that keeps peeping out from the Ravel elegance

and style. This music is elegant and stylish, too. I enjoyed it.

In contrast, Alban Berg's first published work, Opus 1 of 1906, is both very much of its time and very Germanic-Austrian, a late post-Romantic piece, full of that tortured elegance that Schoenberg brought to its final phase and dissolution (Berg was a Schoenberg pupil at this time). *Very* modern for the date. In a way, more modern than Schoenberg himself at that early time. Like all Berg, though, it is human, persuasive and personal and, therefore, given a sympathetic performance such as this, very easy in the listening.

As for the third set of items, Eisler is the musical brother of the ill-famed Gerhard Eisler, pounced upon by the well known C. on Un-American Activities in 1947. This Eisler was a musical "fellow traveler" in that he composed music with political overtones and believed that music was a powerful force in that area, which nobody can deny. A counterpart of, perhaps, our own Charles Seeger in the same period (the "Pete Seeger" family) and, in another fashion, Kurt Weill, Gershwin and plenty more, not to mention John Lennon of a later generation. This Eisler, too, was forced to get out. The little pieces on this disc, however, date from long before and are also of the school of early Schoenberg, more dissonant than the Berg but also much mousier, less forceful. Pleasing little mystical fantasies, thoroughly atonal even though it was early for anything as systematic as the serial music (twelve-tone) of Schoenberg, which Eisler did not adopt.

Pianists in search of unusual contemporary music should grab this disc. Also listeners, the same.

Performances: A— Sound: B

Las Cantigas de Santa Maria. The Waverly Consort, Jaffee. **Vanguard VSD 71175**, stereo, $5.98.

This imaginative and musical reconstruction of a Medieval Spanish collection of songs is based on a currently in-production "stage" show, following after the New York Pro Musica precedent with *The Play of Daniel*, put on a good many years ago with immense success in various New York locations. But the recorded version is an excellent media job on its own, even though the colorful costumes of the "live" show are visible only on the album cover. The collection, dating from King Alfonso X of Castile and Leon, dates from long before Christopher Columbus; this king died in 1284.

He was a poet and musician and probably the actual composer/author of some of these really splendid legend-songs, about the exploits of the Virgin Mary in assorted miraculous healing capacities.

The music is monodic, that is, without harmony—just a single line of melody. How awful this used to seem to us! No more. With the proper musicological aid of old instruments, in particular percussion and, here, a really beautiful set of hand bells, the ancient music comes forth with sophisticated and colorful appeal, as it obviously existed in its own time. The recorded presentation makes use of a narrator, Nicholas Kepros, who reads out each episode in the account while music plays, modern-style, in the background; then the song is sung in the original language, proto-Spanish or Latin. Excellent continuity for home listening.

What is intriguing here is that not a word (nor a note) is other than straight out of the original collection, which numbers more than 400 pieces of music altogether. The original, moreover, is itself "multi media", combining poetry, music and an exquisitely illuminated art-manuscript, still existing in a Spanish museum. The recording (and also the "live" performance) is thus a genuine transcription, or translation, of aesthetic material from one communication medium into another, and the radio-style techniques used in the recording are thus entirely authentic and defensible in terms of that media-translation.

My only mild complaint is a familiar one. There are but two voices, a soprano and a tenor. They sing musically and persuasively. But the vocal sounds each makes are too often just plain modern New York. Granted that nobody knows what voices sounded like in those days—except that most assuredly they did *not* sound like modern New York classical. But in other countries, on other recordings, there has been a strong beginning towards at least the development of vocal styles that suit the older music and thus (a) don't sound anachronistically modern and (b) may well be like the older vocal tones, merely for being able to sing the stuff as written. No reflection on the solid efforts of our two singers here, Jan DeGaetani, mezzo, and Constantine Cassolas, tenor. They sing as well as any normal pro voices can, in this ancient other-world of the vocal art, more than seven hundred years old.

Performance: A– Sound: B+

(Continued from page 58)

ferences, language laboratory work, cassette and tape duplication, you name it and some one is doing it. If no one is, you should. The field is limited only by your imagination.

You can see that some of this work requires a minimum of equipment. This equipment, however, must be reliable because there is usually only one chance to make a recording of this kind.

