

Audio

THE AUTHORITATIVE MAGAZINE ABOUT HIGH FIDELITY

FEBRUARY 1977

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Scenes -
AES Convention

CONSTRUCTION ARTICLES

Class-A Amplifier

Wide Bandwidth Preamp



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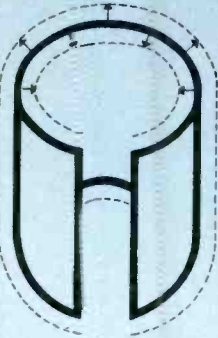


THE FIRST SPEAKERS THE SOUND EXPENSIVE, CAN PRODUCE.

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the HPM-200
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two. One
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driver. A 2-1/2" neoprene-impregnated cloth dome unit that, unlike most speakers, is peripherally driven for low distortion. Also unlike most speakers, this midrange unit is accurate to within 3 dB, even at 60° off axis.

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High Polymer Molecular film produces sound directly on the surface. So there's no need for voice coils or magnets.

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And, to keep all five HPM-200 drivers in balance and working together, we've engineered a massive crossover network that keeps all sound waves in phase over the entire listening area.

But no design dissertation can fully describe what the HPM-200 actually sounds like.

Irving Kolodin wrote for *Saturday Review*, after hearing Berlioz' "Symphonie Fantastique" over a pair of HPM-200s "...such towering presence that one could diagram the disposition of the Chicago Symphony just from the reproduced sound!"



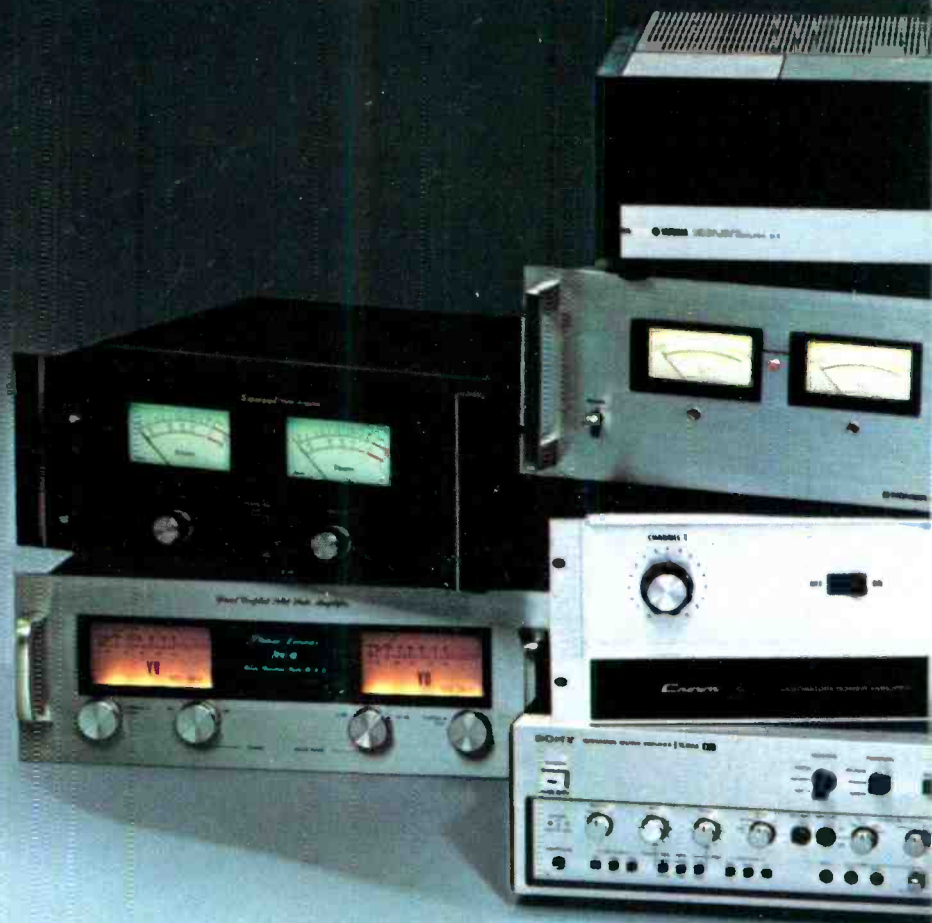
We believe the HPM-200 represents a new standard of accuracy in loudspeakers. Its dynamic range, transparency and overall lifelike impact are without precedent.

Ask your Pioneer dealer to play the super amplifier of your choice through speakers similar to the ones you're now using. Then ask him to play it through HPM-200s.

We assure you, you'll hear things you've never heard before.

HPM-200
PIONEER

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**IN THE LAST 24 MONTHS
11 COMPANIES
HAVE INTRODUCED
“SUPER AMPLIFIERS”
THAT YOU CAN’T FULLY
APPRECIATE UNTIL YOU
HEAR THEM THROUGH
THESE SPEAKERS.**

INTRODUCING HPM-200. THE DESIGNED TO DELIVER ALL THE HIGH-POWER AMPLIFIERS CAN

Most speakers available today were designed at a time when most of the powerful amplifiers you could buy produced under 100 watts a channel.

Which means if you have invested in one of the new super amplifiers, your speakers could well be keeping you from appreciating the full extent of your investment.

So Pioneer has developed a speaker system that can bring you all the peak levels, all the



transients, every last bit of listening enjoyment your super amplifier is capable of giving you.

It's called HPM-200. "HPM" stands for "High Polymer Molecular" film, a material that makes it possible to transform electrical energy into acoustical energy with complete accuracy.

The HPM-200 tweeter and supertweeter are made of this unique material,

which produces sound directly at the film surface.

There are no magnets. And no voice coils. So there are no mechanical moving parts to get between the sound your amplifier puts out and the sound you hear.

And High Polymer Molecular film can handle an almost limitless range of power. Without distortion. Without any loss in linear response.

Since High Polymer Molecular film can be rolled into a 360° cylinder, the tweeter and supertweeter produce equal high frequency dispersion over a full 360°.

Instead of one

200 has optimized bass. The tweeter optimizes bass. The supertweeter covers the spectrum from 25 kHz with minimum distortion and maximum damping.



The revolutionary High Polymer Molecular film tweeter and supertweeter. They don't look, or work like conventional speakers.

The tweeter may look like a conventional

driver. But they're made like conventional drivers. The cone materials include s... carbon fibers that g... them exceptional r... and low mass. So t... can fully reproduce... without breaking u... driven by enormou... power.

The HPM-200 specially-designed

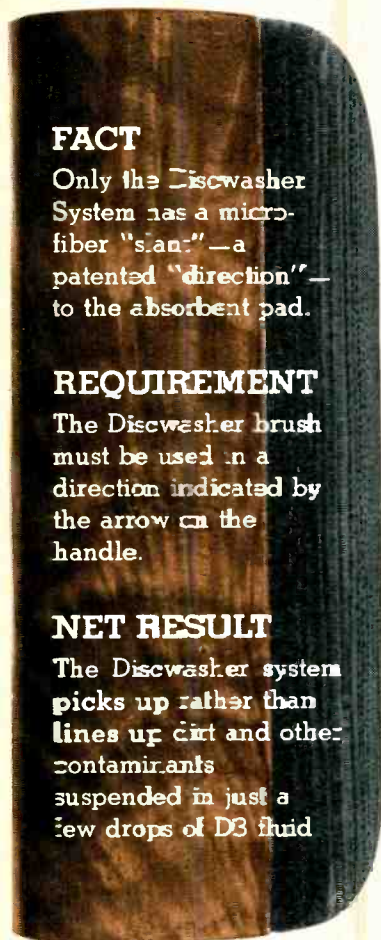


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Patented Direction



FACT

Only the Discwasher System has a micro-fiber "s.an."—a patented "direction"—to the absorbent pad.

REQUIREMENT

The Discwasher brush must be used in a direction indicated by the arrow on the handle.

NET RESULT

The Discwasher system picks up rather than lines up dirt and other contaminants suspended in just a few drops of D3 fluid

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Audio

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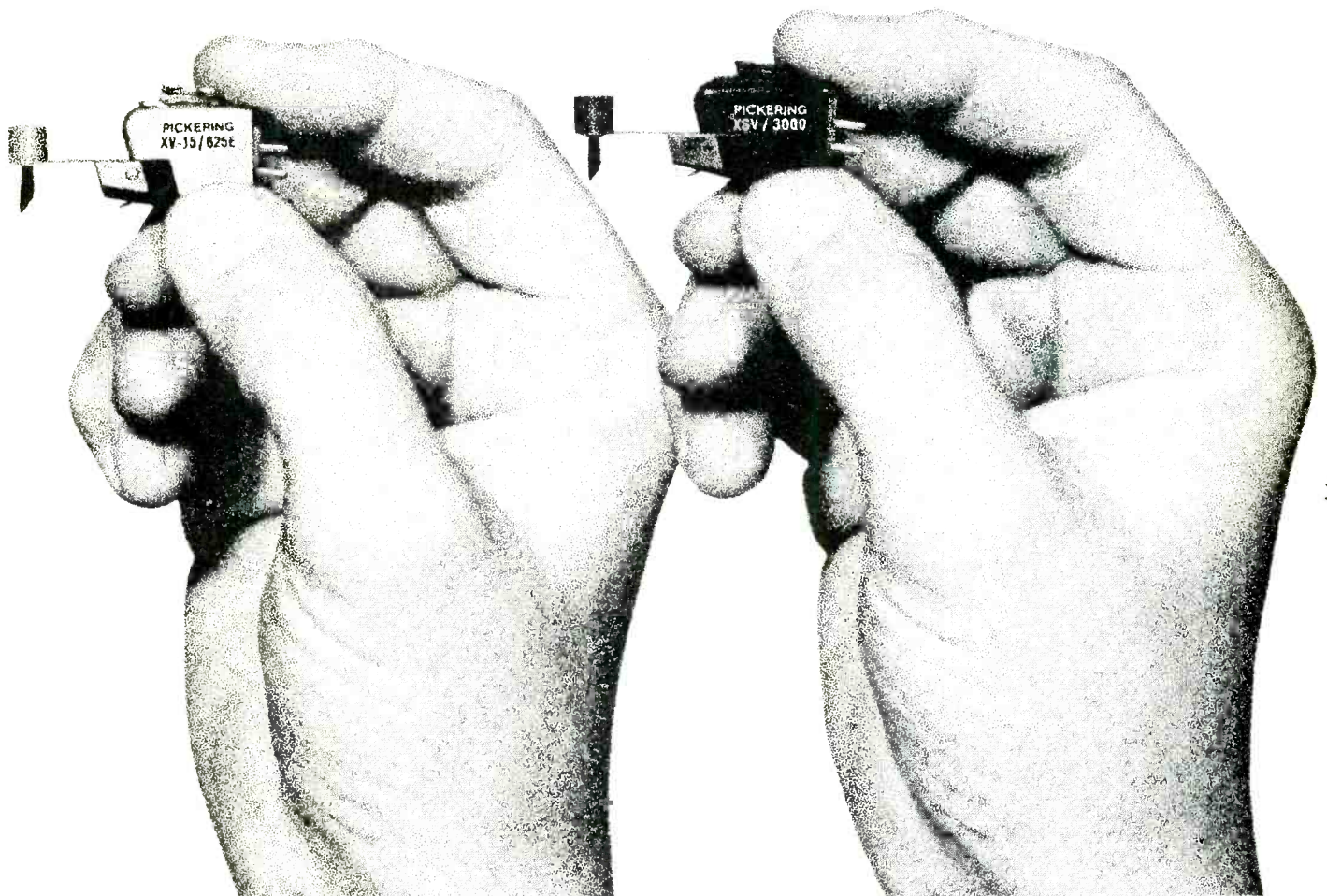
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"The right Pickering Cartridge for your equipment is the best Cartridge money can buy."

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If you have a fine manual turntable, the XSV/3000 is a perfect choice.

If you have a high quality automatic turntable, then installing an XV-15/625E in its tone arm is a perfect choice.

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Pickering's new XSV/3000 is a remarkable development. It possesses our trademarked Stereo-hedron Stylus Tip, designed to assure the least record wear and the longest stylus life achievable in these times with a stereo cartridge. Its frequency response is extraordinarily smooth and flat; its channel separation is exceptional; its transient response affords superb definition. It represents a whole new concept of excellence in stereo cartridges.

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 **PICKERING**

"for those who can hear the difference"

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Empire's Blueprint For Better Listening

No matter what system you own, a new Empire phono cartridge is certain to improve its performance.

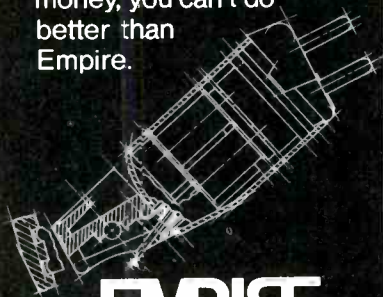
The advantages of Empire are threefold.

One, your records will last longer. Unlike other magnetic cartridges, Empire's moving iron design allows our diamond stylus to float free of its magnets and coils. This imposes much less weight on the record surface and insures longer record life.

Two, you get better separation. The small, hollow iron armature we use allows for a tighter fit in its positioning among the poles. So, even the most minute movement is accurately reproduced to give you the space and depth of the original recording.

Three, Empire uses 4 poles, 4 coils, and 3 magnets (more than any other cartridge) for better balance and hum rejection.

The end result is great listening. Audition one for yourself or write for our free brochure, "How To Get The Most Out Of Your Records." After you compare our performance specifications we think you'll agree that, for the money, you can't do better than Empire.



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Already your system sounds better.

Empire Scientific Corp.
Garden City, New York 11530

Audioclinic

Joseph Giovanelli

Patch Panel

Q. My stereo system sits inside a cabinet for protection against dust and other disturbances. However, when making connection changes in the rear of the components, it is difficult to remove the units and hold them while making those connections. I once read about a control board or control panel, that can be easily constructed, enabling one to make the various connections and hook-ups quickly. I cannot find the article, but, perhaps, you can shed some light on this subject.—John R. Garne, West Franklin, N.H.

A. You can make up a "patch panel" which will enable you to make all the necessary connections to your equipment without having to remove it from the cabinet. There are commercial devices which do at least some of this, and if your needs aren't too complex, they might solve your problems with a minimum of effort.

The unit is a metal panel mounted to the front of an equipment cabinet. It contains rows of quarter-inch phono jacks, which are more durable than the little phono jacks used on the rear of some high fidelity equipment. Their use permits you to connect and disconnect equipment without worrying about the connectors becoming intermittent and loose.

The exact number of jacks will depend on your present and future needs, and each input and output is connected to its own jack. Interconnections between the pieces of equipment are made through cables with phono plugs at each end. These cables should be made of shielded wire with the shield wired to the ground, and the "hot" or center conductor wired to the "tip" side of the plug. The shields from the various cables are connected at the end which faces the input only, which means that the shield is used as a means to prevent hum from stray fields, rather than as a means of signal return.

Because all the jacks are mounted on a common metal panel, it is sometimes possible to have ground loops which could give rise to hum, although this usually doesn't happen. However, if it does, it is often cured

by having one ground brought from the offending equipment to the panel. Be sure to label each jack on the panel with a label suitable for quick identification. Any logical system will suffice.

Wake Up to Records

Q. Is there harm in leaving either a belt-driven or a direct-drive turntable in the play position, with stylus on the record but no power applied, for several hours at a time? This is an attempt to wake up to the sound of a record rather than FM. I realize that this practice would flatten idler pucks on models with such a drive system, but I haven't encountered any warnings with the other drive types.—Gary Sunada, Honolulu, Hawaii.

A. I see no problem in terms of damaging either your turntable or stylus by using the setup you just described. The only reservation I have in mind is in terms of the dust which will collect on the surface of the record, so be sure to close the dust cover of your turntable once the stylus has been placed on the record and the timer set. The discs should also be cleaned before they are put away which may be inconvenient when you are preparing to go to work.

Back Cueing Wear

Q. For precise cueing on record cuts when I am taping them, I have been backtracking my phono cartridge by rotating the turntable backwards. Can this cause damage to the stylus?—Larry M. Bauer, Dayton, O.

A. I do not believe that back cueing your turntable will cause any damage to the stylus, but it may cause excessive record wear if any cut is cued very often in this way.

Turntables of the belt-driven or direct-drive variety can be back cued very nicely. However, turntables which employ an intermediate idler assembly will be difficult to cue when the idler is engaged. Furthermore, this could ultimately damage these idler pucks.

If you have a problem or question on audio, write to Mr. Joseph Giovanelli, at AUDIO, 401 North Broad Street, Philadelphia, Pa. 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.

AUDIO • February 1977

Power Plus.

The Scott R336 Receiver.



Power is important. But power alone is not enough. That's why the popular Scott R336 gives you all the power you need. Plus the performance features you expect.

The Scott R336 provides 42 watts minimum continuous RMS power output per channel. More than enough for most listeners. And both channels are driven into 8 ohms from 20 Hz to 20 kHz with no more than 0.3% total harmonic distortion.

Power? Sure. But check these important performance features many other receivers in this medium price range have sacrificed.

IM distortion (lower than 0.15%). Far below the average. Provides cleaner sound and eliminates listening fatigue.

Signal strength and center channel tuning meters. Provide simultaneous visual indication of correct tuning and optimum signal strength. **Phase locked loop multiplex section.** Maintains superior stereo separation. Remains in alignment for the life of the receiver.

FET RF stage. Assures higher sensitivity and overload immunity.

Log-linear taper volume control with detents. Spreads out volume levels. Provides finer control at low-to-moderate levels.

Clutched bass and treble controls with detents.

Allow altering the frequency response of one channel without affecting the other. Systems can be "custom balanced" to compensate for room acoustics, decor or speaker placement.

Separate high-frequency noise filter. Permits cleaning up of noisy tapes, discs or broadcasts.

Three position FM de-emphasis switch. Permits proper reception of domestic, Dolbyized or European broadcasts.

Two completely independent tape monitors.

Allow two tape recorders to be used simultaneously for direct tape-to-tape copying without passing through the receiver's electronics.

FM Muting. Silences interstation hiss while the tuner scans the frequency spectrum.

Pretuned LC notch filters in the multiplex.

Reduce interference to a minimum.

Signal strength meter circuit. Employs two point sampling for wider dynamic range.

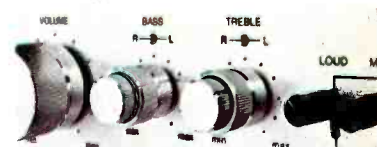
Over 120 db IF gain. Assures better limiting and better AM rejection.

Instantaneous electronic protection circuit in the output stage. Employs voltage/current sensing to prevent output transistor failure and speaker damage.

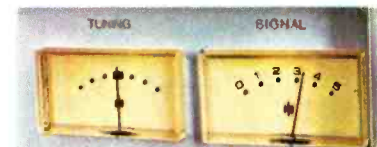
AM section designed around a tuned RF amplifier using J-FET. Improves signal-to-noise ratio.

And the Scott R336 is backed by a three-year, parts and labor limited warranty. Another very important plus.

For specifications on our complete line of audio components, write or call H.H. Scott, Inc. Corporate Headquarters: 20 Commerce Way, Woburn, MA 01801, (617) 933-8800. In Canada: Paco Electronics, Ltd., 45 Stinson Street, Montreal, H4N2E1, Canada. In Europe: Syma International S.A., 419 avenue Louise, Brussels, Belgium.



Clutched bass and treble controls with detents.



Signal strength and center channel tuning meters.



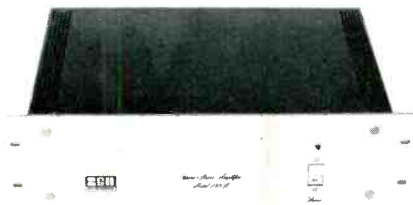
Two completely independent tape monitors.

SCOTT
The Name to listen to.

Receivers / Tuners / Amplifiers / Turntables / Speakers

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THE BGW 250B DOESN'T HAVE—

- Fuses
- Knobs
- Meters
- Current limiting
- Hum
- Noise
- Thumps
- High price

6 BUT, IT DOES HAVE—

- Enough muscle to drive 2-ohm loads (340-watts*)
- Absolute speaker protection (exclusive BGW SCR crowbar)
- Virtually unmeasurable distortion*
- Modular construction
- 12 rugged 150-watt output transistors
- High speed magnetic circuit breaker
- True op-amp front end
- Heavy 3/8" thick rack panel
- Totally enclosed heat sinks
- 660-square inches of efficient heat radiating surfaces
- Rugged steel chassis
- Mono-stereo switch

*Guaranteed specifications:

Stereo mode: 90-watts/channel into 8-ohms, 20-Hz-20-kHz with less than .1% total harmonic distortion (THD). 100-watts/channel into 4-ohms, 5-Hz-15-kHz with less than .15% THD.
Mono mode: 180-watts into 16-ohms, 20-Hz-20-kHz with less than .1% THD. 200-watts into 8-ohms, 5-Hz-15-kHz with less than .15% THD.

The perfect mate is our new model 202 stereo preamplifier featuring the industry's most accurate phono system—82-dB S/N, .01% THD, active 18-dB/OCT. Hi-Lo filters, studio type graphic controls. See all 6 BGW power amps and our new preamplifier at your local dealer.



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Herman Burstein

Tape Guide

Cartridge-Cassette Quandry

Q. I am considering the purchase of a tape player for my car as well as a tape deck for home use. Many of the dealers I have spoken to have recommended cassettes, while others have recommended cartridges. I don't know what direction to take... cassette or cartridge, and I don't want to sacrifice fidelity for convenience. In the past I have been exposed to inexpensive cassette players and have been unimpressed with their performance.—Thomas Mantini, Haverstown, Pa.

A. If fidelity is uppermost in your mind, then I suggest cassette, as things now appear, since the performance of the better cassette machines outdistances that of most all cartridge machines and rivals that of many good open-reel tape decks. To get a good home cassette machine, you will probably have to pay upwards of \$200.00, and perhaps double that, particularly if the machine incorporates the Dolby B noise reduction in order to achieve a really good signal-to-noise ratio.

Tension Choice

Q. In shopping for a tape deck, which pressure mechanism is best, pressure pads or tape tension?—Gary Thoburn, Lexington, Mass.

A. For the best combination of minimum head wear, minimum flutter, and good treble response—tape tension rather than pressure pads is generally the preferred means of obtaining good contact between the tape and the heads.

Fidelity Quandry

Q. Some time ago you stated that FM stereo is capable of higher fidelity than discs. However, FM frequency response is limited to 15 kHz and discs can easily surpass this. Hence your statement is confusing.—Peter Neuhau, Los Angeles, Cal.

A. Requirements for high fidelity include not only frequency response but also low noise and low distortion.

With good transmitting and receiving equipment, FM noise and distortion can be kept lower than on discs. On FM a dynamic range of 60 dB is possible, whereas the typical range on a disc is usually more nearly around 45 or 50 dB, also distortion can be kept under 1 per cent on FM, but not very easily on a disc. With respect to frequency response, very few of us can discern between flat response to 15 kHz and to a higher frequency. Most adults hear little if anything above 13 kHz or so, while many have difficulty distinguishing between an audio system flat to 10 kHz and one flat to a higher frequency.

Selection Specs

Q. I am undecided between which of two tape decks to buy. Both are priced at \$200.00, but one has 0.1 per cent wow and flutter while the other has 0.09.—L.D. Crow, Jackson, Miss.

A. A difference this small in wow and flutter is trivial and not a basis for choosing one machine over another. More important are the differences in frequency response, signal-to-noise ratio, and distortion.

Bulk Eraser Effectiveness

Q. I would like to know if a bulk tape demagnetizer is capable of erasing tape to below erase head levels. Are there any disadvantages to using a bulk demagnetizer?—Joel Jevotovsky, Brooklyn, N.Y.

A. Ordinarily a bulk eraser does a superior job when compared to an erase head. However, there are some tapes which if recorded at a high level may require extra runs past the erase head in order to permanently remove all recorded material. I don't know of any disadvantages to using a bulk eraser, except that it erases the entire tape instead of permitting one to selectively erase the desired tracks.

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 401 North Broad Street, Philadelphia, Pa. 19108. All letters are answered. Please enclose a stamped, self-addressed envelope.

AUDIO • February 1977

If you're surprised to learn that tubes solve some amplifier problems best, you have something to learn about amplifiers. And about LUX.

It may seem courageously retrogressive for a company to introduce a *tube* amplifier—even a highly advanced type—to the semiconductor audio world of 1976. Especially for a company only recently established in the U.S. market with a comprehensive line of solid-state amplifiers and tuners. But for LUX, it is simply consistent with our philosophy, whatever path may lead to improvement in the accuracy of music reproduction will be explored by our audiophile/engineers. Whether it leads to transistors or tubes.

Certainly, transistors are not about to be obsoleted by tubes. However, there are some amplifier problems that tubes still handle better than transistors. Overloading is one such problem.

When a solid-state amplifier is driven beyond its rated power, it clips abruptly. Engineers call it "hard" clipping. The term is apt, as the sound from the spurious high-order odd harmonics is raspy and irritating. Further, if the overall circuitry is not stable, and the protective circuits not very well-designed, the distortion is extended in time beyond the moment of overload. Drive a tube amplifier beyond its rated power and it too clips the waveform, but gently and smoothly. This "soft" clipping introduces much smaller amounts of odd harmonics. The distortion is far less irritating, hence less noticeable.

Notch (or crossover) distortion, present in many transistor amplifiers, is another source of spurious high-order odd harmonics. It occurs when the transistor output circuits are not able to follow the musical waveform accurately at the points where it changes from positive to negative and back again. Since notch distortion, unlike clipping, is at a constant level regardless of the power the amplifier is delivering, the ratio of this distortion to signal is worse at lower power. The gritty quality heard from many transistor amplifiers, particularly when they are playing at low levels, is usually due to crossover distortion.

Of course, tubes also have *their* limitations. Especially

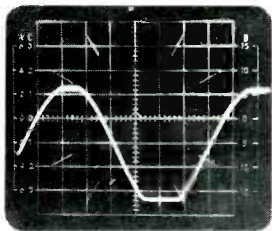
conventional tubes. The only tube previously capable of high-power amplification—the pentode—has inherently higher levels of distortion than the triode. Existing lower-distortion triode tubes cannot deliver sufficiently high power as a simple push-pull pair. But LUX, together with NEC engineers, has developed the first of a new breed of triode tube, the 8045G, which with other related technological advances, makes possible a high-power, low-distortion triode amplifier—the Luxman MB-3045. Among the differences in this new triode: the plate-electrode uses a special bonded metal with high heat-radiation characteristics. Also, the fin structure further aids heat dissipation.

LUX also developed a low-distortion high-voltage driver tube, the 6240G, capable of delivering over 200 volts of audio signal to the output triodes. Also, a new output transformer (LUX's long-time special area of expertise) has been designed to take optimal advantage of the triode configuration feeding it. The quadrafilar winding and core technology of this transformer represents another breakthrough. Overall, from input to output, the use of advanced design direct-coupled and self-balancing differential amplifier stages ensures stability and minimum phase shift.

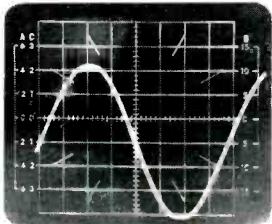
The MB-3045 produces a minimum of 50 watts continuous power into 4, 8, or 16 ohms, at any frequency from 20 to 20,000 Hz, with total harmonic distortion no more than 0.3%. As the MB-3045 is monophonic, a pair of them connected to a stereophonic preamplifier will not be subject to stereo power-supply interaction.

Now, we don't expect the MB-3045 to become the world's best-selling amplifier, any more than our highest-power solid state power amplifier, the M-6000 priced at nearly \$3000.

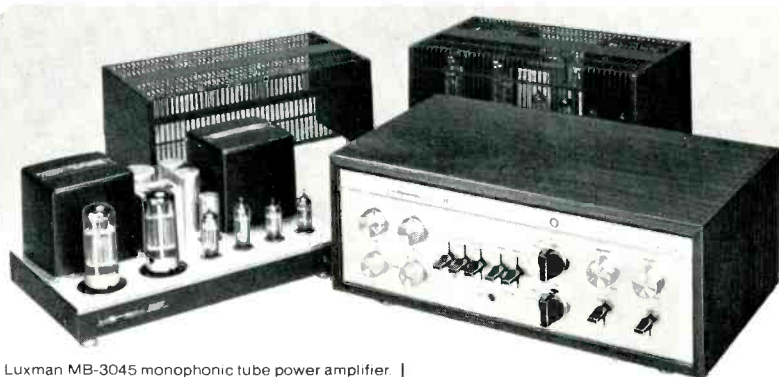
You'll find both at our carefully selected LUX dealers who will be pleased to demonstrate them for you. And any of the other dozen or so LUX models. It's why they're LUX dealers in the first place.



When a typical transistorized amplifier tries to deliver more power than it can, the top and bottom edges of the waveform clip sharply and abruptly and not always symmetrically. Result: high order harmonic distortion, raspy and irritating.



When a tube amplifier such as the Luxman MB-3045 is driven into overload, the clipping is softer, with more rounded edges to the waveform. The resulting distortion is much less audible, bothersome.



Luxman MB-3045 monophonic tube power amplifier. 50 watts minimum continuous power into 4, 8, or 16 ohms, 20-20 kHz, total harmonic distortion no more than 0.3%. Frequency response: 10 to 40 kHz \pm 1 dB. Signal to noise ratio: 95 dB. Variable sensitivity control for matching gain to any preamplifier. \$445.00 each. ■ Luxman CL-35 III stereo tube preamplifier. Total harmonic distortion: 0.06% at 2.0 V, 20-20 kHz, all

output signals. Frequency response: 2-80 kHz, \pm 0.5 dB. RIAA equalization \pm 0.3 dB. Features include: tape monitoring and dubbing, 6 selectable turnover frequencies, twin high and low noise filters, switchable phono input impedance (30, 50, 100 kohms), variable input sensitivities. \$745.00

LUX Audio of America, Ltd.

200 Aerial Way, Syosset, New York 11791
In Canada: AMX Sound Corp. Ltd., British Columbia, Gentrionic Ltd., Quebec

Audio etc.

Edward Tatnall Canby

Socko, one after another, a whole batch of new audio gadgets has hit my ears these past few months. Every last one of them, I note with interest, is somehow intended to increase our active control over the sounds we hear in the home listening space, or the very shape of the sound itself. I've sensed a lot of excitement here, more than usual, and I think the reason is easy to spot. Surround sound plus digital audio. Digital is the spark! It's everywhere, it can do astonishing things, and when the price comes down, which it will, they tell me, once we get away from expensive analog-digital-analog into more direct and cheaper approaches—bucket brigades of them will be mass produced.

Digital plus sound in the round! I talked myself hoarse and wore out my ears at the AES convention last autumn, one of the best ever. We are positively leaping into new things, unimaginable a few years back, ranging from the sublime to the barely amusing. Some of these stick to stereo, two good channels and a batch of new tricks. Some have to do with the other end of the audio chain, new ways to pick up the distributed sounds in the recording space. Some are exploring my favorite long-time hobby, which I knew would have its day—binaural sound in headphones. (How about phones with ears in them—built-in mikes? JVC has them and I have a pair.) Yet the majority of the new ideas inevitably tie straight into surround sound in anywhere from 2-to-16 channels, building upon that fruitful idea which first appeared,

so long ago, in early quadraphonic and all its synthesized predecessors, back channels derived from stereo information as in the Dyna loudspeaker circuits which some of us still use. You may think what you like about the present state of commercial quadraphonic, but without the stimulus of surround sound, the very idea of it, not much of the present ferment of activity could exist. There is simply no stopping this new control of our listening space, on all sides, all around, not merely up front.

crophone systems for *loudspeaker-intended* sound from JVC, and no contradiction, either. There's a version for stereo, and another, closely related, for quadraphonic. Like the Ghent microphone, both of these JVC microphone arrays pick up sound from a single location in the recording space, in the honored fashion of Mercury's Living Presence recordings of years ago, as with a number of later stereo systems, including the M-S (middle-side) and crossed mike techniques. Both CBS and JVC also aim to capture

a more accurate and specific wraparound of sound, filling in the side areas where both stereo and quadraphonic reproduction tends to be ill defined.

JVC really grabs those side sounds and reproduces them in both stereo and quadraphonic. You can hear them, straight out to left and right, many feet from the nearest visible loudspeaker, coming out of—nothing. There's spatial control for you. As for the Ghent, its four microphone transducers, facing the points of the audio compass, deliver an instant SQ encoding in two channels, ready to be decoded into a

surround quadraphonic array. Indeed, as I heard for myself, the product is not only a full four-channel sound but does show distinctly improved side rendering.

The JVC system, both stereo and quadraphonic, is an extraordinarily ingenious binaural "simulation"—a computer-developed tailoring of binaural signals, from microphones set in dummy heads, so that the usual overlap of sound heard from pairs of speakers (both ears hearing *both*



Digital Osmosis

Aside from digital, new ideas are coming out in sympathy, even in old areas. Take single-point microphoning, ancient, from way back, but wow is it back again, if analogish. Two simultaneous developments here from two major organizations, opposite in technology but remarkably similar in intent. One of them is the "Ghent" compound four-way microphone, from CBS Technology Center, the other a pair of binaural-head mi-

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speakers) is partially compensated for and eliminated and the ears are actually fooled into thinking the speakers are headphones, more or less. If I am right, it's done by cancellations, rubbing out selectively unwanted phasings. Hard to believe, but the thing actually works. For stereo there is one dummy head, and for quadraphonic a pair of heads, one right behind the other, the rear head's nose jammed into a sound baffle between the two so he hears only what's behind him, and vice versa. A black box arrangement doctors up the resulting binaural signals before they are fed to loudspeakers. And lo! we do indeed get

side information as we listen, East and West, and even some more radical directionalities too. I broke the JVC track record: With two stereo speakers in front of me, I distinctly heard a recorded telephone ring *behind me*. How's that for control!

Get it straight, in case you are confused. Inside head phones, binaural sound is weak in the front and back but very strong at the sides. Speakers are the opposite, both in stereo and quadraphonic, plenty strong in front (and in back) but vague as to side information. So, thought JVC, if you could make speakers sound even a little bit like headphones, you would

have your side info. And so you did.

In the Ghent, the four microphone elements are followed by a matrix system which, if I am right, functions virtually as an SQ encoder, right in the microphone assembly, to provide the two-channel SQ output. Considering the size and complexity of the professional SQ encoders I have seen, this is some accomplishment! In any case, there is no doubt about the complete quadraphonic sound array which is the result, all from this single mike unit. Potentially very useful, especially in broadcasting—a single microphone and a signal that can be fed straight into a two-channel stereo transmitter. Lovely for live broadcasts.

Single-Point Limitations

I will have to add that both these microphone systems, JVC and CBS, will have the same problems that traditionally go with any single-point microphone pickup, whether mono, stereo or quadraphonic. Very limited flexibility, if the right balance between ambient and direct sound is to be maintained. Hit the perfect spot, the exact right location, and the sound is gorgeous, as Mercury proved so well. But with the many varied sound sources in modern recording, that ideal spot isn't easy to achieve and because there is a clumsiness in balancing different instruments, near and far, that can only be solved by moving *them* around, which is the reason we have turned towards the more versatile multi-mike techniques, in spite of their inherent distortions and cancellations.

The first Ghent recording, made live last fall at a concert in England, turned out to be so close that the solo piano in a concerto was overwhelmingly near at hand, drowning out the hall reverb in the final big chord. Just a matter of trial and error, an unfamiliar microphone and no chance for adjustments during the recording. It should have been farther back. Yet I felt this was good. It's always easy to pull back a bit, but devilishly hard to move forward without getting into balance problems if your sound is too distant. I'd say the Ghent gives a good liveness ratio of direct to reflected sound, and probably a lot better than a standard omni microphone placed at the same spot.

A curious double effect was observable with the JVC dummy-head system as used in loudspeaker reproduction. First, in spite of those binaurally tailored signals, the perceived liveness appeared to be essentially of the loudspeaker type, and not that of the

12



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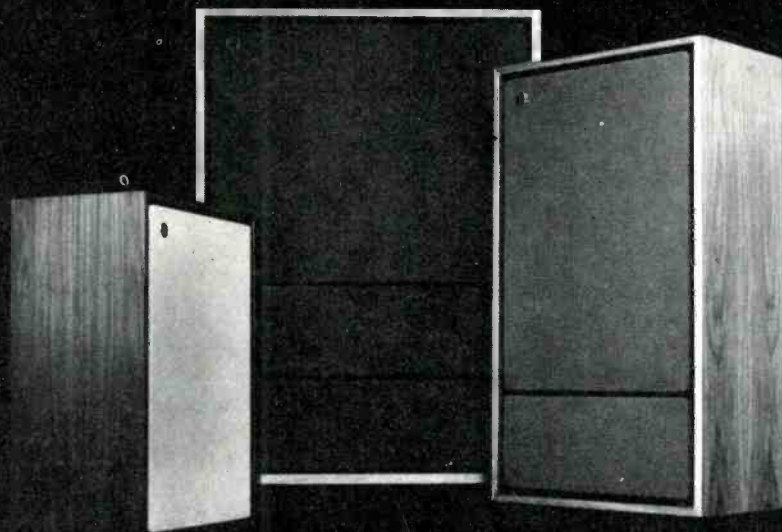
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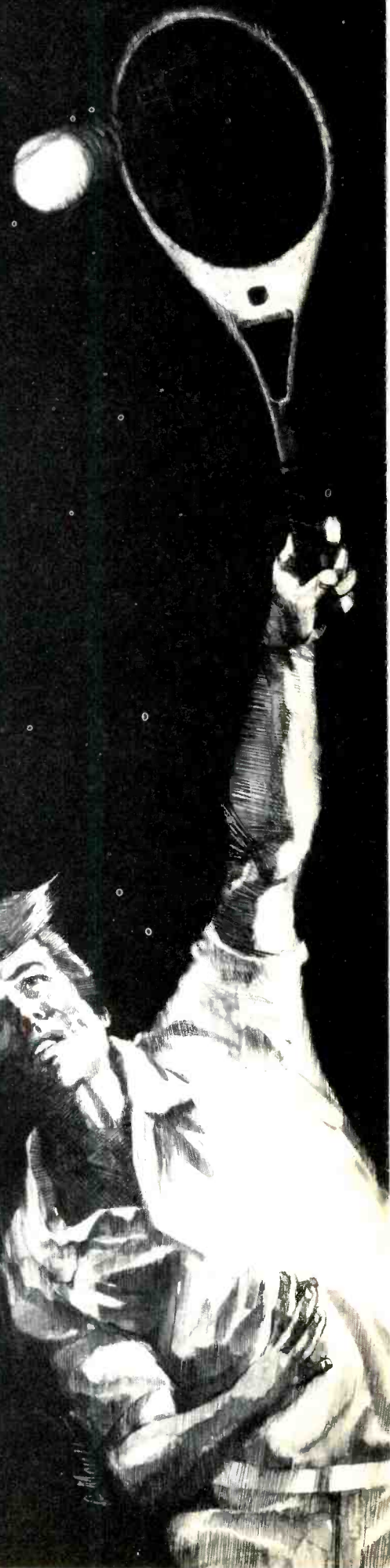
The prestigious British audiophile journal, "Gramophone", wrote: "There can be no doubt that . . . the new range of Tannoy loudspeakers will be received with enthusiasm not only for excellent and effortless reproduction but also for pleasing new design."

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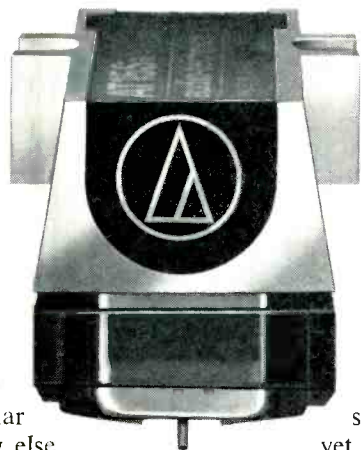


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any good tone arm or player at reasonable settings (1-2 grams), yet sharply reduces record wear. Even compared to ellipticals tracking at a *fraction* of a gram. Your records will last longer, sound better.



Stress analysis photos show concentrated high pressure with elliptical stylus (left), reduced pressure, less groove distortion with Shibata stylus (right).

The AT15Sa even helps improve the sound of old, worn records. Because the Shibata stylus uses parts of the groove wall probably untouched by other elliptical or spherical styli. And the AT15Sa Shibata stylus is mounted on a thin-wall *tapered* tube, using a nude *square*-shank mounting. The result is less mass and greater precision than with common round-shank styli. It all adds up to lower distortion and smoother response. Differences you can hear on every record you play.

Don't choose a cartridge by name or price alone. Listen. With all kinds of records. Then choose. The AT15Sa UNIVERSAL Audio-Technica cartridge. Anything less is a compromise.


binaural sound of phones. The recorded voices did come from astonishing directions but they were often "off-mike" and over-live, too distant, as would be the case with normal mikes set up in the one fixed central location. In headphone binaural sound, there is no such thing as "off-mike." Sounds are always heard as in nature, at *any* distance, though perhaps not from the true direction. Not so with loudspeakers and that is why we invented microphone technique in the first place. Move in close, to balance room sound against direct sound.

