

Audio

The
Authoritative
Magazine
About
High Fidelity

**PIONEER
F-9 TUNER**

AUGUST 1981 • \$1.50 • © 06030

**MEASURING
SPEAKER
MOTION WITH
A LASER**

**HIGH-
PERFORMANCE
THD ANALYZER**

Part Two

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THIS YEAR, PIONEER DISCOVERED A NEW ART.



Pioneer goes beyond state of the art electronics to make a major new contribution in human engineering.

In the past 40 years Pioneer has made countless contributions to the state of the art in High Fidelity. Now Pioneer is introducing new components that actually restate the art. We call it High Fidelity for Humans.

This year to a list of audible innovations and incredible specifications we have added human engineering features that give the owner of our equipment a new ability to control it and the quality of the sound it produces.

For example, Pioneer's new CT-9R, three direct drive motor Cassette Deck has a Time Remaining Counter with a digital readout that shows you how much recording time is left on a tape. So you won't run out of tape before running out of music. There's also an Index Scan feature that previews a tape by playing the first five seconds of each piece of music.

And to give the CT-9R an incredible signal-to-noise ratio with extended high frequency response, Pioneer's engineers developed RIB-BON SENDUST tape heads with laminations 4 to 5 times thinner than conventional Sendust heads. And only Pioneer has them.

Our new Quartz Synthesized F-9 Tuner has a Multipath Indicator that goes so far as to tell you when a signal is being reflected off nearby objects or buildings. So you can adjust

your antenna for the best reception. It can also memorize six of your favorite FM and six AM stations and retrieve them instantly. And to make sure every one always sounds its best, our engineers combined two of our exclusive ID MOSFET transistors in a Push-Pull Front End circuit. When you tune in a weak station there's no worry about stronger stations causing distortion

Pioneer's new components bring tangible as well as audible advances to high fidelity.



due to front end overload. And Quartz-PLL Synthesized tuning makes drift impossible.

Unique features on the new Pioneer A-9 Integrated Amp include a Subsonic Indicator. It lights up only when you need to use the Subsonic Filter to get rid of very low frequency interference caused by record warps and such. Inside, a new DC Servo circuit eliminates all capacitors from the signal path so they can't muddy up the signal.

That gives you a purer signal with superb definition.

Pioneer's SX-7 Receiver brings you precise electronic control of most functions including volume. The Auto Station Scan control pre-



views the entire band and eight FM and eight AM Memory Presets recall the stations you prefer instantly. What's more, Pioneer's patented Non-Switching amp does away with one of the most troublesome and audible forms of distortion—the noise generated when output transistors switch on and off thousands of times a second.

Our new top-of-the-line turntable, the Linear Tracking PL-L800 is another feat of human engineering. It features a linear motor that drives the tonearm across the track by electromagnetic repulsion—another Pioneer innovation. So it's extraordinarily quiet with no noisy belts, worm gears or pulleys and tracking error is virtually non-existent. The tonearm

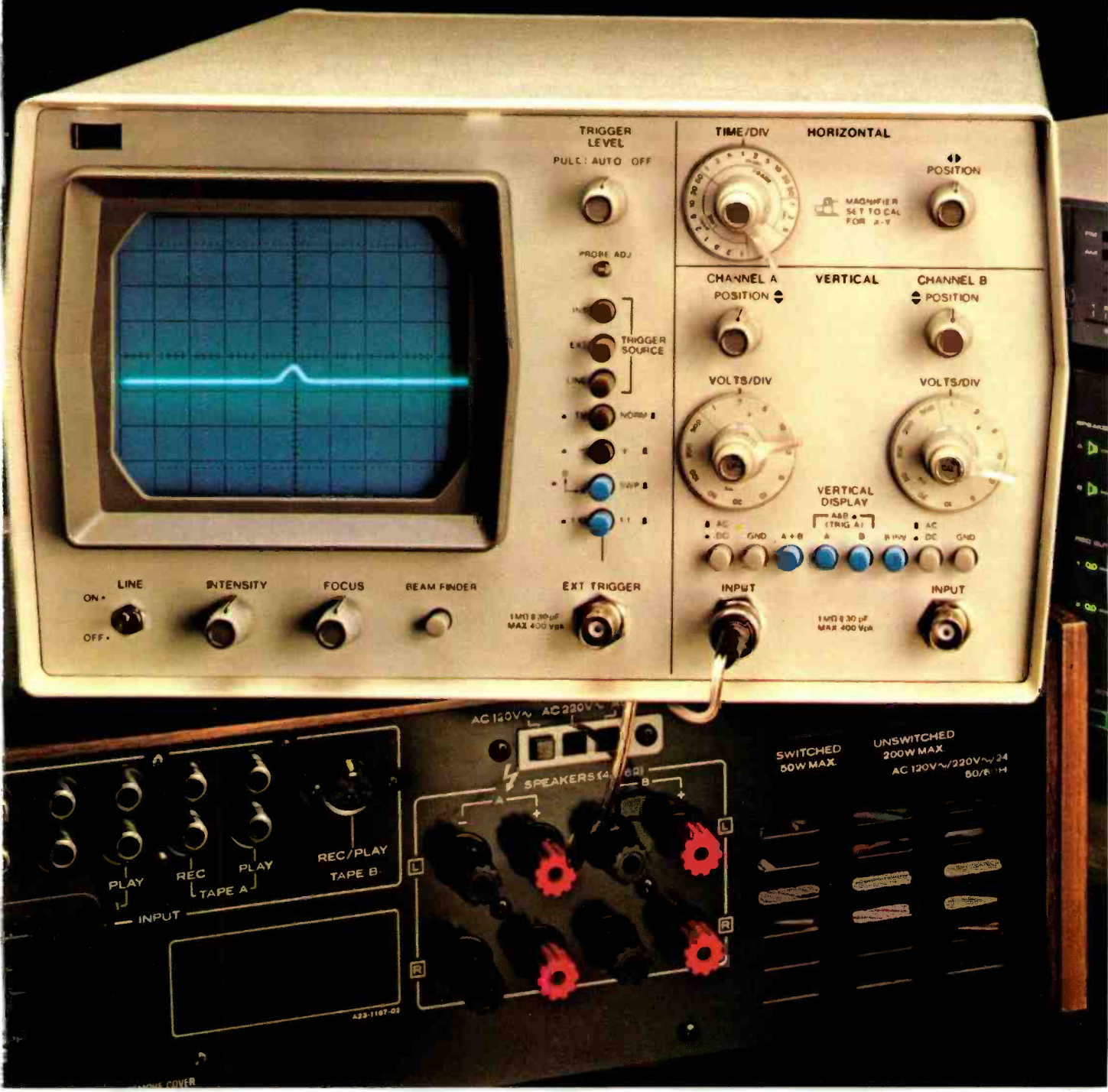
itself is made of Polymer Graphite—an amazing material that dampens resonance. And there's a coaxial suspension system that isolates the platter and tonearm assembly. These features combine to keep what's going on in the room around the turntable from becoming part of the music.

And all this is just the beginning. While the Pioneer concept of human engineering makes our components a pleasure to live with, Pioneer's innovative electronics and technology make them a pleasure to listen to. If you'd like to hear more, visit your nearby Pioneer dealer. You'll see and hear why Pioneer components are #1 with humans who care about music.

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Audio

AUGUST 1981

VOL. 65, No. 8



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The moving coil replacement from Stanton Magnetics... the revolutionary 980LZS!



Now from the company to whom the professionals look for setting standards in audio equipment comes a spectacular new cartridge concept. A low impedance pickup that offers all the advantages of a moving magnet cartridge without the disadvantages of the moving coil pickup. At the same time it offers exceedingly fast rise time—less than 10 micro seconds—resulting in dramatic new crispness in sound reproduction—a new “openness” surpassing that of even the best of moving coil designs. The 980LZS incorporates very low dynamic tip mass (0.2 mg.) with extremely high compliance for superb tracking. It tracks the most demanding of the new so called “test” digitally mastered and direct cut recordings with ease and smoothness at 1 gram $\pm \frac{1}{2}$.

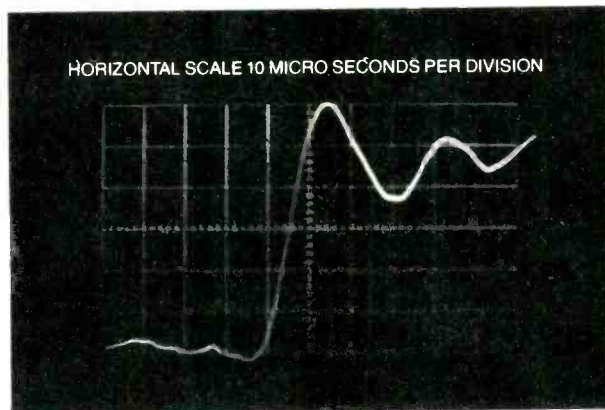
The 980LZS features the famous Stereohedron™ stylus and a lightweight samarium cobalt super magnet. The output can be connected either into the moving coil input of a modern receiver's preamps or can be used with a preamp, whose output is fed into the conventional phono input.

For “moving coil” audiophiles the 980LZS offers a new standard of consistency and reliability while maintaining all the sound characteristics even the most critical moving coil advocates demand. For moving magnet advocates the 980LZS provides one more level of sound experience while maintaining all

the great sound characteristics of cleanliness and frequency response long associated with fine moving magnet assemblies.

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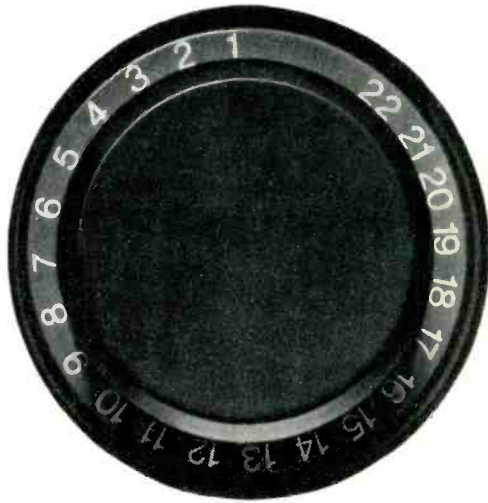


Actual unretouched oscilloscope photograph showing rise time of 980LZS using CBS STR112 record.



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Assistant Editor
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Jon & Sally Tiven

Publisher
Jay L. Butler

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Robert J. Kretling, President
George H. Allen, Senior Vice President/Magazines
Francis P. Pandolfi, Vice President and Group Publisher
Michael Brennan, Vice President and Gen. Manager
Leon Rosenfield, Circulation Marketing Director
William Ganz, Advertising Marketing Director
John J. Miller, Group Business Manager
Karen L. Rosen, Production Director

ADVERTISING SALES
Audio, 1515 Broadway, New York, N.Y. 10036
Jay L. Butler, Publisher
Telephone (212) 975-7247
Stephen W. Willholt, Eastern Adv. Mgr.
Telephone (212) 975-7654

West Coast Sales Office:
Audio, 3807 Wilshire Blvd., Suite 1201
Los Angeles, Calif. 90010
Jay Martin, Western Adv. Mgr.
Telephone (213) 487-5880.

Classified Advertising:
Audio, 1515 Broadway, New York, N.Y. 10036
Catherine M. Paduano, Classified Adv. Mgr.
Telephone (212) 975-7530

England: The Paul Singer-Lawrence Media Group,
54 Burton Court, London SW 3 5Y4, England
Telephone. 01-730-3592

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When you're ready to "face" the music we have a tip for reduced distortion



Whether you are seeking to reproduce the full dynamic range in the grooves of today's new superdiscs, or simply to obtain maximum listening pleasure from treasured "oldies" in your record collection, you need a phono cartridge that will deliver optimum trackability with minimum distortion.

Because the phono cartridge is the only point of direct contact between the record and your entire stereo system, its role is critical to faithful sound re-creation. That's why upgrading your phono cartridge is the single most significant (and generally least costly) improvement you can make to your stereo system.

To that end Shure now offers the Hyperelliptical Stylus Tip configuration—first introduced on the critically acclaimed V15 Type IV—in a full line of cartridges with a broad range of prices.

The Hyperelliptical Stylus Tip has been called the most significant advance in decades in tip geometry. It has a narrower and more uniform elongated contact area that results in significantly reduced intermodulation and harmonic distortion.

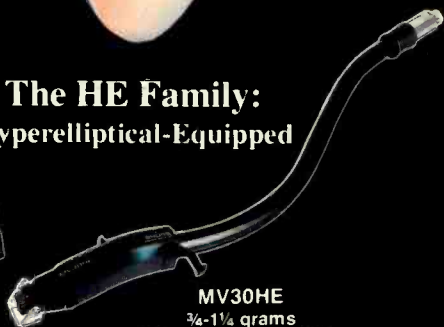
Look over the list at left to see which Shure HE cartridge best matches your tracking force requirements.

Shure has been the top-selling cartridge manufacturer for the past 23 years. For full details on this remarkable line of cartridges write for AL667.