Acknowledgements

I wish to thank Mr. Al Grundy, Institute of Audio Research, Inc., and Mr. John M. Woram, Vanguard Recording Society, Inc., for their help in preparing this material.

*1

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There are other schools which offer basic electronics backgrounds. If we hear of them, we shall print their addresses here in this column as soon as we can.

I know of no other schools which offer formal training in studio operation. There are some dealing with broadcast techniques, but this is really not completely applicable to this discussion. Again, should I learn of other schools, I will print the information. AE

weingarten: Off The Record

Growth equals change equals pain. And the American public, always searching for hedonistic escape, wants none of it, requesting instead a diet of half-baked status quo under glass.

Consider, for example, Joni Mitchell's latest airwave success, *You Turn Me On, I'm a Radio.* The ditty, one of a dozen songs from the composer-singer's latest Asylum album, **For The Roses** (SD 5057), is marred by word and sound gimmicks.

Although the tune contains a touch of satire and *is* catchy, it mostly builds, through strained verbal images, a sense of sameness, a feeling that you've been there before. Not far into the piece, the listener is musically reminded of a recent quasi-calypso hit, *Yellow Taxi.* The sophisticated thrush's voice, moreover, tries too hard for a country sound that out-hillbillies a few stalwarts of Grand Ole Opry.

Yellow Taxi overcame its own flaws by making a salient ecological point, that we, the people, have allowed the money-mongers to turn "Paradise into a parking lot." This song, however, has buried its elusive message so well only a musical archeologist could find it.

The biggest irony, though, is that the highly hummable tune is the *only* loser on the LP, which is distributed by Atlantic. The rest, introspective and frequently poignant, unfortunately lie in state *despite* their intrinsic value.

Joni Mitchell, who could be considered pop music's distaff poet-in-residence, cannot be listened to casually. Of course, that's the real problem. For the fearful pop public wants everything simplified, so it can be spoon-fed benign ideas.

How many, for instance, can cope with comparisons of desperation contained in *Banquet*?

"Some turn to Jesus
"And some turn to heroin.
"Some turn to rambling round
"Looking for a clean sky
"And a drinking stream."

And who wants to deal with the Future Shock outlook talked about in *Barangrill*?

"None of the crazy you get
"From too much choice."

Or the paradoxes man faces, as seen in the same song?

"And you want to get moving
"And you want to stay still."

How many, for example, want the burden of looking at Joni Mitchell's bared and bloodied spirit, as in the title tune?

"In some office sits a poet
"And he trembles as he sings
"And he asks some guy
"To circulate his soul around . . .
"Just when you're getting a taste for worship
"They start bringing out the hammers
"And the boards
"And the nails."

And how many of us can tolerate seeing ourselves trying excessively hard to convince someone of something *we're* not convinced of? Don't we flinch at the lyrics of *Woman of Heart and Mind*?

"You criticize and you flatter
"You imitate the best
"And the rest you memorize.
"You know the times you impress me most
"Are the times when you don't try."

And can we stand the notion of what we do to others, how we use and abuse them, as in *Lesson in Survival*?

"I went to see a friend tonight,
"Was very late when I walked in.
"My talking as it rambled
"Revealed suspicious reasoning.
"The visit seemed to darken him.
"I came in as bright
"As a neon light
"And I burned out
"Right there before him."

Most of all, don't we want to close off thoughts that make us look inward, that make our values seem warped, that make us *know* we're round pegs trying to fit into square holes? Don't we want to ignore our feelings of inadequacy, as in the same song?

"Guru books—the Bible
"Only a reminder
"That you're just not good enough,
"You need to believe in something."

A beautiful but sometimes uncomfortable listening experience results from 11 of these 12 songs, all of which were published by Miss Mitchell in conjunction with BMI and copyright 1972. On the exception, the one hit we can get caught up in the sound instead of the lyrics, we can listen to an army of musicians that includes Tommy Scott, Graham Nash and Stephen Stills, we can avoid ourselves.

Joni Mitchell, who toyed with folk music and contemporary art things before really looking inward, accepts the proposition that change is pain. It's

a shame a wider audience can't share that belief and grow.