Binaural Simulation

But there was something else. JVC wasn't giving us regular loudspeaker sound. What I heard from their tailored binaural simulations was as weird as it was unexpected—*two* spaces, one hovering within the other! There was the normal loudspeaker sound, within the listening room. And at the same time there was another space, a ghost space, pulsing *inside* the other space; the loudspeakers were trying to create a *literal* binaural effect, a space independent of the listening room, exactly as in phones. Interesting, but I must say that the phenomenon was unsettling. One space at a time, thank you, and no double exposures.

This was, of course, the direct if unintended result of JVC's success in delivering real binaural sound out of loudspeakers, but I rather suspect that in other types of recording, such as a normal musical job in the usual reverberant surround, the two spaces would blend together and go almost unnoticed.

Still—did you ever see a double-exposed stereo photo, two 3-D pictures interpenetrating each other? That's what I heard.

In a sense, these CBS and JVC one-point microphone systems are flying in the face of most current audio development, for we are going more and more into multi-microphone, multi-track, multi-mixdown recording, plus synthetic additions in both sound and space. We are even altering the final sound package, right in the living room. Like Audio Pulse or Sound Concepts. Add-a-concert hall! There is no place for either a Ghent or a JVC mike in one of those synthesized spaces. Even so, it is good to have these new and elegant systems on hand for surround-space recording, if only as useful anchors to windward and a balance against excess, they'll be used. 

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Try TDK SA in the chrome position. You'll like the peace and quiet.



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Behind the scenes

The Audio Engineering Society held its 55th convention as another "Weekend at the Waldorf" from October 29 to November 1st. Such is the growth of the dynamic audio industry that this was the biggest East Coast AES convention thus far, with a record first-day crowd of registrants swarming into the exhibit booths in the ballroom and the sound demonstration rooms on the 5th floor. . . and, of course, listening to the papers presented at the technical sessions. As I have pointed out before, no AES convention is dull, but some generate high excitement quotients through significant advances or breakthroughs in audio technology. The 55th AES convention may well be remembered as the beginning of the era of digital audio recording.

Digital recording has always been a "hot" topic among audio engineers. It has been endlessly discussed and treated as a "Holy Grail," a panacea for all the multitudinous ills of analog magnetic tape recording. For some years now, the debut of digital recording has always been "just around the corner." At this convention, two papers were presented and an actual demonstration of digital audio recording was given, which may indeed represent the first steps in the conversion of audio recording from analog to digital technology.

Mr. J. Stanley Kriz, of the Three Rivers Computer Corp., Pittsburgh, Pa., described his "Audio Analog-Digital-Analog Conversion System," which is basic to the technology of moving audio signals into and out of the digital domain. Mr. Richard B. Warnock, of Soundstream, Inc., Salt Lake City, Utah, created quite a stir with his paper on "Longitudinal Digital Recording of Audio." Mr. Warnock's associate and president of Soundstream, Inc., is Dr. Thomas G. Stockham Jr., whom you may recall is the gentleman responsible for the fascinating digital reprocessing of old Caruso acoustical recordings that removed the honky megaphone sound from

the recordings and revealed more of the true nature of Caruso's voice.

During the run of the convention, Dr. Stockham and Mr. Warnock held forth in a 9th floor suite and gave private demonstrations of their digital recording system. Basically, the Soundstream digital recorder consists of a standard Honeywell computer transport operating at 30 ips (which gives 30 minutes recording from a 4600-foot reel of tape), plus various proprietary modules for analog-to-digital and digital-to-analog converters, sample and hold units, encoders and decoders for sync and data bits, memory buffers, input and output low pass filters, etc. The recorder demonstrated was a 15-bit system with a sampling rate of 37,500 per second, which gives sufficient resolution for a d.c. to 15 kHz audio bandwidth. One-inch, high quality instrumentation tape is used, and this prototype machine has two channels for stereo recording, although as many as 40 channels could be accommodated on the one-inch tape. At this point, I think I had better put this discussion on hold, as I'm sure distress flags are flying from readers for whom digital technology is *terra incognita*. What say you, Dr. Tom. . . can we con you into furnishing the readers of *Audio* with a basic primer on digital recording?

The Why and Wherefore

In the meanwhile, there are no doubt those people who ask a very basic question, why digital recording? What is the big deal? Understandably Mr. Warnock and Dr. Stockham have an axe to grind, so when they enumerate the problems of analog tape recording, this must be taken into consideration. Thus, while ultra-sophisticated machines like the Ampex ATR-100, have advanced the quality of analog recording by at least an order of magnitude, it is valid to discuss the inherent limitations of the medium.

In his paper Mr. Warnock notes the following problems with analog mag-

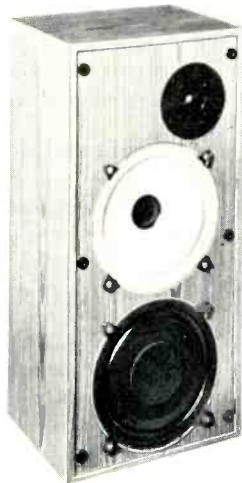
netic tape recording, inadequate dynamic range, i.e., low signal-to-noise ratio; inherent phase distortion; inherent harmonic distortion; insufficient transient response; modulation noise; cross talk; print through; multi-copy degradation; wow and flutter; inherent limitations in noise reduction systems; storage degradation with time, and limited low frequency response. Of the 12 problems listed, Mr. Warnock goes on to state that digital recording *completely eliminates* modulation noise, print-through, wow and flutter, limitations to the low frequency response, and the need for noise reduction systems. Phase distortion, harmonic distortion, and cross-talk are reduced to inaudibility under worst-case conditions. Dynamic range (S/N ratio) is significantly improved. . . and at a rated 90 dB below maximum signal level, that is putting it mildly! Significant improvement in the problems of transient response, storage degradation and multi-copy degradation is also claimed.

All this is very impressive, to say the least, and it is easy to understand why such a glamorous aura surrounds digital recording. A glimpse of how digital recording solves some of the analog recording problems is contained in this note on modulation excerpted from Mr. Warnock's paper:

"Modulation noise is an audible distortion in analog recording that increases and decreases with increasing and decreasing amplitude of the recorded waveform. It results from the varying head-to-tape spacing caused by dirt and dust particles and uneven oxide coating of the tape, among other things. This varying tape-to-head spacing causes a slight time-varying modulation of the originally recorded waveform. In digital recording, the audio content is in the encoded serial combination of *ones and zeros*, and although the tape to head spacing may change, that can affect only the amplitude of the *ones and zeros* and *not their encoded au-*

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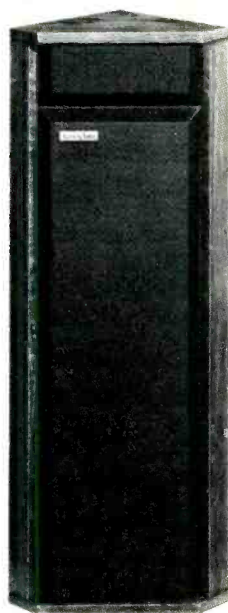
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Descriptive literature on all ALLISON speaker systems, which contains technical specifications and a statement of warranty, is available on request.

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dio content. Thus, modulation distortion is totally eliminated as a problem in the reproduced audio waveform, simply because the audio is encoded digitally."

The Soundstream digital recorder has actually been used to make professional recordings. Jerry Bruck, an engineer highly regarded for his recordings of classical music, recorded Virgil Thompson's opera "The Mother of us All" on a 16-channel analog recorder and fed a 2-channel mixdown from his console to the digital recorder. For whatever reason, the recording venue was New Mexico in a hall with difficult acoustics, and it must be noted that many people do not find this particular piece the most accessible of music. At the demonstration I heard, Soundstream had a tough audience with John Eargle, John Woram, John Curl and editors Gene Pitts, Ed Canby, Barney Pisha, and yours truly on hand. On listening to excerpts from the opera, we were impressed the most with the totally silent background afforded by the 90-dB S/N ratio. Perhaps the particular kind of amplifier and speakers that were used in the demonstration colored our opinions, for while we thought the sound was very clean, with crisp transients and fine articulation on the voices, we felt that a top-quality analog recorder could have done as well. Another recording, this time of some people in a studio simply noodling on various instruments, was a more impressive demonstration of the digital machine's capabilities. What probably influenced our judgments more than anything else was the fact that the top end rolled off above 7 or 8 kHz. This was explained as a function of the particular 15-kHz low-pass filters in the reproduce chain and of the sampling rate. Extension of the bandwidth to full 20 kHz can be accomplished by increasing the sampling rate and using appropriate filters. It all really comes down to the ability of being able to A/B between an analog and a digital recorder under controlled conditions with the same program material...and after all, the digital recorder was a prototype unit. Like anything else, there are problems in digital recording that have not been fully resolved. For example, even with the very best instrumentation tape, dropouts can be devastating to the reconstruction process in playback. However, there are error correction procedures that can reduce audible errors due to dropouts to as few as one or two in five minutes of playback. Dr. Stockham and Mr.

Warnock are to be congratulated for bringing digital recording out of the laboratory and for the advances they have embodied in their prototype recorder. Both men are confident that they will have full audio bandwidth digital recorders in production in the not too distant future. More power to them! Now that we have accorded digital recording the importance it deserves, let's get on with the rest of the 55th AES convention.

And Elsewhere...

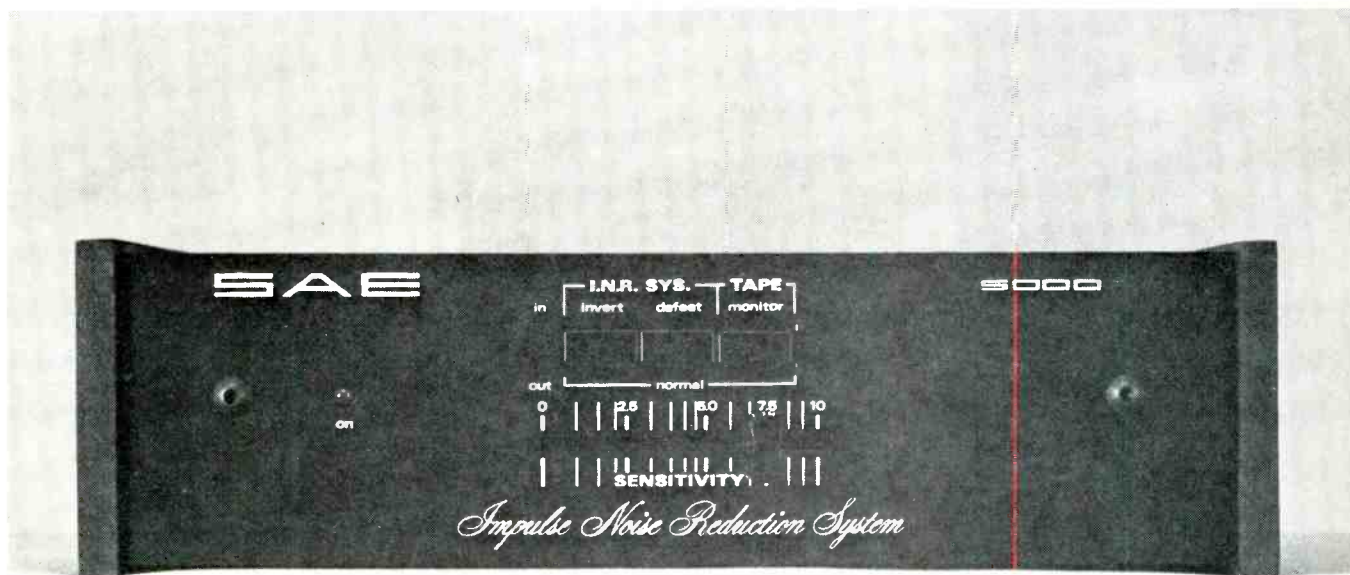
I have become nothing but redundant in reporting that every AES convention has a plethora of mixers and consoles. Why should this one be different? They were everywhere in the ballroom, intimidating in their multi-slider, multi-switch, multi-knobbed, and multi-metered complexity, but for all that, the object of many covetous glances. This year a new element was on display, this being quite a number of specialized mixer/turntable setups for the burgeoning disco market. Even old line hi-fi firms like Bozark are in the act, with their disco mixer garnering quite a number of sales. Shure Bros. surprised people with a low-cost spectrum analyzer and equalization system with easy-to-use LED read-outs. Hard by the entrance to the ballroom, Ampex had their big display and was showing their 16- and 24-channel recorders, as well as the super ATR-100, which is now available with "ear and cue" facilities. (Patience men, my report on the ATR-100 is upcoming soon.) Totally unexpected from Ampex was their new ATR-700 tape recorder, which you could call "semi-pro" although it has features not usually found on that kind of unit. The machine takes up to 10 1/2-in. reels, has a three-motor, servo-lock capstan transport, sel-sync recording, equalization and bias adjustments on the front panel, a "dump edit" mode, and very fine specs on wow and flutter, distortion, and S/N ratio. The big news is its \$1695 price, which means it should attract the interest of high-end audiophiles as well as industrial and governmental users.

Every year, the 5th floor demonstration rooms grow in number, and this year it looked like a mini hi-fi show. There are, in fact, many hi-fi items on display. Pioneer had quite a line up, showing their new PLC-590 quartz phase-locked loop turntable, with direct reading meter to indicate precise turntable speed. Then there was the U-24 program selector, with a multitude of inputs for tape decks, phono

AUDIO • February 1977

The "Click and Pop" machine

only by **SAE**



19

Ever since the invention of the recorded disc annoying "clicks" and "pops" caused by scratches, static and imperfections have consistently disturbed the listening pleasure of music lovers.

Now, SAE introduces the unique model 5000, an Impulse Noise Reduction System which eliminates those unwanted sounds with no adverse effect on the quality of the recorded material.

This breakthrough in electronic circuitry is so demonstrably effective that the SAE 5000 is destined to become an essential part of any sound system.

The SAE 5000 is compact and sleek, built to SAE's exacting standards, and ready to enhance the performance of any system, from the standard receiver/

turntable combination, to the most sophisticated audiophile components.

SAE is proud to add the 5000 to their broad line of *Components for the Connoisseur.*

SAE AM 2/77

SCIENTIFIC AUDIO ELECTRONICS, INC.
 P. O. Box 60271, Terminal Annex
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Please send more information on the 5000.

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SHOULD QUAM GO PUBLIC?



The chances are good that you've already invested in Quam loudspeakers, without even knowing it. You'd be surprised how many of the famous manufacturers of hi-fi speaker systems have Quam drivers lurking anonymously behind their fancy grille cloth!

For over forty years we've cherished our anonymity at the consumer level while enhancing our reputation with the audio professionals who buy speakers in quantity. They appreciate the return on investment they derive from our attention to materials, our quality control, and our performance specifications. The experts know that Quam Speakers are the brand to buy when you're buying more than one!!

If Quam speakers can pass the rigorous tests of the prestige speaker system manufacturers for incorporation in their high-priced original equipment, can they pass your listening test for replacement or extension use in your stereo system? Only if we "go public" and tell you about them! Ask your audio distributor about Quam, the not-quite-so anonymous loudspeaker.

Quam:

The Sound Decision

QUAM-NICHOLS COMPANY
234 East Marquette Road
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inputs, power amp outputs, etc. The D-23 electronic crossover network permits up to a four-way multi-amplifier system. A new "slim-line" pre-amp, the C-21, is simple in facilities but quite sophisticated in high performance electronics. Last, but not least, was the M-22 Class-A power amplifier. Rated at 30 watts per channel with a THD of 0.01%, it has a separate power supply for each channel and generous heat-sinking. This kind of amplifier is a distinct departure for Pioneer. I used a prototype of this amp at home and found it a very clean, exceptionally smooth performer, although a bit lacking in bass power at the dynamic levels I favor. I'll bet this amp will be used in many bi- and tri-amplified speaker systems.

Dick Sequerra (of tuner fame) was demonstrating a mid-sized pyramidal-shaped speaker system which was quite interesting. The room he was in was awful with standing waves, with the obviously extended bass of the speaker exciting them. Mid-range and high end were clean and very smooth, and stereo imaging seemed quite stable. Eli Passen of Gotham Audio was flipping people with the EMT 250 digital reverb system. With controls looking like the throttles on a 747, you can dial in the delay you desire, then the amount of reverb period, and you get a fabulous enhancement of acoustic perspective with no paucity of echo density. For the man who has everything, it's a mere 15Gs. Speaking of delay systems, Bob Berkovitz of Acoustic Research was once again demonstrating his great 16-channel system, this time using somewhat larger speakers than he had in Los Angeles. Oddly enough, I preferred the small units...perhaps because they were less obtrusive to the eye, which always helps in this kind of enhancement. Bob tells me the consumer version of the delay system draws ever nearer!

The Technics room was loaded with tape machines...a new open-reel unit, the RS-1500US, was quite remarkable. It features "isolated loop" tape drive, with a huge capstan driven by a quartz controlled, phase-locked, servo-controlled direct-drive motor, and affords a wow and flutter spec of an astonishing 0.018 per cent W rms @ 15 ips. Supply and take-up reels have separate d.c. motors. The unit accepts up to 10 1/2-in. reels. Tape motion is controlled by full IC logic. The RS-1500 has many other conveniences and features, one handy item being a real-time tape counter for the 15 ips speed. Price is \$1500.00. Next unit in

the Technics room was an "all-out" cassette recorder, the RS-9900US. This machine has separate transport and electronics sections. The transport is a closed-loop, double capstan system with three direct-drive motors and a wow and flutter spec of 0.04 per cent W rms. The transport has full IC logic, three heads for true monitoring, and even adjustable azimuth. On the electronics section, Dolby controls and bias and equalization calibration controls are all accessible on the front panel, and there are all sorts of conveniences too numerous to mention here. At \$1500, this recorder is obviously meant to compete with the top decks in the field. Finally, Technics put their best foot forward with two Elcaset tape decks, the RS-7500US, a three-head unit with servo-controlled d.c. motor, and the RS790US which features four heads (one for pilot tone), four direct-drive motors in closed-loop double-capstan configuration for a wow and flutter of 0.03 per cent W rms. Would you believe a frequency response with Type 2 tape of 25-23,000 Hz \pm 3 dB or a S/N ratio with Type 2 tape *without* Dolby of 63 dB? Of course, it has Dolby NR, so you can add the usual 8-10 dB to the S/N. Here again, there are far too many features to list, but it is something to look forward to when Elcaset gets moving.

On the quadraphonic front, JVC was showing its new noise-gate CD-450 demodulator, but attracted most attention with their new two- and four-channel recording techniques. Two artificial heads are used in the latter technique, but in spite of this, with special equalizing and time delay, signals are provided for loudspeaker listening, in the four-channel configuration. The two-channel set-up uses the same idea, but is for normal stereo listening. After the AES, as guests of JVC, we went quite deeply into these new techniques. We were also given a unique headphone/binocular mike affair and a dummy head, which does some remarkable things. We'll bring you details of all this at an early date...it is utterly fascinating!

Sansui kept its four-channel flags flying with the introduction of their 9001 receiver, with 60 watts/channel and the latest QS vario-matrix decoder/synthesizer. Also available as a separate unit is the QSD2 decoder/synthesizer.

As usual, there is just too much to cover at these conventions. If your goody has been passed over, cuss me when you next see me! Δ

The Sensuous Speaker.

Yamaha's new two-way beryllium dome NS-500.

A very responsive speaker with a rich, conscious sound. A deeply involving sound. Highly defined, finely detailed.

The NS-500 is created from the same advanced beryllium technology that's made Yamaha's revolutionary NS-1000 Series speakers, in the eyes and ears of many audio experts, the highest standard of sound accuracy. (Specific benefits of Yamaha's beryllium technology have been documented in a paper presented to the 52nd Convention of the Audio Engineering Society.)

With the NS-500, you get all of beryllium's advantages (transparency, detail, and lack of distortion that go beyond the best electrostatic speakers), but at a price roughly half that of the NS-1000. Only \$500 the pair, suggested retail price.

The joy of beryllium.

The ideal dome material for a high frequency driver must respond instantly to changes in amplitude and frequency of the input signal. So the ideal dome material must be virtually weightless as well as extremely rigid.

Beryllium is the lightest and most rigid metal known. Its density is less than two-thirds that of commonly used aluminum, and its rigidity is almost four times as great—thus preventing dome deformation and consequent distortion. What's more, beryllium's sound propagation velocity is twice that of aluminum.

The beryllium dome found on the NS-500's high frequency driver is the world's lightest—about half the weight of one petal of a small sweetheart rose. Which is one of the reasons for this speaker's exceptional sensitivity and response. And for its sensuous sound.

A closer look.

To be able to offer the sophistication of beryllium at a more affordable price without sacrificing quality of performance, Yamaha designed the NS-500 as a two-way bass reflex system.

This gives the NS-500 a trace more emotion at the low end than the resolutely objective NS-1000. But it also gives the NS-500 more efficiency (91dB SPL at one meter with one watt RMS input). Which means you don't have to invest in the highest powered amplifiers or receivers in order to drive the NS-500 to its full rated output.

For an optimum match with the beryllium tweeter, Yamaha developed a very light, very rigid "shell" woofer. And a special hermetically-sealed air core LC crossover with a carefully selected 1.8kHz crossover point.

As a result of these design parameters, the NS-500 boasts an insignificant 0.03% THD below 50 dB SPL, from 40 Hz to 20 kHz, making it the perfect complement

to Yamaha's state-of-the-art low distortion electronics.

Underneath the sleek monolithic styling of its solidly crafted enclosures, the NS-500 is full of many exclusive Yamaha features and distinctive Yamaha touches of craftsmanship.

But to fully appreciate the beauty of the NS-500, you really should visit your Yamaha Audio Specialty Dealer.

Which brings us to something else.

Something more than just another speaker pamphlet.

Yamaha's *Reference Handbook of Speaker Systems* is a very thorough guide encompassing all aspects of speaker design, performance, and evaluation. Starting with a detailed explanation of speaker design principles, the discussion then turns to a solid base of objective criteria, written in easily understood language, to help you properly evaluate any speaker in any listening environment. Already a much sought-after reference work among audio professionals, Yamaha's *Reference Handbook of Speaker Systems* is available at your Yamaha Audio Specialty Dealer.

At \$5.00 a copy, it's well worth the cost. However, if you clip out the coupon in the bottom corner of this page, take it to your Yamaha Audio Specialty Dealer and hear a demonstration of the exciting NS-500 or any other Yamaha speaker, the book is yours for half the price.

And if you're not familiar with the name of your local Yamaha Audio Specialty Dealer, drop us a line. In turn, we'll also send you a free preprint of the Audio Engineering Society paper on Yamaha beryllium technology mentioned above.



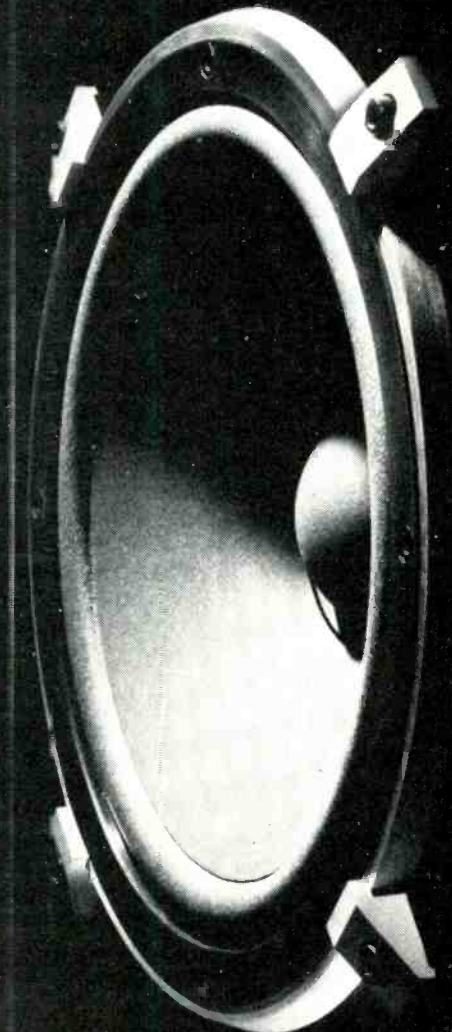
This coupon is worth \$2.50 off the \$5.00 suggested retail price of Yamaha's *Reference Handbook of Speaker Systems*, when presented to any participating Yamaha audio dealer, with a demonstration of any Yamaha speaker system.

Offer expires March 1, 1977.



P. O. Box 660 Buena Park, CA 92622

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After people learn what we've done, no one will heckle our speakers.

We're as close to the impossible as possible.

Our new speakers color sound. Anybody's speakers do.

Should someone tell you otherwise, they speak with forked frequency response.

We at Sony approached the development of the SSU-2000 with this grim reality in mind.

Thus our goal was to create a line of speakers with a minimum of coloration. With a frequency response flat and wide. With low distortion. And with repeatability. Which is critical. Which means that each speaker we turn out will sound like the one before and the one after.

Searching and researching.

Our basic dilemma was that speaker specs don't specify much.

You can build two speakers with identical specs, and find they'll sound non-identical.

That's because your sophisticated ear can pick up differences our clumsy measurements can't.

Some examples:

You can hear how pure water is. The purity of the water in which the pulp for the speaker cone is pressed will influence the sound. (Spring water is the best.)

But water purity would hardly change the frequency response—or any other measureable characteristic.

Nor would the dye used to color the cone—or the glue used in gluing the cabinet.

But you'd hear the dye and the glue.

And there are dozens and dozens of elements that interact this way.

So our job was mammoth. To correlate these factors in order to

reach the goal we outlined earlier. Changing one changes the other and almost changed our minds about going into the speaker business.

But we stuck it out. And found the answer to the juggling of these variables thanks to a major technological innovation.

Trial and error.

That's why we labored for three years to bring you our speakers. While other manufacturers rushed frantically to market with theirs.

We keep the whole world in our hands.

Once we understood how to control the sound of our speakers, we realized we had to control what went into our speakers.

So we did the only logical thing. We built a plant.

And pursuing that logic, we built it at a place called Cofu. Which is at the base of Mt. Fuji. Where we can get all the spring water we want.

This factory does nothing but produce—under outrageously close control—the components for our speakers.

Whatever we do buy, we specify so carefully that our vendors have nightmares about us. (It's unfortunate that we can't make *everything* ourselves, but only God can make a tree, and only wood can make a fine cabinet.)

Few companies make this effort.

So it's safe to say that when it comes to exercising this kind of control, our speakers are a voice in the dark.

Don't judge a bookshelf speaker by its cover.

As you can see, there's a lot that goes into producing a speaker that's

not easily seen. (One beautiful exception—the handsome finish on our cabinets.)

That includes the carbon fiber that we mix into the speaker cone paper.

Carbon fiber is light and strong. (Why they don't use it in girdles we'll never know.)

Light, so our speaker is more efficient. Meaning you need less power to operate it. Meaning you are closer to the ideal of converting electrical energy to mechanical energy without a loss of power.

Strong, to prevent the cone from bending out of shape in the high frequency range.

Moreover, carbon fiber doesn't resonate much. It has what's called a low Q, and it took someone with a high IQ to realize it would absorb the unwanted vibration rather than transmit it down the cone.

We also cut down on unwanted vibration (as opposed to the wanted vibration, which is music), by using a cast aluminum basket rather than a stamped, shoddy cheap metal one.

We could go on, but at this point the best thing would be for you to move on to your nearest Sony dealer. And listen.

Because the results of our three years of labor will be clear after three minutes of listening.

At which point, far from heckling our speakers, you'll be tempted to give them a standing ovation.

SONY®

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SONY is a trademark of Sony Corp.

Suggested retail prices: SSU-2000 \$150 each; SSU-1250 \$100 each; SSU-1050 \$130 a pair.

Check No. 37 on Reader Service Card



Dear editor

Contented Mac Owner

Dear Sir:

I was pleasantly surprised to find you reviewing the McIntosh C-28 Pre-amplifier. I've had the joy of owning one for almost four years now, and it looks and works like the day I brought it home. And your note that it weighs 25 pounds really brought a point home to me, ruggedness of construction is something I value just as much as performance. I would never think of trading my "28" for anything else on the market because of its quietness and incredible versatility.

How about reviewing one of their new super cool-running amps, like the MC-2205? You'll be amazed at the clarity of sound and the incredible metering/overload system. Or how about a unique product like the MPI-4 Maximum Performance Indicator? I've really raised my awareness about power levels with the dual vertical line readout that indicates power output in real time, averages or displays the last highest peak. And the huge multipath display (fed from their MR-78 tuner, of course) is the first I've seen that's truly easier to use than meters and much more informative.

I have one question to ask your manufacturer/advertisers: When, oh when, will someone please make a CD-4/SQ/QS Super-Deluxe Demodulator combination for us poor, frustrated top-of-the-line component owners? I'm gonna sit tight with my \$8,000 two-channel until somebody sees the light. Come on, let's get going!

J.H.
Detroit, Mich.

Editor's note: There are several good demodulator/decoders which have recently come onto the market. While they may not be on a par with your equipment, they are nonetheless a step in the right direction.

AM Fidelity

Dear Sir:

As chief engineer of an AM/FM station I read with interest Eric Norberg's letter in the November 1976 issue of *Audio* relating his experiences with

high grade AM broadcasting and requesting the inclusion of AM tuner data in your Equipment Profiles. Here's my two-cents worth on the "low fidelity" AM band.

AM broadcasters have been using studio equipment that delivers at least 50 Hz-15 kHz response with low distortion for quite a few years. Usually they are monaural versions of audio equipment used for FM broadcasting. In some cases, the same studio is used for both AM and FM origination, with the monaural AM feed developed through a simple summing of the left and right channels through a bridging amplifier.

It has been routine to find 50 Hz-15 kHz response with reasonable distortion in even 10- to 15-year-old transmitters. Current AM transmitters are starting to use various forms of pulse code modulation to improve their phase linearity. With these transmitters, it is not unusual to find frequency response, transient response, THD and IM distortion quite close to the FM transmitters available five years ago.

The major limiting factor in transmitting a high quality AM signal has been the bandwidth of the transmitting antenna. Recently broadcasters have realized that any response limitation in the antenna system has a direct effect on the amount of audio power reaching the air. When you add this to the realization that many broadcasters are becoming more audio conscious in order to have a competitive edge in a tight marketplace, it is easy to see why many AM broadcasters are broadbanding their antennas to give good audio response up to 15 kHz and even beyond.

An AM station with a reasonably broadband antenna can actually broadcast a better top end than an FM station, since AM is not saddled with the 75 μ S pre-emphasis curve used in FM broadcasting. This means that properly received broadband AM can sound like Dolby encoded-decoded FM broadcasts.

While there are some operators, on both AM and FM, who use signal pro-

cessing as an end in itself, most responsible broadcasters want to put out the best signal they can. Most of the "sins" committed by the average AM broadcaster in the area of signal processing are attempts to compensate for the extremely poor performance of current AM tuners. It is not unusual for a so-called "high fidelity" AM tuner to have a high frequency roll-off that starts around 3-4 kHz while "boasting" a distortion figure of 5-10 per cent at 85 per cent modulation. Since the AM band is crowded in many areas, it should also have switchable 5-8 kHz low-pass and 10-kHz notch filters for use when needed. Good sensitivity would be around 0.5-1 mV for a 20-dB signal-to-noise ratio. To date, the only receiver I have found that approaches these figures is a vintage tube-type McIntosh MR-55, which I use for home AM listening.

You will notice that I used 85 per cent modulation as the reference point for my distortion figures. Since the FCC specifies this as the minimum peak modulation level, it does not make sense to use 30 per cent modulation as a reference. Even if there was not this FCC requirement, I don't know of any station that would consistently modulate at this low level.

When you consider the advances made within the past decade in FM tuner performance, it is sad and frustrating to me to realize that the current AM tuners are solid-state versions of the receivers used during WW II. I would like to second Mr. Norberg's request for the inclusion of AM tuner data in your Equipment Profiles, if for no other reason than to shame manufacturers into making a high quality AM section available, if only as an option.

Lou Schneider
Chief Engineer KTIM/KTIM-FM
San Rafael, Cal.

Jailhouse Musicians

I am writing with the hopes that *Audio* Magazine will print this letter. I am a member of an organization known as the C.C.I. Music Association which is composed of both profes-

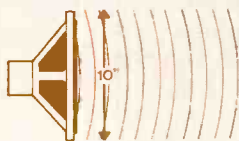
Introducing the Avid 101.

A rational solution to the problems of 2-way speaker design.

Designing a reasonably priced 2-way speaker system has always had its problems. One of the most perplexing of which has been engineering a speaker system with both well-dispersed midrange and really extended bass.

The bass vs. midrange dilemma.

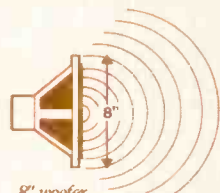
In one respect, a 6 or 8 inch woofer is preferable for a 2-way speaker system because its small diameter



Conventional 10" woofer is directional in midrange.

affords better dispersion in the critical midrange area up to the

crossover point where the high frequency driver takes over.



8" woofer affords superior midrange dispersion.

But, a small diameter woofer just isn't capable of handling the power

required for really extended bass (say to 30 Hz) in traditional designs without the use of costly electronic equalizers.

A real dilemma. The best solution to which we feel lies in a unique new 2-way speaker system—the Avid Model 101.

A rational solution.

The Avid 101 overcomes the traditional bass versus midrange

dilemma through an unusual combination of a large vented enclosure and a specially engineered 8 inch woofer.

Unlike conventional vented designs, the Avid 101's vented enclosure is used to *extend the bass response* of the system, rather than to increase the efficiency. This unique design (essentially a 4th order Chebychev filter alignment) achieves really extended bass—*down 3 dB at 30 Hz*—while the use of an 8 inch woofer insures a smooth, well dispersed midrange up to its 2500 Hz crossover point.

Of course, no ordinary 8" woofer could do the job. It took us over a year to perfect the woofer design and it's quite unique. For example, it utilizes an unusually large magnetic structure and a specially developed rubber-edged

cone of almost twice the weight and stiffness typically used.

But you have to actually listen to the Model 101 to really appreciate just how well it solves the traditional problems of the 2-way speaker.

A high end to match.

Things just wouldn't be complete if we didn't give the 101 a high-end performance that was every bit as good.

Which is why the 101 has three tweeters instead of just one.

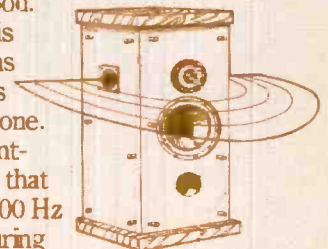
A primary, front-facing tweeter that comes in at 2500 Hz and two side-firing units that kick in around 3500 Hz.

The result is full 180° dispersion in the high end all the way up to 15 kHz for a sense of imagery and openness which, until now, was unavailable in all but the highest priced speakers.

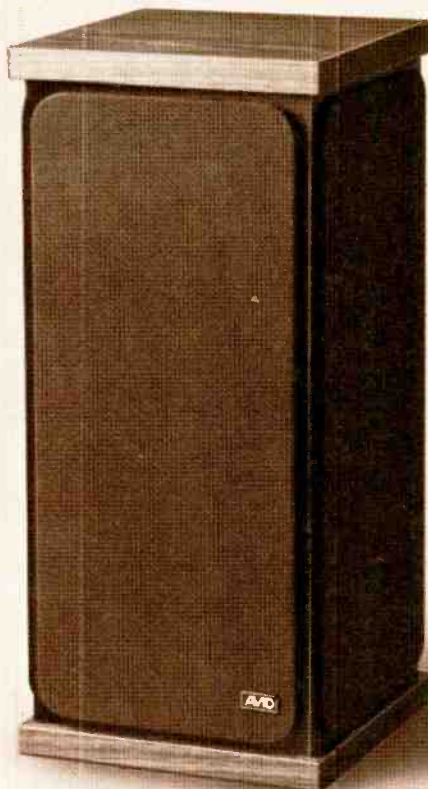
The right choice for most listeners.

We believe that the Avid Model 101 truly represents an advancement in two-way loudspeaker design and is the completely right choice for the vast majority of serious listeners.

Find out for yourself at your nearest Avid dealer. Be an Avid listener.

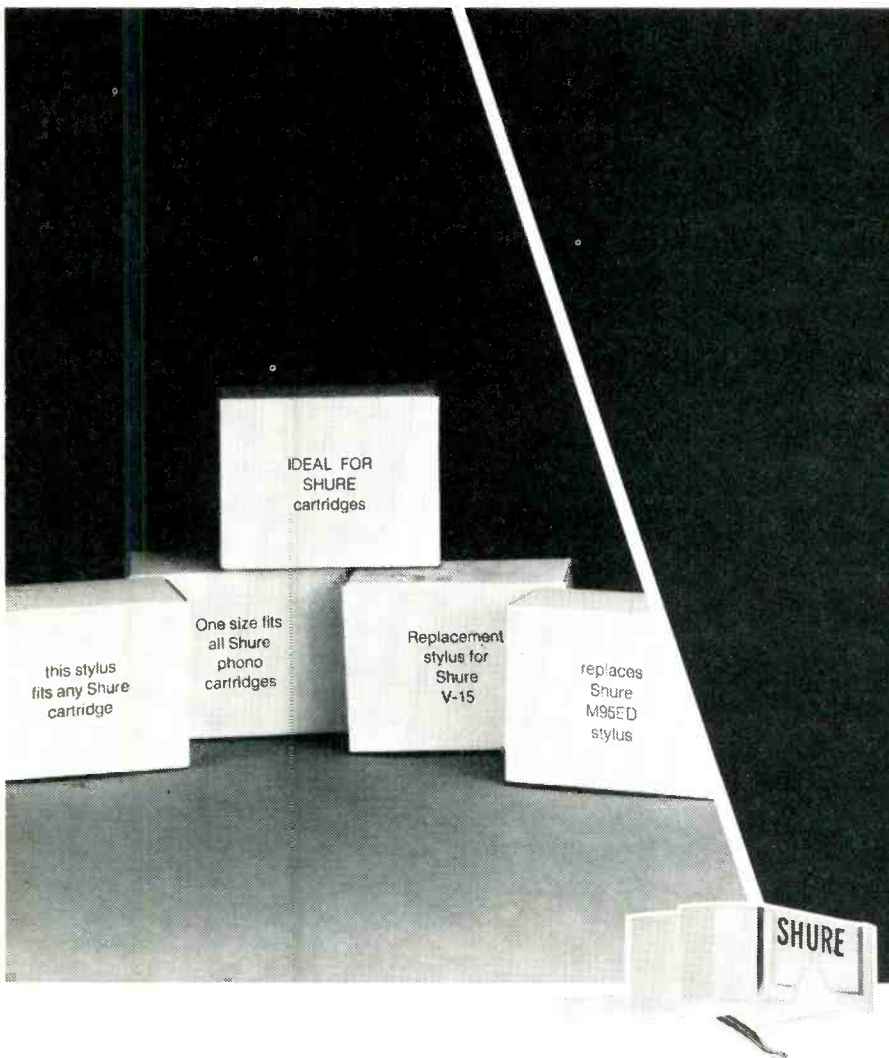


25



AVID

Check No 5 on Reader Service Card



Needle in the hi-fi haystack.

Even we were astounded at how difficult it is to find an adequate other-brand replacement stylus for a Shure cartridge. We recently purchased 241 random styli that were not manufactured by Shure, but were being sold as replacements for our cartridges. Only ONE of these 241 styli could pass the same basic production line performance tests that ALL genuine Shure styli must pass. But don't simply accept what we say here. Send for the

documented test results we've compiled for you in data booklet #AL548. Insist on a genuine Shure stylus so that your cartridge will retain its original performance capability—and at the same time protect your records.

Shure Brothers Inc.
222 Hartrey Ave., Evanston, IL 60204
In Canada: A. C. Simmonds & Sons Limited



MANUFACTURERS OF HIGH FIDELITY COMPONENTS, MICROPHONES, SOUND SYSTEMS AND RELATED CIRCUITRY

Check No. 36 on Reader Service Card

sional and amateur musicians. There are four different types of music groups: Jazz, Rock/Blues, Soul, and Country & Western. The difference between this and other musical organizations in the music field is that members of the C.C.I. Music Association are serving time at the Chillicothe Correctional Institute.

We would like to expand our membership to include outside people, whether they are professional or amateur musicians, or people who just like to listen to good music. You don't have to play an instrument, or even know how to read or write music to become a member. As a group, we can get a lot done if we have an outside membership.

If any of the *Audio* readers are interested, please write to either George Williams, President, or to me, Steve Griffith. We will see to it that you receive a copy of our constitution and by-laws, plus a fact sheet explaining what we are trying to accomplish. If you don't wish to join, but know of someone who would like to donate musical instruments to our organization, please put them in contact with us. I hope that there are people interested in joining our organization. Thank you.

Steve Griffith #144-539
P.O. Box 5500
Chillicothe, OH 45601

Reissue Suggestion

Every month the hi-fi and record magazines carry reviews of the reissues of old records.

May I make a suggestion for consideration by those responsible for selecting these records of historical or artistic value: reissue those famous early electrical recordings by the Associated Glee Clubs of America.

L.K. Crabtree
Vineland, Ont.
Canada

Editor's Comment: Are there any other suggestions for reissue? E.P.