The HE Family: Hyperelliptical-Equipped



V15 Type IV
¾-1¼ grams



MV30HE
¾-1¼ grams



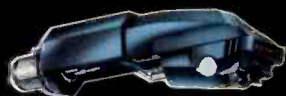
V15 LT
1¼ grams



V15 Type III-HE
¾-1¼ grams



M97HE
¾-1½ grams



M97HE-AH
(with attached headshell)
¾-1½ grams



M97 LT
1¼ grams



M95HE
¾-1½ grams



M75HE Type 2
¾-1½ grams



M75HE-J Type 2
1¼-2½ grams

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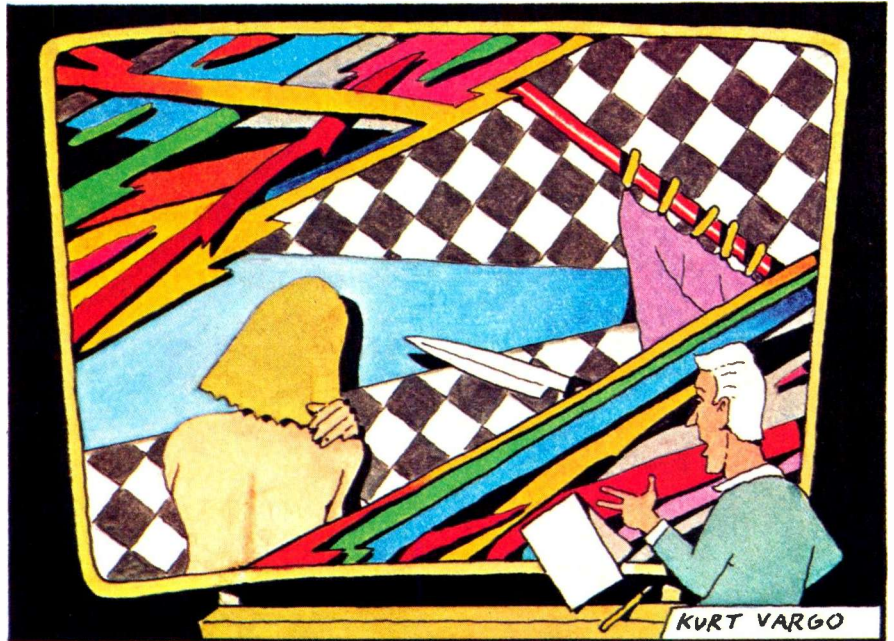
VIDEO SCENES

BERT WHYTE

In this column I am finally reviewing the Pioneer VP-1000 LaserDisc player. I say "finally" because this review has had a long gestation period — almost as long as a full-term human birth!

The reasons for this are manifold, but essentially can be summed up in the fact that the laser videodisc is a new and very complex technology subject to more than a few "teething troubles." Most of the problems with the LaserDisc player were minor, but there were some operational functions which initially either greatly impaired picture quality or rendered the program unviewable. I felt that considering the nature of the technology, the manufacturer should be given ample time to rectify the anomalies in their system. Well, time has passed, changes have been made, all performance parameters have been re-evaluated, and I think it is now fair to review the LaserDisc system currently being sold.

In the June 1980 issue of *Audio*, I explained in detail how the Philips-type laser videodiscs are mastered, and the workings of the laser disc playback system as employed in the Pioneer videodisc player. In the January 1981 issue of *Audio*, I gave a preliminary report on the Pioneer LaserDisc player and some of the problems I had encountered with the unit. Without being unduly repetitive, I'll briefly summarize the LaserDisc system. The 12-inch videodisc has a center "spindle" hole about the same size as a 45-rpm audio disc and is made of what appears to be an acrylic plastic, though it is much thicker, heavier, and more rigid than a conventional LP disc. The original LaserDisc master is recorded via a photo etching process in which a laser beam "cuts" (more properly, "exposes") billions of information pits of a composite audio/video FM signal in as many as 54,000 spiral tracks. Each track has two audio channels (making stereo sound or bilingual use possible) and one video channel. Each spiral track is equivalent to one television picture frame per revolution. The standard play CAV (constant angular velocity) videodisc revolves at 1800 rpm and is played back from the inner to outer circumference, with a duration of 30 minutes per side. The extended play CLV (constant linear velocity) videodisc affords one hour playback per side, with the playback speed varying from 1800 rpm at



the inner circumference of the disc to 600 rpm at the outer circumference. The Pioneer videodiscs are scanned with a helium/neon laser beam, focused to a thirty-thousandth of an inch, 1.1 mm below the protective plastic scuff layer. Three positional servos keep everything lined up on the information pits in the spiral tracks. When the laser beam strikes a pit, the beam is reflected, and these "on/off" reflections from millions of pits are translated into electronic pulses carrying the audio and video information.

The Pioneer VP-1000 LaserDisc player is housed in a beige high-impact plastic case, 21 in. W x 15 in. D x 5 in. H, and weighs in at slightly over 36 pounds. The videodisc turntable has a large-diameter, raised spindle, and the locking lid of the turntable compartment has a round magnetic clamp mounted in the center which mates with the spindle. In use, the videodisc is placed on the spindle and the lid with the clamp locked firmly in place. This secures the disc to the turntable, and the player will not operate unless the lid is locked. To the right of the turntable compartment is a function keyboard with controls for play, pause, 3X scan, rapid scan, slow motion, still and step frame, and two audio channels. Since each of the 54,000 spiral tracks is a separate television pic-

ture frame, there is a frame and chapter search mode and zero through nine number keys for access entry. With this function, it would be possible to have a LaserDisc with 54,000 individual paintings from the great museums of the world. If, on consulting a catalog, you decide you would like to view the Mona Lisa and it is on frame 22,567, press the search button, enter this number, press the search button again, and within 15 seconds the enigmatic smile of that great lady will grace your television screen. I should mention that all these special functions are possible only with the standard play LaserDiscs. Operationally, the Pioneer VP-1000 is very easy to use and should be no problem for even the most "fumble-fingered" people. For even further convenience, there is an optional full-function, infrared wireless remote control available.

Setting up the VP-1000 presents no problems. The rear panel of the unit has virtually the same inputs and outputs found on most videocassette recorders. The exception is a pair of audio output jacks for stereo or bilingual use, and an "adaptor out" jack which is supposed to connect to a PCM playback unit for digital audio discs! Once connected to your TV set, what kind of performance quality do these LaserDiscs offer?

In the best of all possible worlds, with

THE LOWER YOUR RECORDING SPEED, THE MORE YOU NEED MAXELL HIGH GRADE.

Whenever you use your video cassette recorder for slow motion, freeze frame or in the six-hour mode, it must operate at a lower speed. Even though most recorders are designed to handle this, most videocassettes aren't.

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And, because of our unique binding process and calendering system, the oxide particles on Maxell High Grade stay put. This drastically reduces friction and video recorder head wear. So not only will you get better picture quality, but you'll also be able to enjoy it a lot longer.

And you thought all video tape was pretty much the same.

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IT'S WORTH IT.



every part of the Pioneer LaserDisc system functioning in optimum fashion, the results are of outstanding excellence. Excepting a direct live feed via a satellite dish, no other medium will give you television images of such high resolution and definition, free of any picture distortions, and singularly free of any hash, snow, jitter or bounce. The color has great tonal purity, blacks and whites are particularly clean, and contrast and brightness ratios afford crisp brilliant pictures. Unfortunately, my early experience with the Pioneer LaserDiscs were very discouraging, as I noted in my Jan-

uary 1981 report. While I was viewing some movies from the MCA DiscoVision catalog (made originally for the Magnavision LaserDisc player, but supposed to be completely compatible with the Pioneer unit), I ran across a series of "glitches" in the pictures. They were characterized by momentary loss of signal information. The TV picture would twist and distort, color picture would change to black and white, and there was a complete loss of sound! As I noted, these glitches could be repetitive for a certain amount of time and cause a sort of "stuttering" effect. The most ag-

gravating thing was that these glitches could appear on one side of a disc and on the other side not appear at all. Since I had heard that MCA was having a high reject rate on the LaserDiscs, I felt the trouble was in this aspect of the system. This impression was heightened when I received four new LaserDisc movies from Pioneer directly, which purportedly had been mastered in Japan, because they all played back absolutely flawlessly. However, I subsequently obtained several movies from what was said to be "new" production, and promptly encountered those annoying glitches. I was irritated by this, and when a friend was visiting me, I put on the same discs to show him the glitch phenomenon. To my amazement, the glitches occurred . . . but in entirely different places! I then reckoned it must be the VP-1000 unit that was the real culprit. Just to check, however, I played the discs that had not exhibited any glitches and found they were just as flawless as in the first run-through. Gadzooks! Now I was really confused.

About ready to give up on this whole LaserDisc problem, I decided to ask Pioneer for a new VP-1000 LaserDisc player as I had heard that some minor changes had been made since the early unit that had been supplied to me. I also asked that their engineers very thoroughly check and align the new unit that was to be sent to me. The new LaserDisc unit arrived and now, having lived with it for some time and having conducted extensive experiments, I think I can venture a valid opinion on this Pioneer LaserDisc system.

To begin with, my "flawless" LaserDiscs, which played back so beautifully on the original VP-1000, were just as good and glitch-free on the new unit. Two of the original movies, "The Other Side of the Mountain" and "Psycho," had displayed frequent glitches. On the new VP-1000 the glitches disappeared. Another of the original movies, "Family Plot," had also suffered from repetitive glitches. On the new LaserDisc player, the glitches not only appeared, they were worse, to the extent that the picture "froze" in action, as if the "still" function were engaged. The "new" production runs of "The Six Million Dollar Man" and "Sgt. Pepper's Lonely Hearts Club Band" had displayed glitches mostly of the type that turns the color to black and white and stops the sound. Played on the new VP-1000, the glitches cleared up completely. In the course of my tests, I found that in spite of the heavier and more rigid nature of a LaserDisc, they are still subject to warpage. This manifests itself as a distinct "tic-tic-tic" whirring noise at the high 1800-rpm speed of the LaserDisc playback. The more

There is no true accuracy without high efficiency. Interface.

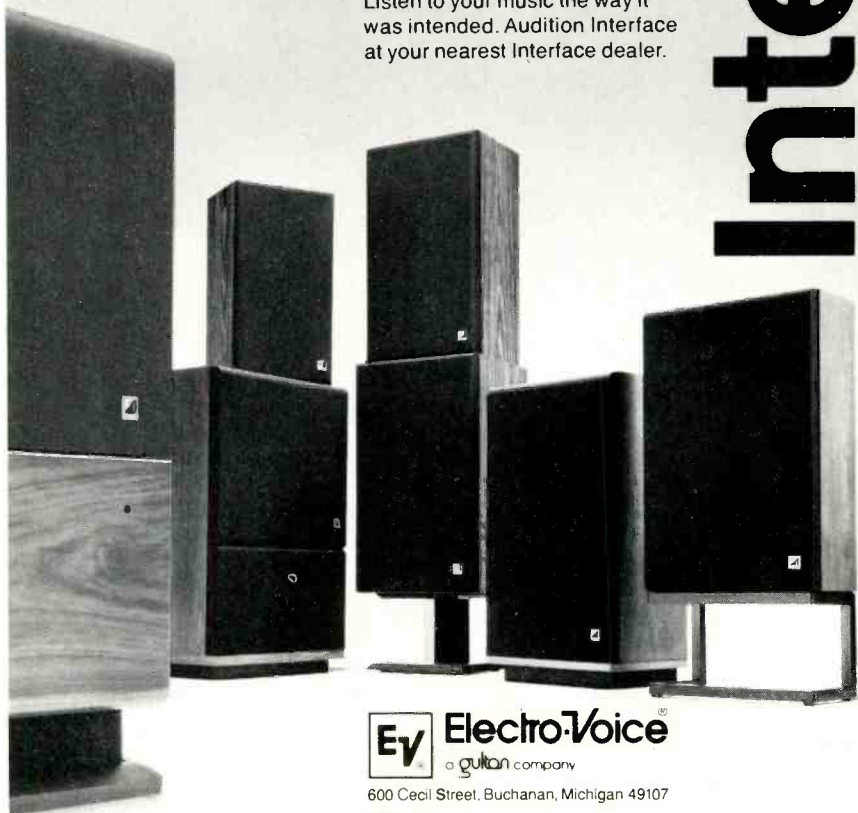
The "power war" is over. High-powered receivers and amplifiers are going the way of the "gas guzzler" in this era of energy consciousness and inflation. Yet technological advancements in source material, such as direct-to-disc and digitally-mastered records, demand far more from your loudspeaker system than ever before.

Without huge amplifiers, accurate reproduction of today's state-of-the-art source material requires very efficient loudspeakers. Efficient loudspeakers allow your amp to idle; being asked to produce very little power during normal playing levels so it needs to respond with its rated capabilities only to handle the sharp transients and increased dynamic range.

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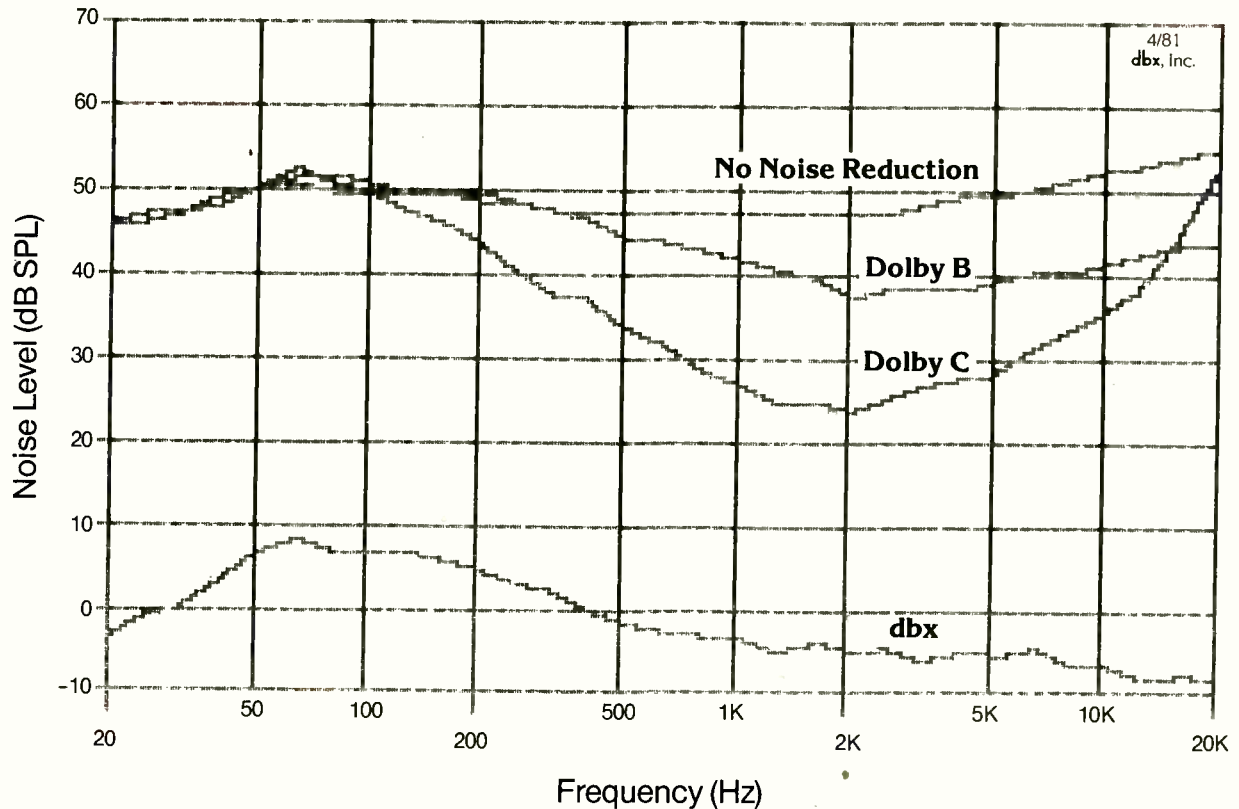
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dbx has been silent too long.