—Tommy (Ode, SP 99001), a remake of the Who's rock-opera, brings with it an all-star cast. The two-disc album, featuring the London Symphony Orchestra and Chambre Choir, in many ways—not the least is a softer approach—is better than the original. Soloists for the A&M-distributed LP, which contains a libretto to make the story-line easier to understand, include composer Peter Townshend, Sandy Denny, Graham Bell, Steve Winwood, Richie Havens, Merry Clayton, Ringo Starr, Rod Stewart and Richard Harris.

—Faces (A&M, SP 4363) is a peak by Shawn Phillips, a Texas-born folk-singer who worked with Tim Hardin and Donovan, the latter being one of his greatest musical influences. Phillips, who plays guitar and sitar in addition to singing, incorporates classical and jazz motifs in his haunting melodies, and then tosses in some of the Eastern sound for good measure; the flip side of the disc also might be termed rock.

—Hot August Night (MCA, 2-8000) transcribes a live Neil Diamond concert at the Greek Theatre in Los Angeles. The two-record package, with 22 cuts, is in reality a rundown of Diamond's greatest hits, with the audience enthusiasm and added verve. Sound quality is excellent as he glides through *Crunchy Granola Suite, Sweet Caroline, Porcupine Pie, Song Sung Blue, I Am . . . I Said* and his other chartbusters.

—Come To Where The Love Is (London, "Phase 4 Stereo," SP 44190) is the 18th album from Ronnie Aldrich, who with two pianos and the London Festival Orchestra and Chorus provides variety in a lush setting. Aldrich, who arranged the dozen pieces, lives on the Isle of Man in a home with sea on three sides; that solitude often is reflected in his music, even when it's bouncy. Highlights include *Alone Again (Naturally), The Impossible Dream, The Candy Man,* and the Bacharach-David *Theme from 'Lost Horizon.'* The chorus, by the way, hums and doo-doo's a little, but the tunes are really instrumentals.

—Garden Party (Decca, DL7-5391) uses the Rick Nelson chartbuster, a repeat from his last LP, as an intro to his under-publicized, under-rated country-rock sound. Rick, backed by the Stone Canyon Band, a quartet, offers 10 songs, nine of them new, six of them self-written. *Palace Guard,* one of the Nelson creations, is every bit as good as the title tune. His uncle Don, for collectors of trivia, plays wood flute on *Are You Really Real?*

—Don McLean (United Artists, UAS-5651) proves that good things come in threes. This, his third long-playing effort, contains nothing as beautiful as *Vincent* or as controversial as *American Pie,* but *Narcisissma* has catchy rhythms and meaningful lyrics, *Bronco Bill's Lament* tells the type of melancholy narrative in song that McLean does so well, and *On the Amazon* is a tour de force of humorous word-play. The composer-singer wrote all but one of the 10 songs.

—Starting All Over Again (Stax, STS-3007) showcases the uni-named Mel & Tim with a strong Memphis-oriented rock 'n' soul sound. Best is the title tune, a hit with its realistic appraisal of the tribulations of loving someone you find hard to accept and its examination of the difficulties of trying once more to make a human relationship work. *What's Your Name* also is excellent, a bluesy throwback to the days of all-black rhythm 'n' blues radio stations. Æ

Darby & Tarlton
Musicians: Jimmy Tarlton and Tom Darby.
Old Timey LP-112, mono

An old timer of fourteen songs by Jimmy Tarlton and Tom Darby originally recorded between 1927-32 and now available again on Old Timey, a division of Arhoolie Records. Mostly for the collector and for people with an historical interest in the newly blossoming bluegrass, this LP is somewhat of an oddity and at times monotonous. But according to the notes the Darby-Tarlton duo "helped change the sound of American country music, . . . helping move the emphasis from the string band, ballad and dance tunes, to the guitar and blues as well as popular and sentimental songs."

Tarlton takes a number of solos, demonstrating a fondness for falsetto and disclosing a range far and wide while playing bottleneck guitar with a chromed steel bar that hints of Hawaii as in *Birmingham Jail #2*. The twosome are strong on harmony and when merged are suggestive of Mariachi singers. On the instrumental side, *Mexican Rag* bears this out wherein Tarlton picks as if lost in a cotton field caught afire.

Tarlton has "come back" in the sixties and the notes state that he has been appearing at clubs and folk festivals and the sound is not nearly as fuzzy and scratchy as it could be considering the vintage.