Prof. Lirpa Exposed

Dear Sir:

I am new to this country and I was recently thumbing through some back issues of *Audio Magazine*, among them the April 1976 issue. Who are you trying to kid with your zany accounts of Prof. I. Lirpa? I don't know if you've divulged this to your readers, but I. Lirpa is Eotin Shirdlu backwards—you don't fool me.

Rishiyur Nikhil
Phila., Penna.

AUDIO • February 1977

The new Dual CS721 is the ultimate expression of the principles that determine the performance of tonearms and drive systems. Its straight-line, tubular tonearm pivots horizontally and vertically within a true, four-point gimbal, thus maintaining dynamic balance in all planes.

Another Dual innovation—Vertical Tonearm Control—contributes in yet another way to fine tracking performance. A vernier height adjustment over

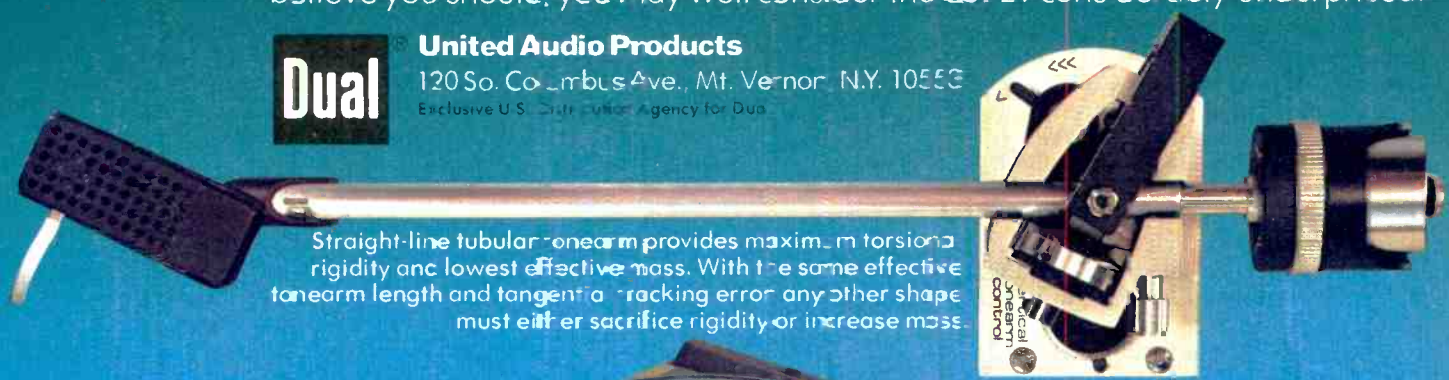
The new Dual CS721 represents everything Dual has learned about turntables.

an 8mm range parallels the tonearm to the record with any cartridge. This eliminates the added mass of cartridge spacers otherwise needed to achieve precise vertical tracking angle. In all, there are seven tonearm settings and adjustments — from stylus overhang to cueing height and descent speed — all serving to optimize tracking performance with any cartridge.

The direct-drive system of the CS721 is of comparable precision. The electronically-controlled, DC, brushless motor is the smoothest and quietest ever made. A major contribution to this end result is an exclusive Dual feature: two stacked coil layers, each consisting of eight coreless bifilar-wound coils, that overlap to achieve a gapless rotating magnetic field. This eliminates the successive magnetic pulses typical of all other motor designs.

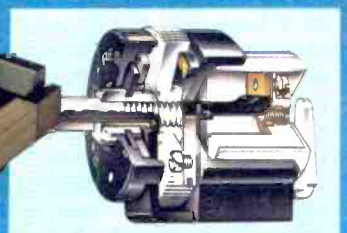
Although the CS721 is Dual's most expensive model, it is hardly the most expensive turntable available today. When you make comparisons, as we believe you should, you may well consider the CS721 considerably underpriced.

Dual **United Audio Products**
 120 So. Columbus Ave., Mt. Vernon, N.Y. 10553
 Exclusive U.S. Distribution Agency for Dual



Straight-line tubular tonearm provides maximum torsional rigidity and lowest effective mass. With the same effective tonearm length and tangential tracking error any other shape must either sacrifice rigidity or increase mass.

The Dual CS721. Single-play direct-drive turntable with fully automatic start and stop, plus continuous repeat. Features include: 10% electronic pitch control, illuminated strobe, dynamically-balanced 12" platter. Less than \$400, including base and cover. **Dual CS704.** Similar, except semi-automatic. Mechanical sensor locates lead-in groove of 12" and 7" records; tonearm lifts and motor shuts off at end of play. Less than \$310, including base and cover.



Counterbalance contains two mechanical filters, tuned to absorb energy in resonance-frequency ranges of tonearm/cartridge system and chassis to avoid feedback.

Specifications (DIN B): CS721, > 72dB; CS704, > 70dB.
 Wow and flutter: < ±0.03%

Other Dual turntables: Fully automatic, single-play/multi-play: 1225, less than \$140; 1236, less than \$170; 1228, less than \$200; 1249, less than \$280. Semi-automatic, single-play Duafs: 502, less than \$160; 510, less than \$200.

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Build a Class A Amplifier

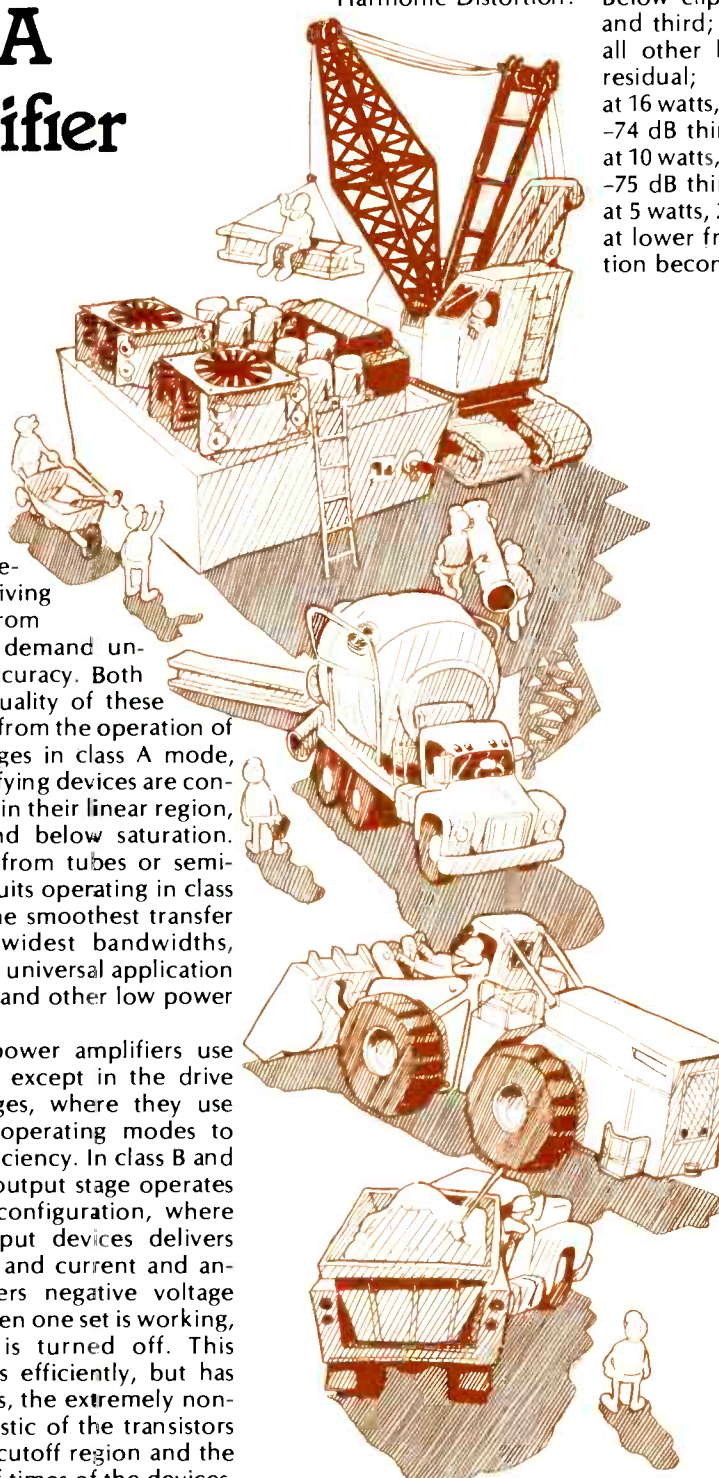
Nelson Pass*

In spite of their high cost and low efficiency, class A power amplifiers have recently been receiving more attention from audiophiles who demand uncompromising accuracy. Both the price and quality of these amplifiers result from the operation of their output stages in class A mode, where the amplifying devices are constantly operated in their linear region, above cutoff and below saturation. Whether made from tubes or semiconductors, circuits operating in class A mode yield the smoothest transfer functions and widest bandwidths, hence their near universal application in preamplifiers and other low power circuitry.

Most audio power amplifiers use class A circuitry except in the drive and output stages, where they use class B or AB operating modes to achieve high efficiency. In class B and AB modes, the output stage operates in a push-pull configuration, where one set of output devices delivers positive voltage and current and another set delivers negative voltage and current. When one set is working, the other set is turned off. This scheme operates efficiently, but has two serious flaws, the extremely non-linear characteristic of the transistors at the collector cutoff region and the turn-on/turn-off times of the devices. Designers of transistor amplifiers have tended to use large amounts of negative feedback to correct for the non-

Designer's Specifications

Power: 20 watts/ch. 8 ohm, 24 watts/ch. 6 ohm, and 28 watts/ch. 4 ohm.
Frequency Response: -3 dB at 0.33 Hertz, -3 dB at 500,000 Hertz.
Slew Rate: 30 volts/microsecond, leading and trailing edges.
Damping Factor: 100 from d.c. to 50,000 Hertz.
Noise: 0.8 millivolt at the output, primarily 120 Hertz.
Harmonic Distortion: Below clipping, harmonics are limited to second and third; all other harmonics were below our 90-dB test residual; at 16 watts, 20,000 Hertz and 8 ohms, -73 dB second, -74 dB third; at 10 watts, 20,000 Hertz and 8 ohms, -75 dB second, -75 dB third; at 5 watts, 20,000 Hertz and 8 ohms, -76 dB second; at lower frequencies and power levels, the distortion becomes very difficult to measure accurately.



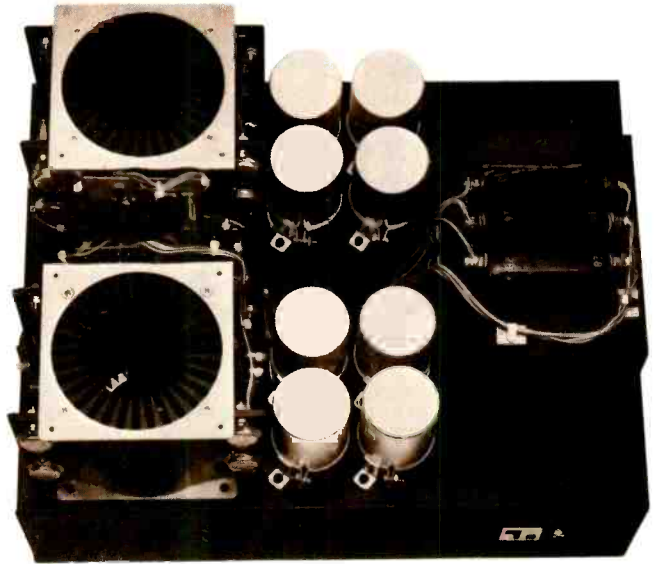
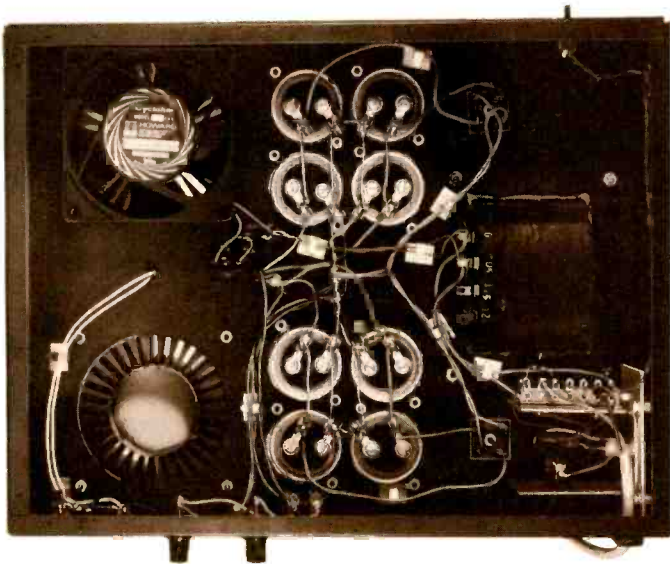
linearities, but this works well only at low frequencies. At high frequencies, the feedback loop is unable to make adequate corrections, and the distortion that occurs at the output is aggravated by overloaded front-end circuitry.

The usual total harmonic and intermodulation distortion figures do not reveal the abrupt output stage distortions accurately because of the averaging factor involved in such measurements. A spike of crossover distortion may reach 2 per cent, but if it occurs only over 5 per cent of the waveform, it averages out to a respectable 0.1 per cent distortion figure. Considering this error factor, it is easy to see why two amplifiers with the same specifications can sound so different. To properly evaluate the distortion, peak distortion and harmonic distribution must be considered. Typical class A amplifiers will exhibit low order harmonics, and their peak distortion is less than twice the average distortion. In class AB amplifiers, very high orders of harmonics occur, and the peak distortion can be as much as thirty times the average distortion.

Another problem common to class B and AB output stages is due to the unequal turn-on/turn-off times of the transistors. Because the turn-off time is greater, both transistor sets can conduct uncontrollably under high slew conditions, making it dangerous to operate the amplifier at high frequencies, a particularly bad problem with some quasi-complementary designs.

In a class A output stage, however, there are no abrupt nonlinearities and no turn-on/turn-off delays. The

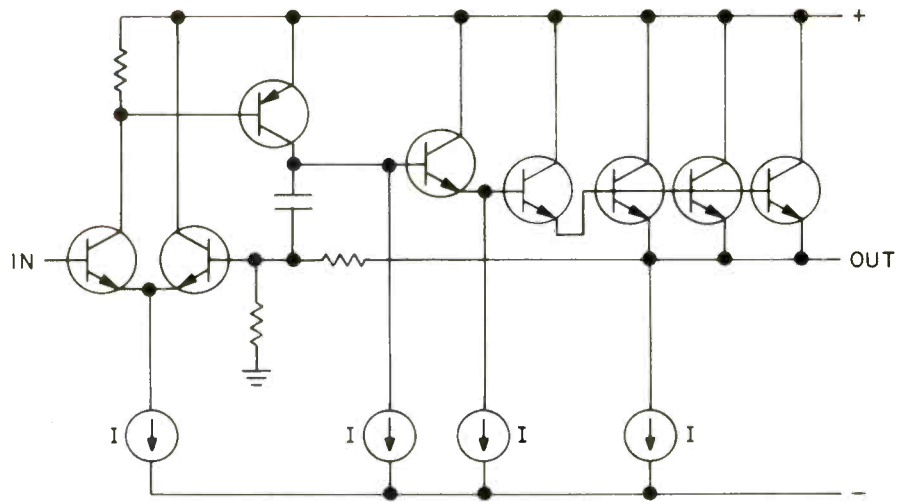
*President, Threshold Corp.



smooth transfer characteristic yields low order harmonic distortions, and these harmonics can easily become unmeasurable at low power levels.

Circuitry

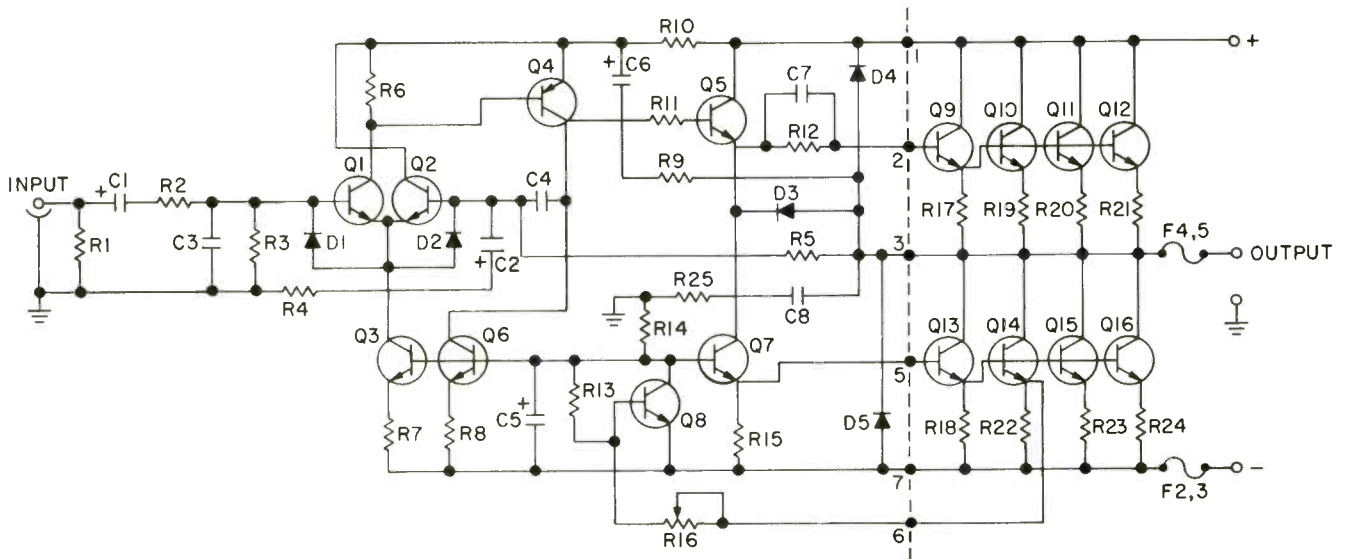
In the course of our research, we developed a small class A power amplifier which delivers 20 watts into 8 ohms. It offers excellent performance over a wide bandwidth, and the design is simple and stable enough that it can be built by the advanced constructor at low cost and with a minimum of test equipment. The parts utilized are usually available off the shelf from Motorola and RCA distributors, and the design will accommodate the usual variations in components without problems, so that it is unnecessary to select semiconductors for particular characteristics. A stereo



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Fig. 1—Basic circuit configuration.

Fig. 2—Overall schematic.



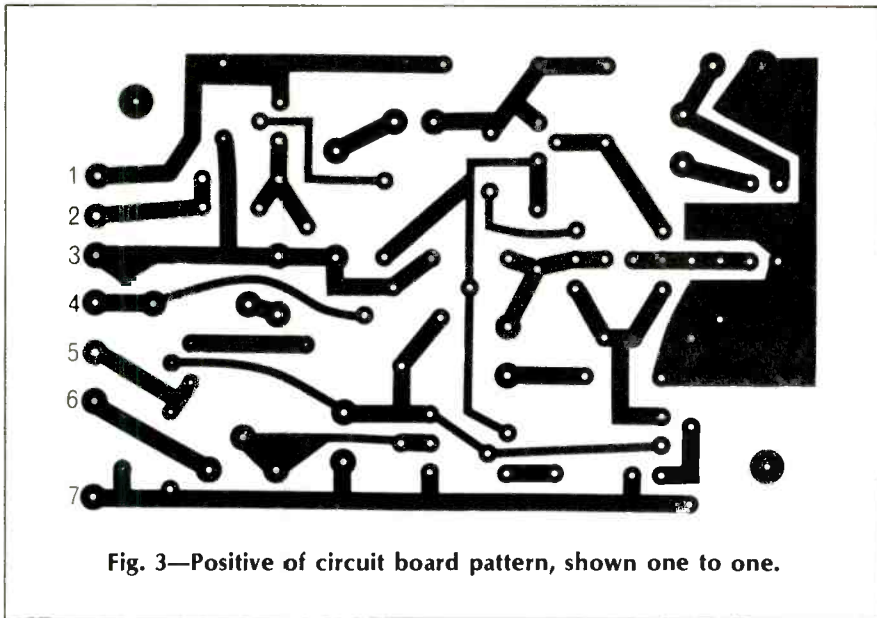
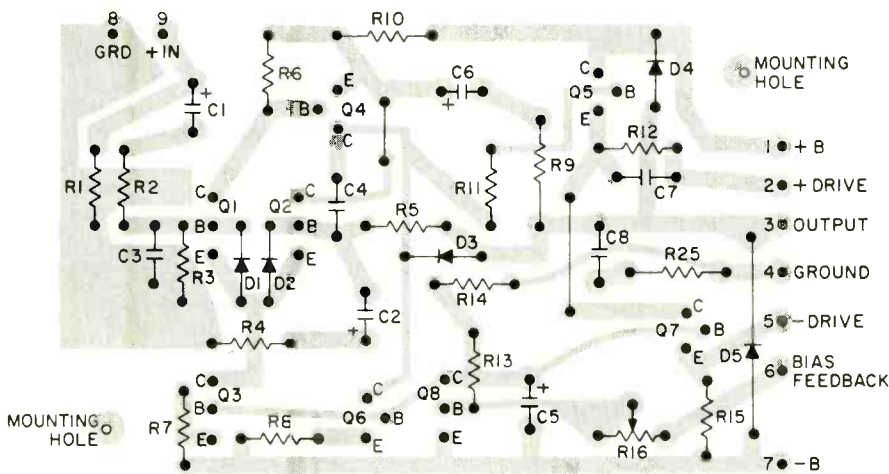


Fig. 3—Positive of circuit board pattern, shown one to one.

Fig. 4—Component location guide for parts side of PC board.



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Table II—Parts List for One Channel.

Q1,2,3,8 Motorola MPSL01	R3 10 kohm	R25 10 ohm, 1/2 watt, carbon comp., 5%
Q4 RCA 1A16	R4 470 ohm, 1%, metal film, 1/4 watt	Power Supply Parts for Two Channels
Q5,6,7 RCA 1A15	R5 4.7 kohm, 1%, metal film, 1/4 watt	T1 Signal 56-12
Q9-16 Motorola 2N5877	R6 680 ohm	B1,2 Diode bridges, 25 amp, 100 volt
D1,2 1N914	R7 680 ohm	C1,2 0.05 microfarad, 600 volt
D3 Any germanium diode	R8 100 ohm	C3-6 20,000 microfarad, 50 volt,
D4,5 1N4004	R9 100 ohm, 5%, carbon comp., 1 watt	computer grade electrolytic
C1,2 1,000 microfarad, P C	R10 47 ohm, 5%, carbon comp., 1/2 watt	F1 10 amp, fast blow fuse
mount, electrolytic, 16 volt	R11 68 ohm	F2,3 4 amp, fast blow fuse
C3,4 75 picofarad, 5% polystyrene,	R12 47 ohm	F4,5 2 amp, fast blow fuse
mica, or mylar	R13 4.7 kohm	S1 Heavy duty SPST switch
C5,6 100 microfarad, 50 volt,	R14 4.7 kohm	
PC mount, electrolytic	R15 47 ohm	
C7 0.004 microfarad, 5%	R16 5 kohm trim potentiometer,	Miscellaneous
C8 0.1 microfarad, 20%, 100 volt	from C.T.S.	A.C. line cord, five fuse holders,
All resistors 5%, 1/4 watt, carbon	R17 1.5 ohm, 5%, carbon comp., 1 watt	chassis, heat sinks for output stage,
film unless otherwise specified.	R18 1.5 ohm, 5%, carbon comp., 1 watt	four TO-5 heat sinks (Thermalloy
R1 1 megohm	R19-24 0.22 ohm, 5%, wirewound,	2228B or equivalent), input and out-
R2 1 kohm	1 watt from IRC (TRW)	put connectors, two 0.1 μ F capacitors
		22% 10 volts.

version of this amplifier can be built for approximately \$200.00.

The basic circuit configuration is shown in Fig. 1, where an input differential transistor pair drives a current-sourced transistor, forming the two voltage-gain stages of the amplifier. The output of the second voltage-gain transistor drives a triple emitter-follower output stage, which provides a current gain of somewhat less than a million. The four current sources in the circuit are used to simultaneously increase the bandwidth and linearity, accomplishing this by idling semiconductors at currents much larger than the currents required to drive the amplifier. With the exception of the output stage, the gain transistors operate with only small variations about their operating points.

The compensation capacitor shown in Fig. 1 is used to provide damping for the circuit, eliminating overshoot and ringing in the output. Its effect is the reverse of the usual lag compensation employed in transistor amplifiers because it actually reduces transient intermodulation effects by creating an internal high frequency feedback loop similar to the damping circuits found in servo systems, where the front end of the amplifier can satisfy its own loop requirements at high frequencies, avoiding front-end overload.

The schematic of the actual amplifier is presented in Fig. 2. The transistors Q3,6,7,13,14,15,16 form the current sources of Fig. 1. Their current value is governed by the active voltage source of Q8, where the circuit is stabilized by taking feedback from R22. This current sourcing system accurately tracks the current value once

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With two motors.
Electronic controls.
"Pause cueing."
Remote control.
And a waiting list
a mile long.**



31

Sorry about the waiting list, but when you see it you'll understand. Here you have a purist's tone arm and superb playback in a "bee eye cee" belt drive unit which we believe promises better long-run performance than a direct drive unit. At about \$279, we think it's irresistible. See what you think at your high-fidelity dealer's. You'll find our 5 turntables folder there. Or write to British Industries Co., Westbury, N.Y. 11590.

5 Turntables B I C™

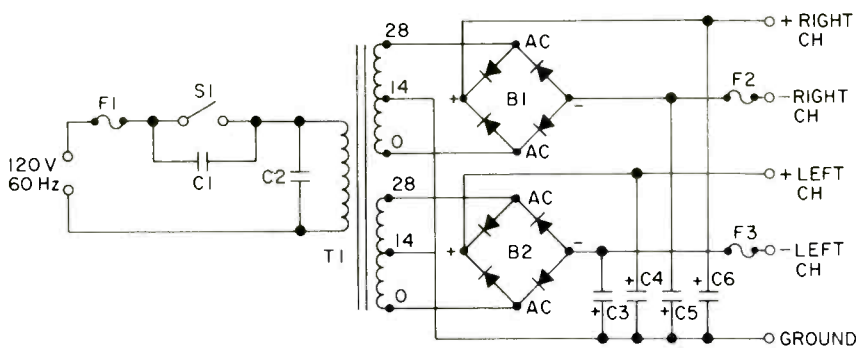


Fig. 5—Schematic of power supply.

it is properly adjusted. The one-to-one circuit board pattern and an up-sized parts location guide are given in Figs. 3 and 4. The location of the parts is self explanatory, except that Q5 and Q7 must be fitted with heat sinks. Reasonable care must be taken to avoid overheating the semi-conductors and other components during soldering, and high-wattage soldering guns must not be used. If any substitute transistors are used, it may be necessary to adjust the values of C7 and C4 for stable operation using an 8-ohm non-inductive load and driving the amplifier with 100 kHz square waves. If the amplifier should exhibit high frequency oscillation, increase the value of C4 or decrease the value of C7.

For this amplifier, there is no such thing as too much heat sinking for the output stage. Extravagance in this area is no vice, and good ventilation is similarly very important. The use of more than 100 square inches of black-anodized aluminum heat sink per output transistor should allow for oper-

ation without a fan. A safe rule of thumb by which to evaluate the quality of heat sinking is to see whether or not you can place your hand on the heat sink without hurting yourself. The heat sink should be grounded to the chassis of the amplifier, and heat-conducting insulators must be used with a liberal quantity of silicone grease between the heat sink and the output transistors.

Figure 5 shows the power supply for a two-channel system which will allow different supply voltages for optimization of the output power versus load impedance. The 105 volt primary tap of the transformer will serve for 8-ohm loads, the 115 volt tap for 6-ohm loads, and the 125 volt tap for 4-ohm loads. With a 120 volt a.c. line, the maximum power yield is 20 watts per channel into 8 ohms, 24 watts into 6 ohms, and 28 watts into 4 ohms. To alter the amplifier for optimal performance into a given load, the tap must be changed and the amplifier must be rebased. If the diode bridges in the power supply are not mounted

on a metal chassis, they too must be provided with heat sinks. Use 16-gauge wiring in the power supply and amplifier output connections, while 24-gauge wire is adequate for other connections. It is important that all of the ground connections be shared by both channels at one point on the ground bus. The ground bus must connect all four power supply capacitors and be of heavy gauge. Additional wiring information is given in Fig. 6, where the grounding and power connections are to be followed *literally* for low noise. At the input connectors, the ground of the input is physically isolated from the chassis. A 0.1 μ F capacitor connects each input ground to the chassis at the input and is used to eliminate r.f. pickup.

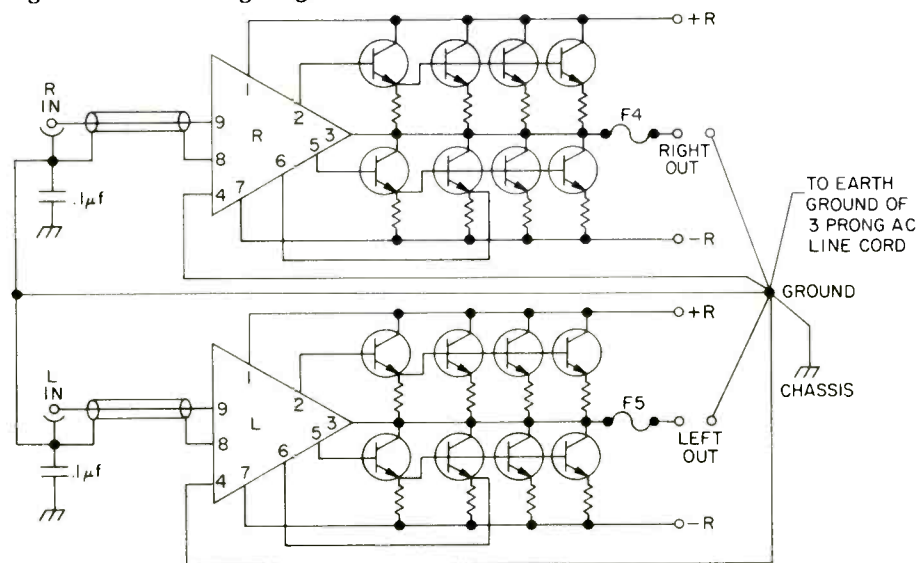
Set Up

Biasing the amplifier is quite easy with either a d.c. voltmeter or an oscilloscope. Before turning on the amplifier, R16 must be adjusted for maximum resistance (minimum bias current). If the bias is set too high, the negative power supply fuse will blow without damaging the circuit. If this occurs at one extreme setting of the potentiometer, replace the fuse, set the pot to the other extreme, and try again. After the amplifier is turned on and doesn't blow the fuses, the bias must be set by adjusting R16, preferably using an oscilloscope. Using an oscilloscope, the bias is adjusted by driving the amplifier with a sine wave into the appropriate load resistor value. Set R16 so that the amplifier clips into the load on the negative half of the wave before the positive half clips. Then operate the amplifier for 15 minutes without an input signal. After 15 minutes, readjust the bias for symmetrical clipping of the circuit when it is very slightly overdriven. Repeat the adjustment again in 15 minutes to insure that the heat sinks have reached thermal equilibrium.

If using a high quality d.c. voltmeter, the bias can be adjusted by a similar procedure, measuring the voltage occurring across R22. For an 8-ohm load, the voltage across R22 should be 125 millivolts. For 6 ohms, the voltage is to be 170 mV, and 220 mV for 4-ohm loads. As before, the bias must be adjusted slightly low and increased slowly to the proper value after the amplifier has warmed up. The voltage should be monitored and adjusted periodically over a half an hour or so.

The prototype amplifier was built without specially selected components and the only adjustments

Fig. 6—Overall wiring diagram.



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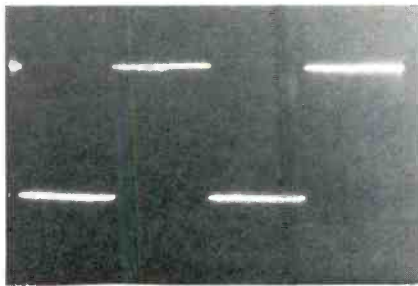


Fig. 7—Response to a 20-Hz square wave.

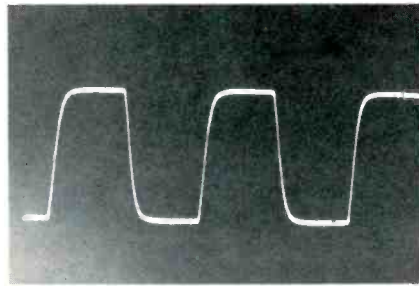


Fig. 8—Response to a 100-kHz square wave.

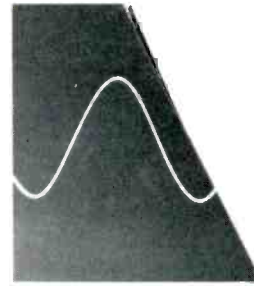


Fig. 9—Response to a 500,000 Hertz wave.


made were the output bias currents. The amplifier yielded the performance figures shown in Table I.

The amplifier's response to square waves is shown at 20 Hertz (Fig. 7) and at 100,000 Hertz (Fig. 8). Figure 9 shows the waveform at 500,000 Hertz at -6 dB power level. All tests were conducted with non-inductive load resistors, but the performance remains unaltered with reactive elements in the load. The amplifier's distortion characteristics remain virtually unchanged with fully reactive loads, and we were unable to detect a significant difference in harmonic ampli-

tudes between an 8-ohm load and a 2-microfarad capacitor driven at 10 kiloHertz.

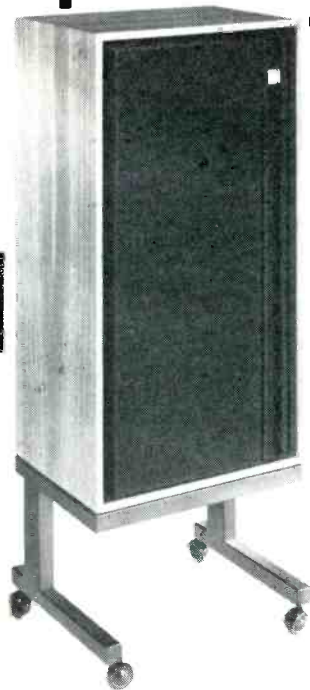
The amplifier cannot be damaged by shorting the output or by overdriving the input. It does not require a load for stability and can be safely driven into any load at any frequency. The components are chosen for very conservative operation; for example, the output transistors are operated at a third their rated voltage, a tenth their rated continuous current, and about a tenth their dissipation capability, insuring a long life span for the amplifier.

After extensive listening tests concluded that the sonic purity amplifier more than justifies its power consumption (less than a cc TV). The sound is neutral, and we have found it useful as a tool in evaluating preamplifier circuits, as it outperforms quite a few of them. It also serves well in driving electrostatic headphones and as the high frequency driver in a multi-amp system.

Technical assistance may be obtained by writing Threshold Corporation, Suite E, 1832 Tribute Rd., Sacramento, Calif. 95815, and enclosing a self-addressed, stamped envelope. 

One step nearer the reference

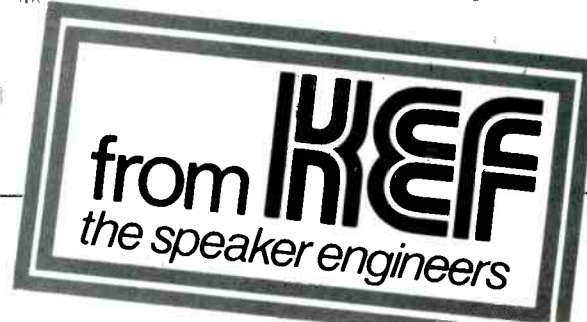
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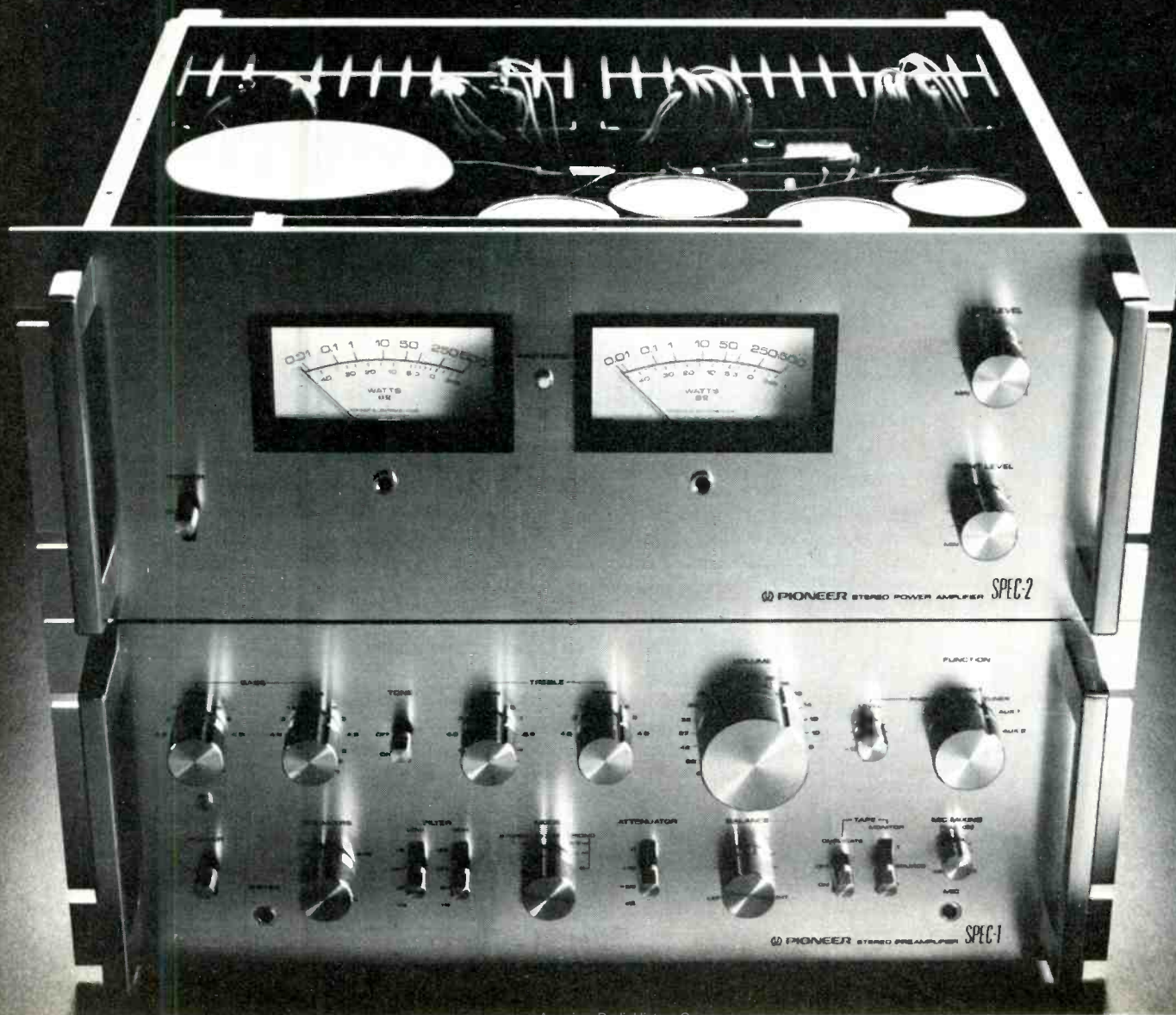
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Pioneer's new Spec 1 and Spec 2 are capable of producing a level of high-quality sound most speakers are simply incapable of reproducing.

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Spec 2 was the first power amplifier designed to deal with the new F.T.C. power regulations. It has a continuous power output of 250 watts per channel minimum RMS. At 4 or 8 ohms. From 20 to 20,000 Hz. With no more than 0.1% harmonic distortion.

Other power amplifiers that used to claim a lot more power can't do that anymore.

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When you listen to a live performance it can have an average sound level of 84 dB. Which most high fidelity systems can reproduce with half a watt of power. But a sudden musical peak of 110 dB takes four hundred times as much power. Which means you need 200 watts of power to reproduce that peak. If your amplifier doesn't have that much reserve power, you get "clipping." Which doesn't happen during a live performance.

So, if you want your system to be able to give you all the power, all the sheer presence of live performance, you need an

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Spec 2 not only produces an uncompromising amount of sound; it does so in a totally uncompromising manner.

For example, Spec 2 uses an advanced toroidal coil power transformer. It's a more expensive transformer than most amplifiers use. But a more efficient transformer. And one that keeps magnetic flux leakage to an absolute minimum.

Also unlike many power amplifiers, Spec 2 doesn't use fans. Because fans can cause noise. Instead, Spec 2 has massive heat sinks and special Pioneer-developed protective circuitry to keep the operating temperature under control.

Spec 2 even has wattage meters that indicate music output

compensate for any deficiencies in program material or listening area.

And, so you can make sure you've made all the right adjustments, Spec 1 has a "tone off" switch that lets you compare your setting with a completely flat setting.