Noise from biased Chromium Dioxide cassette tape, comparing Dolby and dbx noise reduction systems. One third octave analysis. Tape noise level referenced to 200 nWb/m = 110dB SPL.

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First came Dolby B. Then Dolby HX. Now there's Dolby C.

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Because from the beginning, dbx has done what Dolby keeps trying to do: *eliminate* tape noise.

Just compare Dolby's latest attempt with dbx.

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The dbx system reduces tape noise so effectively, that it's beneath the noise floor of even the quietest living rooms. Unlike Dolby C, dbx is effective in more than just the mid-range. It operates across the entire frequency spectrum. There's no low-frequency noise. No high-frequency noise. No noise, period.

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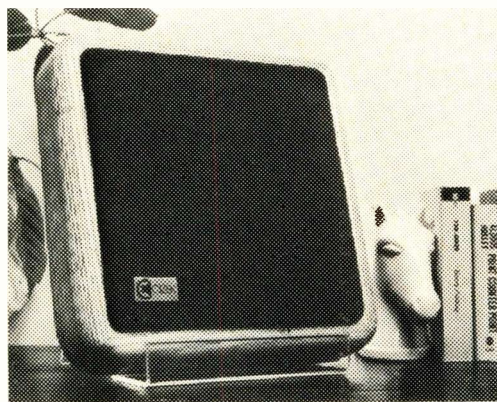
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noise, the more warpage, and this was quite obvious in the case of "Family Plot." I think this warpage can cause enough mistracking of the laser beam that the positional servos can't correct for it . . . hence the glitches. Eccentricity of the LaserDiscs apparently can also be a factor in the appearance of glitches. Even on the new VP-1000 player, when I deliberately "off-centered" a LaserDisc using the very slight amount of "play" between center hole and spindle, I was able to re-establish some glitches. I feel a more accurate and positive centering and locking spindle would be a worthwhile addition to Pioneer's VP-1000 LaserDisc player.

The audio performance of the VP-1000 with the LaserDiscs was quite good, distinctly better than the poor audio one gets from videocassettes with their very slow linear speed. In the case of "Abba" and "Sgt. Pepper's Lonely Hearts Club Band," which are stereo LaserDiscs, the stereo sound was generally good, with plenty of separation and good positional information. However, I felt that, considering the 40 Hz to 20 kHz bandwidth claimed for the system, it didn't sound like really wide-range music, and I thought the sound could have been cleaner as well. Nonetheless, the stereo sound in these productions was a definite "plus" and constitutes a very desirable feature.

In a comparison of the LaserDisc with prerecorded videocassettes, the most noticeable difference is the generally superior resolution and definition of the LaserDisc. With really high-quality duplications such as Magnetic Video Industries' "Sink the Titanic" and "Alien," the differences between the LaserDisc and the videocassette are less apparent, but still tilt in favor of the LaserDisc. In the only direct comparison I could make, I saw "Animal House" via my cable service and happened to have the LaserDisc of this production. The LaserDisc won this round handily, but I have a feeling my cable service leaves something to be desired.

To sum up my impressions of the VP-1000, I would still have to say I have mixed feelings. Pioneer has done, in general, a most creditable job in building such a high-technology product. When everything is working right with this LaserDisc system, it produces really superb pictures. To be sure, the faults mainly appear to be in the software, and with the expertise of 3M brought to bear on the reliable replication of LaserDiscs, this problem may soon be licked. If this should come to pass, the LaserDisc system with its inherent quality and very sophisticated microprocessor functions could be a most formidable contender in the videodisc marketplace. 



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BUILD A HIGH PERFORMANCE THD ANALYZER

PART TWO

ROBERT R. CORDELL

Last month we discussed the theory of operation of total harmonic distortion (THD) analyzers, the features of the analyzer being described here, many of the underlying principles, and finally the details of the signal source portion of the analyzer. This month we will resume the circuit description by starting with the input circuits and the state-variable bandpass filter. Before we go into the remainder of the analyzer, let me present the printed wiring board layout for the signal source, CP1, as Fig. 10 and the corresponding component placement as Fig. 11. I also repeat Fig. 5, which is the block diagram of the analyzer, for clarity.

Input Circuit and Bandpass Filter

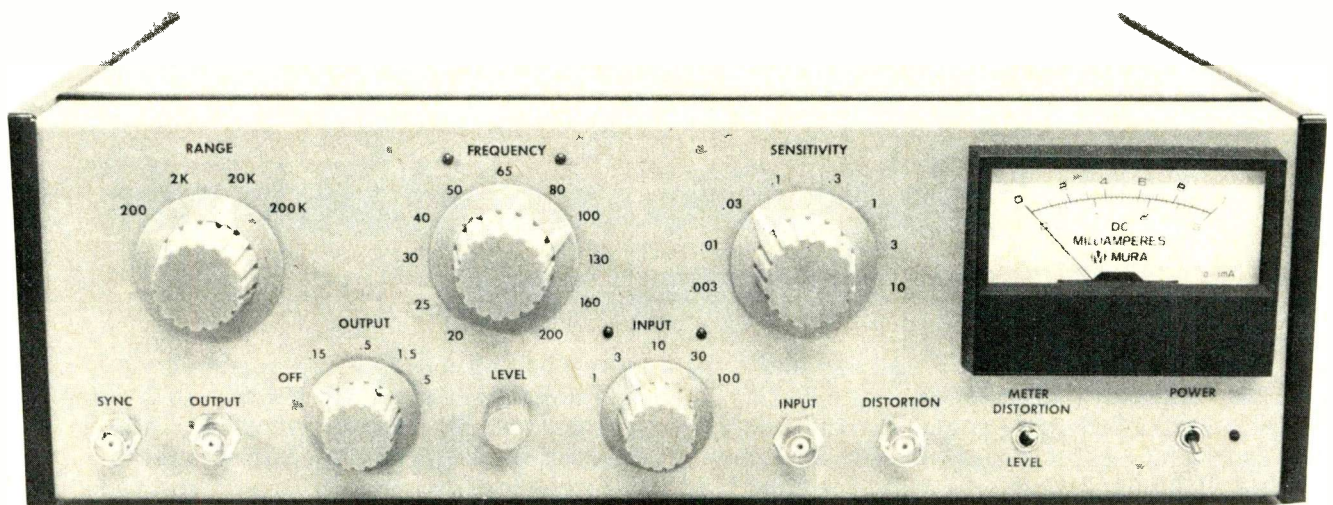
The input attenuator, input amplifier, and voltage-controlled state-variable bandpass filter are shown in Fig. 12.

The input attenuator (S4) selects an appropriate input sensitivity for maximum operating levels of 100 V, 30 V,

input impedance of the analyzer is 100 kilohms on all input ranges.

Because of the high impedances in the attenuator circuit, S4 and its associated components must be placed in a small shielded enclosure in order to avoid stray pickup and oscillations. Depending on stray switch capacitances, small capacitors, such as those shown dotted in Fig. 12, may have to be added to obtain a flat frequency response at all attenuator settings.

The heart of the signal processing in the analyzer is the voltage-controlled state-variable bandpass filter. Its primary function is to deliver a fundamental signal to the differential amplifier (not shown in Fig. 12) whose amplitude and phase are such that the fundamental will be exactly cancelled, leaving only distortion products. In addition, very little of the signal's distortion products should be passed by the bandpass filter so that little or no cancellation or attenuation of distortion products will occur at the dif-



10 V, 3 V, or 1 V. The "nominal" operating levels are a third of these values. Because of the auto-set level feature, actual input levels which are above or below the nominal level by as much as 10 dB can be accommodated; no input vernier control is required. Notice that on the 1-V range a gain-of-three amplifier (IC9) is switched into the circuit to boost a nominal 0.33-V signal to the nominal 1-V internal analyzer operating level. The

differential amplifier. As mentioned earlier, in order to achieve exact fundamental nulling, the gain and center frequency of the bandpass filter are precisely controlled by the auto-tune circuits (Fig. 5).

The state-variable filter in Fig. 12 is a bit more complicated than the simple one illustrated last issue in Fig. 8, but the operating principle is exactly the same. It consists of ICs 10 to 13 and 15. The use of two extra inverters in the loop

(IC11, 13) accounts for the additional ICs. The extra inverter at IC11 permits the bandwidth-setting feedback path (R57 and R62) to be connected in such a way that center frequency changes do not affect filter Q or gain. This type of connection was also used in the oscillator, but there the extra inverter was not needed because of the sign flexibility afforded by the multiplier.

The second inverter (IC13) is required to re-establish the correct polarity for the main feedback loop (R58 and R59) and also provides a useful summing point for the amplitude and frequency control sig-

output. The center frequency and gain of the filter are trimmed by R59 and R62 respectively.

Control of the center frequency of the bandpass filter is quite simple. Recall from our earlier discussion that the center frequency of a state-variable bandpass filter can be changed by simply adjusting the loop gain. In Fig. 12 this is accomplished by connecting a multiplier and series resistor (R65) around the inverter formed by IC13 to provide controlled amounts of negative or positive feedback. When the multiplier provides a noninverted characteristic, additional

IC14, and it is identical to the one used in the oscillator (Fig. 9, Part I). As in the oscillator, any distortion introduced by the control circuit must pass through two integrators before reaching the output (E18), and is thus substantially reduced.

Amplitude control of the bandpass filter is a bit more subtle. Based on last month's discussion of the simple state-variable filter, one's first inclination is to change the gain of the filter by changing the amount of the "damping" feedback, here provided by R57 and R62. This will surely accomplish the desired control, but notice that in this case any distortion

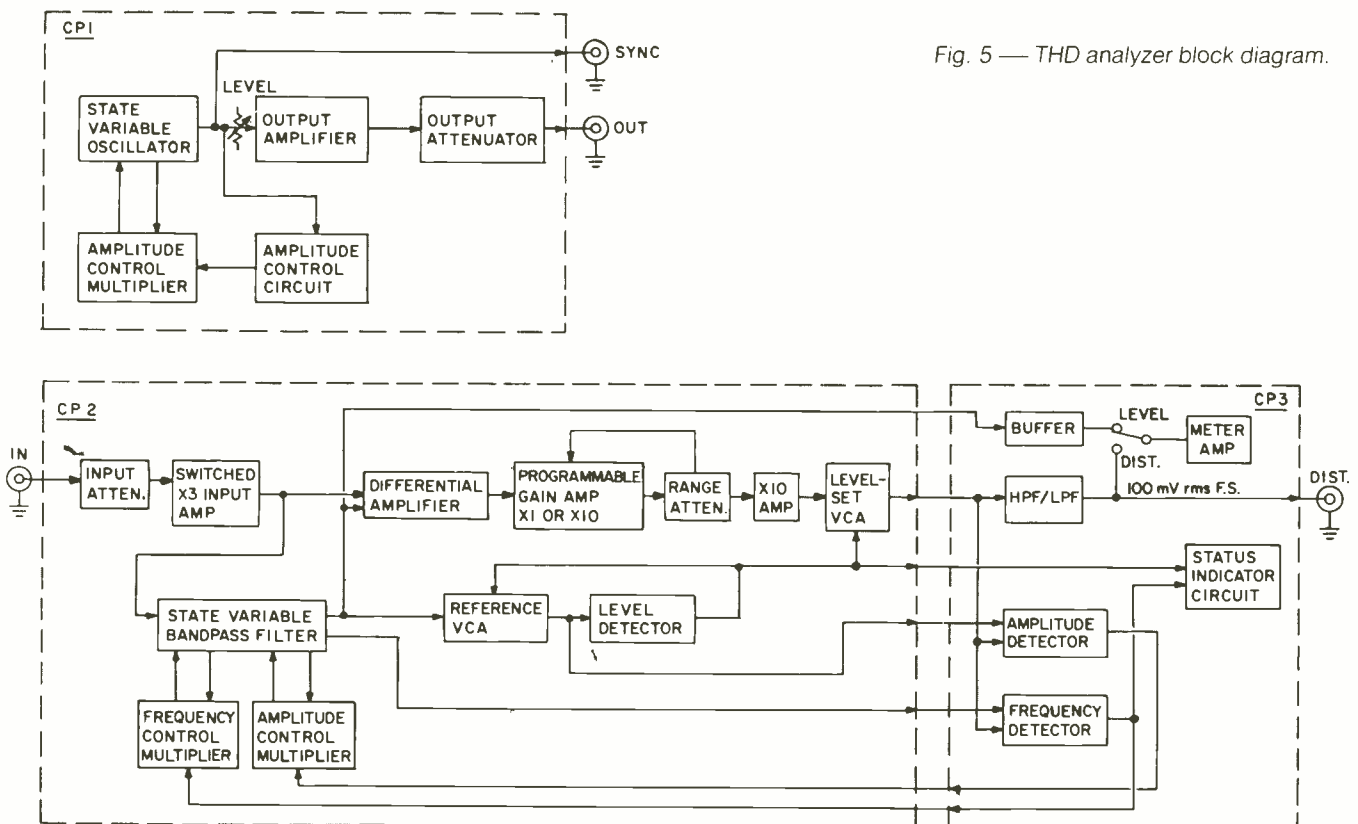


Fig. 5 — THD analyzer block diagram.

nals from the multipliers. In further contrast to the simple state-variable filter, the input signal is here applied to the noninverting input of IC10. This yields a slight noise advantage and also provides the correct signal polarity at the output of the bandpass filter. Because the bandpass filter has a gain of about 5 at the center frequency, some attenuation of the input signal is necessary (R54 and R55) to establish the proper operating level at its

negative feedback is provided around the inverter, making its gain less than unity and consequently lowering the center frequency of the filter. The opposite action results when the multiplier provides an inverted characteristic. In this manner the gain of the inverter can be controlled over a ± 3.2 percent range, resulting in a center frequency control range of ± 1.6 percent.