Dr. Ross: His First Recordings
Arhoolie 1065, mono

These are the first recordings by one Isaiah Ross whom some of you may know from his recent appearance at the Ann Arbor Blues Festival and from reading about him in Pete Welding's *Nothing But the Blues*.

He's a one man band all right and a left-handed one at that, playing his harmonica and guitar upside down and holding nothing whatsoever back. Here are thirteen tracks recorded in Memphis from 1951-54, all of one of which—*The Country Clown*—has never been issued previously. *Clown* is one of the more striking blues for its lyrics and the provocative image "country clown." Wiley Gallatin assists Ross in some fine counterpoint on guitar.

These are the barrelhouse blues of the fifties, the raunchy, rockinghorse, repetitive, rawboned, boogie-blues with washboard substituting for drums. Ross' career in the Army during the Korean War made a firm impression upon him and emerges musically in *Little Soldier Blue* and *Going To the River*.

Originally from Tunica, Mississippi, but now residing in Flint, Michigan, two diametrically opposed areas but with a few things in common, Ross plays a buoyant harmonica in *Going Down South*, wailing for a fare-thee-well, blowing all sorts of high notes on his harp.

The reproduction naturally varies but could be much worse.

This is a study for harmonica hopefuls. You can't beat Dr. Ross!

Boondoggle & Balderdash
MGM 73121, stereo.

Resisting the impulse to toy with their name, I will go on to say this group of sixteen musicians serves up ten soft rock tunes, beginning slowly but getting better as they go along. The material is all theirs, a commendable achievement. There is a smattering of dobro and slight statements by horns in music with a decided emphasis on vocals.

Instrumentally, *You Always Find A Way* is a cut above the rest—in both senses of the word—and more highly developed, a tune in which drums and guitar spread out as though they were in a Midwestern prairie. Other high spots are *Old Porch Swing*, which recalls the rugged endurance of a porch swing, *When Will It All Be Over*, a trip into r & b, and *You've Got Me* featuring some exemplary guitar picking. *7 A.M.* clicks along with a vigorous driving beat, "On the freeway, all the people grinding their teeth and I find myself doing the same," lyrics reminiscent of the time when they wrote poems about Buicks. But most musically interesting is *I've Been Delaved* with its unexpected intervals.

The sound is brushed on like a rather thin whitewash, the audio on side two being superior to that of side one.

All in all an only moderately imaginative effort but pleasant enough.

Slade: Slade Alive
Musicians: Noddy Holder, vocals, guitar; Dave Hill, lead guitar, vocals; Jimmy Lea, bass guitar, vocals; Don Powell, drums.
Songs: *Hear Me Calling; In Like A Shot From My Gun; Darling Be Home Soon; Know Who You Are; Keep On Rocking; Get Down With It; Born To Be Wild.*
Polydor PD 5508, mono

Hold on to your hats. Pad those eardrums. It's Slade, a hard-driving ballistic missile of a group from Britain who never lets up. Loud they are and there's not much subtlety here, but I enjoyed this recording of seven exciting numbers by Slade on Polydor.

It's amazing that a mere four musicians can make this thunderous noise but of course they're heavily amplified and indulge in electronic acrobatics that were all the rage but are slowly blowing themselves out. In Steppenwolf's *Born To Be Wild*, they truly let loose and one feels that the world is coming to an end. Look out, Chicken Little!

They Whooooo like the Stones, owls all, encouraging the audience to participate who comply with clapping and stomping which all creates an unrelenting clamor and turbulence, a rather fierce demonic energy as it were, as in *Hear Me Calling* and the instructional and tightly arranged *Know Who You Are.*

Some relief in sound level comes in John Sebastian's *Darling Be Home Soon* in which Slade aspires to some close harmony but it is not long before they're off again, poking fun, which detracts from an otherwise worthwhile effort.

Recorded live at the Command Theatre Studio, this has the ecstatic immediacy of a live performance—the kind of group you need to experience. And although it appears that Slade is stronger in entertainment than pure musicianship, they manage development, taking us down more than cursory paths.

Interestingly enough, the electric guitar here sometimes resembles a wind instrument. Overall, however, the sound is disappointingly dismal and undistinguished, reproducing quite a din.