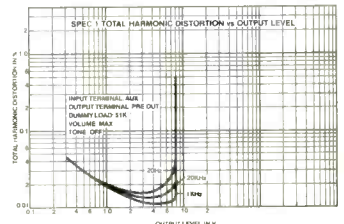
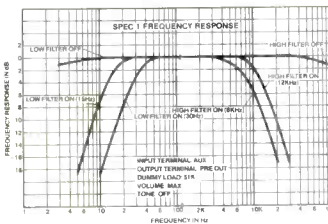
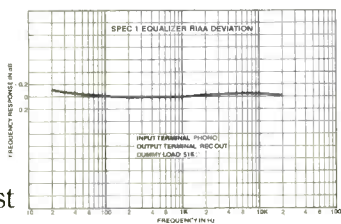
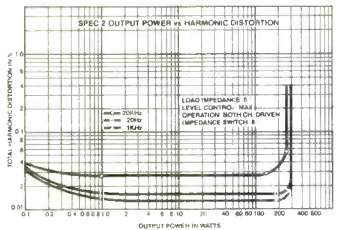
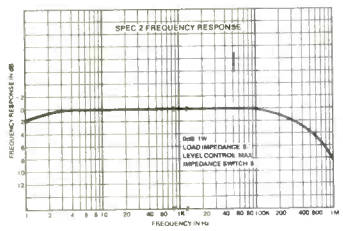
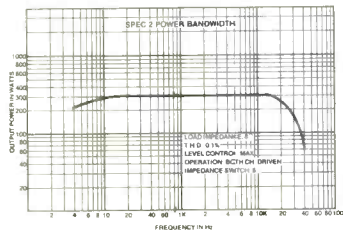
Spec 1 even has its own microphone amplifier, with its own volume control. So you can mix into any program material without touching the main volume control.

THE BEAUTIFUL SOUND OF NOTHING

One thing Spec 1 doesn't do is add anything to the sound it reproduces. The phono section has a completely inaudible signal-to-noise ratio of 70 dB (IHF, short-circuited A network). All other inputs are rated at 90 dB. Which is even more inaudible. And it has a total harmonic distortion of no more than 0.03%. Which is five times under what your ear is capable of detecting.

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Both Spec 1 and Spec 2 are 19" wide. So you can place them in any standard EIA laboratory rack.



in RMS watts at 8 ohms. These had to be specially designed, too. Because conventional VU meters couldn't give an accurate enough power reading.

SPEC 1: TWICE THE CONTROL OF MOST PREAMPLIFIERS

Most preamplifiers have two tone controls. Some have three. But Spec 1 has four. Each of which is calibrated in 1.5 dB clickstops. All together, they give you a total of 5,929 ways to

Or you can stack them like conventional home entertainment components.

Which they definitely are not.

**SPEC 1
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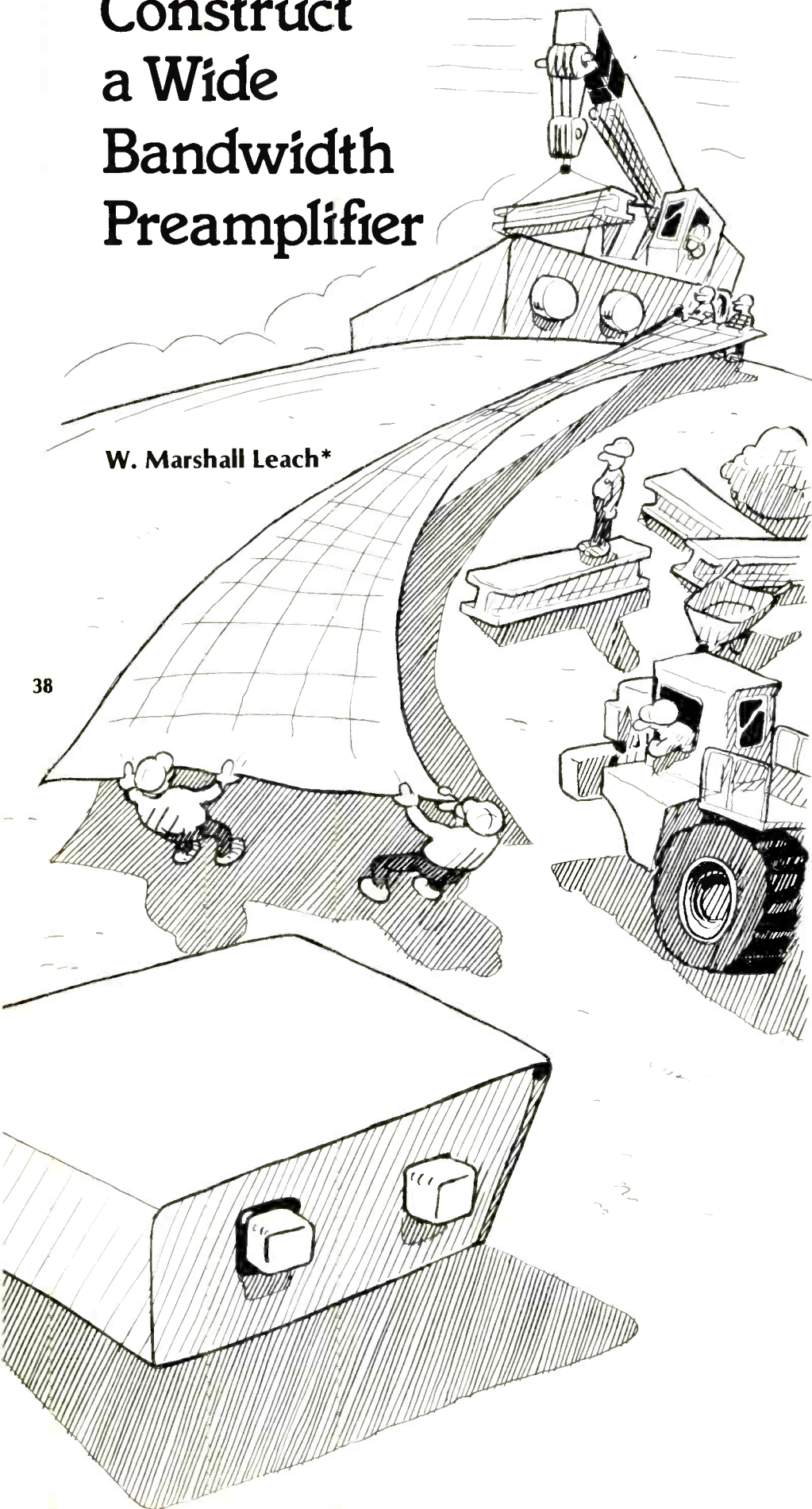
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Construct a Wide Bandwidth Preamplifier

W. Marshall Leach*

38



Some of the most important functions in the signal processing chain of a sound reproduction system are performed by the phono preamplifier. This circuit must amplify signals from millivolt level to peak levels of two to three volts or more in order to drive a power amplifier. In addition, the circuit must equalize the signal to correct for a nonuniform frequency response which can vary by as much as 40 dB over the 20 Hz to 20,000 Hz frequency band. It must do this while introducing a minimum amount of electronic noise, and it must contend with a phono cartridge whose output impedance can vary by as much as a factor of 60 to one over the audio band.

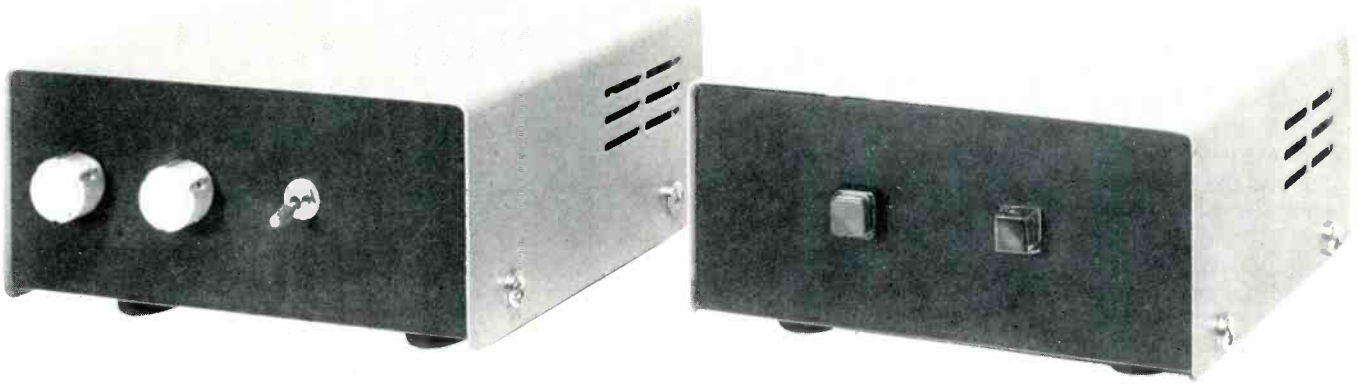
Of particular importance are the high-frequency and transient overload characteristics of the preamplifier. Before a signal enters the preamp input, it has been processed by the RIAA recording equalizer, the constant velocity disc recording process, and the time derivative response of the magnetic playback cartridge. The combination of these three can create input signal levels which are 100 times as great at 20,000 Hz than at 20 Hz. In addition, record ticks and pops, when processed by the time derivative response of the playback cartridge, can contain high-frequency components whose amplitudes far exceed those of normal signal levels. Thus, the high-frequency overload characteristics of the preamplifier become very important considerations if transient IM distortion and slew-rate distortion are to be minimized.

This article describes an RIAA phono preamplifier primarily designed with these considerations in mind, and the author's unit is shown. It uses a separate chassis for the power supply to eliminate hum induced by inductive coupling from the power transformer. At a one volt rms output level, the preamplifier's SMPTE IM distortion measures 0.004%. Its A-weighted signal-to-noise ratio is 84 dB referenced to a 10 mV input signal at 1000 Hz, which could be improved if low-noise, metal-film resistors were employed in the critical input stages.

The output circuit used to drive the power amplifier output has a 10-dB gain to insure that the power amplifier is driven to full output power. This stage has a Butterworth-aligned high-pass filter characteristic which has

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Illustration by Richard Weiss



been designed to reject subsonic and inaudible frequency components below 15 Hz, which can result from record warp, offset center holes in records, turntable rumble, and acoustic feedback. In particular, vented-box loudspeaker systems using high compliance drivers are very susceptible to overdrive by subsonic signals. The rejection of these signals can produce a marked improvement in loudspeaker performance plus a decrease in power dissipation in the power amplifier. An added advantage provided by the subsonic filter circuit is the protection of the loudspeaker and power amplifier from low-frequency transients which can occur when a tonearm is accidentally dropped on a record or when an FM tuner is rapidly

tuned across the band. In both cases, low-frequency loudspeaker cone motion is reduced to a minimum to prevent possible driver suspension damage or power amplifier failure.

An optional center-channel circuit is described which can be used to drive a front center-channel amplifier and speaker system. A three-channel system has long been advocated by Paul W. Klipsch as representing the closest approach to true realization of sound reproduction. The circuit is simple and can be added to the preamplifier at any time.

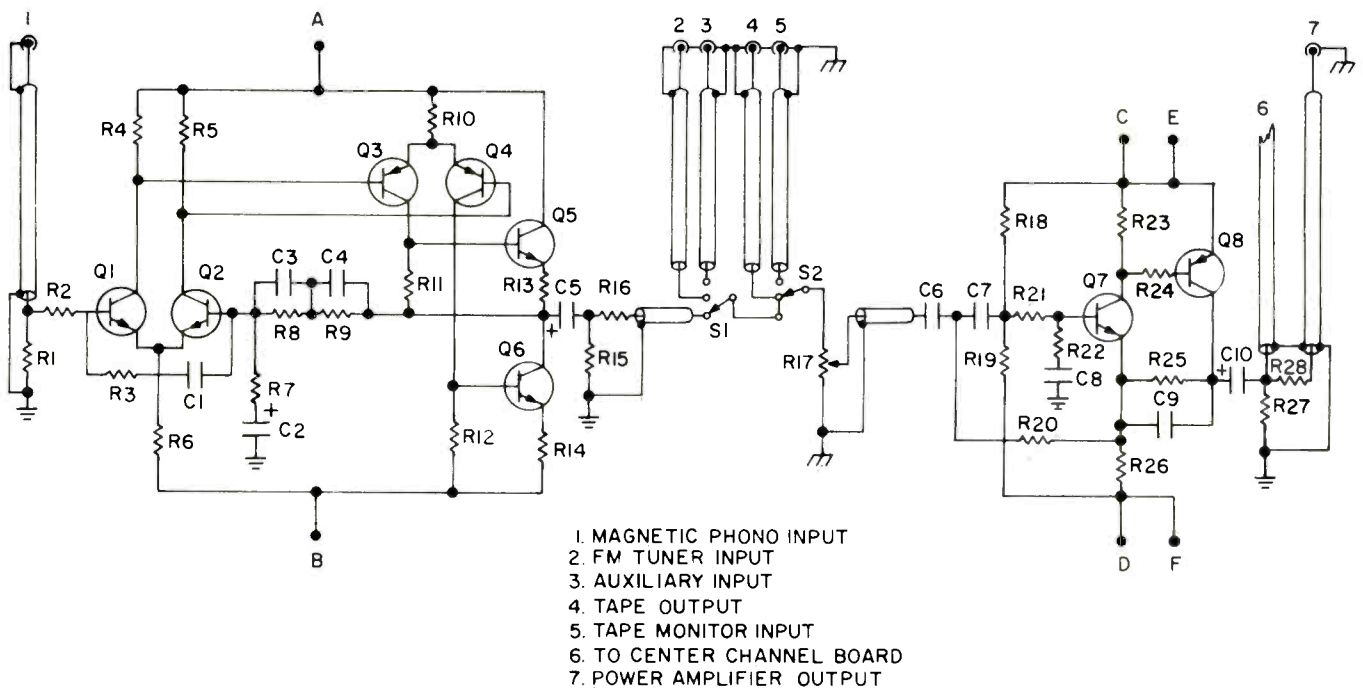
Circuit Description

The circuit diagram of the preamplifier minus the power supply and optional center-channel circuit is

shown in Fig. 1. It has input switching facilities for magnetic phono, FM tuner, and auxiliary inputs, and outputs for tape recorder and power amplifier. In addition, a separate tape monitor switch is provided for tape input. The volume is controlled by a potentiometer which effects only the signal level to the output stage which drives the power amplifier output jack. The circuit uses positive and negative balanced power supplies which are separately regulated by zener diodes for each stage.

The phono preamplifier circuit consists of transistors Q1 through Q6. An initial design used passive equalization between the cartridge and the input stage to equalize for the 75 microsecond pre-emphasis in the RIAA

Fig. 1—Circuit diagram of the preamplifier minus power supply and center-channel circuit.



recording characteristic. This would have greatly reduced the high-frequency overload characteristics required in the phono preamplifier circuit. However, the approach was abandoned because of the uncertainty in the interaction of the output impedance of the phono cartridge and the input impedance of the circuit and because of noise considerations. Transistors Q1 and Q2 form an input differential amplifier. The differential amplifier configuration was suggested by Meyer [1] in 1972 for use as a preamplifier input stage. It has been suggested more recently by Holman [2] in a circuit similar to the one published by Meyer. Q1 and Q2 are biased by R6 at 50 microamperes each. This low bias current is necessary to provide low noise performance since the input stage determines the signal-to-noise ratio of the preamplifier. A potential problem associated with differential amplifiers is that of maintaining a balanced quiescent current in the two transistors. With the aid of a microammeter, the components in Fig. 1 have been chosen to insure that Q1 and Q2 are conducting balanced or equal quiescent currents. This insures optimum distortion characteristics of the input stage since the predominant second-order nonlinearities in the base-to-emitter junction characteristics of Q1 and Q2 theoretically cancel when the bias currents in the two transistors are the same.

The output signal from the input differential amplifier is applied to a second differential amplifier which consists of transistors Q3 and Q4. In addition to supplying a second stage of voltage gain, the differential connection of Q3 and Q4 provides the very important cancellation of any common-mode noise from the input stage due to thermal noise generated by the emitter bias resistor R6. Without this feature, the signal-to-noise ratio that is established by the input stage would be inferior to that which could be achieved by employing a single-ended input stage rather than the differential configuration [3]. The signals from Q3 and Q4 drive the class-A, push-pull output stage consisting of transistors Q5 and Q6. These transistors provide the current gain necessary to drive the feedback network and the following stages of the preamplifier. Since Q5 and Q6 operate in a true class-A mode, there is nothing to be gained from the added complexity necessary to drive a complementary output stage.

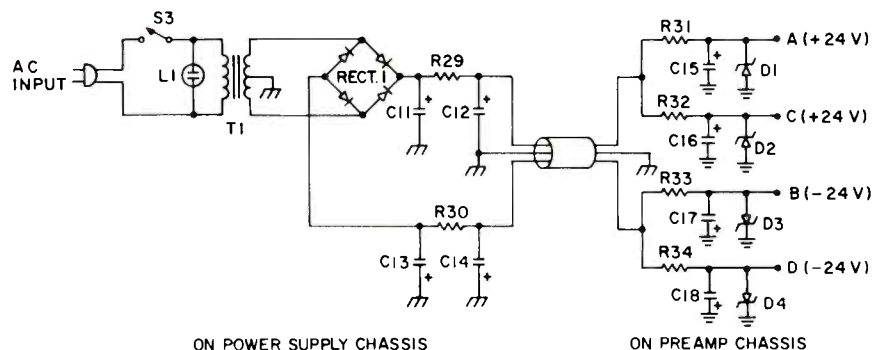


Fig. 2—Power supply circuit diagram. Note that not all components are mounted on the power supply chassis.

The feedback network consists of resistors R7 through R9 and capacitors C2 through C4. The resistors in this network have been chosen so that the closed-loop gain at 20 Hz is 60 dB, more than 20 dB lower than the open-loop gain of the preamplifier. Thus, a low-frequency feedback ratio of greater than 20 dB insures an extended low-frequency response with low distortion characteristics. C2 has been chosen so that the lower minus 3-dB frequency of the phono preamplifier circuit is less than 1 Hz. If the circuit is used to drive a power amplifier without the 10-dB gain output circuit, it is recommended that C2 be changed from 100 microfarads to 5 microfarads in order to provide some rejection of unwanted subsonic signals. With this change, the minus 3-dB lower frequency of the phono preamplifier will be moved up to 8 Hz.

The time constants for the RIAA equalization are set by R8, R9, C3, and C4. Since the open-loop gain and bandwidth of the phono preamplifier will also effect the RIAA equalization, these elements cannot be calculated precisely, rather they must be determined experimentally for optimum equalization. The approach taken in

the present case was to first calculate these components from network theory under the assumptions of an infinite open-loop gain and bandwidth and zero output impedance. The elements were then tuned experimentally to optimize the equalization. This was done with the aid of the passive inverse-RIAA equalization circuit recommended by Audio Research for the testing of preamplifiers. The experimental tuning procedure was performed by exciting the preamplifier from a General Radio pink noise source through the inverse-RIAA equalizer. The output of the preamplifier was then monitored on a Hewlett-Packard real-time spectrum analyzer, and the feedback network elements were tuned for the flattest overall equalization. The transient response of the preamplifier was also monitored during this process with a square wave input signal through the inverse-RIAA equalizer to insure that the square wave response was also being optimized.

The overload characteristics of the magnetic phono input circuit are adequate to insure that it will not be driven into clipping or slewing during normal use. This circuit will put out a

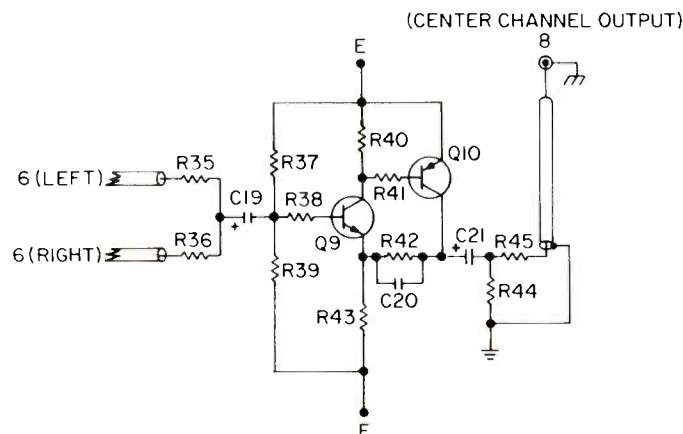


Fig. 3—Center-channel circuit diagram.

40-volt peak-to-peak sine wave signal up to a frequency of 120 kHz, and its clipping characteristics are symmetrical under these conditions. The overload margin of a preamplifier is an important consideration, especially at high frequencies. Although limitations in disc recording make it impossible to cut large amplitude high-frequency signals on records, the output of a magnetic cartridge increases with frequency at 6 dB per octave because of its time derivative response. Normal frequency response plots for cartridges do not show this since the plots are corrected for it. However, phono preamplifiers must handle the boosted high frequencies without overload or slewing. Record ticks and pops are impulsive in nature, and thus they contain very broadband frequency spectra. In combination with the rising frequency response characteristics of the cartridge, they can easily cause high-frequency overload, transient IM distortion, and slew-rate distortion if the high-frequency overload characteristics of the phono preamplifier are not adequate. In addition, four-channel discs recorded with the CD-4 process can cause surprisingly large high-frequency sub-carrier signals at the cartridge output, even if it is not designed for CD-4 use. Although preamplifiers are not designed to put out appreciable signals at these frequencies, the high-frequency overload margin in any circuit which uses negative feedback for equalization can be seriously degraded. Thus, it is the author's opinion that CD-4 discs are best used with only CD-4 equipment.

The output of the phono preamplifier is fed through the input switching facilities in Fig. 1 to a 20-kilohm volume control. When the tape monitor switch is in the normal mode, the input impedance to any tape deck connected to the tape output jack appears in parallel with the volume control. It is recommended that only a high impedance tape deck be used with the tape output, otherwise, the total load impedance on the preamplifier circuit may drop too low.

The volume control drives the output stage which consists of transistors Q7 and Q8. The gain of this circuit is set at 10 dB by resistors R25 and R26. The circuit is designed to have an active-filter, Butterworth high-pass alignment which is flat above 20 Hz. It exhibits a 12-dB-per-octave rolloff below its 3-dB cutoff frequency of 14 Hz. The alignment of this filter is set by C6, C7, R18, R19, and R20. Substitute

PARTS LIST

Parts List for one channel. All resistors are 1/4 watt, 5% unless otherwise specified. Resistors should be carbon film rather than carbon composition unless otherwise specified.

R1 47 kilohm, metal film	R24 100 ohm
R2 1 kilohm, metal film	R25 2.2 kilohm
R3 390 ohm	R26 1 kilohm
R4, R5 36 kilohm, metal film	R27 100 kilohm
R6 220 kilohm, metal film	R28 560 ohm
R7 3.9 kilohm, metal film	R29, R30 270 ohm, 1 watt
R8 330 kilohm, metal film	R31, R33 390 ohm, 1/2 watt
R9 4.3 megohm, metal film	R32, R34 270 ohm, 1/2 watt
R10 2.2 kilohm	(200 ohm, 1/2 watt with
R11 5.6 kilohm	center-channel circuit)
R12 6.2 kilohm	R35, R36 91 kilohm
R13, R14 220 ohm	R37 68 kilohm
R15 100 kilohm	R38 3.3 kilohm
R16 560 ohm	R39 5.6 kilohm
R17 20 kilohm, dual potentiometer	R40 3.3 kilohm
R18 470 kilohm	R41 100 ohm
R19 100 kilohm	R42 3.6 kilohm
R20 33 kilohm	R43 430 ohm
R21 4.3 kilohm	R44 100 kilohm
R22 390 ohm	R45 560 ohm
R23 3.3 kilohm	

C1 0.001 μ F, 100 volt, ceramic capacitor
C2 100 μ F, 10 volt, electrolytic capacitor
C3 220 pF, 100 volt, 5% silver mica capacitor
C4 820 pF, 100 volt, 5% silver mica capacitor
C5 25 μ F, 25 volt, electrolytic capacitor
C6, C7 0.22 μ F, 25 volt, 5% ceramic capacitor
C8 390 pF, 100 volt, ceramic capacitor
C9 10 pF, 100 volt, ceramic capacitor
C10 25 μ F, 25 volt, electrolytic capacitor
C11, C12, C13, C14 2000 μ F, 50 volt, electrolytic capacitor
C15, C16, C17, C18 100 μ F, 25 volt, electrolytic capacitor
C19 25 μ F, 25 volt, electrolytic capacitor
C20 10 pF, 100 volt, ceramic capacitor
C21 25 μ F, 25 volt, electrolytic capacitor

Q1, Q2, Q5, Q6, Q7, Q9 2N5210 transistor
Q3, Q4, Q8, Q10 2N5087 transistor

S1 3-position, rotary selector switch (stereo)
S2 double-pole, single-throw toggle switch
S3 single-pole, single-throw toggle or pushbutton switch
L1 120 volt a.c. neon pilot lamp with dropping resistor
T1 Stancor P8605 transformer (Use Output Taps 2 and 3)
Rect. 1 bridge rectifier, 1 amp, 100 volt PIV
D1, D2, D3, D4 24 volt, 1 watt Zener diode

Miscellaneous Two chassis and covers, phono jacks, power cord, phone jacks and plugs, shielded cable, knobs, screws, nuts, lockwashers, circuit board standoffs (conducting), heat sinks for Q8 and Q10, terminal strips, etc.

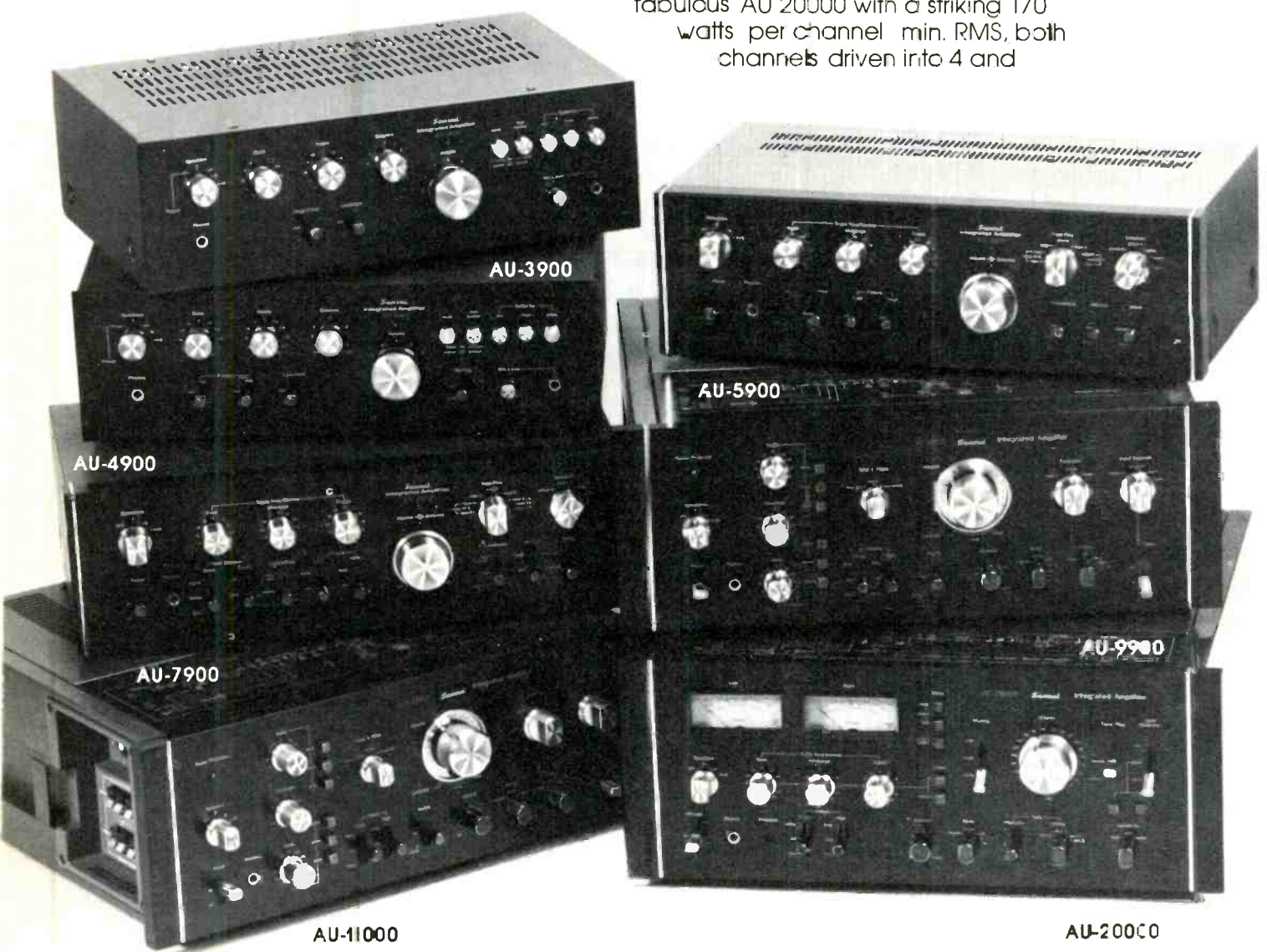
Printed circuit boards and matched transistors for the preamplifier are available for a limited time. Prices are \$10 for a set of stereo boards for the RIAA circuits and output circuits, \$5 for the center-channel board, and \$1.50 for a matched pair of 2N5210 or 2N5087 transistors, plus \$1 shipping and handling. Address orders to Components, P.O. Box 33193, Decatur, Ga. 30033.

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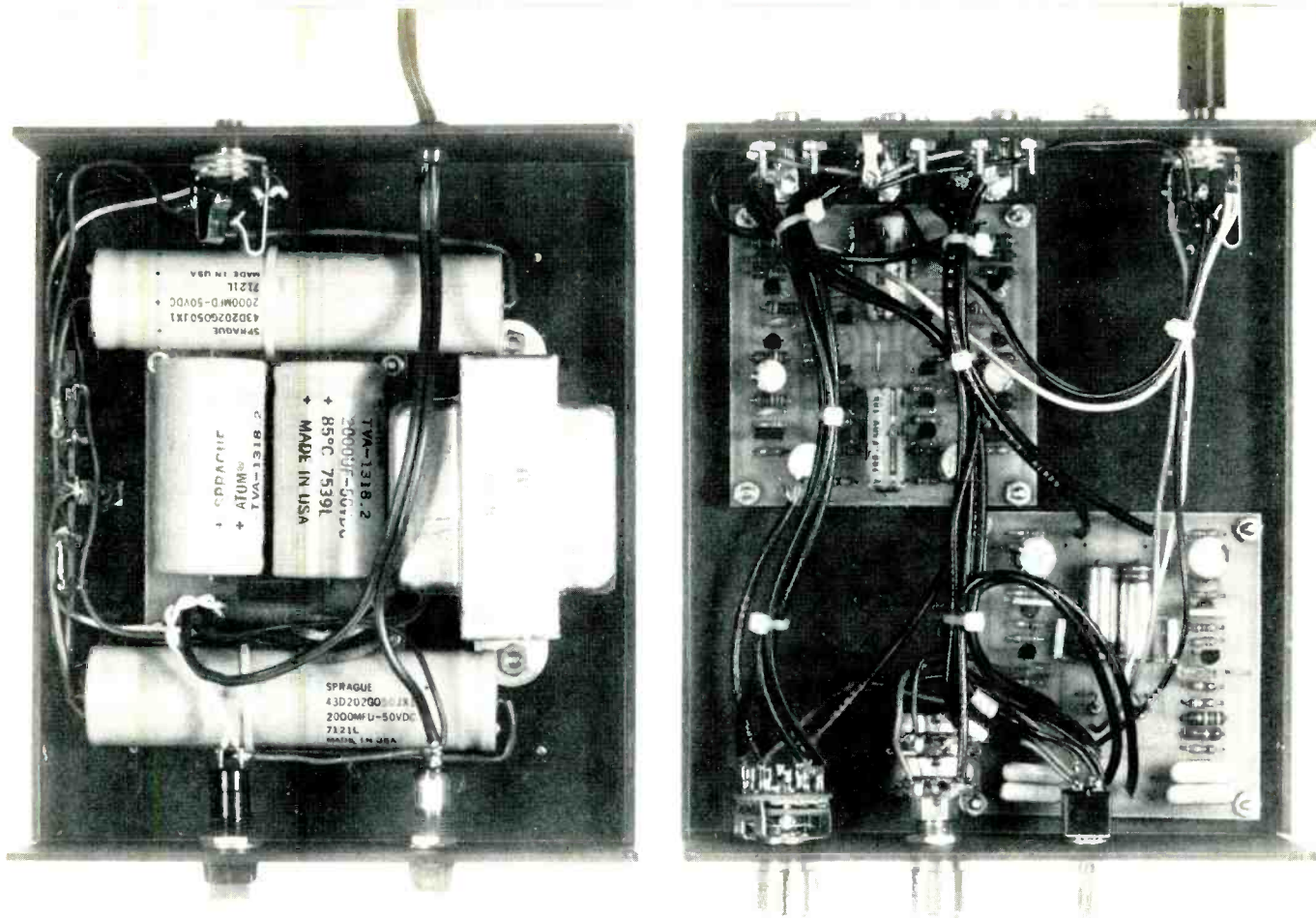


Fig. 6—Photograph of the chassis wiring in the author's preamplifier.

The component layouts for the three circuit boards are given in Fig. 5. The view in these figures is from the component side of the boards, i.e. the side opposite from the foil circuit. There are no special instructions for mounting the components on the circuit boards. It is recommended that the transistor leads be inserted no more than 1/4 inch through the boards before soldering. This will prevent any heat damage from the soldering iron due to excessive heat conduction through transistor leads which are too short. Normal precautions should be taken to insure that all transistors, electrolytic capacitors, and diodes are inserted correctly. Otherwise, failure could result at turn on.

After all components are mounted and soldered to the boards, the next step is to solder all input and output cables and all power supply leads to each board. It is recommended that only shielded cable be used for signal input and output leads. No. 22 stranded wire should be used for the power supply leads. The connection of cable grounds illustrated in Figs. 1 and 3 should be adhered to if ground loops are to be avoided. The figures show that the shielded cable grounds are not connected at the signal inputs of either the output circuit board or

the center channel board or at the tape output or power amplifier output jacks.

The main chassis should be drilled for the input selector switch, volume control, tape monitor switch, power input jack, signal input and output jacks, the circuit board mounting holes, and the external ground lug connection. The latter can be a 6-32 by 1/2 inch screw attached to the chassis with a No. 6 nut and an inside star lockwasher. The screw should be installed near the phono input jacks with its head inside the chassis and with a second nut loosely screwed down over the first nut outside the chassis. The jacks for the magnetic phono inputs should have floating ground terminals, i.e. they are not grounded to the chassis. All other signal input and output jacks should be grounded to the chassis. If these jacks have floating grounds, they should be

connected to ground through a common ground bus which connects to chassis ground through a securely tightened lockwasher grounding lug. One end lug on the volume control for each channel is grounded to chassis through a lockwasher grounding lug mounted concentric with the volume control shaft. The end lug to be grounded is that one which measures zero resistance to the center lug when the volume control is set fully counter-clockwise.

After the chassis hardware is mounted, the shielded cables from all input and output jacks which connect to the selector switch and tape monitor switch should be installed and soldered. Care should be taken when soldering the shielded cable grounds, for the heat can melt the inner cable insulation and cause the center conductor to short to ground. To minimize this possibility, the cable grounds should be soldered before the center conductors. In this way, the center conductors will not be flexed when the grounds are soldered.

The circuit boards can now be installed in the chassis as shown in Fig. 6. These should be mounted with a 3/8 inch No. 4 metal standoff under each corner with 4-40 by 1/4 inch screws and No. 4 nuts. A No. 4 inside star lock-



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washer should be used on each end of each standoff to insure good connection of the circuit board grounds to chassis ground through each standoff. The mounting screws should be securely tightened so that the lock-washers will be firmly engaged. Once the circuit boards are mounted, the remainder of the chassis wiring can be connected. Once this is done, the cables should be neatly tied so that they do not run near the circuit boards. It is preferable to route the cables down along the chassis. However, if there is insufficient room, they can be routed over the circuit boards, as has been done in Fig. 6. The final step is to attach a ¼ inch by ½ inch heat sink made from 1/16 inch sheet aluminum to transistors Q8 and Q10. The heat sinks can be glued to the flat sides of the transistors with a small dab of contact cement. None of these transistors dissipate over 180 mW quiescently, while they are rated at 310 mW. However, the heat sinks are a worthwhile and effective protection measure which will improve the reliability of the preamplifier, especially if it is operated near heat producing equipment.

The power supply is wired as shown in Fig. 2. It should be noted that not all the components in this figure are mounted on the power supply chassis. The output power leads from the power supply chassis and the input power leads to the preamplifier chassis should be wired to a three-conductor phone jack, one conductor of which is grounded to its respective chassis. A six-foot length of three-conductor power cable with phone plugs attached to each end can then be used to connect the power supply to the preamplifier. The a.c. power cord to the power supply should be insulated from the chassis feed-through hole with a proper size strain relief or grommet. In the latter case, an insulated cable clamp should be used to secure the power cord inside the chassis to prevent its being pulled loose.

Check Out and Turn On Procedures

Before any power is applied to the preamplifier, the entire circuit should be carefully checked. Trouble points include diodes and electrolytic capacitors installed with the incorrect polarity, transistor leads reversed, poor ground connections to chassis (especially if the chassis is painted), cold solder joints, shorted cables, etc. After all wiring has been checked, the power supply can be checked out.

With the preamplifier power cable disconnected, apply a.c. power to the power supply and measure the d.c. voltages on C11 through C14. These capacitors should have approximately 42 volts across them with no load. At this point, the polarity of the voltage across these capacitors should be checked to verify that none is installed backward. After the power supply unit is checked out, remove the a.c. power and connect the power cable between the power supply and the preamplifier chassis. If phone jacks and plugs are used for these connections, a slight spark may be noticed when the plugs are inserted if there is a charge stored on C12 and C14. Care should be taken to insert the phone plugs *fully* into the jacks. Otherwise, a short circuit to ground will occur and R29 and R30 will smoke when the a.c. power is turned on.

Before connecting any equipment to the preamplifier, power should be applied and the circuits should be checked out with a d.c. voltmeter. First, measure the voltages across C15 through C18. These should be exactly 24 volts. Next measure the voltages across C12 and C14. These should be 31.5 volts plus or minus 0.5 volts. If these voltages are not in this range, R29 and R30 should be changed to the next higher or lower value to respectively decrease or increase the voltage across C12 and C14. Next measure the voltages from ground to the junctions of C5 and R13, C10 and R25, and C21 and R42. These should be less than one volt. If not, a wiring error has been made or there is a defective component in the circuit.

Before connecting any equipment

to the preamplifier, all a.c. power to the complete system should be turned off. Connect all inputs and outputs including the turntable ground wire which attaches to the No. 6 external grounding screw on the rear of the preamplifier chassis. Since there is a slight turn-on thump caused by the charging of capacitors in the circuit, the preamplifier should be turned on before the power amplifier. It can be left on if desired with no harm to the circuits. Normal precautions should be observed when using the preamplifier. These include never connecting or disconnecting an input or output cable with the power amplifiers turned on. Otherwise, an open ground connection can cause a large 60-Hz signal to be fed to the power amplifier when the phono jack is removed or inserted. Happy listening!

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Low TIM Amplifier

PART II

The low transient IMD (or TIM) amplifier which has been described [1] did not contain a protection circuit in order to minimize the complexity as a construction article. A voltage-current sensing (or VI) limiter has been developed for the protection of the output stage of this amplifier from overload conditions for load impedances less than 4 ohms. In addition, a

second protection circuit has been developed which protects the voltage gain stages of the amplifier in the event of a failure in the output stages. The printed circuit foil patterns for this protection circuit were included on the circuit board layouts given [1]. The two-stage protection circuit will be described in this second part article on the amplifier. In addition, several minor modifications to the circuit will be described which improve its TIM rejection characteristics and which correct some minor errors which appeared in the first article.

Corrections to The Published Circuit

The complete circuit diagram of the amplifier with all corrections and the addition of the VI limiter is shown in

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The DD75 is our first direct drive turntable. It reflects a lot of what we've learned in half a century of building quality turntables.

The heart of any direct drive turntable is the motor. Since it is in direct contact with the platter, it must be as steady—and as free from vibration—as a pacemaker. The performance of the motor is measured by these specifications: rumble, wow and flutter.

But without a lightweight tonearm, unrestrained by friction, the best motor can't deliver high quality, high fidelity sound. After all, the only thing that moves the tonearm is the minuscule stylus tracing the record groove. If the tonearm is heavy, or drags, the sound will be distorted. The specifications which determine tonearm performance—mass and friction—are as important as rumble, wow and flutter.

Direct drive turntables can be manual or automatic. The difference has a direct bearing on record safety. With a manual turntable, you risk scarring your records or damaging your stylus, particularly when lifting the arm off the record. That's because the human hand can't *always* be steady and accurate. The risk is minimized with a system that lifts the arm precisely, automatically.

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The Garrard DD75 delivers rock-steady speed with a DC motor, governed by an electronic servo system. It is totally immune to fluctuations in household current. The specifications are impressive: rumble -70dB (Din B), wow and flutter 0.03%. The same electronic system provides variable speed control, $\pm 3\%$, monitored by an easily-read, illuminated strobe.