The multiplier consists of FET Q5 and

injected by the control circuit will be removed from the filter output by only one integrator. To minimize distortion, we would like to inject the amplitude control signal at the same advantageous point as the frequency control signal, i.e., at the input of inverter IC13. Fortunately, it turns out that a small amount of feedback (positive or negative) around the second integrator (IC15) is equally effective in providing control of the gain as

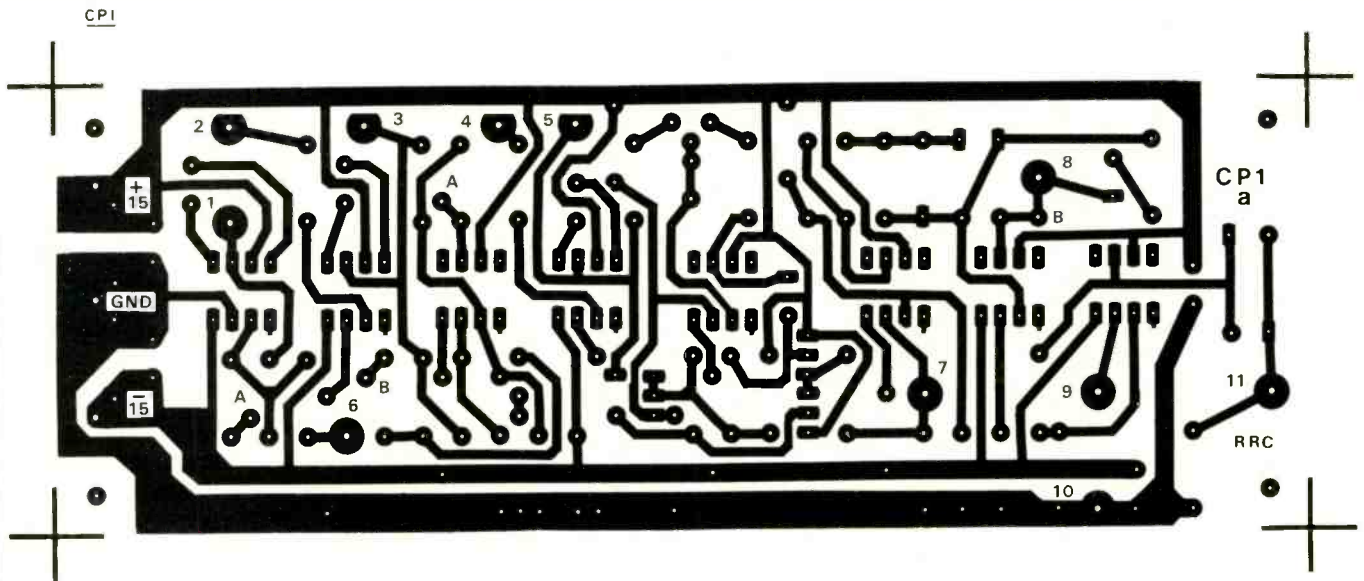


Fig. 10 — Printed wiring board layout for CP1, the signal source.

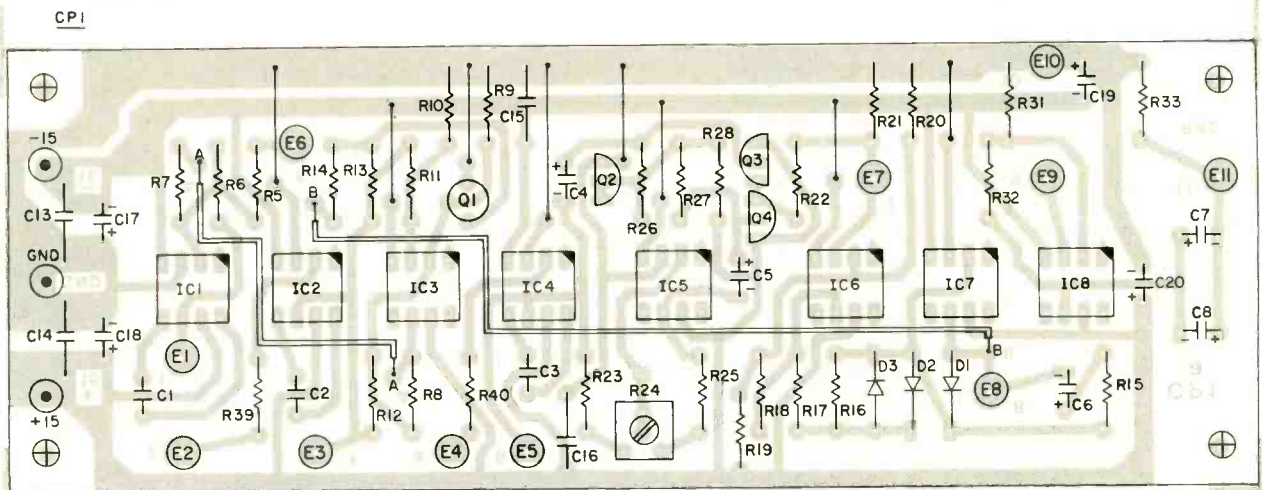


Fig. 11 — Parts placement for CP1, the signal source.

long as the perturbation is small, as it is here. The amplitude control multiplier, consisting of FET Q6 and IC16, thus provides amplitude control feedback from the output of IC15 to the input of inverter IC13. An amplitude control range of about ± 3.5 percent results.

Differential and Product Amplifiers

The differential amplifier which com-

pletes the notch filter and the distortion product amplifiers are shown in Fig. 13. Also shown here is the auto-set level circuit which will be discussed shortly.

IC17 functions as the differential amplifier where the fundamental supplied by the bandpass filter is subtracted from the input signal. The combination of this differential amplifier and the bandpass filter thus comprises the notch filter. The differential amplifier also provides a gain

of 10 to the distortion products. The input signal (E15) is applied directly to the high-impedance noninverting input of IC17 while the fundamental from the bandpass filter (E18) is applied to the inverting input through R84. Because of the attenuation which results from the voltage divider formed by R84 and R85, nulling results when the fundamental from the bandpass filter is about 10 percent larger than the fundamental sup-

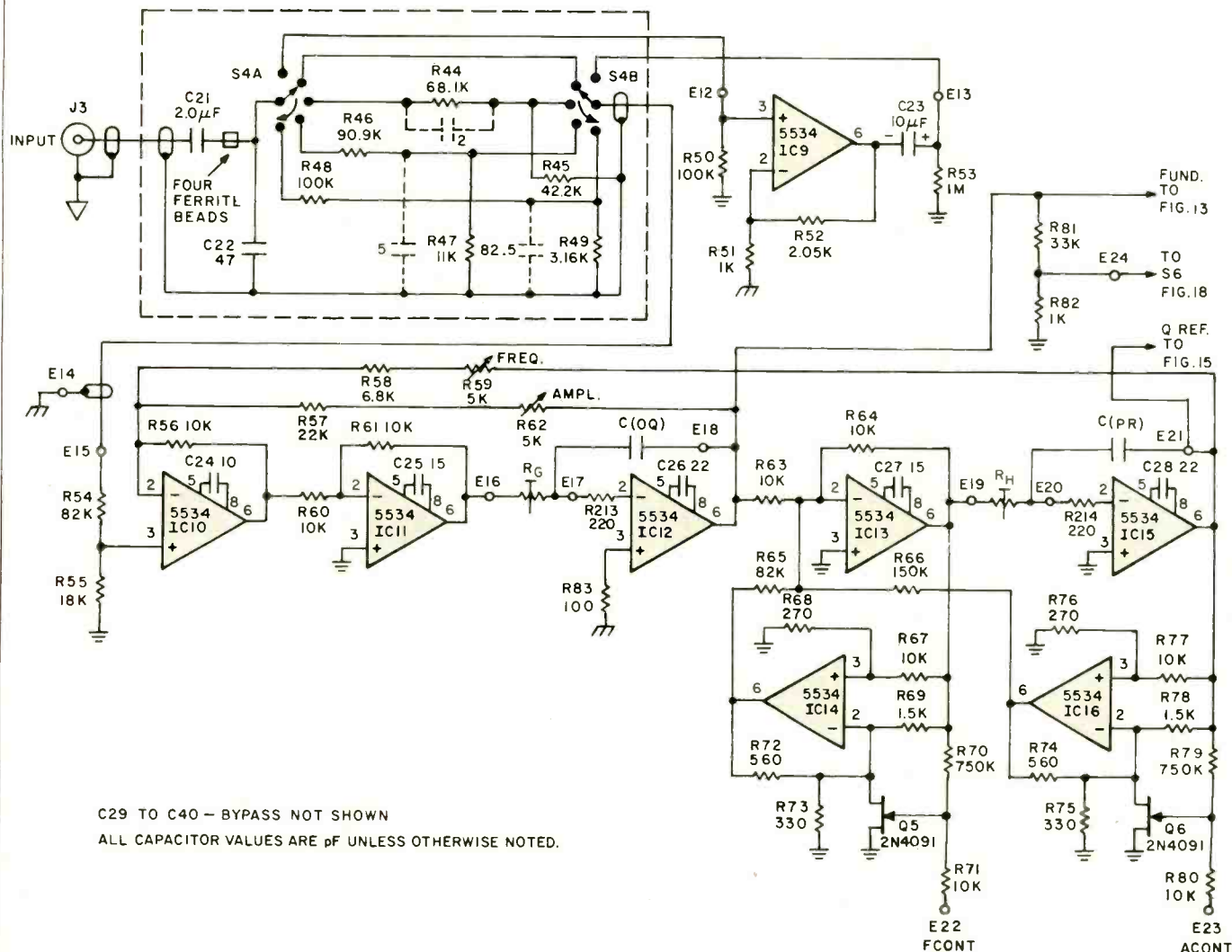


Fig. 12 — THD analyzer voltage-controlled bandpass filter.

plied directly from the input attenuator.

The differential amplifier is followed by another amplifier (IC18) whose gain is 10 on all distortion ranges except the 10 percent and 3 percent full-scale ranges, where it is unity. The gain of this stage is switched by a FET whose gate voltage is controlled by the sensitivity switch (S5). IC18 is followed by an attenuator which is also controlled by S5, establishing full-scale sensitivities of 10, 3, 1, 0.3, 0.1, 0.03, 0.01, and 0.003 percent. This is followed by a fixed gain-of-ten amplifier (IC19). The distortion product signal then proceeds to the auto-set level volt-

age-controlled amplifier (ICs 20 & 21).

Voltage-Controlled Amplifiers

Because the voltage-controlled amplifiers (VCA) are central to the operation of the auto-set level circuitry, we will discuss their operation before proceeding further.

A simple VCA is shown in Fig. 14. It consists of a 1496-type balanced modulator IC (whose internal circuit is shown) and an op-amp.

The op-amp is connected as an inverting feedback amplifier, the ratio of whose input and feedback signals is

controlled by the 1496. As this ratio is varied from a very small number, through unity and on to a very large number, the gain changes proportionately from small to large. In fact, in this circuit the gain is numerically equal to the ratio. A d.c. control voltage applied to the 1496 controls this ratio and thus the gain.