Yet Slade generates new peaks of excitement and goes home hoarse. After you listen to this, if you're tempted, try to catch them on one of their U.S. tours. They've already had some Top 10 Hits in Britain!

Performance B Sound C+

(Continued from page 79)

Faster Copying

Q. Everyone knows that recording at 7½ ips results in less hiss on playback than slower speeds. It is also known that copying a 3¾ ips tape at 7½ ips and then playing it back at 3¾ ips results in a copy in one-half the time. Now does it follow that a 3¾ ips tape copied at 7½ ips has less hiss when played back (at 3¾ ips) than if it were copied at 3¾ ips? Even if hiss is not reduced, one can still copy tapes in less time than it normally takes; or would this result in some loss of fidelity?—Geo. B. Moore Jr., APO Seattle.

A. I don't believe you have anything to gain but time in copying at the faster speed. And, unless your tape machines are well equipped to handle high frequencies, you may lose in terms of treble response. When a 3¾ ips tape is played at 7½ ips, all frequencies are doubled. Thus a 12,000 Hz tone becomes 24,000 Hz. If your playback and/or record amplifier exhibits dropoff at this frequency, there will be treble loss. You won't gain in terms of S/N because as each tone is played at half the speed at which it was recorded, its level drops correspondingly. Furthermore, copying at elevated speeds raises the problem of obtaining a sufficiently high bias frequency (to avoid interaction with high signal frequencies) and of driving bias current at such high frequency through the record head (bias loss increases with bias frequency as the result of head inductance and winding capacitance).

Double Speed Copying

Q. Is there any disadvantage in copying 3¾ ips tapes by operating the playback and recording machines at 7½ ips? —George S. Hatch, Jr., APO.

A. When you play a tape at twice its normal speed, all frequencies are doubled. This raises the problem of exceeding the treble response capability of your tape amplifiers. Furthermore, in recording you should use twice as high a bias frequency to minimize the chance of beat frequencies between the bias signal and the audio signal.

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.

AE

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In this article we would like to share with you the technology that produces the sound which has made the 901 the most highly reviewed speaker regardless of size or price.* There are five basic elements of this technology. Each element is important but it requires all five to produce the desired result.

1. An Optimum Combination of Direct and Reflected Sound

The combination of 11% direct radiation from the front of the enclosure with 89% radiation reflected at 30° angles from the rear wall, simulates in your listening room the spatial characteristics of the larger environment of the live performance. This is responsible for the "open" and "natural" sound that is immediately apparent in an A-B listening test of the 901 with any conventional speaker.

2. Multiplicity of Full-Range Drivers

The research that was presented at the Audio Engineering Society meeting in 1968 † revealed that the irregularities of the acoustical radiation inherent in the crossover range of any woofer-tweeter speaker could be overcome by the use of a multiplicity of full-range drivers. The 901 uses nine full-range drivers in each enclosure. The benefit of this approach is appreciated when you try to follow a single instrument through a heavily orchestrated passage.

3. Active Equalization

In the audio frequency range, precise tailoring of electronic circuits to match the characteristics of a speaker can achieve a far more accurate balance of radiated tones than can be achieved by the mechanical components of any speaker acting alone. The active equalizer in the 901 contains over one-hundred components and is precisely tailored to the characteristics of the 901 speaker. This precision tailoring of the equalizer to the 901 is responsible for the accurate musical timbre for which the 901 speaker is famous.

4. Flat Power Response

The concept of flat "frequency" response was sacred in the tradition of speaker design until the arrival of the 901. The research that gave birth to the 901 clearly showed that the reverberant acoustical field dominates the direct field in live performances. Flat frequency response would be appropriate only if the reverse were true. The basic patents covering the 901 are testimony to the importance of the discovery that flat "power" response is the correct criterion for speaker design. Flat power response combined with reflected sound enables the 901 to produce all overtones of musical instruments without the shrillness characteristic of direct radiating speakers.

5. The Technology of Quality Control

The sound of any loudspeaker depends on everything from the texture of the paper cone to the thickness of the glue joints. Unfortunately, the standard techniques for measuring loudspeakers are not adequate to guarantee that speakers with equal measurements will sound alike. The BOSE Research Department has worked on this problem for many years. The result is the SYNCOM™ speaker computer, introduced in 1972. This computer tests and selects every BOSE speaker to standards that mark a significant advance in your listening enjoyment. The SYNCOM computer, and the difference it makes, will be the subject of a future article.