Unlike the tonearm in most direct drive turntables, the slender arm of the DD75 is extremely low in mass—just 16 grams. It rides effortlessly on jewel bearings, with friction so low that it will track the finest cartridges at their minimum rated stylus pressure.



In addition to fully damped cueing, the DD75 automatically lifts its tonearm and shuts off the motor at the end of play. This is done *non-mechanically* by a reliable photo-electric circuit. You never have to leap across the room to stop playing the lead-out groove. You can even use this system in mid-record, by lightly touching the *Stop* button. Play can be resumed at the precise point where it was interrupted.



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Fig. 1. All changes in component values are indicated by an asterisk in the supplemental parts list. The NPN driver transistor is properly labeled Q10 rather than Q11 as was originally published. A change which should answer some questions which have arisen is shown in the bias circuit. The positions of R24, D3, D4, and D5 in Fig. 1 now correspond to those on the circuit board layout. This change has required a modification in the figure for the diode bias mounting diagram. This is given in Fig. 2.

It has been previously published in a Letter to the Editor that use of the specified anodized heat sinks could result in an ungrounded circuit board. To prevent this, the anodization should be thoroughly scraped or filed away beneath all lockwashers and nuts used both to attach the circuit boards to the heat sinks and those used to attach the mounting L-brackets to the heat sinks. For proper hum elimination, it is necessary to ground the circuit boards to the heat sinks through each of the four mounting screws and to ground the heat sinks through both mounting L-brackets. The use of non-anodized heat sinks will eliminate this problem.

Modifications to The Published Circuit

The modifications to the circuit involve the time constants used in the

input low-pass filter and in the TIM suppressing alternate feedback network. R2 should be changed from a 2.7 kilohm resistor to a 4.7 kilohm resistor. This change moves the 3-dB cutoff frequency of the input low-pass filter to 100 kHz from 150 kHz. This helps prevent the application of inaudible, high-frequency overload signals which could aggravate charge storage effects in the output stages.

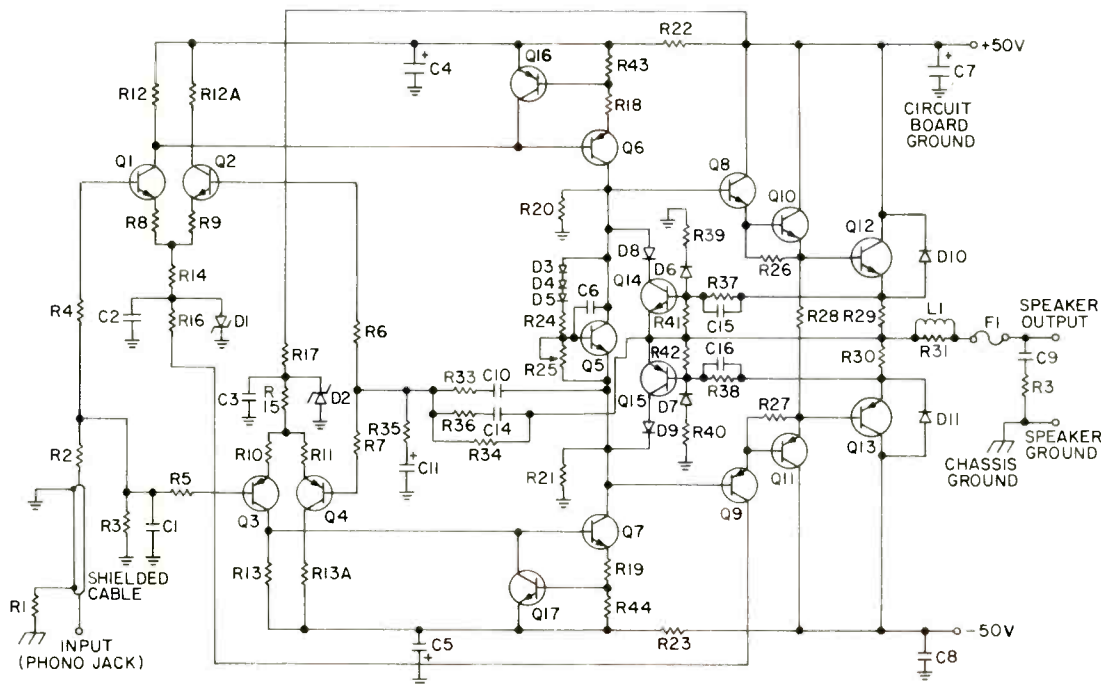
The most important modifications which have been made involve the TIM suppressing feedback network. As shown in Fig. 2, the 10 pF lead-compensation capacitor C10 now connects to the emitter of Q5 rather than to R34. This change was necessitated when an amplifier was encountered which exhibited a marginal stability problem due to mutual coupling effects and mutual inductance in the leads which attach the output transistors to the circuit board. By connecting C10 to the emitter of Q5, the lead compensation is taken from output of the second voltage gain stage, thus bypassing any phase shifts which are encountered by the signal in traversing through the driver and output transistors and their connecting leads. The second change in the feedback network is in the value of R-36. This has been changed from 10 kilohm to 33 kilohm.

The purpose of C14 and R36 is to extend the loop bandwidth of the am-

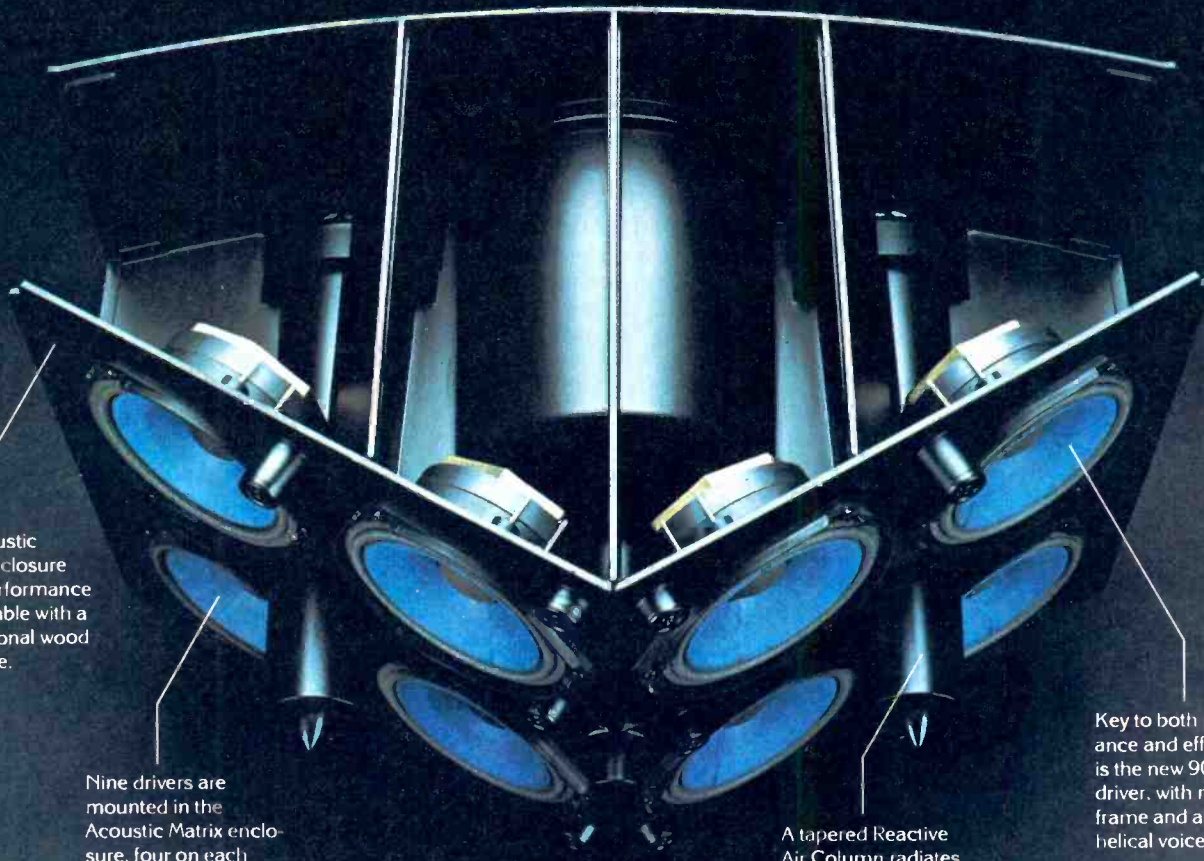
plifier from approximately 38 kHz to approximately 100 kHz. This frequency coincides with the 100 kHz cutoff frequency of the input low-pass filter. The loop bandwidth of an amplifier is that bandwidth experienced by a signal when it propagates from input to output and then back through the feedback network. Without C14 and R36, this would be equal to the open-loop bandwidth which is approximately 38 kHz. In addition to the improvement in the loop bandwidth, C14 and R36 serve the function of causing the amplifier to reject inaudible high-frequency input signals which lie above 50 kHz. It is important to note that the high-frequency overload rejection is not accomplished by slowing down the amplifier loop response, but by speeding it up. It can be shown by feedback control theory that this is an elegant solution to the transient overload problem in the input stages, for it uses the feedback signal itself to cancel out ultrasonic overload signals which lie outside the open-loop bandwidth of the amplifier.

One question which has not been addressed is the effect of the TIM suppressing feedback network on the phase response of the amplifier. The phase shift is approximately 30° at 20,000 Hz. However, below 20,000 Hz, the phase decreases linearly with frequency. This means that the amplifier

Fig. 1—Complete circuit diagram of one channel showing the modifications to the feedback network and the voltage-current sensing protection circuit.



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exhibits no group delay distortion, for its phase response corresponds to a constant time delay of about 4 microseconds. That is, all audible frequencies propagate through the amplifier with the same time delay, adding in their proper phase relationships at the output.

It can be shown that the output impedance of any negative feedback amplifier is inductive above its loop bandwidth. This has caused oscillation problems in many amplifiers with capacitive loads, for the inductive output impedance tunes with the capacitive load to form a resonant circuit. At best, an amplifier with insufficient loop bandwidth will exhibit severe ringing when driven by a square wave into a capacitive load. This problem is

ance of an amplifier into a capacitive load is a good indicator of how well it is capable of driving dynamic speakers in the frequency range directly above their resonant frequency, electrostatic speakers, and piezoelectric speakers.

Protection Circuit

In Fig. 1, transistors Q14 through Q17 and their associated components form the protection circuit. Protection of the output stages is provided by Q14 and Q15. These two transistors are connected so that they sense both the current supplied by the output transistors, i.e. the voltage across R29 and R30, and the voltage on the speaker line. Speaker load impedances above 4 ohms will not cause activation of Q14 or Q15. However, for

addition, the voltage on the speaker line (which is absent when the output is short circuited) provides a reverse bias voltage at the emitters of Q14 and Q15 which helps prevent their conduction. The combination of the voltage across R29 and R30 and the reverse bias voltage at the emitters of Q14 and Q15 cause the limiter not to be activated for load impedances above 4 ohms.

The reverse emitter bias voltage for Q14 and Q15 is determined by resistors R39 and R40. These have been chosen to limit the peak current into a 2-ohm load to about 4 amperes. Into a short circuit, the peak current is limited to about 2 amperes. Thus, the peak current is a function of load impedance—the smaller the load impedance, the lower the threshold of the current limiter. The approximate relation between the peak current before limiting, the load impedance R_L , and the threshold resistors $R_{39} = R_{40} = R$ is given by the equation

$$i_{\text{peak}} = \frac{0.7}{R_E - \frac{R_L}{R} (R_L + 120)} \text{ amperes (1)}$$

where $R_E = R_{29} = R_{30} = 0.33$ ohms.

A current limiting circuit can be inherently unstable and cause oscillations under limit conditions. This can be understood by a simple heuristic argument. Once an overload occurs, the limit circuit is triggered, and the overload condition is eliminated. This causes the limit circuit to deactivate, at which time the overload condition reappears. This is a vicious cycle which can manifest itself as oscillations. Capacitors C15 and C16 help prevent this problem in the VI limiter of Fig. 1. In addition, the limiter threshold is set so that it is improbable that the limiting function will be activated under normal signal and load conditions.

Diodes D6 and D7 are necessary to prevent Q14 from limiting during negative signal swings and Q15 from limiting during positive signal swings on the speaker line. Diodes D8, D9, D10, and D11 provide protection of Q14, Q15, Q12, and Q13, respectively, from inductive transients which may occur on the speaker output line.

Transistors Q16 and Q17 provide an important protection function in the event of a failure in the output stage or a blown fuse on one side of the power supply. These transistors will saturate if the current demand on Q6 or Q7 exceeds 20 mA, thus limiting the current to this value. This protects

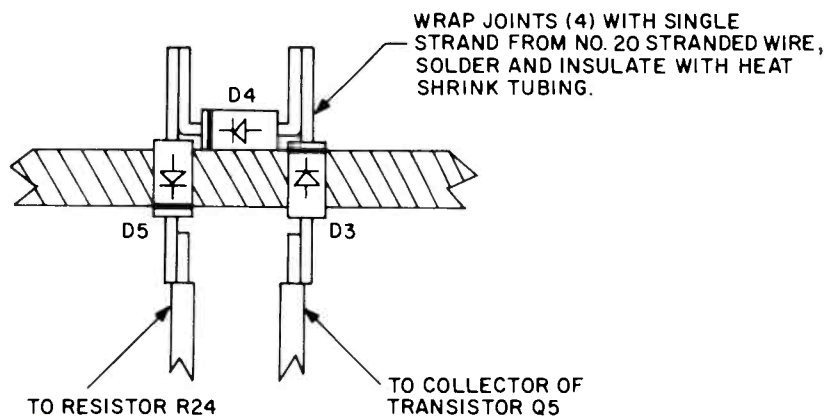


Fig. 2—Diagram showing mounting of the temperature compensating bias diodes on the main heat sinks. The banded end of each diode is the cathode.

eliminated in the circuit of Fig. 1 by the combination of an open-loop bandwidth of approximately twice that of the audible spectrum, the input low-pass filter, and the TIM-suppressing feedback network. The amplifier will drive a 2 microfarad capacitor for a load with essentially no ringing with square-wave signals. This makes L1 and R31 unnecessary in their usual function of preventing oscillations into capacitive loads. However, their removal is not recommended since they provide some degree of r.f. protection from r.f. signals which may be picked up on the speaker lines. Capacitive load testing of amplifiers is not a recommended procedure for the unexperienced. Next to a short circuit, the capacitor is probably one of the most demanding load tests on an amplifier. Nevertheless, the square-wave perform-

load impedances below 4 ohms, these two transistors act as current limiters to prevent excessive power dissipation and possible failure in the output transistors.

To understand the operation of Q14 and Q15, it is convenient to consider two speaker load conditions, a short circuit and an open circuit. First, for a short circuit, the current through R29 and R30 will be very large, even for small input signals. This current is sufficient to cause a voltage drop across R29 and R30 which will cause Q14 and Q15 to conduct. Their conduction reduces the drive voltage to the driver stages which in turn reduces the current supplied by the output transistors. In contrast, an open circuit on the speaker line will cause very little current to be supplied through R29 and R30, a current which is insufficient to activate Q14 and Q15. In



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transistors Q1 through Q7 from an electrical failure which might occur in another part of the amplifier. Under normal signal conditions, Q16 and Q17 will be an open circuit.

All components for the VI limiter mount on the printed circuit layout of Fig. 3 except diodes D10 and D11. These are soldered across the collector-to-emitter terminals on the sockets for transistors Q12 and Q13, respectively. It should be noted that R18 and R19 should be reduced from 390 ohms to 360 ohms when Q16, Q17, R43, and R44 are added to the circuit.

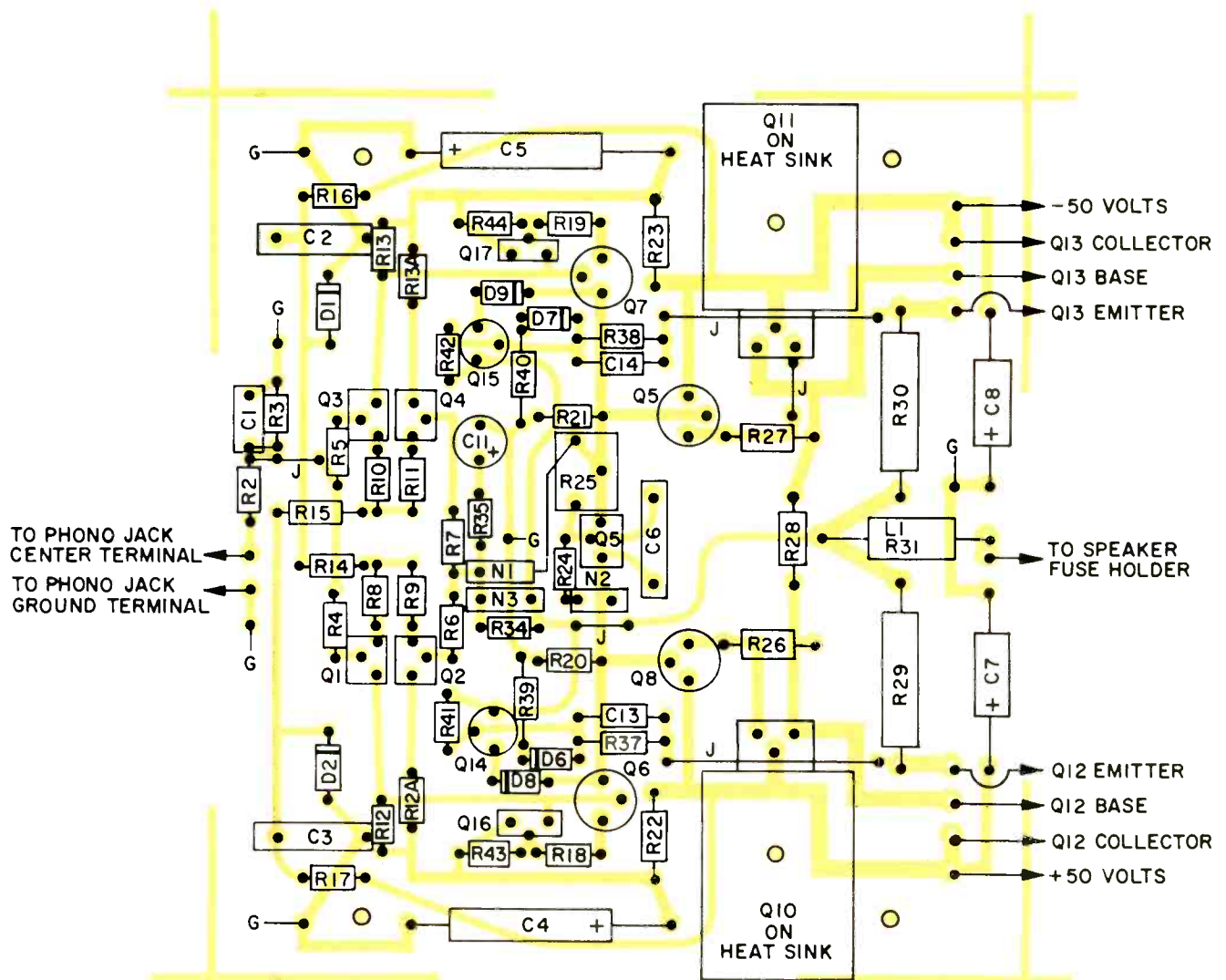
Since the values of R33 and R34 are 30 ohms, the total emitter load resistance of Q6 and Q7 will remain 390 ohms.

A Note on Power

Comments from readers of the first article have shown a great deal of interest in increasing the output power of the amplifier. This can be accomplished easily by using a power transformer which has better regulation than the one specified. A recommended substitute is the Signal transformer number 68-6 or 68-8 which are available from Signal Transformer Co.,

Inc., 1 Junius Street, Brooklyn, New York 11212. This transformer has multiple primary taps. The tap which produces a d.c. power supply voltage closest to ± 50 volts (not to exceed ± 52 volts with 120 volts a.c. input line voltage) should be used. The amplifier will then be capable of 100 watts per channel with an 8-ohm load. If any problems are then experienced with either power supply or speaker fuses blowing at high volume levels (especially with 4-ohm loads), the fuses can be changed to ones with a 5-ampere rating. Higher rated fuses should not

Fig. 3—Circuit board parts layout for one channel. View is from ground plane side of the board on which most components are mounted. Note that R33 and C10 are now connected to the rear of the board from the junction of R34 and R35 to the emitter of transistor Q5. This modification is discussed in the text.



- N1 - R33 & C10 IN SERIES SOLDERED TO REAR OF BOARD FROM JUNCTION OF R34 & R35 TO EMITTER OF Q5
- N2 - D3, D4, & D5 CONNECTIONS
- N3 - R36 & C12 IN SERIES

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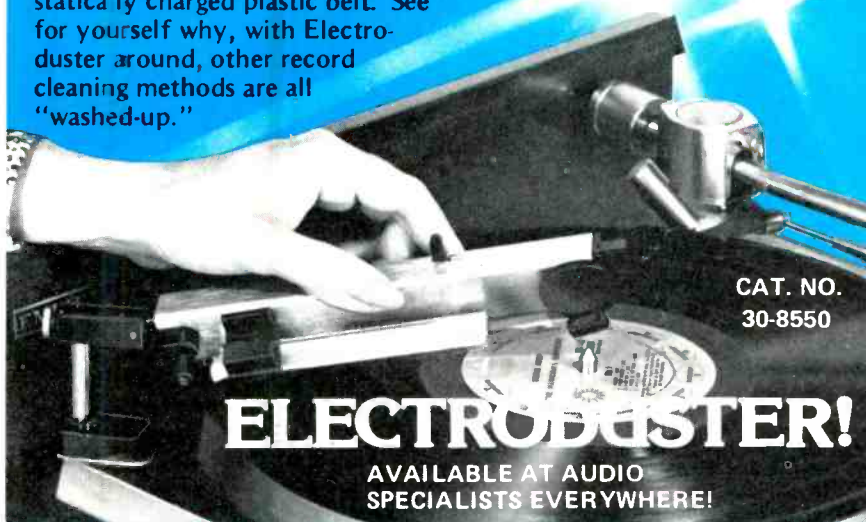
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be used. Under no circumstances should anything but fast blow fuses be used for either the power supply or speaker fuses.

In addition to the transformer change, it is recommended that the Motorola transistors MPS8099 be substituted for Q1 and Q2 and MPS8599 substituted for Q3 and Q4. These transistors have a higher voltage rating than the 2N5210 and 2N5087 which were originally specified. An optional modification for the higher powered unit would be to use four output transistors per channel. By connecting an additional output transistor in parallel with each existing one, the power dissipation per transistor is halved, which improves the reliability of the output stage. The additional output transistors are not necessary if load impedances less than 6 to 8 ohms will not be driven. Δ

PARTS LIST

Original Parts List Modifications

- Q1, Q2, Q5, Q17 - MPS8099*
(or 2N5210)
Q3, Q4, Q16 - MPS8599* (or 2N5087)
Q14 - 2N5681
Q15 - 2N5679
D3 through D5 - 1N4004* (or 1N4002)
D6 through D11 - 1N4004
R1 - 10 ohm*, 1/4 watt
R2 - 4.7 kilohm*, 1/4 watt
R18, R19 - 360 ohm*, 1/4 watt
R28 - 100 ohm*, 1/2 watt
R29, R30 - 0.33 ohm*, 5 watt
R31 - 10 ohm*, 2 watt
R33 - 100 ohm, 1/4 watt
R36 - 33 kilohm, 1/4 watt
R37, R38 - 120 ohm, 1/2 watt
R39, R40 - 1.5 kilohm, 1/2 watt
R41, R42 - 33 kilohm, 1/4 watt
R43, R44 - 30 ohm, 1/4 watt
C10 - 10 pF*, 100 volt ceramic capacitor
C11 - 100 μ F*, 10 volt electrolytic capacitor
C14 - 47 pF, 100 volt ceramic capacitor
C15, C16 - 0.05 microfarad, 25 volt ceramic capacitor
* - Indicates a change in value from that originally specified.

The circuit boards for the power amp are available from: William R. Dunn, Georgia Institute of Technology, EES-ASD/STL, Atlanta, GA 30332. The price is \$16.00 per pair, plus \$1.00 postage and handling. Note: These boards have provisions for 4 output transistors per channel.

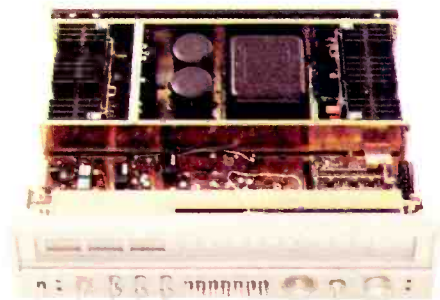
AUDIO • February 1977



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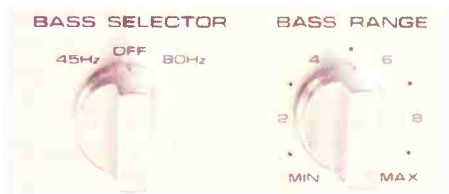
Tuning. Precise, accurate tuning is a *must* for FM listening. And the RS1080 includes 3 separate tuning meters: signal strength, center-of-channel, and most



important, a multipath meter with phase-locked-loop circuitry.

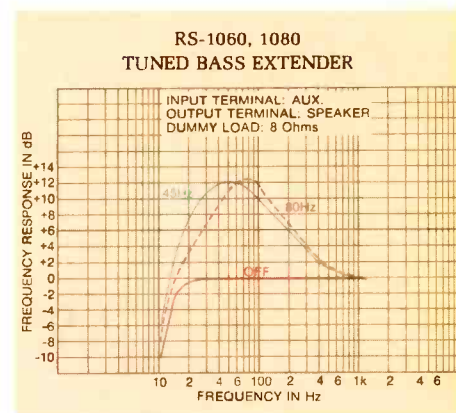
FM Dolby. For the ultimate FM listening experience, the RS1080 has built-in, factory calibrated FM Dolby decoder circuitry. This feature lets you hear the full dynamic range of Dolby broadcasted music. Another *must* if a receiver is designed to be the world's finest.

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NEW TESTS FOR

PREAMPLIFIERS

Tomlinson Holman*

58

For many years, audible differences among phono preamplifiers have been noticed by careful listeners. With the introduction of transistorized preamplifiers, these differences became more obvious, leading to the widely-held impression that the audible quality of preamplifiers is related to the basic technology employed. Phonograph preamplifiers have been ranked using conventional tests of frequency response, noise, distortion, etc., however, subjective judgments of "quality" will yield different results. Frequently subjective judgments have sent engineers back to their test benches to ascertain what aspect of performance caused specific listener reactions, and in many cases new tests were instituted to characterize the differences. A case in point is that of crossover distortion in early transistor power amplifiers; engineers by and large did not consider measurements of low-output level distortion important until listener reactions prodded them to do so.

Ultimately, the object of all measurement must be considered to be the assessment of the subjective quality of the device under test. Since conventional tests are widely considered as inadequate to characterize quality, new tests which represent real-world conditions more accurately are necessary. The reasons for the existence of new tests are that the usual test signals employed do not adequately represent the demands of program material, and the results of tests should be weighted for human perception or annoyance value. One weighting which is frequently employed is to equalize noise measurements for the well-known fact that the human hearing mechanism is not particularly sen-

sitive to low and very high frequencies at low levels as first described by Fletcher-Munson. Such weighting helps to correlate objective measurement with subjective assessment. Yet, in many other areas, weighting ought to be considered necessary, but adequate standards to correlate with perception have not yet been developed. For example, total harmonic distortion is just that, *total*. The regular test gives equal weight to all harmonics, whereas it is clear that, due to the masking effect of a tone on its close-in harmonics, ninth harmonic distortion should be given far more weight than second.

There are three basic forms of testing, and they may be assigned an order based on ease of replication of the results. The first is electrical tests conducted by engineers with a collection of equipment which measure various aspects of performance. This form of testing is the easiest to replicate and communicate since the hardware produces numbers. Methodology may vary from laboratory to laboratory, so that some small differences may be expected, but for identical, well-specified measurements, high correlation is usually found. Of course, such measurements form the basis of published specifications and test reports.

The second form of testing is the audible A-B comparison of a device under test versus a known standard device. If certain precautions are observed (such as matching levels carefully), results of such tests usually correlate well from listener to listener. While the convenient handle of numbers is much harder to hang on these results than with electrical tests, complex statistical analysis of paired comparisons (such as brighter-duller on a scale from 1 to 5) may be used to produce numerically significant results which may be correlated.

The third form of testing is the extended listening test. While the least easy to replicate, this form has been responsible for discovery of performance areas like crossover distortion. Since this form is the most like the environment in which we listen everyday, it may be said to be occurring continuously. If many people in different settings with different program material come to identical impressions about a piece of equipment without prejudice from market forces, then, more than likely, that area of performance is one which, while not characterized by conventional tests, is nevertheless real. In a number of cases in recent history, awareness of performance properties has grown from a conviction held by many based on lengthy listening to engineering tests with numerical confirmation.

When we came to investigate phonograph preamplifier performance, it quickly became clear that there were audible differences among designs that had nearly identical measurements on conventional tests.¹ The most obvious difference to observers on a level-matched, instantaneously-switched, A-B comparison was that the perceived frequency response did not correlate with standard measurements.

Cartridge-Input Impedance Interactions

Typical cartridges of the moving magnet or variable reluctance variety consist of a coil of wire wound on a core. Such an arrangement may be mostly characterized electrically by a resistance in series with an inductance. The inductive property implies that the impedance of the cartridge rises dramatically with ascending frequency. Therefore, the loading provided by the input impedance of the phonograph preamplifier in paral-

* Chief Electrical Engineer, Advent Corp., Cambridge, Mass. 02139

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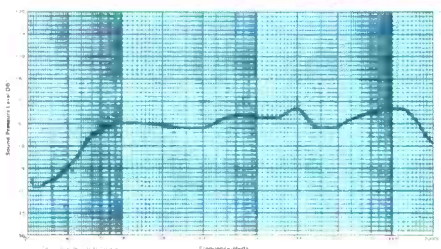
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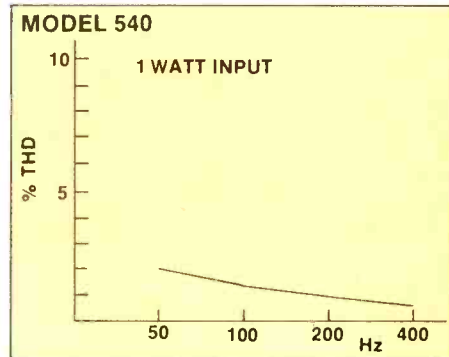
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lel with the cable capacitance also becomes increasingly important with ascending frequency. For example, at 1 kHz, a typical cartridge has an impedance of about 1.5 kilohm, but at 20 kHz, its impedance may be about 50 kilohm. Since one standard input impedance is 47 kilohm, the input impedance and cable capacitance form a voltage divider with the source impedance, rolling off the electrical high

“...it quickly became clear that there were audible differences among designs with nearly identical measurements on conventional tests.”

frequency response by about 6 dB. Cartridge designers make use of this fact of life by tailoring the mechanical system of the cartridge in an inverse manner to the electrical response to yield a substantially flat overall response. However, since the source impedance approaches the load impedance at the highest audible frequencies, the cartridge becomes increasingly sensitive to the load at higher frequencies. Cartridge designers absolve themselves of responsibility by stating the proper load for their cartridges e.g. “load impedance 47 kilohm, 300 pF.” Unfortunately, many tonearm/cable makers do not specify capacitance, and virtually no preamplifier maker specifies input impedance completely.

The degree of this problem is by no means trivial. It is not unusual to find a variation of ± 3 dB from desired response due to this effect. A recent survey of phonograph preamplifier input impedances used the criteria that the input impedance of the preamplifiers should be able to be modeled by a 47 kilohm $\pm 10\%$ input resistance in parallel with a capacitance of from 0 to 200 pF. Only 11 units of 26 tested met this criteria. An additional three units of the 26 could generally

be characterized as having input resistance and capacitance in the right range, but could not be completely modeled by an equivalent R and C. Twelve other units had more serious interaction, including one with over 600 pF input capacitance and a number with input resistance as low as 35 kilohm. Also, there was no good correlation within a given manufacturer's line or with price.

In a system with unknown interaction, two techniques may be employed to ameliorate the interaction problem. One is to use a cartridge with fairly low inductance, as it will be less sensitive to loading than high inductance cartridges (low 200 to 300 mH, high 600 to 800 mH). Alternatively a buffer amplifier may be built and inserted between the phonograph cartridge and the preamplifier input. The buffer amplifier terminates the cartridge in 47 kilohm in parallel with a chosen input capacitance and may serve as a sonic reference for comparison with preamplifiers with unknown input impedance. There is a small penalty paid in noise for such an arrangement, however, proper frequency response usually subjectively outweighs a small noise contribution. The schematic for such a buffer amplifier is shown in Fig. 1.

If you have a system in which you know the rated load impedance of the cartridge, the cable capacitance of all interconnecting phono cables, and the input resistance and capacitance of your preamp, you can determine the proper value for a cartridge termination capacitance and add that value across the input of your preamplifier.

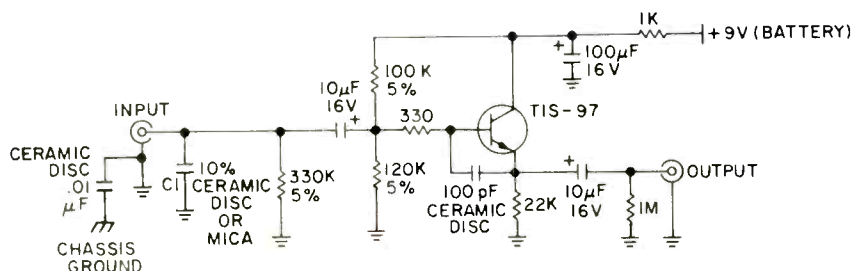
An easy way to do this is to use a short Y adapter cable (the Switchcraft version contributes 20 pF to the total), and solder the proper capacitor between the center lug and shell of a phono connector. Connect the cable from the cartridge to the Y along with the termination capacitor and connect the Y adapter to the preamp.

There may be several sources for the cartridge/input interaction. An important source are capacitors used for eliminating radio-frequency interference directly across the input to the preamplifier or strapped from base/grid/gate (for bipolar transistor/tube/field effect transistor inputs respectively) to the emitter/cathode/source or from collector/plate/drain to base/grid/gate. While these capacitors may reduce the susceptibility to r.f.i. each use must be examined for its contribution to any frequency response error in the audio band. Amplifier stages also have input capacitance which is dependent on the devices used and on the topology of the circuit.²

Another source is the result of “looking into” an active amplifier at its input terminals. The open-loop (without the application of feedback) input impedance of a bipolar transistor is only moderately high (about 50 kilohms); negative feedback is used to raise the input impedance to a very high value, then an input termination resistor of, typically, 47 kilohms is wired across the input terminals to properly load the cartridge. Unfortunately, the amount of available feedback decreases at high audio frequencies due to stability considerations, and thus the input impedance falls off with increasing frequency and causes an interaction.

Descriptive terminology used by listeners to describe frequency response errors due to cartridge/input impedance interactions runs the gamut from grittiness, graininess, shrillness, dullness, transistor sound, forward, recessed, etc. When preamplifiers which demonstrate impedance interaction are used with a buffer amplifier or are modified so as not to interact, the differences previously noted from the standard on an A-B test tend to disappear. A-B testing has demonstrated that in normally operating equipment, overall level is the most critical parameter to match, followed by frequency response. Matching the levels and frequency response with a cartridge source usually eliminates most of the differences between preamplifiers. Since interaction is a prevalent problem, the assessment of

Fig. 1—Preamplifier input buffer. See text for choice of C1. Only one channel is shown.



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phonograph cartridges is complicated by the fact that cartridges interact differently with the various input impedances. Conclusions drawn about cartridges when used with preamplifiers of unknown input characteristics may be invalid except for describing a particular combination of cartridge and preamplifier.

Since most differences between phono preamps disappear when the level and frequency response are matched, the sum of frequency response errors including RIAA equalization error and cartridge/input error should currently be considered to be the most important in assessing differences between various pieces of equipment.

Other Performance Areas

The phonograph preamplifier is a logical place to alleviate another system problem prevalent today. Many listeners choose fairly high compliance cartridges and combine them with conventional tone arms. Such a system often has a resonance between the stylus compliance and the tone-arm effective mass plus cartridge mass in the 7 Hz region. Since few records are really flat, warp frequency components will lie in the same band as the resonance and will be accentuated. These warps may not be directly audible by themselves, but they are likely to cause intermodulation or overload of power amplifiers and loudspeakers. In a typical system playing at 90 dB SPL three feet from the loudspeaker, nearly the full woofer excursion is used up in repro-

available to him, he had chosen a very highly compliant cartridge for his massive tonearm. Such a system has a resonance down around 4 Hz which is in the area of highest-amplitude warp frequencies.³ Here the combination of cartridge mass, very extended infrasonic response in the phonograph preamplifier, and record warp had conspired to overload the tape recorder with 4 Hz range garbage. What was happening to his loudspeakers is interesting to contemplate.

An optimum design for an infrasonic filter is one which greatly attenuates the region of record warps and tonearm resonances without audible consequences in the low bass range due to the phase effects associated with such a filter. A three-pole (ultimate slope 18 dB/octave) filter was studied for its effect. Such a filter may be designed so that it has no attenuation at 25 Hz, 1 dB at 20 Hz, a 3 dB point of 15½ Hz, and is 21 dB down at 7 Hz, and 35 dB down at 4 Hz. This is adequate attenuation for warps, as may be seen by observation of woofer cones while playing warped records. To study the phase effects, first program material was used to ascertain any consequences. When no change in the character of the bass reproduction was found, a worst case test was conceived, and an all-pass filter was constructed with the phase response of the infrasonic filter, but with a flat frequency response. A shaped pulse from a test generator was passed through the all-pass filter to a power amplifier and headphones

Broadcasting Organization has made 70 mS at 50 Hz the acceptable limit, and the CCIF has made 80 mS at 50 Hz the limit for imperceptibility on program material, while Bell Labs concludes 70 to 90 mS at low frequencies is inaudible. Since the three-pole design has better than 10 times less group delay at these frequencies, it seems probable that such a filter has inaudible phase characteristics.

An interesting filter-related phenomena has been noticed independently by a number of listeners. On playing somewhat warped records on a level matched A-B comparison, the unit which contained an infrasonic filter seems to make the bass sound "tighter." Since this runs contrary to what one would expect if group delay were a dominant effect, the answer could well lie with the fact that in the unit which passes the infrasonic warp, the intermodulation between the warp and the bass colors the program material. This makes sense if one remembers that the ears' perception of amplitude and frequency modulation peaks at around 4 Hz, around the same frequency as the worst warps.

Noise performance of the cartridge/preamp system is also a case of interaction. The design for noise should account for the fact that normally a cartridge is connected, rather than a short circuit, as applied in most specifications. It is possible to design for the short-circuited input test so that the best numbers are produced; however, such a design will have substantially more noise with a cartridge connected than will one designed for the real-world condition with a cartridge. Also, noise design should take into account the low-level frequency response characteristics of human hearing. When the design is optimized with a cartridge connected and weighted for human perception, using good devices, then further improvement is very difficult. Because the thermal noise associated with the source impedance is the dominant noise source, and since a commercial pressing rarely approaches the noise level established by the cartridge and electronics, practical improvements in noise level are unexpected.

Sine wave input overload has been subjected to a numbers race with limited meaning. Since the input level is limited by the ability of the cartridge to track the groove, it is fairly simple to set meaningful criteria. The worst case combination of high output cartridge and peak recorded velocity (that cartridge cannot track that record!)

"The reasons for the existence of the new tests are that the usual test signals do not adequately represent the demands of the program material."

ducing the warp. This causes audible intermodulation with the program material. In one case a tape machine was returned to its manufacturer for a gross form of distortion which would happen periodically, even accompanied by complete cutoff of the signal. When nothing wrong could be found with the machine itself, and it was noticed that the signal cutoff happened with a period equal to one revolution of a record, the owner was questioned about his record playing equipment. With the best advice

rated flat to 10 Hz. The filter was switched in and out to determine if any change could be heard. With a training period, very careful listeners barely perceived the difference. The amount of group delay (the time difference caused by the phase effects between the extreme bass and the mid-range) introduced by the filter is 20 mS at 20 Hz. Broadcast and standards organizations have perceptible group delay standards, since long telephone lines are subject to phase effects. The German Post Office and

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yields a number which, when converted to 1 kHz, is 95 mV rms. It should be emphasized that this is a worst case condition not likely to be approached in practice. However, the specification of 1 kHz input overload does not specify the overload characteristics completely since, in general, the input overload varies with frequency according to an inverse RIAA function. Since the disc is recorded with the same function, the overload of the preamplifier is thus fitted to the

the record or from r.f.i., will be detected as nonlinear behavior, and garbage will be dumped from that process down into the audio band. Since input r.f.i. filters may cause audible frequency response errors, the preamplifier may be called upon to handle ultrasonic signals, with filtering after the preamp. So long as such signals do not overload the preamplifier in amplitude or in slew rate, they will be passed cleanly and filtered by a subsequent filter.

plied to an inverse-equalizer network, in our case an inverse-RIAA network, to compensate for the frequency response of the device under test. The output spectrum of the device under test is then examined for the presence of intermodulation products which were not present in the input signal. A test performed using Otala's specified conditions for high-quality equipment with a composite input level of 85 mV rms yields no measurable intermodulation products on a topology which produces no measurable asymmetry on the square wave test described above. Inadequate slew rate could lead to transient intermodulation distortion. However, the very fast transients which produce this form of distortion are limited in rise time and level by the finite acceleration of the stylus and by the electrical low-pass filter formed by the cartridge source impedance and the load of the cable and input impedance of the preamplifier. The required rise time and symmetry to pass this test are well beyond what can be expected from phono cartridges; however, a test which is unusually sensitive may give an engineer technical information about the source and form of asymmetries in his circuit.