Referring to Fig. 14, bias resistor R3 sets up a bias current in Q7 and Q8 of about 1 mA. Transistors Q5 and Q6 are connected as common-base stages and provide a low-impedance point at their emitters where a.c. signal currents can

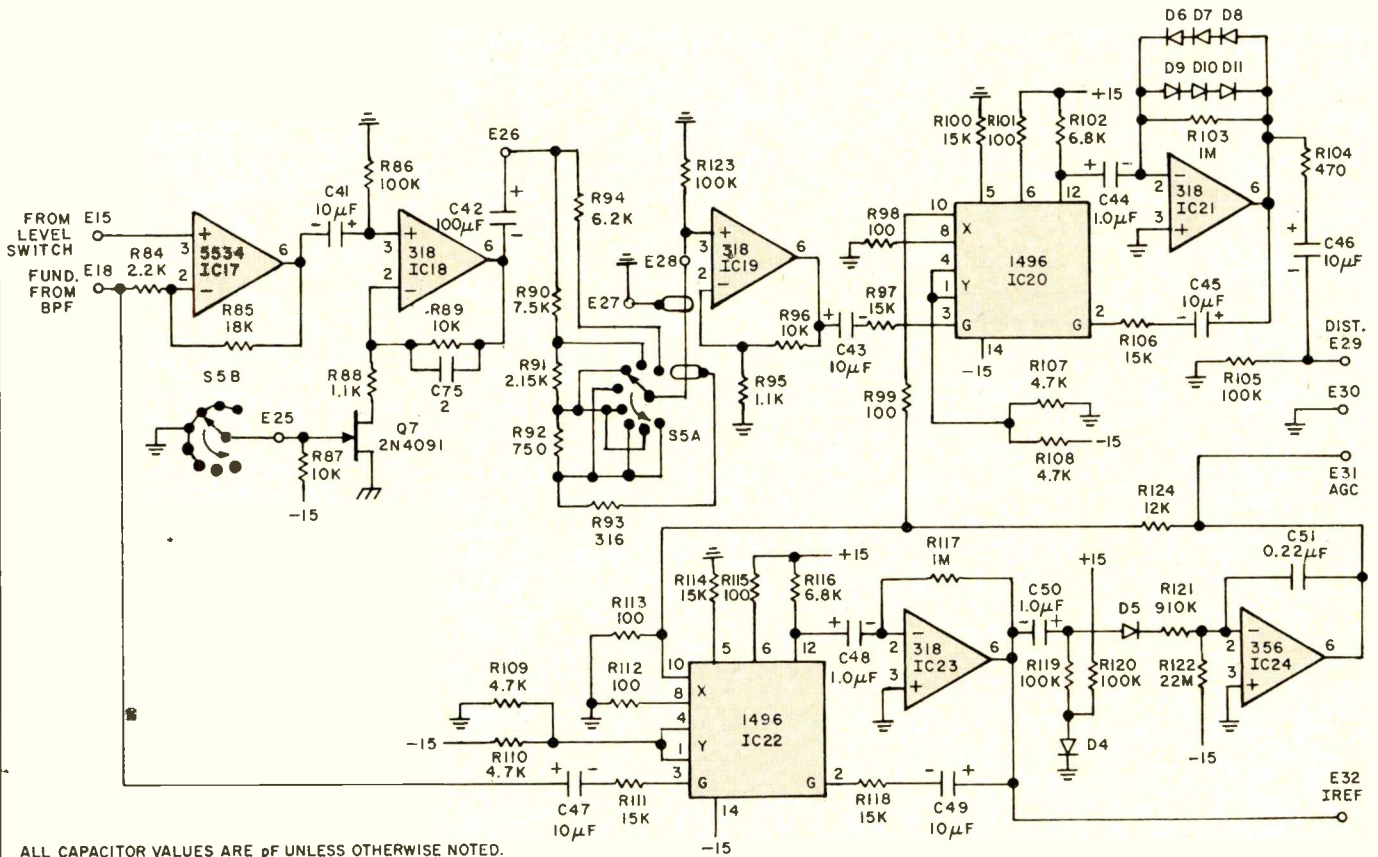


Fig. 13 —
THD analyzer
product amplifier
and level set.

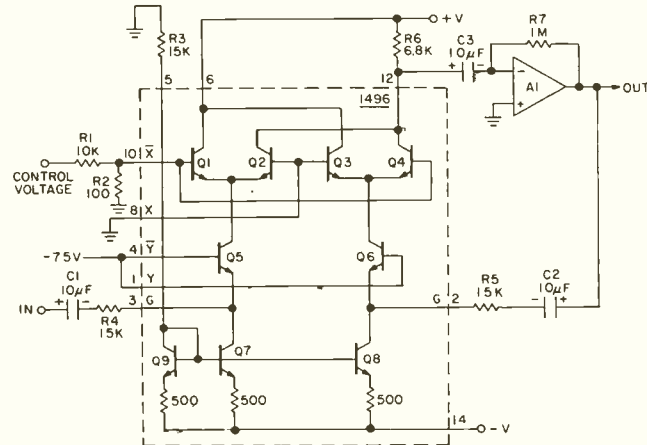
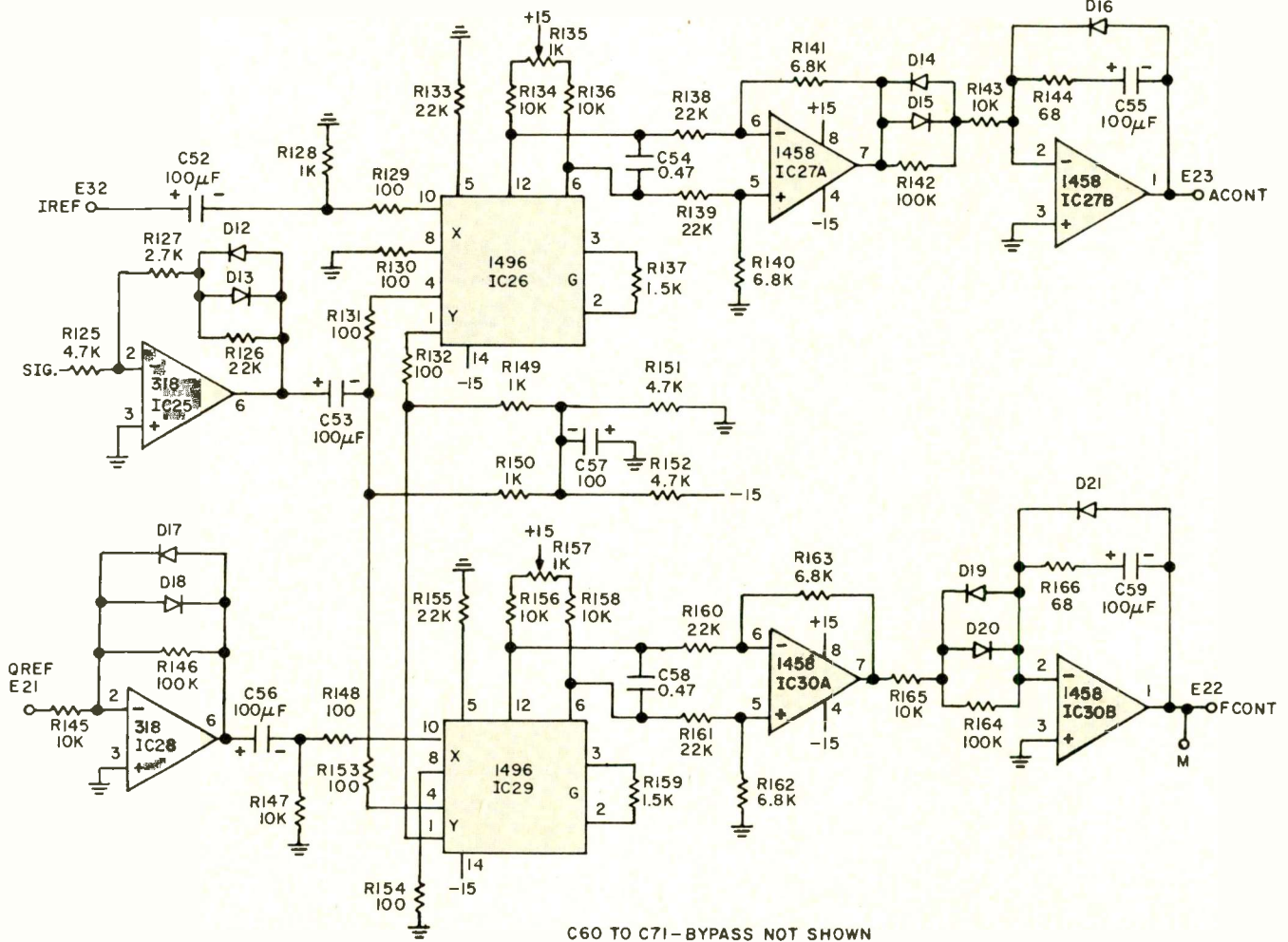


Fig. 14 —
A simple
voltage-controlled
amplifier (VCA).

be added to the d.c. bias currents. The input signal current established by R4 is applied to the emitter of Q5, while the feedback current established by R5 is applied to the emitter of Q6. The action in the upper "quad" of transistors (Q1-Q4) determines what portion of each of these a.c. signals reaches the output at pin 12 and thus the inverting input of the operational amplifier.

We see that at the collector of Q5 we have d.c. bias current plus a.c. input signal, while at the collector of Q6 we have d.c. bias current plus a.c. feedback signal. Each of these currents is applied to the emitters of a differential pair, where some will flow in one emitter and the remainder will flow in the other emitter of a



C60 TO C71—BYPASS NOT SHOWN
ALL CAPACITOR VALUES ARE μF UNLESS OTHERWISE NOTED.

Fig. 15 —
THD analyzer
amplitude and
frequency detectors.

given pair. Each of these currents thus splits in some proportion. The key operating principle in this circuit is that the a.c. currents into the emitters of a differential pair will split in the same proportion as the d.c. bias currents flowing into the pair.

The attenuated control voltage applied to pin 10 controls this split. When the control voltage is zero, both transistors in each differential pair have the same base voltage and conduct equally. In this case, half of the input signal and half of the feedback signal current reach the output at pin 12 via Q2 and Q4 respectively. Because of the extremely high gain of A1, the signal and feedback currents at pin 12 must essentially can-

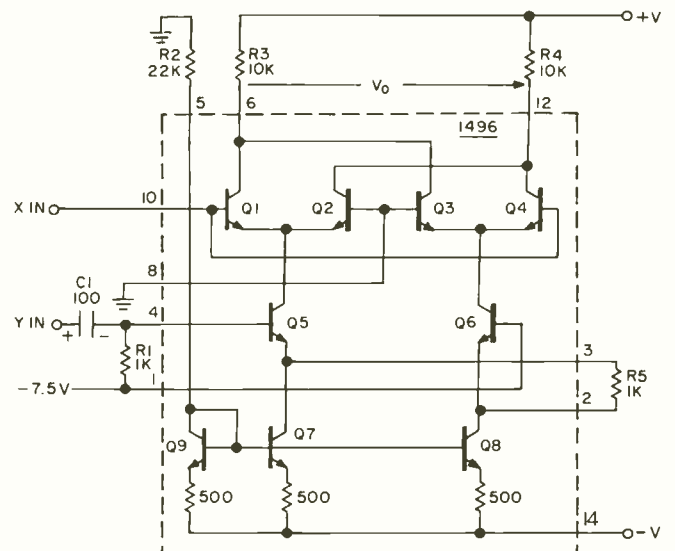
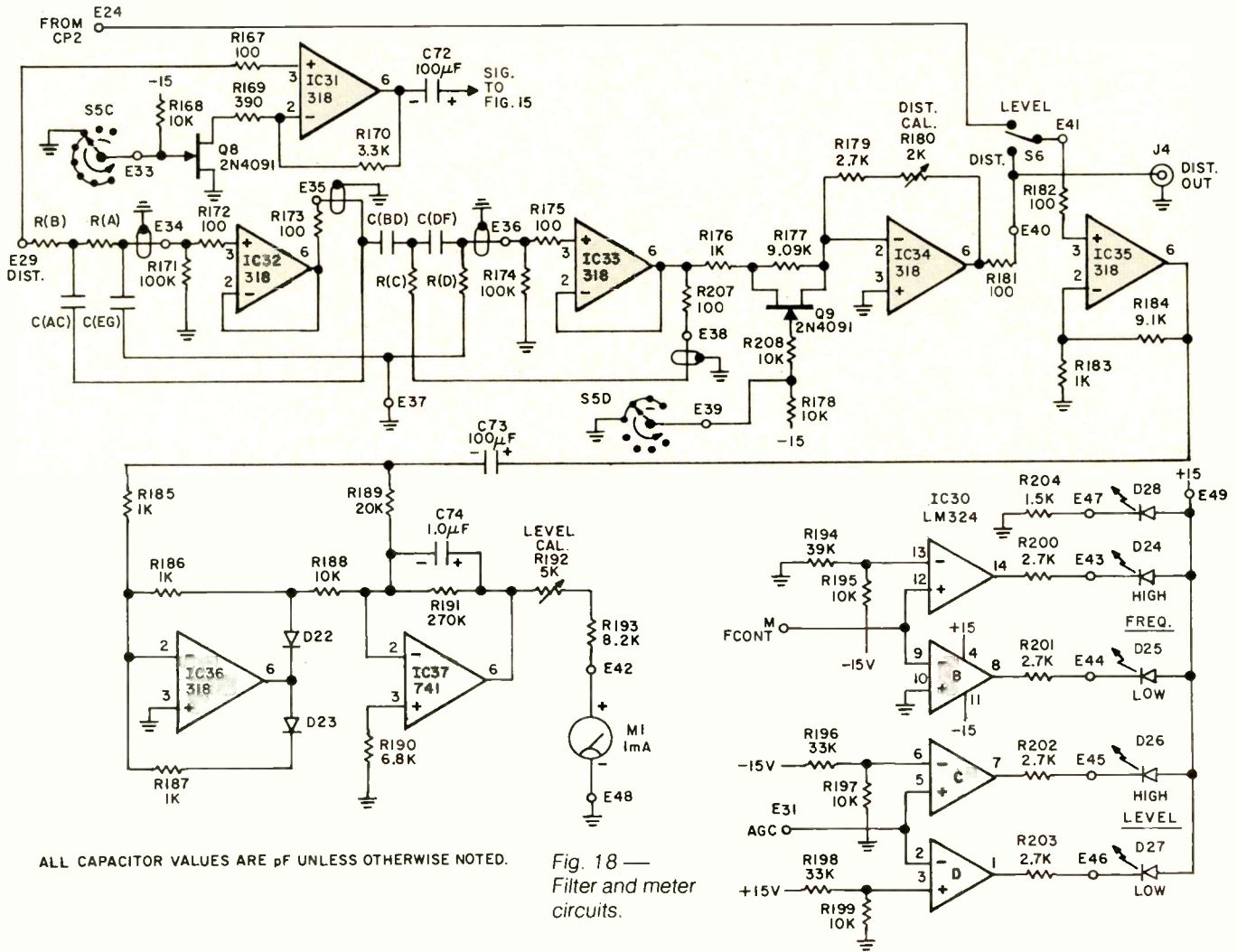


Fig. 16 —
A simple
phase detector.