† Copies of the Audio Engineering Society paper, ON THE MEASUREMENT AND EVALUATION OF LOUDSPEAKERS, by Dr. A.G. Bose, are available from Bose Corp. for fifty-cents each.

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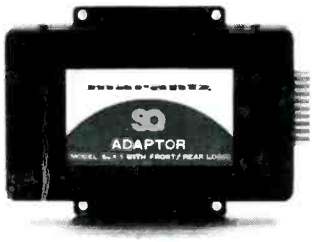
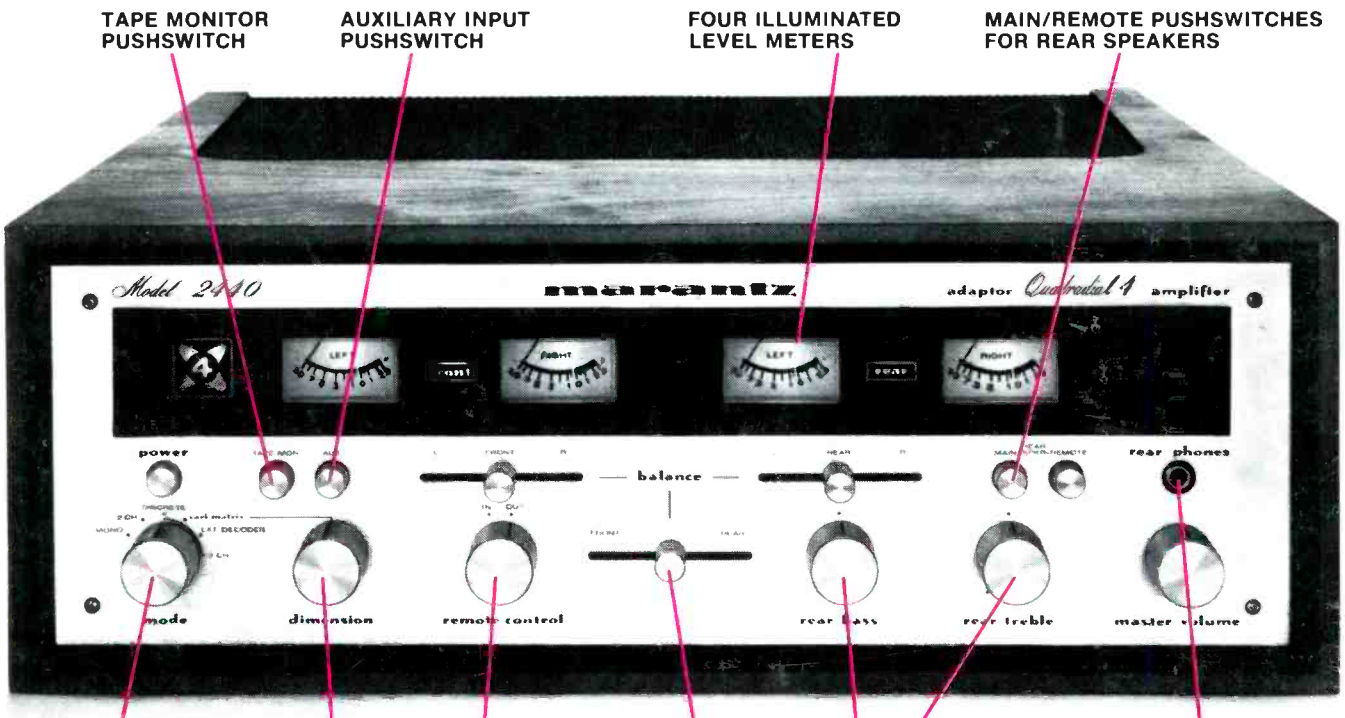


OPTIONAL MARANTZ MODEL SQA-1 DECODER (shown) is just one of a variety of optional matrix decoders which snap instantly into *exclusive SQ* decoder pocket* found on all Marantz 4-channel equipment.



*SQ is a trademark of CBS Labs. Inc
**CD-4 is a trademark of Victor Co. of Japan

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