A new design has developed with input from listening experiments and with development of test bench procedures designed, in general, to better correlate to the real-world applications of phono preamps. The object was to meet all the normal criteria of phono preamps, to pass the new tests as they evolved, and to do so at the lowest price. The design is detailed in the JAES article, where a few of its salient features may be seen in the measured performance of a number of prototype channels. The new tests were passed without sacrifice of any conventional specifications and with only a small increase in cost over the simplest units. A

"Conclusions about cartridges when used with preamps of unknown input characteristics may be invalid except for describing a particular combination."

medium. Any deviation from such an input overload curve should be noted.

Slew rate is the principal high frequency limitation in most circuits. Slew rate relates to the ability of the output of the amplifier to move fast enough to follow every nuance and twist of the input signal completely. It is expressed in volts/ μ S referenced to the output of the device under test. By various mathematical manipulations, we can change the reference back to the tip of the stylus and determine the required slew rate at the output of the preamplifier required to follow the groove. Using specifications for one of the hottest cutterheads, combined with half-speed cutting, liquid nitrogen cooling, a high sensitivity cartridge (again, it could not track this cut), cutting just one pulse, etc., the required slew rate turns out to be about 0.03 V/ μ S at the output of the phono preamp. If we understand that a physical process is involved, actually getting a mechanical stylus to follow a groove shape, where a mechanical limit is established by the contact radius of the stylus with the radii of the groove wall, then such a number does not seem outlandish. And measurements made of "hot" records yield about one-half this value. Faster slew rates, *per se*, are unnecessary to follow the music, however, some margin of safety is useful to prevent the onset of any nonlinearity. It is thus useful to have a wide power bandwidth in a preamplifier since any information coming into the input of the preamplifier above the audio band, whether from

Equalized preamplifiers, such as phono preamps, are also subject to a particular form of intermodulation distortion termed difference-tone intermodulation. Such distortion arises when two high frequency tones, closely spaced, are introduced into the device and intermodulate with one another so as to produce a first-order intermodulation product ($f_2 - f_1$). Since the equalization boosts low frequencies almost 40 dB more than the highest frequencies, the intermodulation product is additionally amplified by the equalization. Intermodulation of 0.1 per cent in a flat amplifier case may be magnified to almost 10% by equalization. Using measurements from commercial records as a basis for testing, tones of 13.0 and 13.1 kHz were mixed 1:1 and applied to the input of the device under test at a composite level of 40 mV rms. Distortion ranged from 1 per cent for a simple two transistor topology to less than 0.02 per cent (measurement limit) for the best topologies.

Transient intermodulation distortion relates to an amplifiers' ability to reproduce a high frequency tone in the presence of transients. A newly proposed test for transient intermodulation distortion correlates, with some adjustment, to the square-wave asymmetry test proposed in the JAES article. Otala's test consists of a 3.18-kHz square wave on which a 15.0-kHz sine wave rides in a specified level relationship. The combined tone is low-pass filtered by a 100-kHz filter (6 dB/octave). For the case of an equalized preamp, the signal is then ap-

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CHEAP AND DIRTY

INVERSE RIAA/

SQUARE WAVE GENERATOR

Dennis Bohn*

A useful test box to have handy while designing and building phono preamps is one which will yield the opposite of the playback characteristic, i.e., an inverse RIAA (or record) characteristic. The circuit (Fig. 1) is achieved by adding a passive filter to the output of an LM387, used as a flat-response adjustable gain block. Gain is adjustable over a range of 24 dB to 60 dB and is set in accordance with the 0 dB reference gain (1 kHz) of the phono preamp under test.

For example, assume the preamp being tested has +34 dB gain at 1 kHz. Connect a 1 kHz generator to the input of Fig. 1. The passive filter has a loss of -40 dB at 1 kHz, which is corrected by the LM387 gain, so if a 1 kHz test output level of 1 volt is desired from a generator input level of 10 mV, then the gain of the LM387 is set at +46 dB (+46 dB - 40 dB + 34 dB = 40 dB = X100; 10mV X 100 = 1 volt). Break frequencies of the filter are determined by equations (1) - (3)

$$f_1 = 50 \text{ Hz} = \frac{1}{2\pi R_9 C_4} \quad (1)$$

$$f_2 = 500 \text{ Hz} = \frac{1}{2\pi R_{10} C_4} \quad (2)$$

$$f_3 = 2120 \text{ Hz} = \frac{1}{2\pi R_{10} C_5} \quad (3)$$

The R7-C3 network is necessary to reduce the amount of feedback for audio signals and is effective for all frequencies

beyond 20 Hz. With the values shown, the inverse RIAA curve falls within 0.75 dB of ideal.

The remaining half of the LM387 can be used to build the 1 kHz square wave oscillator, and the required configuration is shown in Fig. 2. Briefly, operation is as follows. Resistor string R2 and R4 sets up an approximate reference point of 1.8 volts with the output low. When the output switches to high, a hysteresis effect is achieved via resistor R5, when an additional amount of current is fed into R4, thus raising its potential to about 2.0 volts. The 0.47 μF capacitor therefore alternately charges through R1 up to 2.0 volts, and discharges through R2 down to 1.8 volts. This portion of the circuit is thus a free-running, regenerative comparator with hysteresis. The resistor network comprised of R6 through R8 constitutes a -60 dB pad with equal port impedances of 10 kilohms. This reduces the 30-volt, peak-to-peak output level down to about 30 mV, so it can drive the inverse RIAA generator half of the LM387 without overloading it. While this is not the world's very best square wave generator nor most accurate inverse-RIAA generator, it is economical, and the design equations are included for those who wish to alter the oscillation frequency of the square wave generator.

*Written while at National Semiconductor, Santa Clara, Calif.; now with Phase Linear, Lynnwood, Wash. 98036.

Fig. 1 — Inverse RIAA response generator.

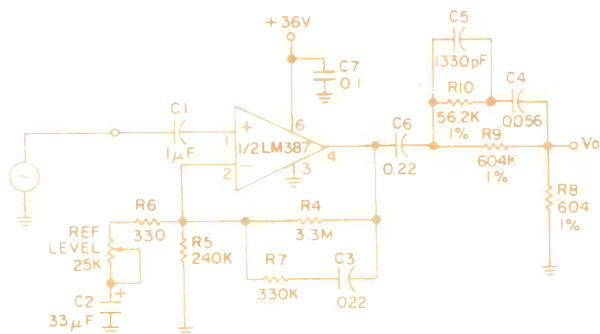
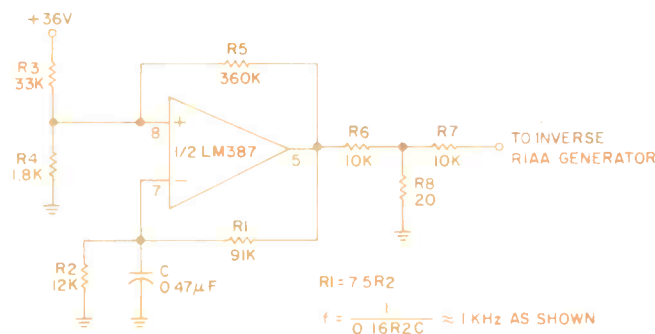


Fig. 2 — Square wave oscillator.



Equipment profiles

McIntosh Model MR-78 FM/Stereo, FM Tuner



66

MANUFACTURER'S SPECIFICATIONS

IHF Usable Sensitivity: 2.5 μ V (13.15 dBf).

Sensitivity for 35-dB Quieting: 2.0 μ V (11.2 dBf).

S/N Ratio (Mono): 75 dB.

THD (Mono): 0.2 per cent, any audio frequency.

Capture Ratio: 2.5 dB.

Selectivity: Normal, 55 dB; Narrow, more than 90 dB; Super Narrow, greater than 90 dB.

Spurious Rejection: 100 dB.

Image Rejection: 100 dB.

IM Distortion: 0.2 per cent (any combination of frequencies).

Maximum Input Signal Across Antenna Terminals: 12.0 volts.

Muting: 70 dB noise reduction.

Muting Threshold: Distant, 5.0 μ V (19.2 dBf); local, 20 μ V (31.2 dBf).

Stereo Separation: 40 dB @ 1,000 Hz.

Frequency Response: Stereo, 20 Hz to 15 kHz, ± 1 dB.

Audio Output Level: Fixed, 2.5 V into 47 kilohms, 1.0 V into 600 ohms; Vari-

able, 2.5 V maximum into 47 kilohms. (NOTE: Above specifications are stated for "normal" selectivity position unless otherwise indicated.)

GENERAL SPECIFICATIONS

Power Requirements: 120 V, 50/60 Hz, 35 watts.

Panel Dimensions: 16-in. (40.6 cm) W x 5 7/16-in. (13.8 cm) H.

Chassis Dimensions: 15-in. (38.1 cm) W x 13 (33 cm) D.

Weight: 27 lbs. (12.25 kg).

Price: \$899.00

In recent months, many readers of *Audio* have commented about the generally "poor quality" of most FM signals received in their listening areas. Almost invariably, these readers go on to question the wisdom of spending a great deal of money on one of the "super-tuners" only to be confronted with FM programs that do not justify such expenditure. This reviewer couldn't agree more, which makes the McIntosh MR-78 an even more interesting tuner than it would otherwise have been, for McIntosh seems to have emphasized a particular aspect of tuner performance that can make a difference in reception—selectivity. But more on this shortly.

The front panel of the McIntosh MR-78 maintains the traditional "Mac" look of "black glass" and features that company's well-known Panloc mounting method (shelves and shelf mounting brackets, together with necessary mounting hardware are, as usual, supplied). The large, illuminated dial area at the upper center of the panel has a linear dial scale, calibrated at every half MHz, as well as a 0-100 logging scale for easy referencing of favorite stations. The smooth-traveling dial pointer is illuminated over a portion of its length. Also located within the dial opening are symmetrically positioned center-of-channel and signal-strength meters. To the

left of the dial area are two rectangular areas denoted as "function" and "selectivity." Illuminated words "stereo," "filter," and "muting" appear (when selected) in the upper area, while the lower area is illuminated with either the notation "-7 dB," "-22 dB," or "-55 dB." These correspond to the three settings of the selectivity switch just below. The dB numbers represent adjacent channel selectivity and should not be confused with the more familiar alternate channel selectivity values which are, of course, much greater. A large tuning knob, coupled to a backlash-free flywheel and dial string arrangement, is located to the right of the dial area opening.

In addition to the selectivity selector switch, other rotary controls along the bottom section of the front panel include a meter selector switch, which chooses either the signal-strength or multipath-indication function of the signal-strength meter; a filter switch which, in addition to having an "off" position, has two settings for noise reduction during weak-signal stereo FM reception; a muting switch, with positions for local and distant reception (which vary the muting threshold); a mode switch with "stereo only," "mono," and "stereo auto" positions, and a volume control which also turns power on and off to the tuner.

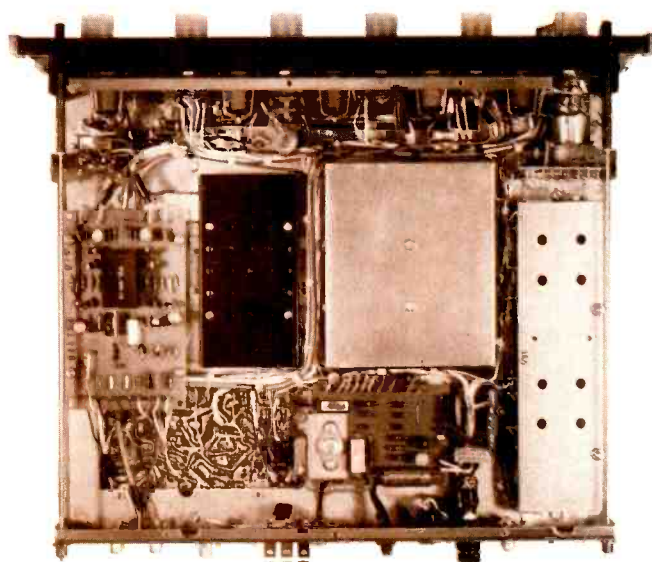
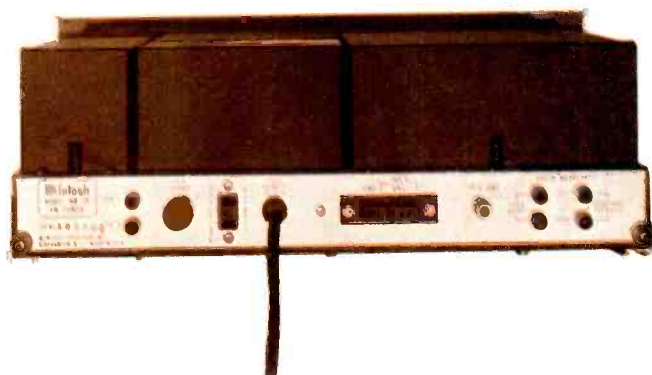
The rear panel of the MR-78 has a pair of test points which are intended for use with the McIntosh Maximum Performance Indicator, an accessory product marketed by that company. A fuseholder cap is also accessible from the rear for replacement, if necessary, of the tuner's 0.5 ampere slow-blow line fuse. Push-type terminals are supplied for 300-ohm antenna transmission line connection, while a 75-ohm coaxial connector is offered for connection of that type of transmission line. Two sets of audio output jacks (one pair for fixed output, the other controlled by the front-panel volume control) and one convenience a.c. receptacle complete the rear panel layout.

Internal Construction and Circuit Highlights

As can be seen in the internal view of the chassis, the McIntosh MR-78 is extensively shielded. Six major circuit board modules are used in addition to the r.f. front end. These include the i.f. circuit board, the selectivity junction board, the multiplex section, and the power supply circuit board. The front end utilizes a five-section tuning capacitor. A junction FET is used as an impedance converter to drive a 5-watt power transistor in the r.f. stage for high overload capability. An antenna matching circuit at the r.f. input has a two-position selectable switch which alters the r.f. bandpass characteristics of the input circuit. The switch positions are labelled "Lo Gain" and "Hi Gain," a bit confusing unless the user reads the manual carefully and discovers that the gain references refer to the *antennas* which might be used with the tuner. Thus, the "Lo Gain" position is intended for use in seeking out distant or weak signals while, in most applications, the "Hi Gain" position should be used since it yields the lesser amount of r.f. signal at the input to the r.f. amplifier stage, as well as a sharper bandpass characteristic.

A block diagram of the r.f. and i.f. sections of the MR-78 is reproduced in Fig. 1. A balanced integrated circuit mixer stage is used as a further safeguard against possible overload and to reduce oscillator pulling. Its 10.7 MHz output is coupled to the i.f. amplifier section by means of a bifilar transformer. Linear phase filters are used in both the "normal" and "narrow" selectivity settings of the MR-78, while for the "super narrow" selectivity setting a 4-pole 4-zero crystal filter having constant delay is introduced into the i.f. chain. McIntosh developed a new type of FM detector for this tuner which they call a linear phase bridge discriminator. It uses a balanced transmission line bridge in conjunction with a differential voltage doubling circuit to achieve ultra-low orders of distortion in the demodulated FM audio signals.

A block diagram of the multiplex and audio sections is illustrated in Fig. 2. An IC audio amplifier with over 120 dB of negative feedback in two feedback loops is used to drive the stereo demodulator. Muting, "stereo only" tuning, and automatic mono/stereo switching are all performed within the stereo decoder circuitry. A stereo filter circuit follows the matrix decoder and de-emphasis networks to reduce noise when tuning to weak stereo stations. This filter employs a twin-T bandpass filter design to suppress noise while only minimally affecting stereo separation and imaging. The



audio amplifier section consists of a pair of two-transistor amplifiers, one for each channel. Each amplifier delivers 2.5 volts to the fixed output jacks and to the volume control sections which feed the variable output jacks. The power supply section consists of a 24-volt regulated supply, which uses electronic filtering and supplies power to all signal stages, while a second, half-wave rectifier supply, also equipped with electronic filter circuits, feeds the necessary d.c. voltages to the multiplex decoder section.

Laboratory Measurements

Although most listening situations require selectivity settings of "normal" on the MR-78, we decided to measure performance in this setting as well as in the "narrow" selectivity setting. In the "normal" setting, IHF sensitivity measured $2.0 \mu\text{V}$ (11.2 dBf) and 50-dB quieting was reached with an input signal strength of $3.0 \mu\text{V}$ (14.7 dBf) in mono. Referring back to the published specifications, readers will note that McIntosh has not brought their specs into line with the newly adopted IHF/IEEE/EIA FM tuner measurement standards. Thus, no claim is made for 50-dB quieting sensitivity, for example, and Mac offers us a 35-dB quieting point instead. While we recognize that McIntosh has, in the

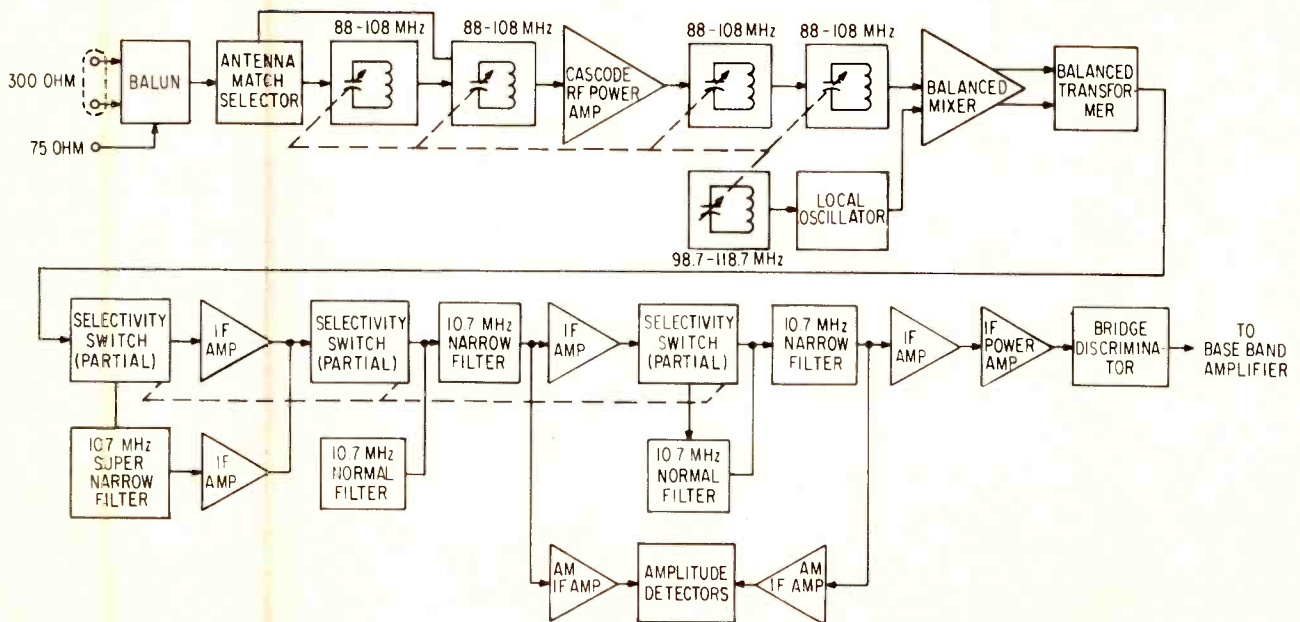
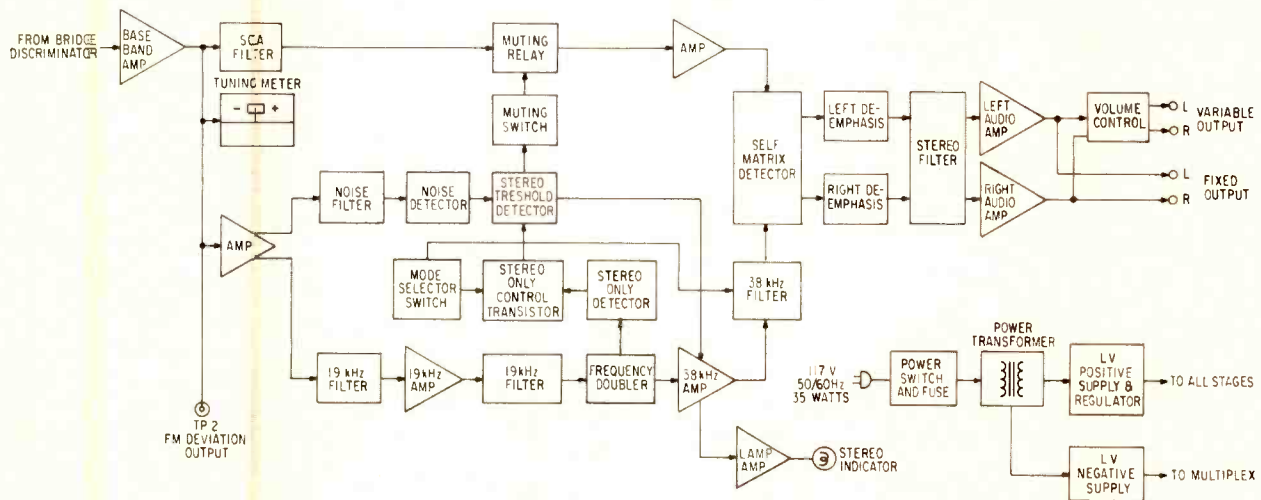
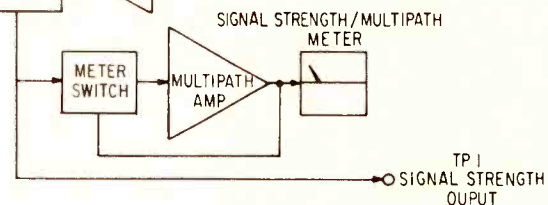


Fig. 1—Block diagram of r.f. and i.f. sections of the McIntosh MR-78 tuner.

Fig. 2—Block diagram of the multiplex, audio, and power supply sections.



past, differed with the rest of the industry in the matter of publishing specifications, we do feel that the new tuner standards are worth following and would hope that if it has not already been done, McIntosh would bring later published specs into line so that they might be easily compared with those of other companies. Be that as it may, $3.0 \mu\text{V}$ (14.7 dbf) is a very respectable figure for 50-dB quieting. Stereo sensitivity was $4.5 \mu\text{V}$ (18.3 dbf), at which signal strength in stereo was sufficient to cause nearly 35 dB of quieting. The 50-dB quieting point in stereo was attained with an input signal of $32 \mu\text{V}$ (35.3 dbf). Ultimate S/N in mono was an incredibly high 81 dB (we never thought our signal generator could read that low—now we know it can), while in stereo, best quieting for strong signals was 73 dB. Total harmonic

distortion in mono was a low 0.06 per cent, while in stereo, for the same strong signals used, THD read 0.1 per cent at 1 kHz. Curves of results obtained in the "normal" selectivity setting are plotted in Fig. 3.

Switching to the "narrow" selectivity setting, S/N readings in both mono and stereo remained virtually the same, but, as was to be expected, THD readings increased slightly, to 0.08 per cent for mono and 0.35 per cent for stereo. These results are shown in Fig. 4.

Returning to the "normal" selectivity setting, we measured a capture ratio of 1.8 dB. Alternate channel selectivity was 57 dB for this setting, while image and spurious rejection were both in excess of 100 dB (the limits of our test equipment). Maximum deviation from ideally flat frequency

response, for both mono and stereo, was less than 1.0 dB, with the deviation approaching that number at 15 kHz but remaining within 0.2 dB for frequencies from 10 kHz down to 50 Hz. Muting threshold occurred at 7.0 μ V for the "distant" position, 30 μ V for the "local" position. Stereo switching occurred at around 4.0 μ V (17.2 dBf).

Stereo separation measured around 52 dB at mid frequencies for the "normal" selectivity position, decreasing to 43 dB at 100 Hz and 26 dB at 10 kHz, as plotted in Fig. 5. In order to properly ascertain the THD produced by the tuner at high modulating frequencies, it was necessary for us to employ our spectrum analyzer and to "sum" the harmonic products mathematically to arrive at the 0.14 per cent THD figure shown for a 10-kHz modulating frequency. If this is not done, non-audible products (not properly identifiable as harmonic distortion) "cloud" the single-reading measurement that is obtained on a conventional meter-type distortion analyzer.

Fig. 6 is a plot of separation versus frequency with the selectivity control set to the "narrow" position. Separation naturally suffers somewhat when this narrow setting is used, but remains well above 30 dB for most frequencies tested. Distortion in stereo also rose somewhat in the narrow setting, as shown in the curves of Fig. 6., while in mono, THD remained incredibly low at mid-frequencies even when the "narrow" setting of the selectivity switch was used. Sub-carrier product rejection was so good that it was not even necessary to use the recommended 15-kHz low-pass filters for all of our high-frequency noise and distortion measurements, except as already noted for the 10-kHz readings. Audio output level was exactly 2.5 volts, as claimed, for a 100 per cent modulation signal at the fixed output terminals. Since our own signal generating equipment is limited to 0.2 volts output, there was no way for us to verify McIntosh claims regarding 12-volt antenna input-overload capability, though we have no reason to doubt the claim based on subsequent strong-signal listening tests. We purposely carted the tuner over to a mid-city location where we have access to a listening room that is just a few blocks away from several high-powered FM transmitters. Previously, we had measured signal voltages of 2 to 3 volts at that location and found that most tuners did exhibit cross-modulation and other overload effects. With the Mac tuner, we were able to clearly separate closely spaced, high-signal stations on the dial with nary a trace of interference from other strong-signal stations in the same vicinity.

Use and Listening Tests

Back in our own lab (some 20 miles from the city), we began to appreciate the importance of that selectivity switch on the front panel. If you are an inveterate FM DX-er, you will be amazed (as we were) at how many signals you can separate and receive clearly by using the "narrow" (and at times even the "super-narrow") selectivity switch positions on the MR-78. Here is a tuner that doesn't compromise between low distortion and wide bandwidth. The 55 dB of selectivity (that claimed in the "normal setting") is no problem if you are not plagued by adjacent and alternate channel signals. In fact, the "normal" setting, coupled with those linear phase filters in the i.f. section, provided the kind of reception from the few good quality stations we have in our listening area that we often dreamed about. Program quality varied, of course, but when we were fortunate enough to tune to a live concert (yes, we still do have some live FM programming in this area, albeit at midnight each night), the results were truly astounding. We had the feeling that the late Major Armstrong, too, would have smiled if he could have heard FM the way we heard it over the Mac MR-78.

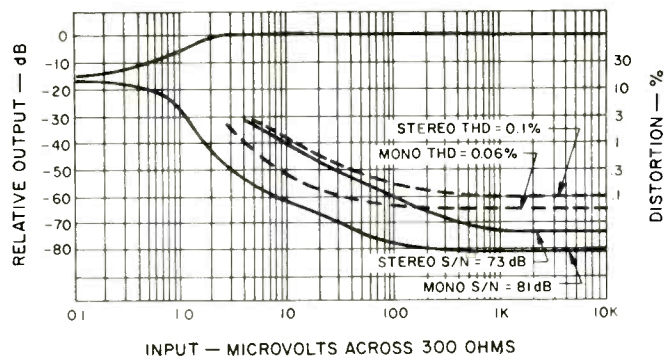


Fig. 3—FM quieting and distortion characteristics with selectivity switch set to "normal."

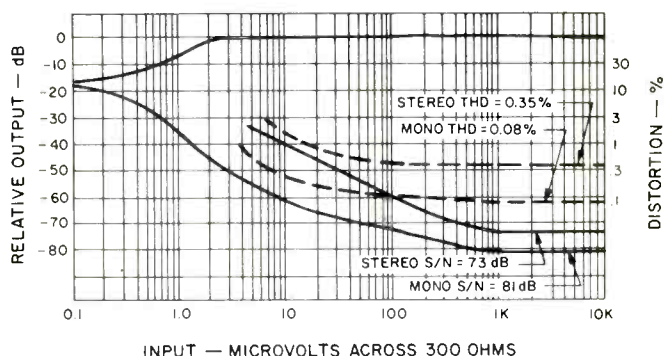


Fig. 4—FM quieting and distortion characteristics with selectivity switch set to "narrow."

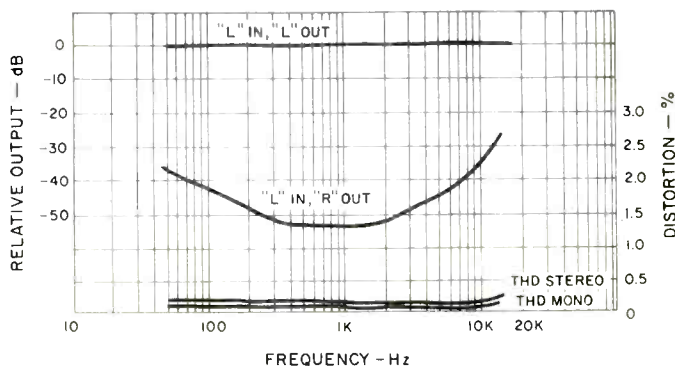


Fig. 5—Separation and distortion vs. frequency with selectivity switch set to "normal."

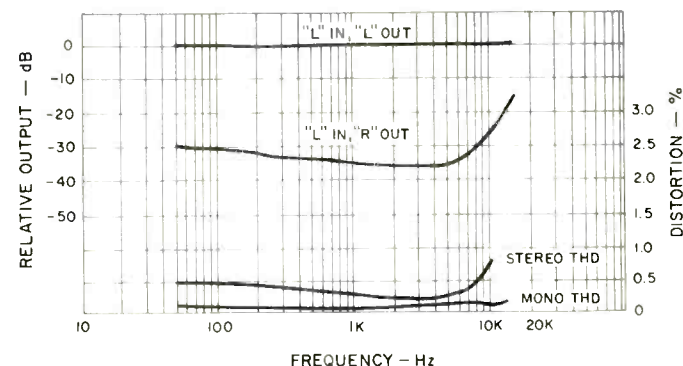


Fig. 6—Separation and distortion vs. frequency with selectivity switch set to "narrow."

There was only one instance where we found it necessary to use the "super-narrow" position of the selector switch, and that was when we were trying to listen to a weak signal originating some 120 miles from our listening location—one nestled between a stronger signal 200 kHz below it and a much stronger local station 200 kHz on the higher side of the dial. If you've ever tried to receive that kind of signal on a lesser tuner, you'll know what we mean. In any case, when we did switch to the "super-narrow" position, we actually were able to listen to the desired distant station and dis-

tortion, though audibly higher, was still at tolerable levels.

Naturally, one would think twice before spending close to \$900.00 for an FM tuner, but if you are confronted with the same sort of signal conditions as exist in our test location and have been repeatedly frustrated in your attempts to zero in on desired stations, only to be annoyed by rasps, buzzes, and spiked sounds "spilling in" as interference, the McIntosh MR-78, with its three positions of selectivity, may well be one of the only, if not the only high quality tuner which will do the job.

Leonard Feldman

Check No. 90 on Reader Service Card



70

Dual Model 1249 Automatic Turntable

MANUFACTURER'S SPECIFICATIONS

Speeds: 33 1/3 and 45 rpm.

Motor: 8-pole synchronous.

Wow & Flutter: 0.06 per cent (DIN 45507).

Rumble: -63 dB weighted.

Pitch Control: 6 per cent at 33 1/3 rpm.

Tangential Tracking Error: 0.16 deg/cm.

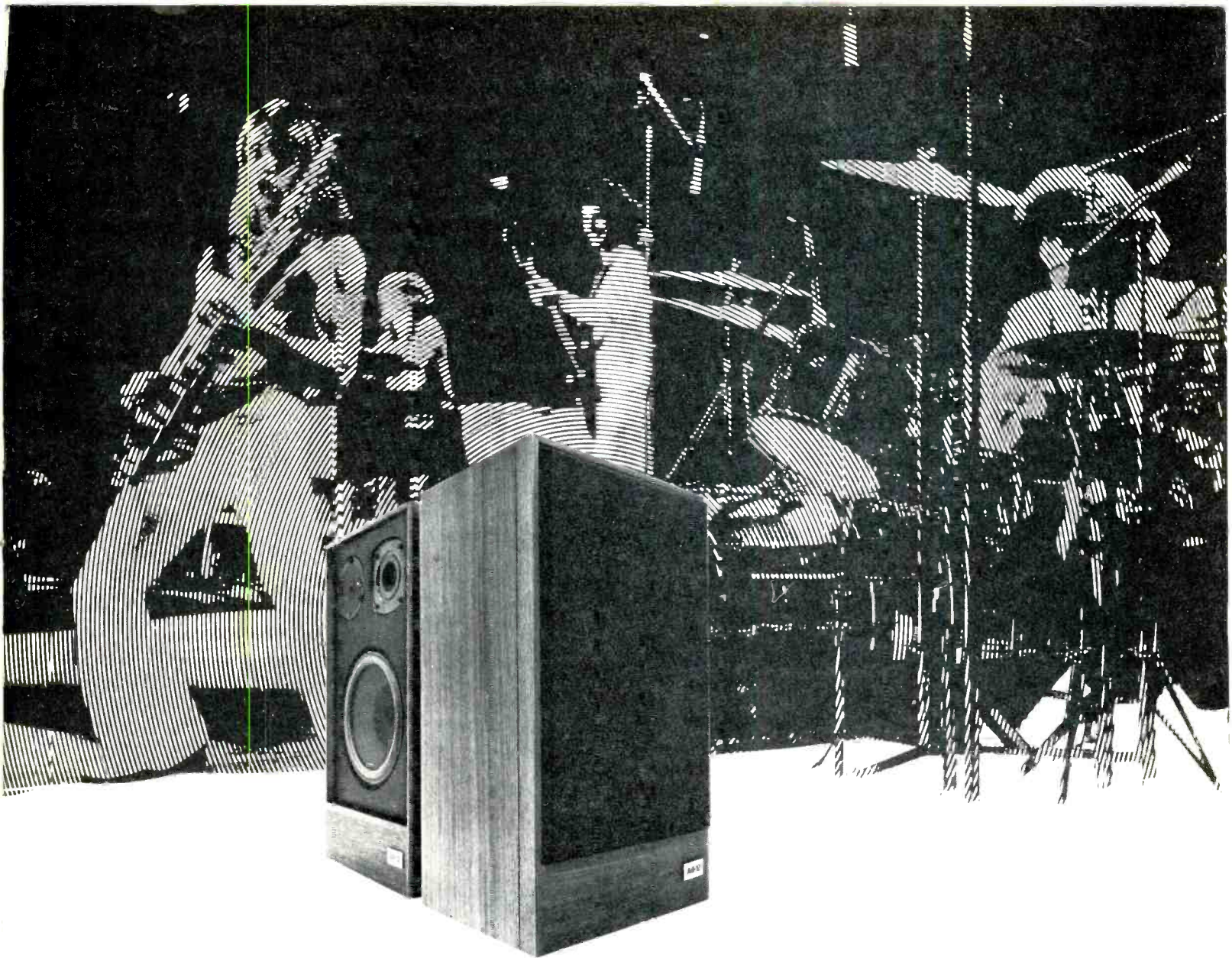
Dimensions: 16 1/4 (41.3 cm) x 6 1/4 (15.9 cm) x 14 (35.6 cm).

Price: \$280.00.

The Dual Model 1249 could be considered the automatic version of the Model 601 (reviewed in Jan. 76, pg. 50), to which it bears a certain resemblance. However, the 1249 will take up to six records, either 33 1/3 or 45 rpm, and there is a provision for manual operation. In terms of basic performance the measured figures came quite close to those of the Model 601—which is hardly surprising.

The styling is neat and attractive, in the familiar charcoal and silver combination favored by Dual, and the base has a walnut finish—but black and white versions are also available. The motor is an eight-pole synchronous type, and it

drives the heavy flywheel by means of a flat belt—the total weight of the platter and flywheel being 4 1/4 lbs. Speed changes are effected by a lever which moves the belt up or down on the dual-diameter motor spindle. The two-position speed change switch is at the front, on the left, and concentric with it is a small fine-speed adjustment knob. Strobe markings are cut into the platter rim, and illumination is provided by a neon lamp located on the right. Further over on the right, is a small satin-finished panel with the Start/Stop switch and the Dual logo. Directly behind the switch is a small knob marked 1 and ∞ (infinity) which can set the mechanism in the continuous play mode. Behind it are the cueing lever and the anti-skating device which is unusually elaborate, consisting of three scales—one for conical styli, one for elliptical, and one for CD-4. The tonearm is aluminum with a low friction, four-point gimbal suspension. The tracking force adjustment control is mounted on an extension to the right of the pivot, and at the base is a two-position lever which can lift the tonearm up another quarter inch to maintain the 15 degree stylus angle when playing a stack of records. The reference used is the center of the stack—or three records, so the error is quite small—probably less than the divergencies between cartridges. The cue lift adjustment control is placed near the base of the arm.



The new AR-12 is for people who like their music loud and clean

With today's rock listening levels requiring several times the output power of a few years ago, more rugged loudspeakers must be built to convert this added power into clean acoustical energy without destroying either the speakers or your eardrums.

That's why AR's Advanced Development Division designed the new AR-12 to handle double the power of its predecessors. The long-throw acoustic suspension woofer of the AR-12 allows the wide cone excursions necessary for today's bass-heavy recordings. And it's mounted in a larger volume cabinet usually reserved for our more expensive systems to give you accurate reproduction of lowest bass guitar and synthesizer notes as well as organ pedal tones.

The AR-12 midrange driver uses a new 1" coil design with magnetic fluid centering which permits vastly

increased power handling capacity while retaining a 2 1/4" cone with its superior dispersion for uniform listening characteristics throughout the room. The AR-12 tweeter is the same advanced hemispherical dome design used in our most expensive systems, and it also shares magnetic fluid design for crystal clear reproduction of the "hot" highs prevalent in today's recordings.

Not only does the AR-12 set a new design standard for clean reproduction at high power levels, but like all AR loudspeakers, each AR-12 is tested to perform to within 1 dB of this standard, the same tolerance applied to professional microphones.

The audible result of this dedication to excellence is described by International Musician and Recording World as follows: *The depth and clarity was exceptional and I can honestly say*

that I heard things in the recordings I had not heard before despite many listenings...

So if you like your music loud and clean we invite you to take your favorite recording to your AR dealer and ask him to play it through AR-12 loudspeakers using the most powerful electronics he has in his soundroom. We think you'll find the effortless accuracy of the AR-12 the sound you want to live with.

Write to us for complete information on the loud and clean speakers from AR and a list of demonstrating dealers in your area.

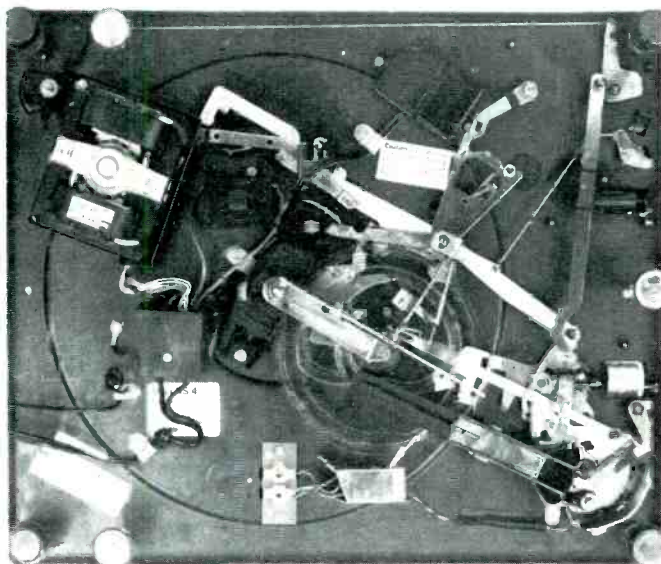


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Check No. 51 on Reader Service Card



Like all Dual turntables, the 1249 uses a clip-on cartridge holder instead of a detachable head, and an alignment gauge is supplied with the unit. No trouble was experienced in mounting the cartridge, a Shure V15 MkIII, for optimum tracking, and then the tonearm was balanced in the usual way by adjusting the counterweight at the rear. Tracking force was set to 1 1/4 grams and the anti-skating control was turned to the same setting. Tonearm resonance, with the Shure, was a 2 dB peak centered on 9.5 Hz.

Measurements

The first test was for wow and flutter, and the measurement came out at a hair under 0.05 per cent using the DIN standard. Rumble was -63 dB ARRL weighted, which was excellent. The tonearm tracking error was slightly less than the claimed maximum of 0.4 degrees per inch, and both vertical and horizontal friction were too low to be accurately measured. The speed adjustment gave a range of six per cent at 33 1/3 and three per cent at 45 rpm. The tracking force dial is calibrated from 0 to 3 grams, and the error there was negligible. The force required to operate the cycling mechanism at the end of the record was quite small—less than 0.3 gram, which should not bother the most fragile cartridge.