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Fig. 18 — Filter and meter circuits.

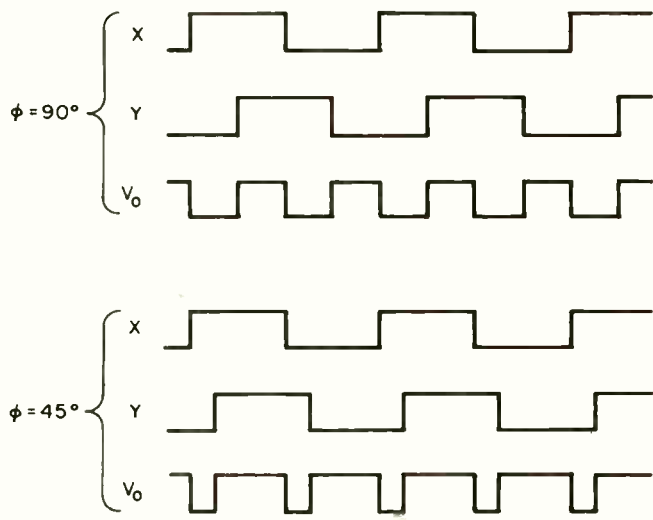


Fig. 17 — Phase comparator operation.

cel each other for finite output levels from A1. They must therefore be virtually equal. This in turn indicates that the signal currents in R4 and R5 must be equal for a zero control voltage, implying unity gain.

A positive control voltage at pin 10 will cause Q1 and Q4 to conduct more heavily than Q2 and Q3. Thus, a greater proportion of feedback current reaches pin 12 (via Q4) than input current (via Q2). In order to maintain cancellation of the two currents at pin 12, the input signal must be larger to begin with than the feedback current, implying less than unity gain. As an example, it is well known that a potential of about 60 mV across

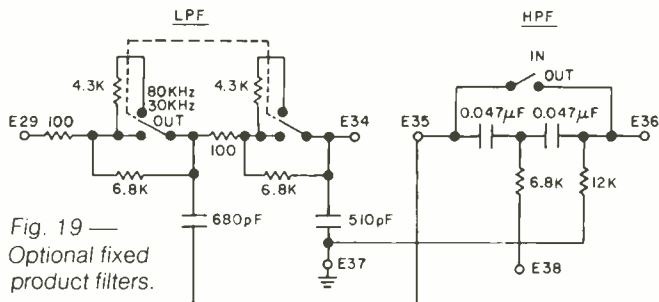


Fig. 19 —
Optional fixed
product filters.

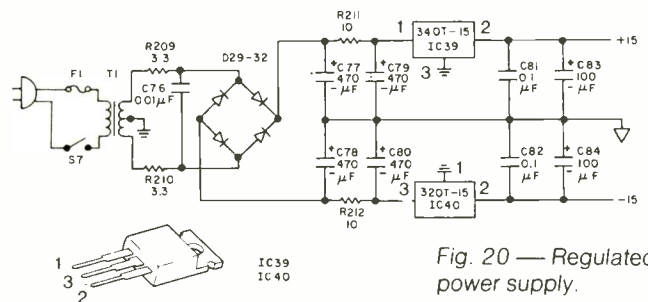


Fig. 20 — Regulated
power supply.

the bases of a differential pair will cause a 10-to-1 ratio of conduction in the two transistors. In this application, a +60 mV control voltage at pin 10 will thus result in a gain of about 0.1. The situation is the inverse for a negative control voltage; a -60 mV level at pin 10 will result in a gain of about 10.

A particularly nice feature of this arrangement is that the gain in decibels is a linear function of the control voltage. Here we get a variation of 20 dB/60 mV or about 0.33 dB per mV. The 100-to-1 attenuator formed by R1 and R2 simply allows for more manageable control voltages (3.3 dB per volt). The gain control range here is in excess of ± 20 dB.

Auto-Set Level Circuit

With a knowledge of the operation of the VCA, the auto-set level circuit in Fig. 13 becomes easy to understand. It consists of two identical VCAs, each with the same control voltage and thus each with the same gain. The first VCA (IC20, 21) controls the gain in the distortion product signal path and receives its input from IC19. It produces the level-adjusted distortion product output at E29 for use on CP3. The second ("reference") VCA (IC22, 23) controls the gain in an automatic gain control (a.g.c.) loop; its input is the filtered fundamental output from the bandpass filter (E18).

In addition to the reference VCA, the a.g.c. loop includes a level detector (D5) and an op-amp (IC24) connected as an integrator. The d.c. output of the integrator is the control voltage for the VCAs. The a.g.c. circuit is arranged so that the integrator will always adjust the gain of the reference VCA so that the level of the fundamental at its output is 1.1 V rms. Thus, if the input to the notch filter is the nominal 1-V level, the fundamental from the bandpass filter will be 1.1 V and the gain of both VCAs will be unity, as it

should be for this situation. If the input signal level were to increase to 2 V, the gain of both VCAs would drop to 0.5, implementing the proper gain correction in the distortion product signal path.

Auto-Tune Control Circuits

The amplitude and frequency detectors which comprise the auto-tune control circuit are shown in Fig. 15. If the gain and center frequency of the bandpass filter are not perfect, the notch filter will not produce a complete null of the fundamental signal. Some fundamental will thus appear in the distortion-product signal path. An amplitude error will produce a "left-over" fundamental component whose phase is zero (or 180) degrees relative to the input signal. A fundamental component with this phase relationship is said to be a "normal" component. A frequency error will produce a so-called "quadrature" fundamental component whose phase is either leading or lagging 90 degrees relative to the input signal.

The amplitude detector functions by looking for normal fundamental components in the distortion signal and adjusting the bandpass filter gain up or down depending on the phase relationship (0 or 180 degrees). It ignores quadrature fundamental components. Similarly, the frequency detector functions by looking for quadrature fundamental components and adjusting the filter center frequency up or down depending on the phase relationship (lagging or leading). It ignores normal fundamental components.

The special detector circuit which possesses the properties mentioned above is called a "phase detector" because it is sensitive to the phase of the signal being detected. An ordinary envelope detector or rectifier is not suitable because it will detect the signal regardless of its phase. Here, the phase of the

"left-over" fundamental is a crucial piece of information.

A simplified schematic of a phase detector is shown in Fig. 16. Like the VCA, it is based on the 1496-type balanced modulator IC. The phase detector is a more conventional use of this IC. Bias resistor R2 sets up an appropriate current flow in current sources Q7 and Q8. The application of a positive input signal at the Y input will cause Q5 to conduct more current than Q6; the opposite will occur for a negative input signal. A positive input at the X input will cause Q1 and Q4 to be "on" and Q2 and Q3 to be "off." The output (V_o) is taken differentially between pins 6 and 12.

We can easily see what polarity of output will be produced for any combination of positive or negative X and Y inputs. For example, if X and Y are both positive, most of the current flow is in Q5 and Q1, pulling pin 6 lower than pin 12 and producing a positive output. In general, a positive output is produced when both inputs have a like sign, and a negative output is produced when the X and Y inputs have differing signs. In a sense, this circuit performs similarly to the "EXCLUSIVE NOR" logic function. We immediately see that two perfectly in-phase signals at X and Y will always have the same sign and thus produce a maximum positive output.

The diagram in Fig. 17 lends further insight into the phase sensitivity of this type of detector. Square-wave inputs are shown for simplicity of illustration, but the circuit functions similarly for other waveforms. In the top illustration we see what happens when the X and Y inputs are 90 degrees out of phase; the average d.c. output at V_o (which is what matters) is zero. This illustrates how the amplitude detector can ignore a quadrature component.

It is easy to see that if we slide the Y

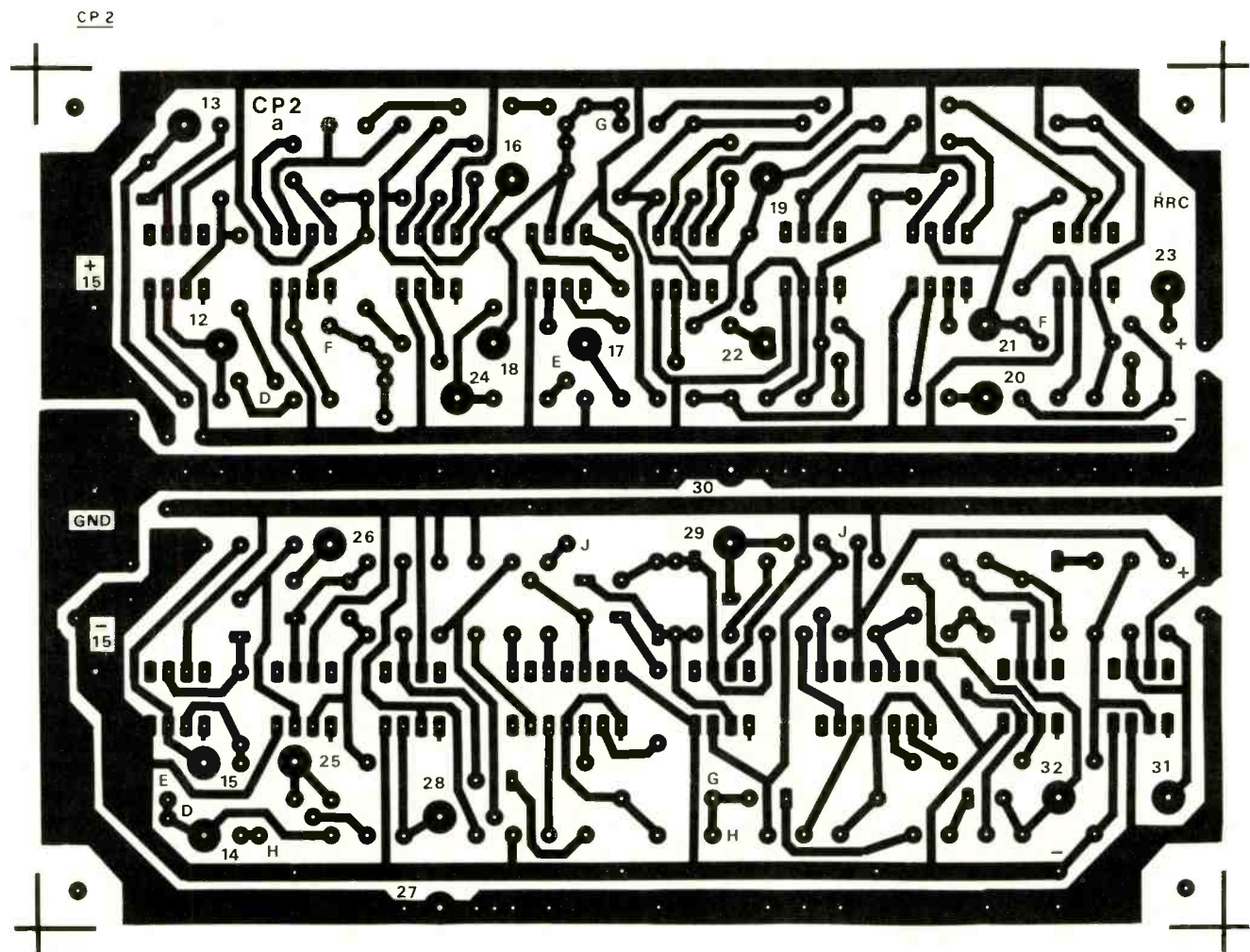


Fig. 21 — Printed circuit board CP2 for the input circuit, bandpass filter, product amplifiers, and auto-set level circuits.

input back and forth along the time axis, an asymmetry will be produced in the V_o waveform, corresponding to an average d.c. value.

The bottom illustration depicts a 45-degree relationship between the X and Y inputs. By trigonometry we can argue that the Y signal consists of equal portions of normal and quadrature components in this case. This would be representative of a situation where there were both amplitude and frequency errors simultaneously. We see that in this case a positive average d.c. output is produced at V_o . It is not, of course, quite as strongly positive as when X and Y are perfectly in phase.

We can see that if we apply an "unknown" signal to the Y input and a "reference" signal to the X input, the detector will respond to components in the unknown signal whose phase is similar to (or the inverse of) that of the reference. Components in quadrature with the reference will be ignored. In addition, the effects of noise and signals at other frequencies will average out to zero.

Returning to Fig. 15, the amplitude detector consists of ICs 25-27. The distortion product signal ("unknown") is taken from the output of IC31 (Fig. 18) and passes through IC25 where it sees a small-signal gain of five and is soft-limited beginning at ± 0.7 V swings by the

feedback diodes. The signal is then applied to the Y input of IC26 where it is phase-compared with a "normal" fundamental provided by the output of the reference VCA (IC23).

The differential output of the phase detector is filtered and applied to IC27A where it is converted to a single-ended signal. This signal drives the integrator (IC27B) to produce the appropriate gate voltage for the amplitude control FET (Q6). The integrator will continue to adjust the gate voltage until the output of IC27A is driven to zero. Notice that when the error from IC27A is greater than ± 0.7 V, D14 and D15 conduct and speed up the integrator to achieve

CP 2

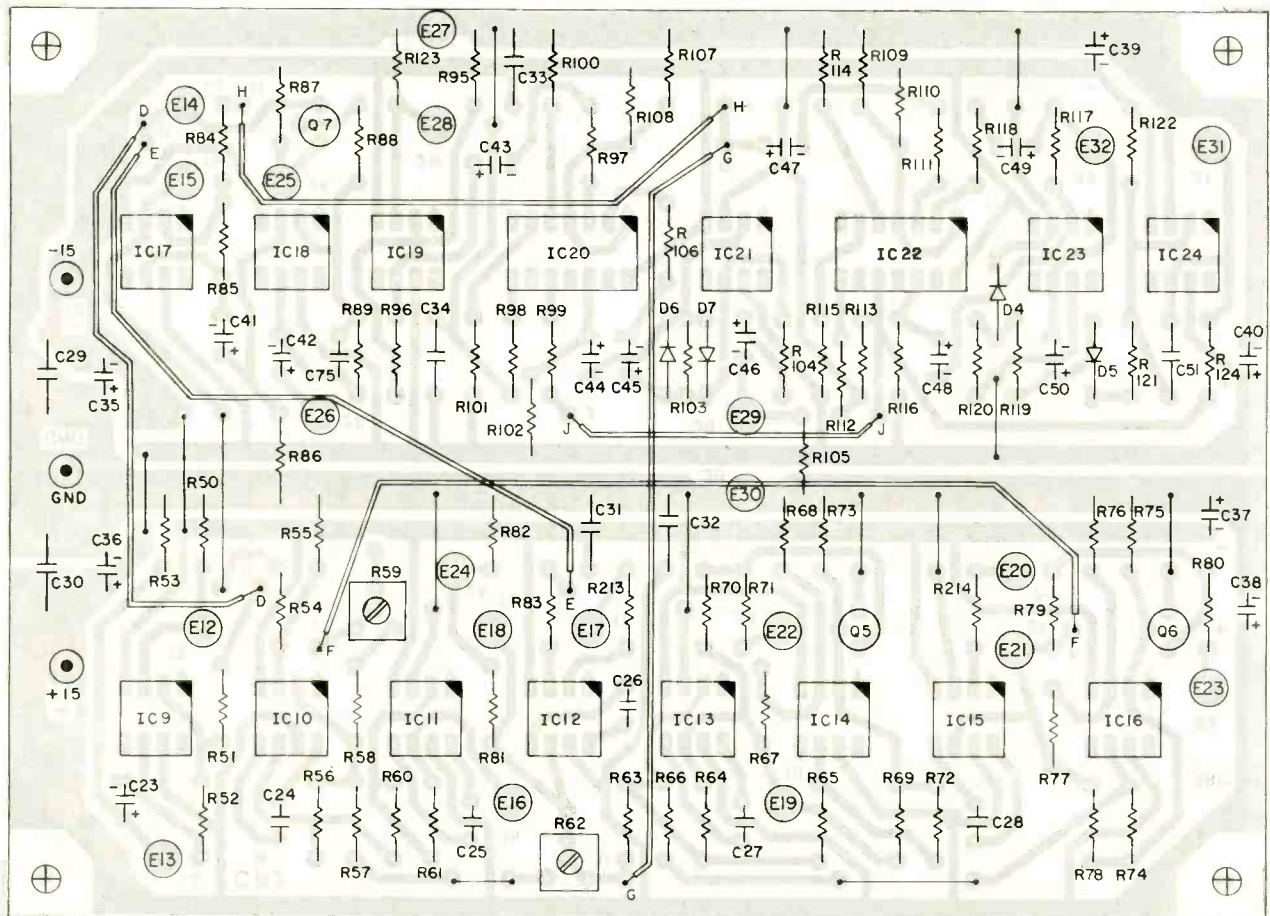


Fig. 22 — Component placement for CP2.

faster tuning following a transient.

Operation of the frequency detector (ICs 28-30) is identical to that of the amplitude detector except that it is supplied with a quadrature fundamental reference (lagging 90 degrees) instead of a normal fundamental reference. The quadrature reference is supplied from the low-pass output (IC15) of the state-variable filter and passed through amplifier-limiter IC28 before application to the X input of IC29.

Filter and Meter Circuits

The filtering, metering, and status indicator circuits are shown in Fig. 18. The distortion product signal from the auto-

set level VCA on CP2 (E29) is first amplified by a factor of one or 10 in IC31 to keep it at a reasonable level for use by the auto-tune circuits for all sensitivity settings of S5. Switch S5C sets the gain of this stage to 10 on the 0.03- through 10-percent sensitivity ranges to compensate for attenuation introduced by the S5A attenuator on these ranges. Note that S5C does not affect gain in the distortion metering path.

The distortion product signal from E29 is also applied to the low-pass product filter. As mentioned earlier, the second-order Bessel low-pass product filter is set for a 3-dB cutoff frequency equal to 10 times the fundamental frequency.

The filter consists of a pair of resistors (on S3), a pair of capacitors (on S1) and an op-amp (IC32) connected as a voltage follower [3]. This filter is followed by the second-order high-pass filter (IC33) which is similarly realized. Its filter Q is chosen to provide a slight gain bump at the second harmonic frequency to partly offset the small loss in the notch filter at this frequency. For reasons of high-frequency filter stability, the high-pass filter has the same set of cutoff frequencies on the 200-kHz range as on the 20-kHz range.

As mentioned in Part I, the tracking product filters add a considerable portion of the switching complexity and ex-

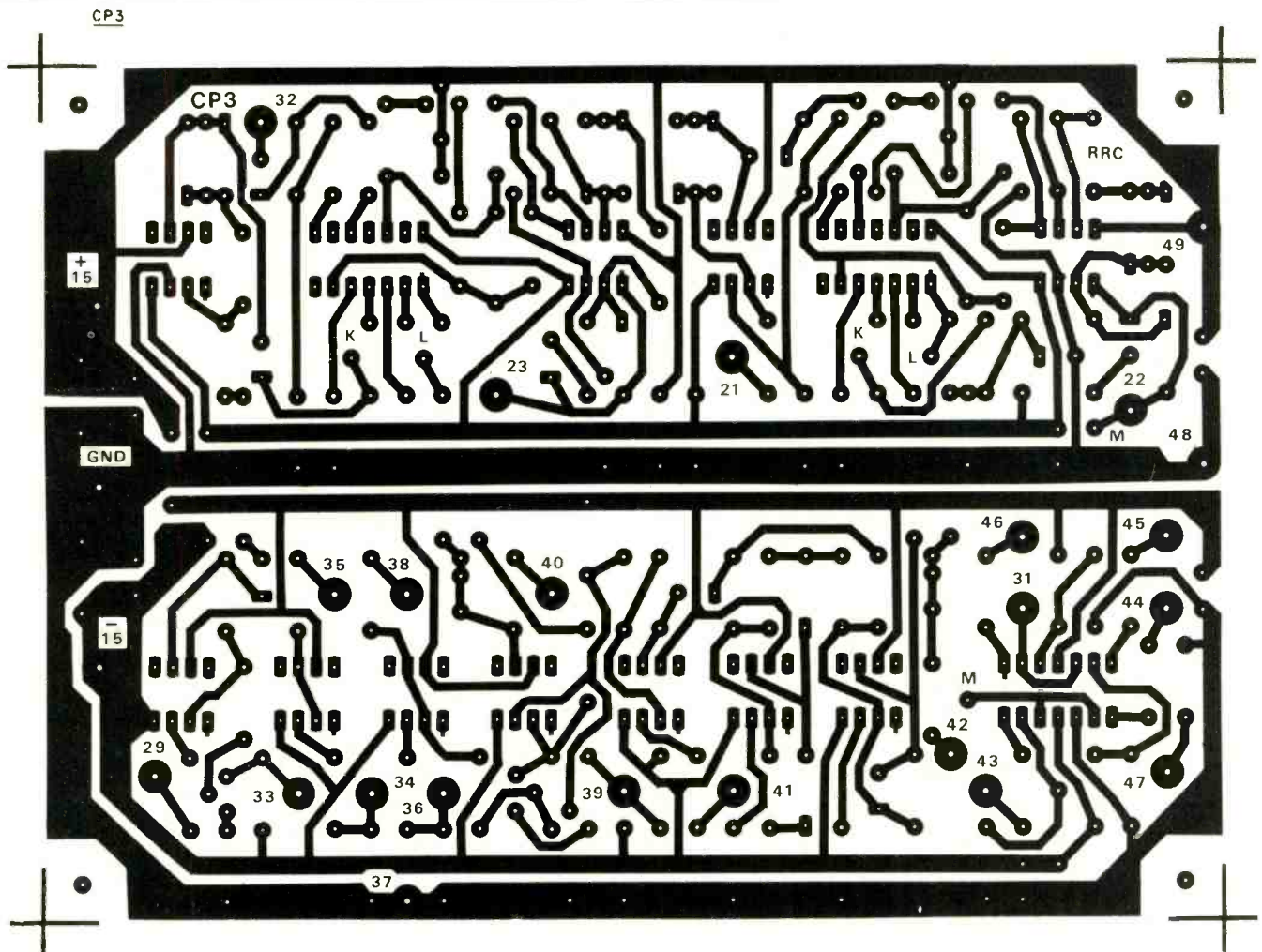


Fig. 23 — Printed circuit board CP3 for the auto tune control, product filter, meter and status indicator circuits.

pense (about \$25.00) to the analyzer. Many professional analyzers provide only a switchable 400-Hz high-pass filter and a low-pass filter which can be set to 30 or 80 kHz or switched out. This simpler filtering approach can be implemented as shown in Fig. 19 with a SPST switch for the high-pass and a center-off DPDT switch for the low-pass. Use of this simpler filtering will typically result in an increase of the analyzer's residual by 0 to 3 dB and will make the reading somewhat more susceptible to hum and noise in the UUT.

Following the filters, the distortion product signal is brought to a 100-mV full-scale level by the switched-gain am-

plifier composed of FET Q9 and IC34. The total gain of this combination is either 0.33 or 3.3 depending on the setting of S5D. Trimmer R180 provides calibration for the distortion measurement.

Provision is also made to monitor the input level with the meter circuits. This makes it possible to make a complete THD measurement on a piece of equipment without any other test instruments. Selection of distortion or level as the quantity to be measured is accomplished by S6. In the "Level" position, an attenuated output from the bandpass filter is applied to the meter circuits. The full-scale "Level" range then corresponds to the setting of the input attenu-

ator. Note that this provides a narrowband measurement of the input signal level.

The distortion product signal is then applied to the meter circuit, consisting of IC36 and IC37. IC36 is connected as a unity-gain inverting feedback amplifier which has two feedback paths, one for positive output-signal excursions (D23) and one for negative output excursions (D22). Positive and negative half-wave rectified signals thus appear at the two feedback resistors. The negative half-wave rectified signal and half the unrectified input signal are added at the input of IC37 to produce a full-wave rectified result. This amplifier also provides appro-

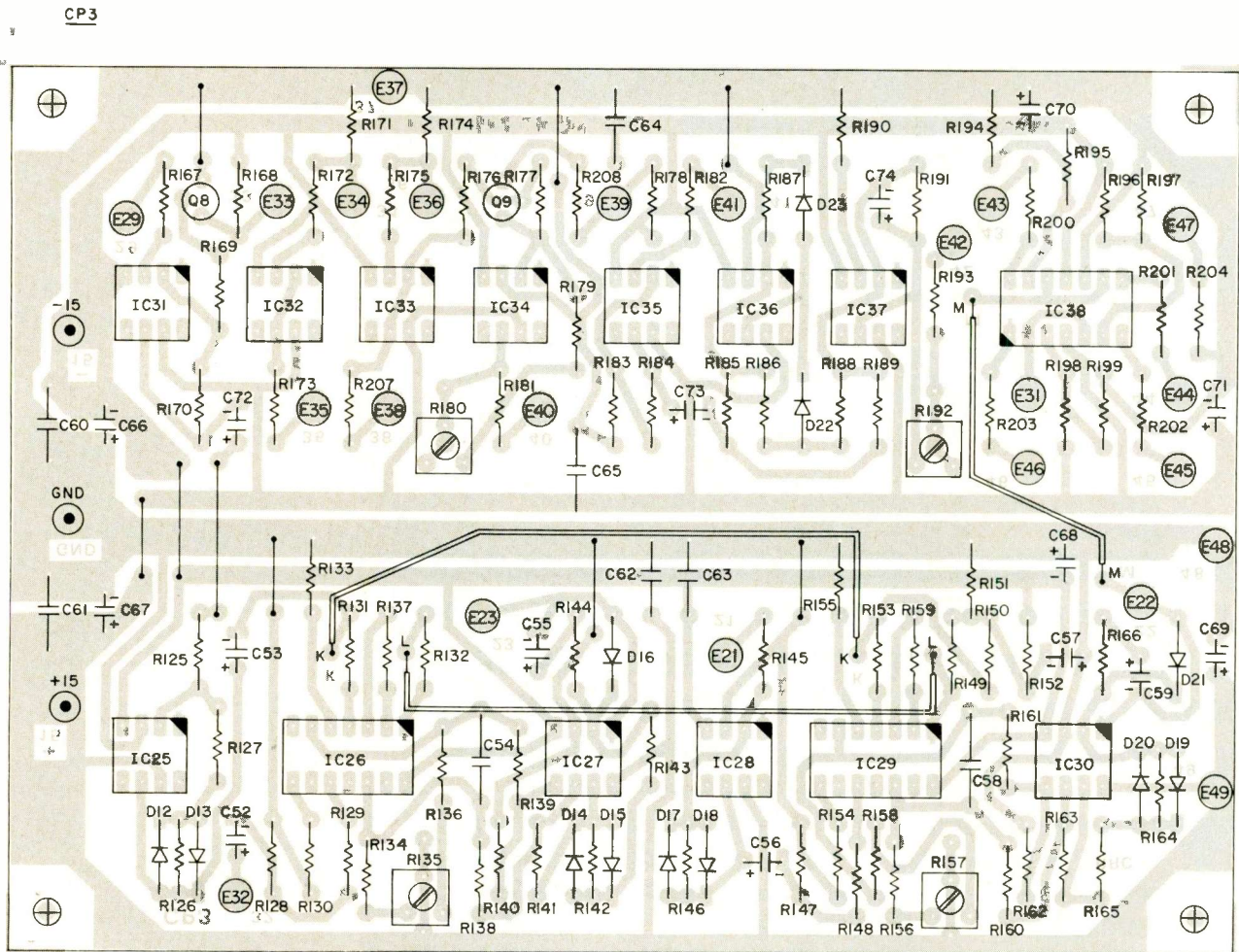


Fig. 24 — Component placement for CP3.

appropriate low-pass filtering of the result. The single-ended output of IC37 is then used to drive the meter movement.