Like all dual turntables, the 1249 is a pleasure to use—the automatic mechanism seems foolproof and the phono cartridge is treated very gently. The cue lift control is free from annoying side drift, and all the controls were positive. For manual operation, all you have to do is raise the tonearm and place it over the record, the motor starts automatically, then you use the cue control to lower the arm. At the end of the record, the arm is returned to the rest position. In the automatic operation mode, the spindle is changed and the two-position stylus control is set to *Multi*. The cycling time is quite low, about 10 seconds from switching on until the stylus lands on the record, and about the same wait between records.

The cables fitted to the 1249 are the low-capacity type; an Audio-Technica CD-4 cartridge was used for a period of time and proved to be very satisfactory. All in all, the Dual 1249 can be recommended to those who want the convenience of a multi-play turntable and the top performance of a single play unit.

George W. Tillett

Check No. 71 on Reader Service Card

What have Quad been up to recently?



Current Dumping that's what

Current Dumping is the name given to a totally new power amplifier circuit developed by QUAD.

A current dumping amplifier basically consists of a low power amplifier of very high quality, which controls the loudspeaker at all times and a high powered heavy duty amplifier which provides most of the muscle.

The small amplifier is so arranged – it carries an error signal – that provided the heavy duty transistors (the dumpers) stay within the target area of the required output current, it will fill in the remainder accurately and completely.

The reproduced quality is solely dependent on the baby

amplifier, which because of its low power, can be made very good indeed.

The QUAD 405 is the first amplifier to incorporate current dumping.

There are no internal adjustments, so nothing to go out of alignment.

There are no crossover distortion problems and performance is unaffected by thermal tracking.

The QUAD 405 offers impeccable performance, reliably and predictably.

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Check No. 1 on Reader Service Card

What's new

Technics Reel-to-Reel Tape Deck

The Model RS-1500US is an "isolated loop," direct-drive, reel-to-reel tape deck, with a quartz-controlled, phase-locked loop d.c. motor and a stroboscope for tape speed measurement. The "isolated loop" starts and finishes on the same giant sized capstan, the surface of which is finished to 5 microns. The capstan is driven by a d.c. motor locked to a quartz crystal servo circuit. Both the supply and take-up reels are driven by separate servo-controlled d.c. motors for maintaining constant tape tension under various tape loads. The tape transport functions employ full IC logic without a single relay or mechanical switch, and pitch controls are variable up to ± 6 per cent. Sepa-



Check No. 80 on Reader Service Card

rate three-way adjustments of recording bias and equalization accommodate all tapes presently on the market. A separate operational amplifier is provided for mike mixing, and a mike attenuator switch provides 20-dB attenuation to prevent recording overloading, while a real-time tape counter indicates actual program time. Maximum reel size is 10 1/2-in., the tape speeds are 15, 7 1/2, and 3 3/4 ips, and the head configurations include a 2- or 4-track playback head, a 2-track erase, and a 2-track record. The specifications claimed include a speed accuracy of 0.1 per cent, a frequency response from 30 Hz to 25 kHz ± 3 dB at 7 1/2 ips, A weighted S/N ratio of 60 dB, and a wow & flutter of 0.3 per cent W rms. Price: \$1500.00

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Heathkit Receiver

The Model AR-1515 is a stereo receiver with a 70 watt output per channel and a claimed harmonic distortion of 0.08 per cent from 20 to 20,000 Hz. The unit has a digital frequency readout with AM/FM broadcast frequencies, dual tuning me-

Check No. 81 on Reader Service Card

ters, stereo blend, subsonic and high-frequency filters, and tape dubbing inputs and outputs. The stated FM sensitivity is 1.8 μ V, selectivity is 100 dB, and hum and noise are 65 dB below full output in the phono mode, and 80 dB on high level sources. Price: \$549.95 in kit form.

Martin Directory

The Pro Audio-Video Product Directory is a compilation of technical information and detailed specifications of more than 300 professional equipment products from 30 manufacturers. Divided into six categories, compressors and limiters, equalizers, expanders and noise gates, reverberation systems, microphones, and microphone accessories, this

is the first time a professional equipment specifications list has been published, under one cover, for manufacturers such as AKG, Atlas, dbx, Gotham, Neumann, Orange County Electronics, Orban/Parasound, Sennheiser, Shure, Spectra Sonics, and Tapco. Price: \$2.00, refundable with the first \$25.00 purchase. Write to Martin, 320 W. 46th St., New York, N.Y. 10036.

Yeaple Stereopillow

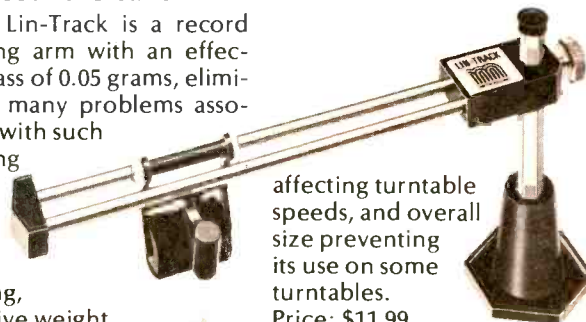
The Stereopillow speaker is a full-size polyurethane pillow with two 4 1/2-in. long-excursion drivers mounted on internal near-field effect baffles with passive equalizer circuits in each channel to

Check No. 82 on Reader Service Card

provide controlled amounts of bass and treble boost for a flat acoustic output over the audible frequency range. The claimed frequency response is 30 to 16,000 Hz, and a 95 dB output with 0.5 W input. Price: \$79.95.

Metrosound Cleaner

The Lin-Track is a record cleaning arm with an effective mass of 0.05 grams, eliminating many problems associated with such cleaning arms such as poor tracking, excessive weight



affecting turntable speeds, and overall size preventing its use on some turntables. Price: \$11.99.

Check No. 84 on Reader Service Card

The column

Michael Tearson Jon Tiven



74

The Pretender: Jackson Browne
Asylum 7E-1079, stereo, \$6.98.

In all truth, I expect it to be several months before I fully come to grips with **The Pretender**, Jackson Browne's fourth album. The third one, **Late for the Sky**, originally did little for me, sounding rehashed. But one by one, the songs unfolded their particular charms and that album has risen greatly in my esteem.

Early listenings to **The Pretender** followed the same pattern. The new album has no obvious rocker, like **Late's** *The Road and the Sky*, but where it rocks, it builds up cautiously, as in *The Fuse*. What clearly emerges in an awareness of the anguish and rethinking of personal goals that an especially brutal year has required. Thus, *The Pretender*, placed both strategically and thematically at the album's close, is the ultimate statement—a redefining of the self at a

time when the only choice is to face tragedy and either grow stronger or go under. The opener, *The Fuse*, shows the basic Browne optimism with faith intact and built upon a sturdy foundation. The song to his son, Ethan, *The Only Child*, is disarmingly direct and touching.

For now, **The Pretender**, still sounds rehashed, but I don't feel let down at all, in fact more than a bit exhilarated. By June I know I'll be able to write several different reviews of it, each one distinct and different—it's that kind of record. M.T.

Sound: B Performance: A-

Slipstream: Sutherland Brothers and Quiver
Columbia PC 34376, stereo, \$6.98.

It seems that each album Iain and Gavin Sutherland have done has had at least a couple of absolutely unfor-

gettable songs. Their Columbia debut, **Reach for the Sky**, had a fistful and still stiffed. That being the case, it's not going to happen for the vastly inferior **Slipstream**. M.T.

Sound: C- Performance: D

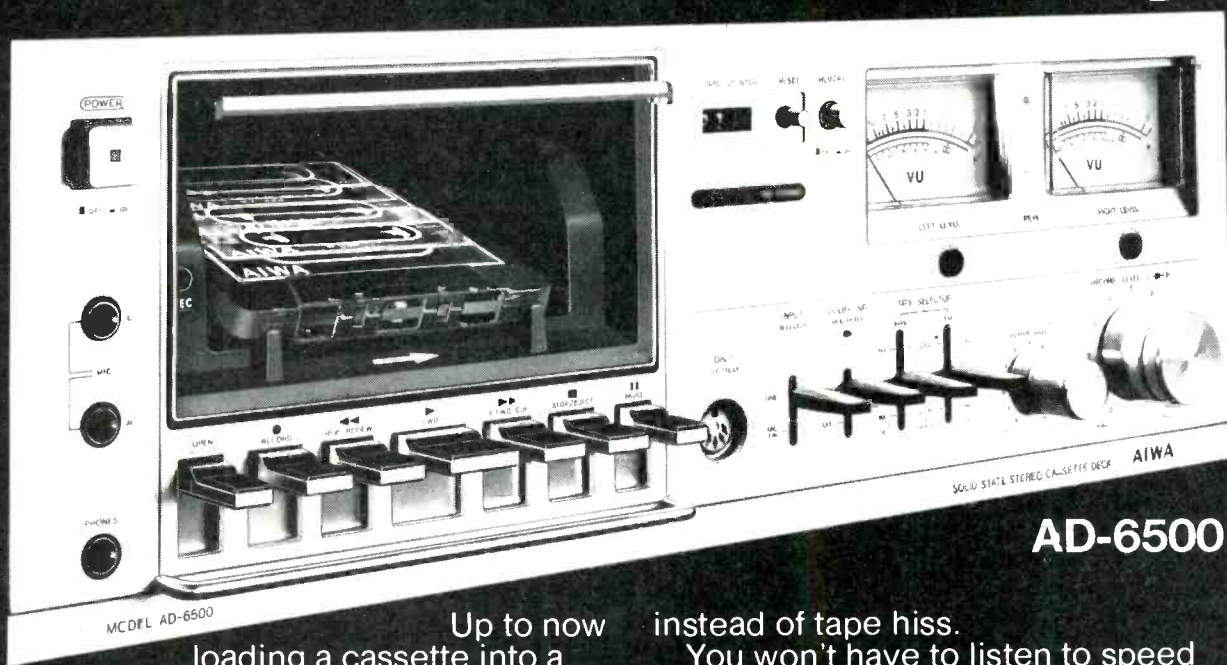
Johnny the Fox: Thin Lizzy
Mercury SRM 34174, stereo, \$6.98.

With **Jailbreak** the last time out, Thin Lizzy finally started to happen in America and **Johnny the Fox** won't hurt their momentum any. Continuing the characters and street themes of **Jailbreak**, Phil Lynott's writing is focused with its strong melody and plot sensibilities. The band is tight and right, fully assured and confident—it sounds right from the first note. With the furious stride Thin Lizzy is hitting, they figure to be one of 1977's real breakthroughs. M.T.

Sound: A- Performance: B

AUDIO • February 1977

Now you can get loaded automatically.



Up to now loading a cassette into a front loading cassette deck was a little like putting a square block into a round hole. But now there's the AIWA AD-6500. The world's first cassette deck with automatic cassette loading. So you can play any cassette quickly, easily and precisely.

But there's a lot more to the AD-6500 than how you get a cassette into it. There's also the music that comes out of it. Like a frequency response of 30Hz to 17kHz with FeCr tape. Musically speaking that means hearing all the music—not just part of it.

And because we used Dolby* we also improved the S/N ratio to 62 dB. So you can listen to the music

instead of tape hiss.

You won't have to listen to speed variations either. Because the AD-6500 has a frequency controlled servo-motor as well as inaudible wow and flutter (0.07%).

And with the AD-6500 you can see as well as hear what you're listening to. With 2 VU meters complete with 2-step peak level indicator lights. There's also memory rewind and quick review/cue system for easy, efficient use. Three-step tape selector for the 3 different kinds of tape. Fully automatic stop. A Ferrite

Guard Head (FGH) and more.

So get the AIWA AD-6500. Because the only thing easier than loading it is listening to it.



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Check No. 2 on Reader Service Card

The Best of George Harrison: George Harrison

Capitol ST-11578, stereo, \$6.98.

What makes this record remarkable is the amazing sound quality achieved on side one, which consists of George's best Beatle work, plus the never-before-on-album *For You Blue*, as well as *Bangla Desh* on side two, which also sports some of his solo hits, inexplicably excluding *Beware of Darkness*. You'll have to look hard to find a better sounding album than side one of this disc.

M.T.

Presentation: B

Burton Cummings: Burton Cummings
Portrait PR 34261, stereo, \$6.98.

Rotogravure: Ringo Starr

Atlantic SD 18193, stereo, \$6.98.

Perhaps the greatest record producer of all time is Phil Spector, but his effect on the 70s has not made music better. Before Spector, the producer was just the anonymous creature who rarely got credit for the success of a record, even if he was primarily responsible for the artistry of it. With the advent of Uncle Phil and the much heralded Spector Sound, The Producer began to come into his own as public figure. Here in the 70s the record producer is just as likely to be out to make a name for himself as the person who sings the tune. And the master himself, Phil Spector, has all but deserted the record scene, leaving lessers like Richard Perry and Arif Martin to vie for the coveted "producer of the year" crown when both should be anonymous.

Perry produced the most successful records (talking strictly in sales) by Harry Nilsson, Ringo, Carly Simon,

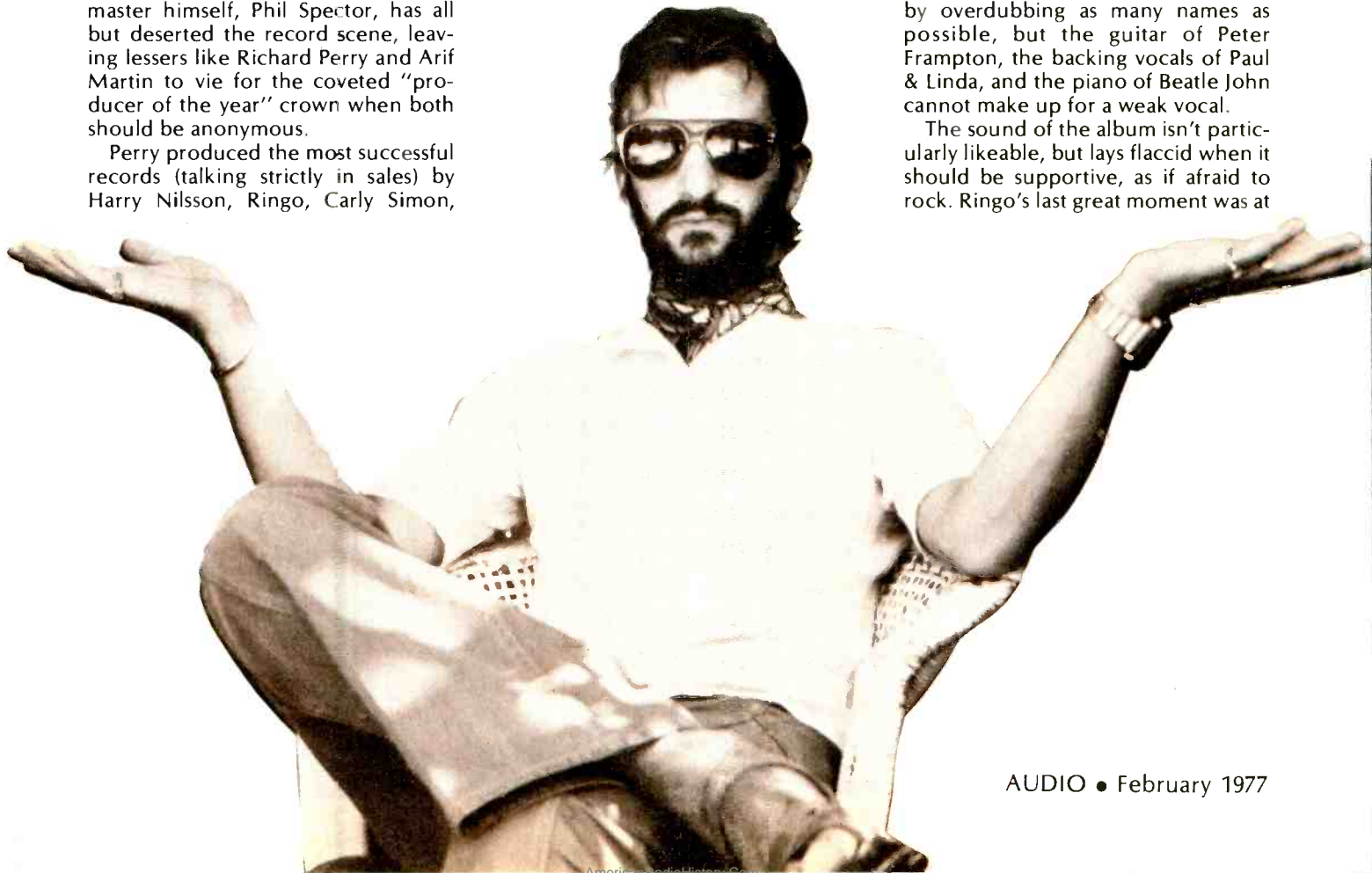


and a slew of others. Currently we find him trying his hand at Burton Cummings, former lead singer with the now-disbanded Guess Who and who has been without chart success lately (although his hits of the past are not to be questioned). Cummings is not what I'd call a great talent—personally I think he stinks—but with the antiseptic touch of Richard "I hate rock 'n' roll but if you got some strings, I think we can have ourselves a hit" Perry he is chartbound. Cummings aspires to be the next sensitive singer/songwriter/pianist, sort of Son-of-Elton with a little of the worst of Eric Carmen thrown in for bad measure. The session men used on the record are well heeled in their abilities to be mundane and avoid excitement. Perry's touch is rarely anything but overbearing, and although he obviously aspired to emulate Spec-

tor at some point, today he sounds like he comes to each session with spray starch. He and Cummings are ideally suited to each other, and I hope they're happy together for many years to come.

Ringo, on the other hand, has a past which refuses to stop haunting him. He at least realizes that he's no great shakes as a songwriter—he only contributed to three of the songs on the album—and usually steps aside from the drums (favoring Jim Keltner, an L.A. session man). Now if he was blessed with a great voice, he'd be in great shape to be the Ronnie Spector of the 70s, but unfortunately he's got a voice which at best displays character in place of musicality. The only time when Ringo is able to front a song is when he's got some hysterical lyrics to play with, and aside from the first two songs on **Rotogravure** he's in bad shape. Ringo has a hard time coping with a new romantic tune from McCartney, *Pure Gold*; John Lennon's contribution to this album doesn't offer much, *Cookin' in the Kitchen of Love*; George Harrison's *I'll Still Love You* stands among his weakest, and Eric Clapton's writing talents are very much in question while Clapton's title itself, *This Be Called A Song*, is an overstatement. Producer Arif Martin (The BeeGees, Andy Pratt) tries to rescue the album by overdubbing as many names as possible, but the guitar of Peter Frampton, the backing vocals of Paul & Linda, and the piano of Beatle John cannot make up for a weak vocal.

The sound of the album isn't particularly likeable, but lays flaccid when it should be supportive, as if afraid to rock. Ringo's last great moment was at



the Bangla-Desh Concert when he played drums and proudly sang *It Don't Come Easy* (written with Harrison) and his next golden move seems further away with each successive solo album. He may have been a Beatle once, but now he's just a Ringo. *J.T.*

Sound: C Performance: B-

Hoppkorv: Hot Tuna

Grunt BFL—1-1920, stereo, \$6.98.

Why anyone would want to call an album **Hoppkorv** is beyond me, but Hot Tuna has and it's a welcome bounce back from their disastrous **Yellow Peril**. The disc contains the usual Tuna recipe—the occasionally augmented power trio (especially nice with Karin Tobin's vocal on Buddy Holly's *It's So Easy*) running through some blues of both city and country origin, a cover or two, and some obscurely titled Jorma Kaukonen originals of which *Santa Claus Retreat* and *Song from the Stainless Cymbal* work best, both as songs and as titles. *M.T.*

Sound: B Performance: B

Wipe the Windows, Check the Oil, Dollar Gas: Allamn Brothers Band
Capricorn 2CX 0177, stereo, \$6.98.

As a final live album, **Check the Windows** contains no surprises. Only old favorites by a fine band in its own element, the concert. This one's for the believers—decent. *M.T.*

Sound: C+ Performance: B

Unknown: Tom Petty & the Heartbreakers

Shelter SRL 52006, stereo, \$6.98.

Nobody seems to know a whole lot about this Tom Petty character except that he's American. He came to L.A. to find fame, fortune, and a record deal; he got one, and made a record. Personally, I hope that he doesn't have any past at all and is under the age of 25, otherwise all my illusions about this record will instantly shatter—but it's one darn good record (although it's got its weak spots) and shows a whole lot of promise both aesthetically and commercially.

The general direction of the album is straight ahead rock 'n' roll, and the name of another Shelter artist comes to mind immediately upon playing the album, Dwight Twilley. Whether Dwight actually performs on this album or had anything to do with the signing of Petty to Shelter, I don't know (no information is given), but it

sure sounds like Dwight & Phil singing backup on *Strangered in the Night* and several other tracks. The Petty sound is fairly original, although strong traces of The Rolling Stones (particularly the Mick Jagger in Petty's pipes) and occasional musical glimpses of Van Morrison (*Hometown Blues*), the Byrds (*American Girl*), Music Machine (*Rockin' Around with You*), and even Bruce Springsteen (*The Wild One, Forever*) creep in from time to time.

The production is not overpowering (Denny Cordell handles it) but the simplistic arrangements seem to work best for the songs with few exceptions. There are only a few less than enjoyable songs on the disc (*Mystery Man* and *Luna* aren't particularly thrilling), but what you have here is a hard-hitting, raunchy, and arrogant band that's steered clear of all musical and lyrical contrivances and come up with a winner. *J.T.*

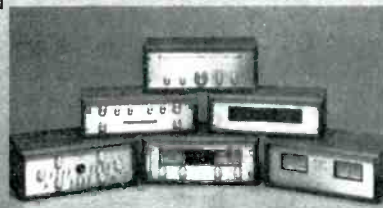
Sound: B Performance: A-

Phase Linear FM Tuner with exclusive Dynamic Range Expander.

With the new Phase Linear 5000 FM Tuner you can actually improve FM broadcasts to rival that of tapes and records. Advanced electronics combine excellent reception capabilities with a unique Dynamic Range Expander that restores compressed FM signals to their original sonic quality. The Phase Linear 5000 has many other un-

usual features not available on most conventional tuners, including an L.E.D. Multipath Distortion Indicator that identifies this type of distortion, thus simplifying its removal; a Variable Muting Control; De-emphasis; and more.

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See your dealer and listen to this remarkable tuner.



Manufactured in the USA. Distributed in Canada by H. Roy Gray, Ltd.

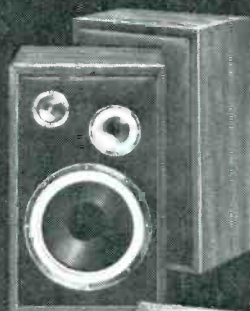
Everything built into the Miida 3140 stereo receiver is there for a reason ...and that reason is performance.

For the discriminating audio enthusiast: AM, FM and FM Stereo with Phase Locked Loop Multiplex with outstanding reception and positive separation. Dual inputs with monitor and crossdubbing. Superb amplifier for dramatic, full depth performance with power to spare.

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Did You Miss...?

Solo: Don McLean
UA LA652-H2, stereo, \$7.98.

As a representation of what the man is all about, **Solo**, a four-sided live set, is the best record Don McLean has made. Recorded in England, where his following is the most fanatical, it contains virtually every song Don is known for, including his albatross, *American Pie*. The audience is sympathetic and enthusiastic yet never intrusive. The recording is straightforward and without unnecessary tricks. Put simply, **Solo** is the basic Don McLean.

M.T.

Sound: B Performance: B

Amigo: Arlo Guthrie
Reprise MS 2239, stereo, \$6.98.

Arlo Guthrie's first album in about two years is spotty. Each side opens with promise, the rollicking *Guabi Guabi* borrowed from Ramblin' Jack Elliott and Arlo's own *Darkest Hour* on side one, and his funny *Grocery Blues* on side two. Beyond that it's pretty boggy, lightweight songs excepting the intense *Victor Jara*, a paean to the slain Chilean poet-martyr, co-written with British poet Adrian Mitchell.

Utterly missing is Arlo's passion. John Pilla's production is rapid, sounding rushed and sketchy. Precious little thought has been given to effective arranging. The case is not quite hopeless.

M.T.

Sound: D+ Performance: D+

The Song Remains The Same: Led Zeppelin

Swan Song SS-2-201, stereo, \$11.98.

First off, I don't think there are many souls out there who believe that this album is a pure recorded document of a live Zeppelin show, and I don't think anyone in the Zeppelin ranks would insist that there was no retouching of the originals. I'm certain that there are plenty of repaired guitar parts, and even a superficial examination would reveal a certain amount of editing. Yet I wouldn't consider these faults any more than I would criticize the use of EQ as an afterthought, when those members of the listening audience who were at the original concerts don't remember Page's guitar as being quite so shrill. I consider these things to be concessions to the studio in order to

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make a better record, and considering how awful Led Zeppelin can be on-stage compared to their records, the minimal amount of production isn't particularly annoying.

What I think is a more subtle way the album misrepresents the group is that all of the tracks are over three years old. Granted, Zeppelin isn't the cleanest-sounding group in the world, but if you think this album sounds sloppy, they play with about half that precision nowadays. Still, I far prefer a record of a live performance from this era to something more recent—Page could tear his guitar to pieces back then, whereas now he's rarely in such energetic/violent form. The excesses of Robert Plant (singing *San Francisco/Wear Some Flowers in Your Hair* in the middle of *Dazed & Confused*, the ridiculous affectations) weren't quite as bad as they are nowadays, and his voice was also in better shape back then. And while there is no truth in advertising (nowhere is there a mention of when the tracks were recorded on the album jacket), better we should hear the LZ Model 1973 than the present live group.

Instead, if we are to criticize this rock institution, we should question the inclusion of *Moby Dick* and *No Quarter* when there are far more interesting Zeppelin songs to be had. Perhaps *Dazed and Confused* contains some of Page's finest moments, but why 27 minutes when even half that would be sufficient (note the version on the *Live Yardbirds* album featuring Jimmy Page does not suffer by its brevity). Zeppelin's oldies medley is more of a fixture in their repertoire than any of these tunes, but for some reason (publishing of others' songs means less money for the starving Zepps) it was excluded here.

But I'll be damned if it isn't one of the better albums released last year, certainly the best live record since Deep Purple's *Made In Japan*, and any year that three discs emerge from Led Zeppelin has got to be allright. *J.T.*

Recording: B+ Performance: A-

BB&A Live in Japan: Beck, Bogert & Appice

Epic ECPJ-11 (Japanese import), stereo (2 record set), \$15.00.

It's incredible that the Japanese are able to get the cleanest, brightest, and sharpest live recordings while Americans and Englishmen always make the records sound like the microphones were placed in the back of the hall. And if you are, like myself, interested

in what the state-of-the-art in live recording can be, then you must check out this album.

Aside from that, this hard-to-get import has recently been turning up in many shops, and considering the recent sales surge of Jeff Beck records, it should sell well. While Beck's latest effort **Wired** is clean, polished, and mature, this record is Beck at his most volatile, playing alternately at his trashiest and at his most peculiar. If not for the lameness of the other two members, I'd be certain to say Beck is

most at home with a power trio, but Bogert and Appice play far too much and far too tastelessly, aside from the fact that neither of them is capable of writing a song or singing competently. Still, for the Beck Fanatic (and there are more of them around than ever before) and anyone interested in hearing a little more of probably the most influential contemporary guitar player around, **BB&A Live in Japan** shouldn't be neglected. *J.T.*

Sound: A+ Performance: B+ (a bit spotty)

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Classical Reviews

Edward Tatnall Canby

Telemann: Pimpinone (1725). Siegmund Nimsgern, Uta Spreckelsen, Ensemble Florilegium musicum, Hirsch. **Telefunken 6.35285**, 2 discs, stereo, \$13.96.

An opera by Telemann? A short comic operetta, rather, in high Baroque style, and set off, for further entertainment, by no less than three complete Baroque concerti, two for solo violin and strings and one for oboe. That's how it was put on in the beginning and it works, too, on records.

In Bach's day, Telemann was the best known of all North German composers and the most cosmopolitan, a musical pan-European if there ever was one. Whereas Bach was a small provincial choirmaster, though well known as an organist. Telemann was the ultimate "pro," a totally competent professional in precisely the sense we use that word for ourselves today—and it is even more remarkable since he was entirely self taught. Not a lesson. Given genius, it happens.

The nearest relatives to this little work that we know are usually somewhat later, ranging from the very similar **La Serva Padrona** by Pergolesi through Haydn's operas and on into the comic Mozart. Most Baroque-period operas now being heard are the big tragedies, on a lavish scale, such as those by Handel. The intimate little farces, though, were just as important. This one, like Pergolesi's, has just two characters, in the classic situation—the fussy, middle aged rich man, single, and his demure, lovely, calculating little housekeeper. You can guess the plot. He's after her; she is coy but has her net set—for the money. She gets her man and is he sorry. This is not a feminist opera. Under the hilarious outward charm is a very sardonic viewpoint.

A delightful performance, lively, intense, beautifully sung and acted (vocally speaking). The little housekeeper is the classic type, Susanna of the Mozart and Rossini operas, cute as all get out and with a voice that is heavenly-accurate and sharp as a cricket. Few singers could even approach this highly ornamented music, let alone give it style, as she does. As

for *him*, he sounds exactly as he must have looked, seedy, middle aged, the pot belly and double chin all too evident, the slightly undignified lust barely concealed. But this *is*, of course, done purely via the singing voice. (He doesn't look the part at all in his photo.) Superb job. And such a sparkle of wit and intensity between the two! Once you adjust to the sound of the singing you can't help but be happy.



A curiously Baroque habit, as of Hamburg's opera at the time, is followed faithfully here—the recitatives, the musical conversation, are done in German, even rather slangy German; but the arias, solo and duet, are entirely in Italian—except when the going gets thick; then the two of them lapse back into German. Very human in an odd way. All of this is set forth, with translations, in the booklet that comes with the opera, so you will have no trouble in following the sense of things—if, indeed, you bother; the acting-singing really tells you all you

need. And the intervening concerti are the perfect foil for the vocal music, giving that instrumental sense of rest which you will want, before going on with the vocal plot. A splendid recording.

Anne Diener Giles and Allen Giles play Music for Flute, Harpsichord and Piano! (Quantz, Dutilleux, Müller-Zurich.)

Crystal S 312, stereo, \$6.98.

Eberley and Skowronski — Separate but Equal: Helen-Kay Eberley, sopr., Vincent Skowronski, violin; Donald Isaak, piano.

Eb-Sko Productions 1001, stereo, \$6.98 (1726 1/2 Sherman Av., Evanston, Ill. 60201).

Two husband-wife musical teams on these two discs (one team employing a third musician as accompanist) and the two discs make an interesting contrast.

Eberley and Skowronski, violin and soprano, have incorporated themselves and put out their own disc, for sale at their own music store, see above address, if you don't find it elsewhere. One side goes to him, the other to her—hence the title. These are two highly professional musicians in their own fields, both with excellent ears and a good dramatic sense for resulting good pitch and recorded drama. But they share (not surprisingly) a common professional attitude; each treats his or her "instrument" for itself, choosing recital music that best suits its expression, and thus on both sides, the music is subservient to the medium. On both, this leads to unfortunate stylistic lacks—everything tends to sound the same. Very good violin, very good singing, but unequal as far as the composers themselves are concerned.

Thus, Skowronski on side 1 plays a very unsuitable 18th century French Baroque manner—that is, for those who know that type of music—using a piano instead of the proper harpsichord, playing many a wrongly turned ornament, and so on. Not good Leclair! But the Ravel (*Pavane*) and Szymanowski, both early 20th century, are excellent. *His* style, definitely. On the flip, Mrs. S. (Eberley) sings a tepid Mozart but puts out

some powerful Richard Strauss in a grand big voice—that's *her* style. Her lves and Walton, too, are archly humorous in the proper current-day manner.

The other team, the two Giles, she on flute, he on piano and harpsichord, offer a model of the good recital on discs for the general listener. These two not only play very well—*what a superb flute!*—and are gorgeously recorded, but they move knowledgeably and imaginatively from the 18th century North-German Quantz (with harpsichord) straight into 20th century French/Swiss, playing both types of music with convincing style. On records this is surely the better approach, though there will always be a demand for recital material such as that offered by Eberley and Skowronski.

Bach: Art of the Fugue. Academy of St. Martin-in-the-Fields, Marriner. Philips 6747 172 (2 discs), stereo, \$15.96.

The Art of the Fugue is indeed all fugues, from beginning to end. But more to the point, in our day, it isn't composed "for" any instrument at all.

It was left simply as so many notes on paper, abstract, representing pitches (relative to each other) and duration (relative). Not a thing more. Thus the big piece is an abstraction to end all (musical) abstractions, and so it has remained for well over 200 years. For engineers and, especially, mathematicians, this should offer no great mental hazard, since it's no worse than Ohm's Law. But for a lot of music lovers, the idea of a piece of music existing in a sonic vacuum is perplexing. It shouldn't be.

Because, like most abstract concepts, this one can be realized—and in various alternative ways. Miraculously, when the printed notes are indeed made into actual sound, to reflect the above mentioned pitches and durations, we hear real music. All that is necessary is to provide the sonics—and for that a sense of musical history is useful in a practical fashion. As in this recording, we find today that the appropriate and satisfactory thing to do is to fix things up as Bach might have done in his time, with instruments of his day. For Bach, like Einstein, lived in his own period and thought in its terms, even in the abstract.

Here is the modern result. Not too long ago, the *Art* was often realized into updated sound, for huge orchestra, vast organ, and piano. Here, we find the harpsichord, a good old-type organ, a solo "chamber" group of strings, and a few winds. This could almost be a recital such as Bach himself might have put on—or more likely, excerpts from several such recitals. There is plenty of tonal variety, to make the music interesting for the ear, but not a trace of anachronistic "modernizing"; each piece sticks with its own instrumental sound throughout, as was normal in Bach's day. Solo harpsichord, solo organ, assorted combinations of the other instruments, only occasionally the whole array in orchestral ensemble. Excellent realization.

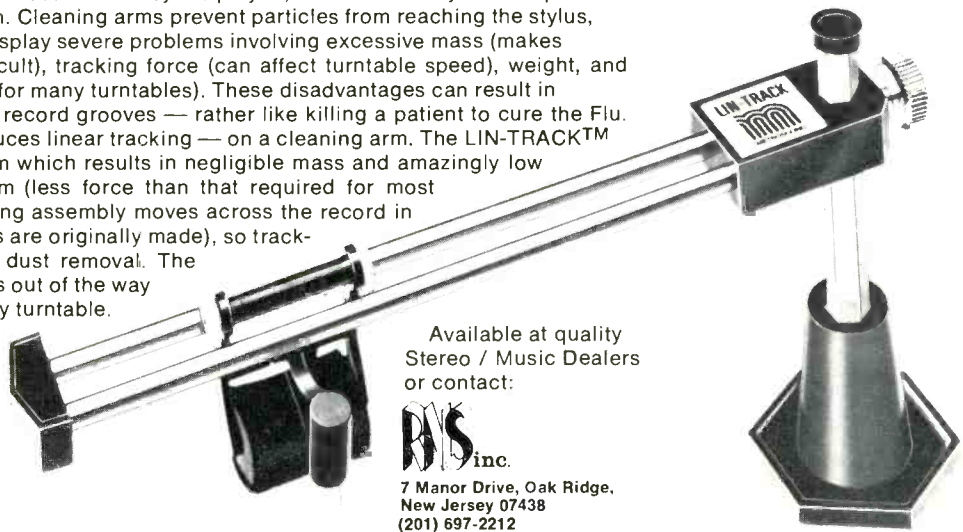
The sound on Philips discs is lovely, the playing highly musical, the tempi uneccentric, neither too fast nor too slow, the unfolding of the elaborate developments of the simple eight-note basic idea is carried through without false dramatics, in the clearest imaginable fashion. There are many other realizations of this big work on records and no two are the same, but this seems to me the best bet so far.

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Jazz & blues



82

Soprano Sax: Zoot Sims.

Musicians: Sims, soprano sax; Ray Bryant, piano; George Mraz, bass; Grady Tate, drums.

Songs: *Someday Sweetheart, Moonlight in Vermont, Wrap Your Troubles in Dreams, Bloos for Louise, Willow Weep for Me, Wrap up, Ghost of a Chance, Baubles, Bangles and Beads.*

Pablo 2310-770, stereo, \$6.98.

The soprano is the most demanding and treacherous of saxophones. Sims began to play it in 1972 and now handles it with the ease and mastery he has so long brought to the more flexible tenor. We've had samples of it on record before, but never a whole album's worth; here, Zoot establishes himself as one of the major soprano players in jazz.

Conceptually, there is no great difference between his soprano and tenor playing, as both have the same spontaneous flow of swinging and joyful musicality. But the soprano sound is entirely different, and hear-

ing Zoot anew, in a sense, makes one realize that this remarkable musician is too often taken for granted, perhaps because what he does seems so easy, unforced, and natural.

Until John Coltrane picked it up, the jazz soprano had been almost the exclusive domain of the immortal Sidney Bechet, who played it with a huge vibrato and the romantic gusto of an opera singer. Johnny Hodges refined Bechet's methods, but gave up the instrument too soon; much later, Bob Wilber—like Hodges, a Bechet pupil—followed in his footsteps with admirable results. Kenny Davern, Wilber's partner in the group Soprano Summit, is another notable practitioner in the classic tradition. Tenorist Lucky Thompson, of the modern-mainstream school, brought a cool sound and lucid conception to the horn. In free-form jazz, Steve Lacy predated Coltrane's encounter with the soprano; he alone plays this horn exclusively.

A host of alto and tenor saxophonists adopted the soprano under Coltrane's spell, and it became an accepted and even expected double in the modern jazz saxophonist's arsenal. Most post-Coltrane players, however, employed it in the expressionistic manner of their master, and in an idiom where precise intonation, the instrument's severest problem, was seldom an issue.

Zoot works within a tradition that does demand accurate intonation, and he keeps the horn in perfect control. In terms of precedent, his tone most resembles Thompson's, but it is warmer and more lyrical. It is a pleasing sound, with none of the excessively nasal or braying characteristics sometimes associated with the soprano. If Lester Young had ever played it, this is what he might have sounded like.

Zoot could manage to swing in the context of a Bavarian village band, but this rhythm section is peaches and

cream. Bryant is impressive as soloist and perfect as accompanist; Mraz is supple and musical, with a firm tone and beat, and Tate plays for the cause. The program of standards and blues is well paced, and it is good to hear that grand old tune, *Someday Sweetheart*, once again. Other highlights include a delightful fast blues, *Wrap Up*, and a moving *Ghost of a Chance*. But there are no letdowns on this exceptionally pleasant record of timeless, relaxed jazz.

The sound, as customary in Norman Granz productions, is workmanlike and ungimmicked, though the piano seemed slightly too high in level to these ears. *Dan Morgenstern*
 Sound: B+ Performance: A

Hot Sonatas: Joe Venuti and Earl Hines.

Musicians: Venuti, violin; Hines, piano.

Songs: *Hot Sonatas, She's Funny That Way, The One I Love, Rosetta, Blues In Thirds, C Jam Blues, Easy To Love, Fascinating Rhythm, East of the Sun, Love for Sale, You Can Depend on Me.*

Chiaroscuro CR 145, stereo, \$6.98.

The combination of violin and piano, so well established in classical music, has seldom been explored in jazz. This album, then, is of historic as well as musical significance, doubly so since it brings together two grand old masters of the art for the first time.

The energy and enthusiasm displayed by these septuagenarians is astonishing, as is their unimpaired virtuosity. Hines, who excels when unencumbered by a rhythm section, can be a somewhat overwhelming accompanist, but is marvelously supportive here. Rhythmically, both men are surefooted and compatible. Harmonically, Hines is the more adventurous of the partners, but both are essentially melodic improvisers.

Venuti's phrasing is sometimes sweet, but his pure, light tone insures against the sentimentality that sometimes cloy the work of his most noted disciple, Stephane Grappelli. Without sounding old-fashioned, Venuti's playing retains the affirmative, unproblematic spirit of the 1920's jazz, where he first made his mark. Though he has mellowed, he is still full of mischief. He knows every fiddler's trick there is and has invented a few himself (like the one where he loosens the hair on his bow and wraps it around the violin to achieve his "four string Joe" effect), but his playing isn't trickier; it's sheer magic.

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Hines is also a wizard. His ability to suspend, stretch or compress the beat is breathtaking; sometimes you think he's lost the pulse, but he always lands squarely on "one" again. When he is at the top of his game, as on this album, his work is as fresh and inspired as it was when he set a new standard for jazz piano 50 years ago.

A high level is maintained throughout the nearly 50 minutes of music here, but the peaks occur on *Rosetta*, the churning *C Jam Blues*, the title track (a nearly undisguised *I Got Rhythm* variant), and the splendid *Blues in Thirds*, one of Hine's most attractive compositions, which here becomes the vehicle for more than seven minutes of consummate music-making.

The sound is clean and well balanced, if a bit dry. A superb record.

Dan Morgenstern

Sound: B+ Performance: A+

Echoes of a Friend: McCoy Tyner

Songs: *Naima, Promise, My Favorite Things, The Discovery, Folks.*

Milestone M-9055, stereo, \$6.98.

Perugia: Roland Hanna

Songs: *Take The A Train, I Got It Bad And That Ain't Good, Time Dust Gathered, Perugia, A Child Is Born, Wistful Moment.*

Arista-Freedom 1010, stereo, \$6.98.

The Quintessential: Earl Hines

Songs: *Look at Me, Jive Sugar, I Do It Better At Night, I'll Never Be Alone.*

Chiaroscuro CR 131, stereo, \$6.98.

Striding After Fats: Teddy Wilson

Songs: *Striding After Fats, Blue Turning Grey Over You, Ain't Cha Glad, Blues For Thomas Waller, I've Got A Feelin' I'm Falling, Zonky, Black and Blue, Handful of Keys, Ain't Misbehavin', Squeeze Me, Honeysuckle Rose.*

Black Lion BL 308, stereo, \$6.98.

Solo Piano: Phineas Newborn Jr.

Songs: *Together Again, Serenade In Blue, Where Is The Love, Lorraine's Walk, Willow Weep For Me, Nica's Dream, Goodbye, Flamingo, Live and Love, One For Horace, Bouncing With Bud, Memphis Blues, The Midnight Sun Will Never Set, Out of This World, Giant Steps, Everything I Have Is Yours.*

Atlantic SD 1672, stereo, \$6.98.

The successes of Chick Corea's **Piano Improvisations** and Keith Jarrett's various solo concerts on the ECM label have paved the way for the recent avalanche of solo piano albums. The piano has held its place as one of the most captivating and certainly the most versatile of all solo instruments

because of its capacity to serve as a small orchestra in the hands of a talented performer. Without any accompaniment, the improvising solo pianist is exposed with all his strength and weaknesses, and thus the weaker player has all his weaknesses amplified when left without the concrete support of the rhythm section.

McCoy Tyner's performance on **Echoes of a Friend** leaves little room to argue that he is one of the most overpowering solo pianists. Taken out of the rhythm section, Tyner's statements gather in intensity, becoming fuller and more convincing than before. Because he plays so much piano, some what he says at the keyboard is unintentionally offset by the interplay between other members of the group.

Echoes of a Friend is a tribute to John Coltrane, one of the musical geniuses of our time...of all time. Coltrane's ambitions—the endless musical search upon which embarked—are attributes preserved, extended, and acknowledged in Tyner's playing. Coltrane's legacy served as the fuel that keeps the Tyner universe in motion.

Recording solo piano is a somewhat simpler task than recording groups of any size because each additional player in the studio today generally is provided with at least one additional mike. And more variables make for more errors. By placing one mike in the optimum position at the piano, a quality recording is almost assured—more easily than with a group recording. There is really nothing to drown out a solo pianist, save perhaps the pianist singing his own lines as he plays—a la Erroll Garner or Oscar Peterson, but even that problem is minimized. Thus, over- or under-recording becomes the critical factor in recording solo piano, particularly here since Tyner plays with such boldness in all registers of the piano. His heavy use of dark pedal tones and deep fourth structures all across the bottom register of the keyboard holds the potential for an over-recorded and mushy mess. But, because of the meticulous recording done at Victor Studios in Tokyo during 1972, **Echoes** is a Milestone release of uncompromising quality. **Echoes** is Tyner in the full sense of the word.

Another pianist whose strengths are amplified by a solo piano date is Roland Hanna. His versatility is nearly unequalled, as proven by the moods, emotions, and styles of playing he

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produces in one sitting at the piano. He is a veritable master of quotation and the musical cliché, yet, unlike keyboard artists of lesser stature, his performances are not dependent on these devices. In fact, the fingers of his two hands serve as members of different sections of the orchestra—wholly independent entities producing all kinds of contrapuntal diversions, as on his most recent solo release, *Perugia*.

Roland's understanding of Thad Jones' *A Child Is Born* becomes more profound each time he plays the piece; it's as if *Child* was written by Thad specifically for Hanna.

Roland is one of the very few pianists who, because of his ability to convey moods and ideas, and rhythmically take the audience on a magic carpet ride, can imply the entire rhythm section despite its absence. Such is the case in his Latinesque excursion on *Time Dust Gathered*. The performance is so ingrained with motion and emotion, one doesn't easily realize the rhythm section isn't there.

Perugia was recorded live at the 1974 Montreaux Jazz Festival. While the recording is very crisp—the highs of the piano are of impeccable clari-

ty—these ears detect a very high pitched frequency throughout the recording, the sound some of us hear when a neighbor down the block turns on the TV. My ears are particularly sensitive to such frequencies, even though others may not find *Perugia* marred by this idiosyncrasy.

Perugia is still a fine recording; the music should not be missed. Even with the high frequency stigmata, the quality is superior to Roland's previous solo outing, *Sir Elf* (Choice CRS 1003), on which he gave a sparkling performance, with a lovely rendition of the old classic *Yours is My Heart Alone*. Roland is also a master of stride piano, giving us a fine *Take the A Train*.

However, the stride piano personified is on *The Quintessential* by Earl Hines, who is 30 years Hanna's senior and one of the acclaimed masters of the style. *The Quintessential* is the third in a series on the Chiaroscuro label containing original compositions by Hines. The recording quality succeeds in bringing the listener as close to the performer as possible, save for a live performance. You'll feel like you're sitting right beside the piano in an old cafe, and you can even glance

over Hines' shoulder at the music—four lead sheets are reprinted inside the record jacket. Closing time sees Hines beautifully interpreting the tranquil ballad, *I'll Never Be Alone*.

Teddy Wilson's *Striding After Fats* is another album in the same vein, an excellent showcase for a pianist who made his mark with greats like Benny Goodman, Lionel Hampton, Gene Krupa, et al. Wilson's album deals with standards, in this case by Fats Waller, while Hines' dealt with originals. Two Waller originals I thought should have been included but aren't are *Margie* and *Jitterbug Waltz*. Other than that small nitpick, I cannot say anything negative about either the audio fidelity or the quality of the performance on this disc.

Solo Piano by Phineas Newborn begs repeated listenings, for Newborn, like Oscar Peterson, is a technical phenomenon. He is in full command of his own strong voice and performs everything from *Where Is The Love* to *Giant Steps*. His performance makes one wonder why it has been so long since his last disc, released in the middle 60s. Eric Henry

Sound: A Performance: A

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1971-1976/Did You Hear Me?: Leo Kottke

Capitol ST-11576, stereo, \$6.98.

When an artist leaves a record company after a successful stay, as Leo Kottke has done, a "best of" collection covering that period is standard procedure. Truly a rarity, Kottke's has been done with the artist's full co-operation and participation, including some editing and remixing. The album has a generous 14 cuts with instrumentals and vocal selections. Some of the choices are positively diabolical, like the instrumental break only from *Morning is the Long Way Home*. I mean I could quibble with this selection or that, but since the whole is put together so well, it would just be nitpicking on personal taste.

Leo Kottke is a sensational acoustic guitarist, especially on 12 string. **Did You Hear Me?** is an excellent showcase-introduction to the artist. *M.T.*
Sound: A Presentation: A

Golden Age Jazz Band: Golden Age Jazz Band

Arhoolie 4007, stereo, \$6.98.

The Golden Age Jazz Band is one of many local semi-pro groups who

spend their work-week as bankers, brokers, salesmen, engineers, computer operators, and what-have-you, but record and play weekend gigs to small but enthusiastic audiences.

Banjoist-leader Dick Oxtot, for some years a fixture in the San Francisco Bay area, has recorded with New Orleans veteran George Lewis and blues singer Barbara Dane. Residing in Berkeley, he has organized traditional jazz recording sessions in his home, as well as live concerts in local clubs and halls. Oxtot's band usually features a singer who belts in the Ma Rainey-Bessie Smith urban blues style. In 1963 Janis Joplin cut a number of sides with Oxtot (also available on Arhoolie). On this recording the band is joined by Diane Holmes, who has a big voice which conveys some suggestion of Bessie Smith's timbres, but the majesty that was Bessie's escapes her, as it escapes most white singers who try to recapture her style.

The band makes a brave attempt to evoke Jelly Roll Morton, King Oliver and early Louis Armstrong, but, for the most part, its playing lacks the heat and drive of the original. Only on *Savoy Blues* and *Chattanooga Stomp* is their music touched with the natural, easy flow and swinging gait of its

classic model—Jim Goodwin's cornet is strong and singing, trombonist Bob Mielke is properly soulful and gutty.

Clarinetist Bill Napier is the most consistent player, performing well through the album in the George Lewis style, although lacking in Lewis' soaring fervor. *John Lissner*

Sound: A Performance: B

Your Mind Is On Vacation: Mose Allison

Atlantic SD 1691, stereo, \$6.98.

While this may not be classic Mose Allison, it may be the most relaxed he has ever been on record. His absolutely idiosyncratic style is captured full-bodied, included the Errol Garner-like mumblings Mose makes while he is soloing on piano. About half the record uses a standard Allison piano-bass-drums format, with sax added on two selections and a horn section on five more. Even if some of the material is old stuff, it loses nothing in new clothes.

As I said, **Your Mind** may not be Mose Allison's best-ever album, but as an old musical friend, he's always welcome. *M.T.*

Sound: C Performance: B

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Tom Bingham

Bonaparte's Retreat: The Chieftains
Island ILPS 9432, stereo, \$6.98.

This, The Chieftains' sixth album, is a magnificent achievement. They, along with the Boys of the Lough, are the finest exponents of traditional Irish music around. Chieftains' leader, Paddy Maloney, a brilliant Irish piper and a wonderfully warm soul, produced this album with a combination of love and care, along with grace and dignity. When special effects are called for, he has occasionally added bones or a whole Morris dance troupe. The title track, a sweeping cinematic 15-minute suite, includes a touch of narrative balladry supplied by Dolores Keane. This suite is the Chieftains' finest recorded moment.

What makes the Chieftains even more special is that despite all the hoopla which has surrounded them since the film "Barry Lyndon" used their music, they remain very real people and not stars at all. They remain true to their roots of the Irish land as well as its music. **Bonaparte's Retreat** is a masterpiece.

Michael Tearson

Sound: A Performance: A+



Melting Pots: Susie Monick
Adelphi AD 4107, stereo, \$6.98.

An unexpected joy of an album, **Melting Pots** showcases Susie Monick's often extraordinary banjo expertise in what might best be described as progressive post-bluegrass, and toward that end an eclectic and impressive cast has been brought together.

The Ralph Stanley standard *Clinch Mountain Backstep* features Jeremy Steig and Eddie Gomez on flute and bass for starters. On that cut and through most of the album there is a classy guitar-bass-drums combination of Steve Burgh, Tony Markellis, and Richard Cooks. An exception to this is *Whiskey Before Breakfast* featuring a trio of fraileid banjos in a lovely change of pace. *Devil's Dream/Bluedream* and *Marmalaid* are a fascinating pair. *Devil's Dream* is a very popular fiddle tune, while the latter is a retrograde of the same tune. With *Streptocosmos*,

Susi plays a funky solid body electric banjo. Among others who pitch in their talents on the disc are David Amram, John Hartford, Jay Unger, and Peter Ecklund, plus a number of others including the fabulously pseudonymous Alto Madness. The disc never gets boring.

The cover is a painting of Daliesque melting banjos. The record is a gas—good music, good companionship, and good times all in one handy package.

Michael Tearson

Sound: B+ Performance: B+

Live At The Cellar Door: Seldom Scene

Rebel SLP-1547/48, stereo, two discs, \$10.98.

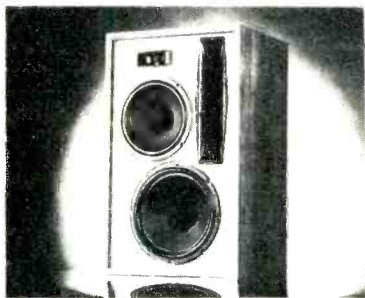
The Seldom Scene are undoubtedly the favorite "Newgrass" band of most bluegrass aficionados, consistently topping the reader polls held by the

major bluegrass publications. Oddly enough, they are almost totally unknown outside their field, but **Live At The Cellar Door** should help to change that.

While not their best album to date—**Act III** deserves that honor—it shows the full range of their versatility and originality, coupled with a sense of humor, and intercommunication with their hometown audience (Washington, D.C.) which is missing from their drier studio recordings. Most importantly, their legendary instrumental prowess—both as individual artists and as a close-knit, cohesive unit—is conclusively proven to be more than studio-controlled perfection, a charge leveled at them by many tradition-oriented bluegrass fans and made plausible by their early aversion to live appearances, hence their name "seldom seen."

The Seldom Scene's musicianship is downright uncanny. Mike Aldridge's

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innovative rip-and-smear dobro lines and Ben Eldridge's mellowed banjo picking sound so effortless, they make these instruments seem like the easiest in the world to master. Mandolinist John Duffey occasionally lets his fingers run away with him, but few of his colleagues can touch him when he's in peak form. Tom Gray is the bluegrass bassist. The group's solo breaks and improvisations are among the most intelligent in bluegrass, with a constant flow of ideas moving together into concise, judicious formations. On the minus side there's a bit of "show-boating" on a few tracks which gets tiresome after a few hearings.

The lead vocals by John Starling and John Duffey are closer to contemporary-folk or "uptown" country music than to bluegrass, and this impression is reinforced by Starling's fondness for mid-to-slow tempos and reflective lyrics. Their harmony on vocals are similarly restrained and attractive.

The dobro is beautifully miked so that Auldridge's incredible precision is left naked for all to hear. The other instruments are all cleanly recorded with the exception of the bass, which is slightly muddy and mixed too loudly for my taste. Until recently Rebel consistently pressed on the crunchiest vinyl available, but now these surfaces are only intermittently noisy and quite acceptable overall.

Records can be obtained through Rebel Recording Co., Rt. 12, Asbury, W. Va. 24916.

Sound: C+ Performance: A-

Buddy Emmons Sings Bob Wills: Buddy Emmons
Flying Fish 017, stereo, \$6.98.

Buddy Emmons does what? Sings? But why not? True, he made his reputation as an innovative country/jazz steel guitarist and as an instrument-maker whose revolutionary concepts have proven to be major advances in the continuing evolution of the pedal steel guitar. But that doesn't automatically rule out the possibility of hidden vocal talent.

Although Emmons' last album (**Steel Guitar**, Flying Fish 007) found him in rock territory (as well as providing a capsule history of the development of the country steel guitar), in Western Swing he's found an idiom at once suited to his steel, his singing, his country roots, and his jazz inclinations. Indeed, Emmons' vocal ability is a very pleasant surprise. He gets right into the spirit of the music, with a tough, blues-edged voice that fits in well with the Western Swing vo-

cal tradition founded by Tommy Duncan and Milton Brown.

But the album is not merely a showcase for Emmons, but a high-flying, no let-up workout on 12 Bob Wills' standards by 11 of the best Western Swing revivalists in the Nashville studios. The rhythm section is superb, with forceful drumming by Karl Himmel alternating with Larrie Londin, some of the most propulsive bass work in recent memory by Henry Strzelecki, and hard-riding hot-piano licks by Pig Robbins (who performed the same role on Bob Wills' late 60s MCA albums). The fiddle and guitar ensembles are intelligently arranged, while the solos and obbligati are flawless and inspired. Trumpeter Don Sheffield is heard on a few tracks, sparking the ensemble on *Deep In The Heart of Texas*, a sure-shot rouser of an album opener, and blowing Dizzy Gillespie-style breaks on *Roley Poley*, with an arrangement extremely close to Wills' boppish 1945 original.

The material is choice and diversified, with both swing tunes, such as *I Needed You* and *New Road Under My Wheels*, along with more purely country ballads (such as *Deep Water* and *If No News Is Good News*) in abundance. *Bottle Baby Boogie* is an r&b-rocker of the type that influenced Bill Haley, who began his career in Western Swing, while *Four, Five Times* comes complete with Cab Calloway-ish vocal jive. There are only two instrumentals, Wills' fiddle specialties are recalled in *Twinkle, Twinkle Little Star* (and don't let that title fool you), also spotlighting Johnny Gimble's electric mandolin, which he played for Wills early in his career, while Herbie Remington's *Boot Heel Drag* is a comfortably mid-tempo steel feature of the 1950s variety.

It's worth noting that Emmons doesn't lean on his current experimental steel approach, but generally reverts to the classic 40s styles of Leon McAuliffe and Noel Boggs. On two tracks, *End of the Line* and *Bottle Baby Boogie*, Johnny Gimble does a Slam Stewart humalong with his fiddle playing. Throughout the album, Leon Rhodes plays some fine mainstream-jazz guitar, *Time Changes Everything* standing out in particular.

The recording is crystal clear—beautifully defined and mixed to the benefit of all. Whether you're a Western Swing fanatic or have never even heard the music, this is one record you shouldn't miss.

Write Flying Fish Records, 3220 N. Halsted, Chicago, IL 60657.

Sound: A- Performance: A

AUDIO • February 1977

Traditional Tunes: Alistair Anderson
Front Hall FHR-08, stereo, \$6.98.

Alistair Anderson caused quite a stir in folk music circles when he made his American television debut on a PBS series from the Philadelphia Folk Festival. He is one of the few exponents of the English Concertina as a virtuoso solo instrument, as it is generally considered too small and simple to be used for anything more than an accompaniment to singing. **Traditional Tunes**, Anderson's first U.S. album, not only lives up to the expectations aroused by his TV appearance but also spotlights his talents on the Northumbrian smallpipes, an instrument rarely heard on this side of the Atlantic Ocean.

Anderson plays the concertina with a jolly lilt that adds an extra sparkle of jauntiness to the already catchy Northumbrian and Scottish dance tunes. The tunes he has chosen are largely unfamiliar—although *Morpeth Rant* is well-known in New England, and *The Musical Priest* was popularized in the U.S. by Horselips—but don't be surprised if you find yourself humming and whistling them before long.

Although I'm not familiar enough with the Northumberland smallpipes to really judge, Anderson's clean, flowing execution on the pipes seem to rival his concertina virtuosity. *Gillean The Drover* is a particularly affecting air. Two selections are double-tracked with smallpipes on the left and the concertina on the right. It's interesting to note that on these cuts the pipes negotiate the faster passages with more agility than the slightly stiffer concertina. *Maggy's Foot* has some unusual rhythmic twists, while *If Love Doesn't Bother You* has a very Medieval sound, the result of a unique blend of timbres on a haunting air.

Although the solo concertina performances prove that Anderson doesn't need any accompaniment, the addition of Bill Spence on hammered dulcimer and guitar, and/or pianist Toby Frank (both of Fenig's All-Star String Band) on several tracks adds both variety and musical interest. Fink's strong New England-style rhythm piano helps spark *Random Notes* and the set of three 9/8 jigs which opens side two. Spence's dulcimer merges effectively with the concertina on *The Last of The Twins* and *Swalwell Lasses*, while his guitar helps to establish a contagious dance beat on *Sheehan's Ree!*/*The Dawn*.

Two concertina tunes deserve special mention. *The Strenuous Life* is a

Scott Joplin rag played on a lower pitched, tenor-treble concertina—the instrument heard on the rest of the album is a treble concertina—which has a reed organ sound and catches the period flavor of the piece. *Bill Charlton's Fancy* is a clever little ditty with a repeated melody and ever-more complex ornamentation.

All instruments are clearly recorded and judiciously mixed. The balance of the smallpipes and concertina on the double-tracked selections is so well done, one would hardly guess the artificial nature of the performances. Available from Front Hall Records, RD1, Wormer Rd., Voorheesville, NY 12186.

Sound: A — Performance: A

Back In The Swing of Things: Hank Thompson
ABC/Dot DOSD-2060, stereo, \$5.98.

Hank Thompson was the last of the great Western Swing bandleaders. Emerging almost 30 years ago, he hit his peak in the mid-50s—by this time, Western Swing was already fading into oblivion, yet Thompson remained a major country star throughout the 60s. Though he's continued to record steadily during the 70s, he hasn't had a major hit since *Smokey The Bar*, about seven years ago.

Thus the current Western Swing revival is made to order for Hank Thompson. Still in his early 50s and very active as a popular club entertainer, he's far from an over-the-hill relic of a once-glorious past, but a polished performer who has maintained his old verve and virile swagger intact while waiting for his music to come back into vogue.

What this means is that **Back In The Swing of Things** could easily have been a classic. Although it comes close at times, some poorly chosen material prevents this album from fulfilling its potential. What could anyone do with *Three Little Swigs* ("from a bottle of gin"), with its references to big bad wolves and chinny-chinchins? Similarly, *Another Shot of Toddy* has mock-hillbilly lyrics which are almost too broad for "Hee-Haw"! At least *Play For Me One Polka* makes up for its corny scenario with a top-notch arrangement including a pizzicato fiddle break.

These tracks aside, the rest of the album is excellent. Honky-tonk-flavored songs like *Forgive Me* and *Annie Over* are combined with a light, swing-inspired bounce, a precision-drilled, four-fiddle section, and

Thompson's smooth, distinctive vocal phrasing. The result is a less blues-oriented, less improvisatory, more sentimental brand of Western Swing than in previous decades. Country tear-jerkers of the type pioneered by Floyd Tillman are especially suited to the Hank Thompson approach, as *I'll Sign My Heart Away* and *Yesterday's Girl* will demonstrate. Personally, I would have preferred a few more up-tempo swingers, such as Joe Allen's *Big Band Days* and *Hangover Tavern*, the latter featuring double steel guitar trade-offs by Curley Chalker and Bob White.

Producer-arranger Tommy Allsup has hired some of the finest Western Swing musicians currently active for this session, including ex-Bob Wills fiddlers Johnny Gimble and Keith Coleman. While the band's contribution is felt throughout, the players should have been given more space to stretch out. At a total playing time of 28 minutes, there certainly was more room for instrumental solos.

Though the original tracks were well-recorded, someone decided to mix Thompson's singing too loudly at the expense of the fiddles. Thompson's rich, sharp-edged baritone has lowered somewhat over the years; apparently it was felt his upper register needed a slight boost, resulting in a treble echo in spots.

Sound: B — Performance: B+

King of Stride: Joe Turner
Chiaroscuro CR 147, stereo, \$6.98.

As the title indicates, this is pianist Joe Turner, not the Kansas City blues shouter of the same name.

This Joe Turner has been widely touted as the "last of the great stride pianists." But Turner is not just a stride pianist, he is primarily a jazz melodist, always maintaining the original line upfront, but dressing it up with strong bass patterns, upper-register chords and fills, expansive runs, and auxiliary notes and phrases of varying description. In this sense, the stride bass patterns become just one of many means (albeit the most prominent one) by which Turner explores the implications of a melody.

Turner's favorite approach is to play the first chorus out of tempo, then proceed to fall into a rollicking stride bass rhythm. Unfortunately, when he applies the pumping-bass routine to inappropriate tunes like *Emaline*, *I Know That You Know*, and *Cocktails For Two*, the results may be technically dazzling, but they're too far-fetched to hold up under repeated lis-

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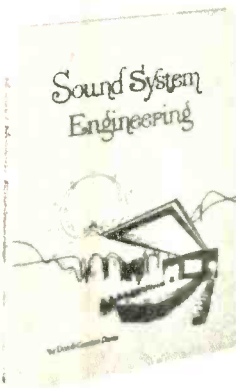
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tening. Turner is much more impressive when he either steers clear of stride—as on *The Gypsy*, *Effervescence* (a Fats Waller novelty rag), and his blues originals, *The Cookery and Blues For Barney*—or treats it lightly, as on *The Moon Is Low*, *Love Me*, and a Tatumesque *Body and Soul*. Still, *Taboo* and *The Ladder* show that when the occasion calls for it, Joe Turner can stride with the best.

Several of Chiaroscuro's early releases suffered from a tightly restricted piano sound. There is no such problem here, with a wide-ranging, full-bodied sound equal to Turner's two-fisted keyboard style. However, numerous ticks and scratches are intermittently disturbing.

Tom Bingham

Sound: B+ Performance: A-

Ain't It Good To Have It All: Jim & Ginger

ABC ABCD-938, stereo, \$6.98.

I guess now that the Captain and Tenille are big bucks with sappy songs, imitators had to come along. Jim & Ginger are just a little more country, that's all. *Michael Tearson*

Sound: C Performance: C-

Mark Twang: John Hartford
Flying Fish 020, stereo, \$6.98.

Since his last album for a major label about three years ago, John Hartford has been an itinerant musician of the first caliber, honing his act into one of the most individual and engaging anywhere. He's totally at ease either on fiddle or banjo, occasionally slipping into extraordinary hambone and mouth noises with special attention to his tapping right foot.

Mark Twang is an excellent studio record of just what Hartford is live. Nothing is lost playing without an audience, a remarkable feat. The set includes some solid songs like *Skipping in the Mississippi Dew* and the sage *Don't Leave Your Records in the Sun*, some silliness, and a banjo showcase in *Austin Minor Symphony*.

Throughout his changes, Hartford is immediate and warm and seemingly well recorded. However, in the liner notes Hartford notes the engineer's insistence on including the disclaimer, "The seeming technical imperfections in this record which may be indiscernable to the listener were included at the request of the artist." He was right. I really didn't notice.

M.T

Sound: A- Performance: B-

Theater music

Donald M. Spoto

Così fan tutte: Mozart (English Version). A Metropolitan Opera Association Production conducted by Fritz Stiedry.

Singers: Thebom, Peters, Tucker, Guarrea, Alvary, Steber.

Odyssey Y3 32670 (3 discs), mono, \$8.98.

In his biography of Mozart, W.J. Turner called **Così fan tutte** "a masterpiece alone and unequalled in the history of art," a tender comic opera that is also a "terrifying work" that shows "the unexpectedness of one's own natural behavior." Whether one agrees with Turner's extravagant praise or not—I count myself on his side—the work, finished one year before the composer's death, constantly amazes with its uncontrived complexities, its gentle richness and overwhelming lyricism, its total distance from every musical and psychological cliché. And although the story is, from a merely realistic point of view, quite impossible (name one libretto that is possible; few of them, if any, are, thank heavens ... but that's another issue), it is surely not a "despised plot" (thus Bernard Shaw).

During the late 40s and early 50s, the Metropolitan Opera recorded more than a half dozen complete operas featuring its "original casts," orchestra, and conductors. **Così** was among them. Like several others, it was performed in English for a time (that custom is, happily, now *démode*), and Columbia recorded it. It is now rereleased—presumably to help the debt-ridden Met, as much as Columbia—on the company's Odyssey label. There are assets and liabilities to this version, but I think it will serve the unfinicky, and especially the novice, quite well. In any case, it deserves more than passing interest in the history of opera discs.

First, the liabilities. There's a whopping technical error: the usual structure of sides 1 and 6, 2 and 5, 3 and 4

has been oddly modified in the final pressing, and the labels and liner notes contradict the final reality. Side 1 is backed by side 5, and the concluding side 6 is the obverse of side 2. Let the unprepared beware; let those with automatic changers take notice. And if future sets are issued, one hopes at least the labels will be put to right.

Also, there are unfortunate cuts. **Così** is a long opera; even with negligible cuts, it needs four complete discs. To reduce it to three is to invite discontinuity, omission of important passages—a truncated version, indeed. That's what happens here. Re-

citatives are lopped off like so many unnecessary appendages (which they never are in Mozart); Ferrando's second act cavatina *Tradita, schernita* disappears, as does Dorabella's aria *E amore un ladroncello*. Many ensemble numbers sound as if the singers were being rushed (as they must surely have been), and the pace too often becomes breathless rather than lively.

But it's not all bad. Conductor Fritz Stiedry elicited some wondrously crisp, balanced sounds from the Metropolitan orchestra, and the singers, some of them still active today, are here preserved at the top of their form. Eleanor Steber's Fiordiligi will never match Schwarzkopf's, and Blanche Thebom's Dorabella does not have the dark, rich quality of Christa Ludwig in the role, but they are fine in their own way. In 1952 (the year of this recording), Steber could float a lovely pianissimo high E, dip more than an octave in the same breath and convey real emotion. (Her *Vanessa* five years later is also noteworthy, dramatically effective, in a different way altogether, dark, undulating and proper for that curious character.) Blanche Thebom understands Dorabella and is perhaps the best acting singer here. You can see her hesitate when her sister asks her which of the "imposters" she will trust with, and she rightly stumbles before her "No, you decide, dear sister." Richard Tucker was beginning to be a really heroic tenor; his Ferrando is finely nuanced and solidly delivered. Frank Guarrera and Lorenzo Alvary are strong and clear as Guglielmo and Don Alfonso, respectively, and the young Roberta Peters is simply delightful as the maid Despina. Flippant when she should be, Peters also produces a roundly comic alto as the disguised "doctor" come to "cure" the masked lovers who have feigned poisoning. Later, as a Despina-turned-notary, she's really quite funny.

Richard Tucker



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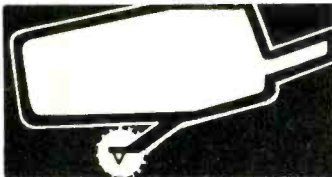
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There are some very fine ensembles, too: that sublimely beautiful *Soave sia il vento* terzetto in act one is movingly, languidly sung; the first act finale is frothily engaging; and the overture states themes quite precisely.

This English version is one of Ruth and Thomas Martin's better translations, and although I'm opposed to these in principle, I must admit it's faithful to the spirit and sense, not slavishly literal or cutesy modern—it doesn't strain for the easy quip.

So here you have a rereleased *Così fan tutte* that is interesting as an historical curiosity, and would be a good introduction for students or novices in the world of opera. They should all, however, eventually graduate to the 1962 Boehm-Schwarzkopf-Ludwig version on the Angel label, which also numbers the discs correctly.

André Kostelanetz Plays A Chorus Line, Treemonisha and Chicago.
Columbia KC 33954, stereo, \$5.98.

Whaddya mean "plays..."? There are two—count 'em, two—orchestral renditions from Treemonisha, and two from Chicago. (The notes claim he "adds a special bonus with another of Joplin's best known melodies." Some planning!) The other side has five from the outrageously overpraised *A Chorus Line*. And they all sound alike. That pretty, dull, Muzak-like Kostelanetz sound—the sort of thing that Fiedler and the Pops pulls off with more dash. I suppose this is music to do something else by. Anything but listen. But then, after all, Marvin Hamlisch (composer of *Chorus Line*) gives Sominex a run for its money.

The Private Lives of Elizabeth and Essex: The Classic Film Scores of Erich Wolfgang Korngold.
RCA Red Seal.

This is an odd hemi-album: it contains only 3 scores that are not represented in LSC-3330, another Korngold album (*The Sea Hawk* and others). RCA might have been well advised to issue instead a 2-disc set to include more of each and others not here, rather than opt for needless repetition.

Korngold wrote music for Hollywood for a quarter century, and, with Max Steiner, Franz Waxman and others, made film music an entity of itself. His overture to *The Private Lives of Elizabeth and Essex* was composed for the Beverly Hills world premiere in 1939 and has not been heard since. It

AUDIO • February 1977

is a lovely pastiche, really: a delicate sentimentality pervades the whole, and while it is self-consciously soundtrack music, is provocative rather than dominantly descriptive. Bette Davis and Errol Flynn were properly served by Korngold's rich score.

The Prince and the Pauper (1937) is a less impressive score, in spite of its almost unintentional symphonic structure. But the love theme from *Anthony Adverse* is an interesting string exercise (although I do not think it suggests the film's largeness or emotional spread). The music for *The Sea Wolf* is perhaps Korngold's most intriguing score. The subtle psychologies of Jack London's deceptively simple tale of Wolf Larsen, stern captain of the *Ghost*, were woven by Korngold into a musically arresting portrait. His use of the harmonica with a full symphony orchestra is neither gimmickry nor iconoclasm—it works well as the xylophone in the love scene. Only the hyperglittering finale disappoints. The *Cello Concerto in C*, opus 37, is a 12-minute expansion of the sections of surprisingly modern music for *Deception* (1946). From the opening allegro through the adagio and closing fugato, the score is richly inventive and should be heard more often independently.

The album also contains a suite from *Another Dawn* and *Of Human Bondage*. All are newly recorded by Charles Gerhardt and the National Philharmonic Orchestra, whatever that is.

Lucky Lady: Original Soundtrack Recording. Music by Ralph Burns and others.

Arista AL 4069, \$6.98.

It's pertinent, in discussing this soundtrack recording, to raise the old question of whether a musical score for stage or screen should stand (or fall) on its own; whether a prior viewing is necessary before one can fully appreciate or roundly excoriate. I recall, back in the fifties, that the issue was jejune with regard to *My Fair Lady*; those who'd seen the show loved the album—those who hadn't rushed to the Mark Hellinger in New York. But that was a Broadway show. Movies raise different reactions.

Lucky Lady had, if I remember correctly, a lukewarm reception. This album would certainly not encourage me to see the movie, poorly pressed, heavily scratched and wobbly, badly edited from the track. And the songs—apart from one or two old-

ie/goodies—are of a banality that is monumental. Liza Minnelli is quite delicious doing *While the Getting Is Good*, which has a nice bouncy flavor to it and conveys her own proper churlishness at this sort of stuff. The title song, on the other hand, is forgettably unmelodic (doesn't composer Burns know anything about syncope as an occasional device?). Burt Reynolds (do you believe that?) wanders through a one-minute version of

the Waller/Razaff *Ain't Misbehavin'*, which is a misbehavin' disaster. We never do hear Gene Hackman, the film's third star.

What is terribly interesting is the selection of old cuts: Bessie Smith crooning the *Young Woman Blues* and *Hot Time in the Old Town Tonight*. Sad, tired old Bessie. Her way still works, after all these years. I would have loved to have seen her in person. She graces this flaccid disc.

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The announcement that The Audio Critic would be coming in January created a response beyond all expectations. Subscriptions started to pour in as early as mid-September.

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Shorter but equally interesting articles on speakers, tonearms and other equipment are also in the same issue.

The press run of The Audio Critic is, for the moment, still limited.

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WANTED: SQ full logic decoder and Technics SH-405 demodulator at reasonable price. Robert Guerin, 7125 Gail Way, Fair Oaks, Ca. 95628.

WANTED TO BUY, Altec Lansing 415-A biflex speaker. Write, Chappie Anderson, Box 546, Hollandale, Miss. 38748.

MCINTOSH MC-3500 power amplifiers. Charles Kappesser, 101 Earl Avenue, Syracuse, NY. 13211, 315-455-1563.

ALTEC 604B Co-ax, 16 ohm. B. Fischer, 22 Joycroft Rd., Waterbury, CT 06708

WANTED - KENWOOD Model-550 tube type F.M. stereo. Tuner, no scratches, will repair electronics. Samuel Clark, R #1, Box 16, Cornersville, Tenn. 37047

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WANTED: ALTEC 729A stereo equalizer. Ph. 204-943-8820. Write 1814 - 411 Cumberland, Winnipeg, Manitoba, Canada

QUAD electrostatic speakers (any condition), electronics (including Model II). Mention lowest price. DMS, 1360 Lake Shore, No. 2202, Chicago, IL 60610

MARANTZ 7C and 2 J. Fong, 1238 Green St., San Francisco, CA 94109.

INFINITY Monolumina or similar laser light show. Call (213) 376-8451 collect

WANTED: WHARFEDALE 70 speaker, state condition and price. E. Galloway, 714 Stadium Place, Logansport, Ind. 46947

WANTED: McIntosh 50W2, 20W2, MC-40, MC-3500, C-11, MI-2, G-101, Marantz 1C, 6, 3, 4, JBL SE 400S, SA660, Les Gueydan Jr. P.O. Box 455 Metairie, LA 70004 1-504-831-3190 from 6 to 10 P.M. CST.

WANTED: TASCAM 4 OR 8-TRACK 1/2" recorder with 501 or 701 electronics (and model 10 consoles & modules.) Wanted: Revox 1/2 track 1/4" recorder, 15 IPS, SEL sync. V. Bond, Box 2159, Winnipeg, Manitoba, Canada R3C 3R2 (204) 888-6099

WANTED: CASSETTE & cartridge tape decks manufactured by Akai, model GXC-390. Audio Box A72-2

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The Revolutionary

Wow & flutter: .04%*. Signal/noise ratio: 62 dB.**

Introducing the incredible Elcaset system. Developed by Sony to bring you unsurpassed cassette sound.

- 1.** The Elcaset tape is as wide as reel-to-reel tape: 1/4"
- 2.** Tape moves twice as fast: 3 3/4 ips. Result: the widest dynamic range, the widest frequency response, the cleanest sound ever offered in a cassette format. Unlike the standard cassette, the Sony Elcaset sound is not compressed, constrained. It's expansive and full. It "breathes." It's true high fidelity.
- 3.** The tape is lifted out from the cassette and guided across the heads by a stabilizing pin in the deck

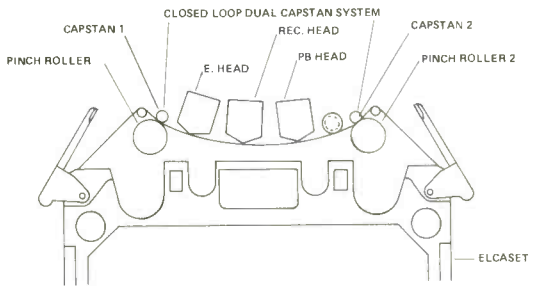
itself — just as in reel-to-reel.

Result: lowest wow and flutter, superior tape/head alignment, even better frequency response. (See diagram).

- 4.** All-new tape formulation with thicker oxide coating and thicker polyester for highest quality sound.

- 5.** Automatic tape formulation adjustment. Small holes encoded on the cassette case "tell" the Elcaset deck what type of tape is being used (SLH, FeCr). The Elcaset then automatically adjusts both bias and EQ for optimum performance.

Tape (Actual Size)



Sony Elcaset System

Frequency response: 25 Hz-22 kHz, ± 3 dB***

An engineering triumph, the Sony EL-7 Stereo Elcaset Deck was designed exclusively for the new Elcaset tape.

1. Closed-loop dual capstan tape drive. One of the most advanced tape drive systems now available, it assures constant tape-to-head contact pressure, low wow and flutter and virtually nonexistent modulation noise.

2. The 3-motor system starts with a DC servo motor for utmost reliability. A sophisticated feedback circuit corrects for line voltage fluctuations, and other speed-altering factors. This is the finest tape recorder motor system money can buy. Proof? Wow and flutter of only .04%.

3. Sony's 3-head system offers the most precise tape/head alignment possible. All three heads are made of ferrite and ferrite—a super-strong formulation that lasts up to 200 times longer than standard perm-alloy. Head surfaces are mirror-smooth for friction-free tape travel and optimum tape/head contact. Incredibly close tolerances in the head gap assure widest frequency response.

4. Direct coupling of playback head with the FET first-stage reproduction amplifier significantly reduces distortion, improves signal/noise ratio and frequency response linearity.

Also available: The Sony EL-5 Stereo Elcaset Deck. Includes many of the same high performance features of the Sony EL-7, at a lower price.

Deck

Brought to you by

SUPERSCOPE



Memory tape counter provides automatic sequential rewind and playback immediately after recording from a specific spot on the tape.

Timer activating capability, in conjunction with an external timer, turns on/off playback or record mode unattended.

Illuminated "feather-touch" solenoid operation. Logic-controlled system allows instantaneous mode change, bypassing stop.

Air-cushion eject slowly, softly opens tape compartment door, thus minimizing wear on eject system.

Dolby Noise Reduction System includes 25 μ S de-emphasis circuit for Dolby FM, as well as controls for standard Dolby applications.

*WRMS **FeCr tape, Dolby****out. ***FeCr tape. ****TM Dolby Labs, Inc. (Source: Sony Corp.)

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Both of these decks will improve the sound of your cassettes. One even improves your tuner.

Introducing the RS-671AUS and the RS-677US with Dolby[®] FM. Both decks will dramatically improve the sound of your cassettes. But with the RS-677US you'll also get a dramatic improvement in the sound of your tuner. Like a quieter FM S/N ratio. Increased dynamic range. Even better FM reception.

And to improve the sound of your cassettes both units employ a two-motor drive system. Including an electronically controlled DC motor used exclusively for capstan drive. The results: 0.075% (WRMS) wow and flutter for the RS-671AUS. And 0.07% (WRMS) for the RS-677US.

You also get a quiet S/N ratio of -65dB (CrO₂ tape, above 5kHz). As well as lower distortion and excellent transient response. The reasons: A Technics low-noise pre-amplifier. Selected low-noise transistors. And Dolby.

And both decks also give you an extremely wide frequency response of 30 Hz — 17kHz

(CrO₂ tape). Thanks to the exceptionally narrow gap of our patented HPF heads.

You'll also get quiet, highly accurate recordings, with plenty of dynamic range, because both decks have peak check VU meters. So you can precisely set recording levels for the barest minimum of overload distortion, especially when recording from live sources.

Both decks have memory rewind. Fast-acting silent electronic switching. A lockable pause control. Mike/line mixing. A CrO₂ tape selector. And with the RS-671AUS, you'll get selectors for high and low bias. And with the RS-677US, memory play and solenoid activated remote control.

So when you're ready to improve your system, the RS-671AUS and the RS-677US are ready for you.

*Dolby is a trademark of Dolby Laboratories, Inc. Cabinetry is simulated wood.



Solenoid Remote Control.

Technics by Panasonic

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