The status indicator circuits indicate whether the incoming level is too high or too low for proper analyzer operation, and whether the incoming frequency is too high or too low for the auto tune circuits. A quad op-amp comparator (IC38) drives the four indicator LEDs.

The frequency indicator circuit monitors the gate voltage on the frequency control FET (Q5) to see if the frequency is within the tuning range. If the gate voltage is zero or positive, the frequency is too low, and the "Low" LED is lit. If the voltage is more negative than -12 V, the

FET is pinched off and the frequency is too high.

The input level indicator circuit monitors the a.g.c. control voltage in the auto-set level circuit. If this voltage goes more negative than -3.5 V, indicating that the input level is more than 11.5 dB above the nominal 1-V internal operating level, the "High" LED will be lit. Similarly, a level more than 11.5 dB below the nominal operating level will light the "Low" LED.

Power Supply

The regulated ± 15 V power supply for the analyzer is shown in Fig. 20. The circuit employs a full-wave bridge recti-

fier and standard three-terminal regulator ICs.

The input circuit, bandpass filter, product amplifiers and auto-set level circuits are realized on printed circuit board CP2. Its layout is shown in Fig. 21 and the component placement diagram is shown in Fig. 22. The auto tune control, product filter, meter and status indicator circuits are realized on CP3. Its layout is shown in Fig. 23, while component placement is illustrated in Fig. 24.

This completes the description of all of the circuitry in the THD analyzer. Next month we'll conclude with construction details, the adjustment procedure, troubleshooting, and performance data. Δ

Measuring Speaker Motion With A Laser --- PART ONE

G. J. ADAMS*

Laser interferometry allows for the first time accurate measurement of speaker cone vibrations at high frequencies without any attachments or modifications to the cone.

The loudspeaker industry has always been quick to recognize the usefulness of new measuring instruments and techniques in its struggle to unravel the mysteries of the loudspeaker. This article describes a measuring tool which is new to the industry, the laser interferometer, which for the first time allows accurate quantitative measurements of loudspeaker cone vibration to be made at high frequencies without the need for mechanical attachments or modifications to the loudspeaker cone. Before describing this new instrument, I would like to present a brief historical background of the invention and development of the moving-coil loudspeaker, together with a simple description of its operating principles and the techniques used previously for the measurement of loudspeaker cone vibration.

Historical Background

The moving-coil loudspeaker driver began its record of commercial success in the early 1920s with the introduction of the Phonetron loudspeaker [1, 2, 3]. This device consisted of a large conical diaphragm supported at its base by a free-standing framework, and driven at its apex by a moving-coil type motor

*B&W Loudspeakers, Worthing, Sussex, England



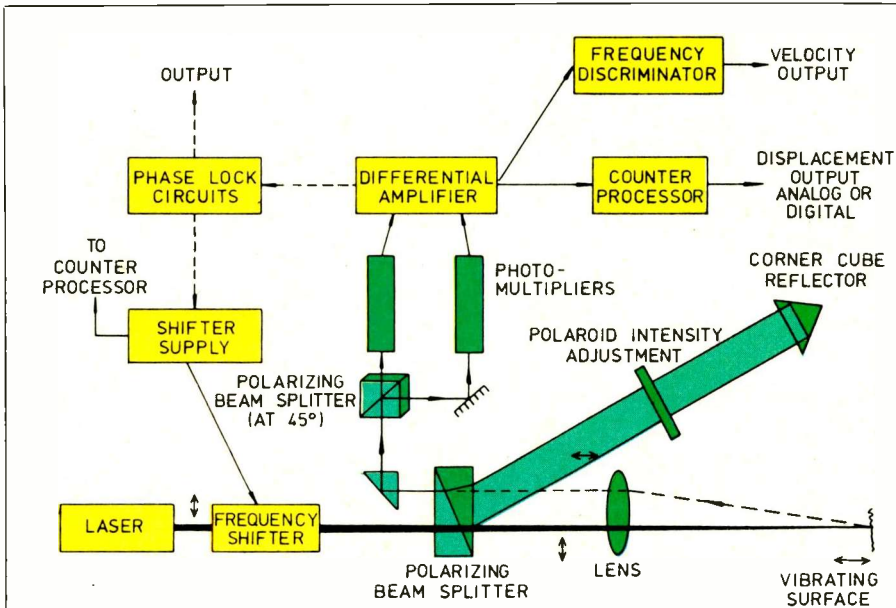
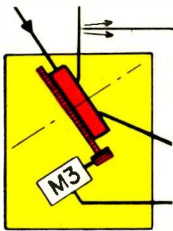


Fig. 1 — Block diagram showing the main components of the Harwell laser interferometer.

system attached to the same framework. The Phonetron was followed a few years later by the introduction of the Radiola 104 loudspeaker [4, p. 80] by the American General Electric Co. This loudspeaker proved to be a notable commercial success thanks to the ingenuity of its designers, Rice and Kellogg [5], and their foresight in building into the loudspeaker an audio power amplifier (of about 1 watt maximum output power) to overcome the inherent low efficiency of their direct-radiator loudspeaker. Although the invention of the moving-coil driver can be attributed to a number of the inventors of the late nineteenth century (e.g., Siemens [6, 7], Cuttriss and Redding [8], and Lodge [9]), there is little doubt that Rice and Kellogg were responsible for the first widespread commercial success of the moving-coil loudspeaker driver.

Rice and Kellogg's investigations of the feasibility of constructing an effective "hornless" loudspeaker involved some theoretical work in addition to much experimentation. Their simple theoretical analysis revealed a feature of the moving-coil driver, not mentioned by the inventors, which with correct design enabled a far superior frequency response

to be obtained than was achievable with the then-popular moving-iron driven horn loudspeaker. Hunt's clear and concise explanation of this feature [4, p.81] is difficult to improve:

"Sound radiation gives rise to a mechanical resistance to the vibratory motion of a small diaphragm mounted in a baffle; this radiation resistance, and hence the radiated sound power, would increase with the square of the frequency if the vibratory velocity were maintained constant; but the square of the vibratory velocity (on which the sound power also depends) will decrease with the square of the frequency throughout the frequency range above resonance, where the motion of the system is primarily controlled by mass reactance. It follows that if the fundamental resonance of the diaphragm system is made to occur *below* the lowest frequency of interest, the complementary variation with frequency of the two factors that jointly control the sound output will yield a uniform response throughout the middle range and up to some higher frequencies at which the assumptions begin to fail."

This acoustical virtue that Rice and Kellogg recognized and put to work,

continues, after a period of more than half a century, to be the basic precept that guides the design of direct-radiator loudspeakers.

Present-day moving-coil loudspeaker drivers show only minor design changes over the original Rice-Kellogg design — a fitting tribute to the ingenuity of these two engineers. Although several other types of loudspeaker driver have been developed commercially, often in an attempt to improve upon the moving-coil driver, the latter still remains the mainstay of the loudspeaker industry. Its continued popularity is evident from the vast quantity of loudspeaker cones manufactured each week — one major European manufacturer alone produces over half a million cones per week!

Many of the design changes made to the moving-coil driver have been a result of endeavors to improve the uniformity of the sound-output versus frequency response of the driver in the high-frequency range where the assumptions mentioned by Hunt fail. At these frequencies the loudspeaker cone no longer vibrates as a rigid whole, as it does at low frequencies, but exhibits vibrational modes such that different parts of the cone vibrate with different amplitudes and phases with respect to the driving signal (input voltage). In addition, the radiation resistance becomes dependent on the cone geometry and the distribution of the modes on the cone surface. As a result of these effects the sound output of the driver at different frequencies in the high-frequency range is generally non-uniform — clearly an undesirable feature.

The distribution of the vibrational modes on the cone surface (commonly referred to as the "breakup pattern") is a function of the frequency of the driving signal, the geometry of the cone, and the material parameters (e.g., the density, stiffness, etc.) of the cone. Because calculation of the breakup pattern, and hence calculation of the sound output, of a loudspeaker cone has only recently become possible using high-speed digital computers, the choice of the geometrical and material parameters of a loudspeaker cone to give the most uniform high-frequency response has been largely an empirical art. Loudspeaker designers have thus spent many hours in the past experimenting with different cone shapes and materials. The tech-

nique used to measure performance in these experiments was usually the frequency response taken under free-field conditions using a microphone to sense the sound output and a variable-frequency sine-wave voltage to excite the loudspeaker. However, with the growing interest in the mechanical behavior of the cone in the high-frequency range, workers in the loudspeaker field began to seek and make use of methods for measuring the cone vibration pattern.

Probably the first technique to be used to observe the cone vibration pattern followed on from the method used by Chladni (in about 1790) to examine the modes of vibration of a glass plate. A sprinkling of fine sand or dust on the vibrating cone migrates to those areas of the cone which show the least vibration [10, 11]. Using sine-wave excitation, any standing waves of sufficient amplitude to disturb the dust are revealed by piles of dust lying at the nodes. Some good examples of the patterns obtained using lycopodium powder are given in [12, 13 and 14]. The invention of the electronic stroboscope provided a rather more convenient method of observing the vibration pattern. Here the cone is illuminated during vibration by an intermittent light source whose frequency is slightly less than, or greater than, that of the driving signal. The mode of vibration is thus revealed to the naked eye as if in slow motion [15, 16]. An example of the result that can be obtained using a stroboscope is given in [17]. Unfortunately, the dust and stroboscope methods are only successful where the amplitude of vibration is reasonably large. Because the vibration amplitude is roughly proportional to the inverse of frequency squared, these methods are usually limited to the observation of the lowest frequency modes only. N. W. McLachlan in his as yet unsurpassed treatise on *The Loud Speaker* [15] describes several imaginative schemes for measuring vibrational modes of large amplitude including the use of an "acoustic compass" consisting of a small, light propeller suspended on a delicate thread. McLachlan also describes the use of an a.c. bridge for measuring the "apparent" radiation resistance of the cone. This resistance is dependent upon the mechanical behavior of the cone and thus gives some indication of the frequencies at which vibrational modes occur. Unfortunately, this

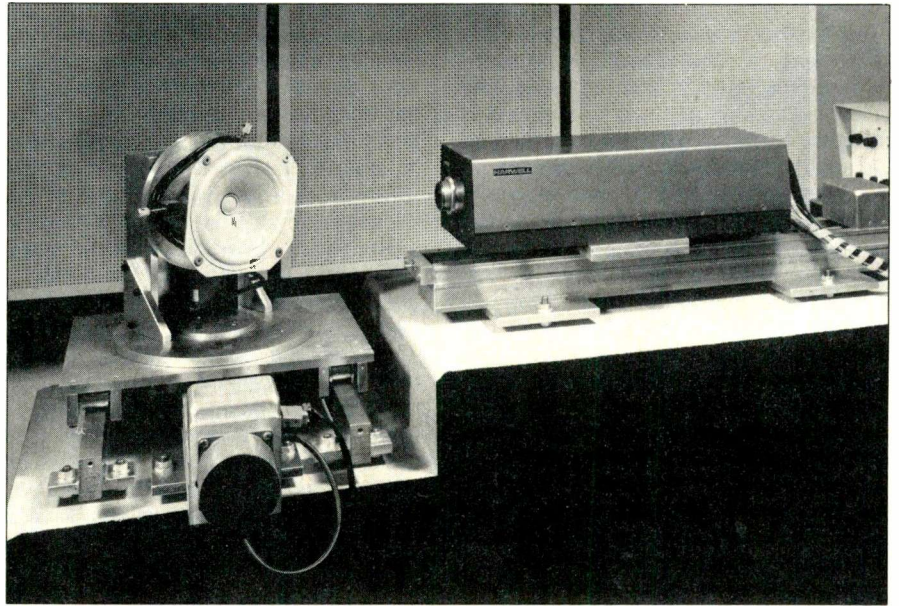


Fig. 2 — The laser head and the loudspeaker driver under test are firmly mounted onto a concrete block. The

latter is mounted on vibration isolators to reduce the transmission of ground vibration noise to the measuring system.

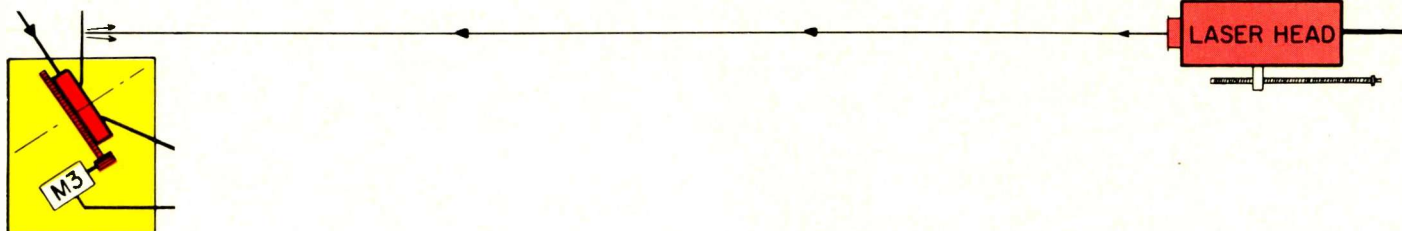
measurement is not sufficient in itself to enable one to deduce the modes of vibration.

Corrington and Kidd [18] made what would appear to be the first serious attempt to measure the modes of vibration of the cone at high frequencies. Their measurement apparatus consisted of a small capacitor probe positioned just above the point of interest on the cone surface. The capacitance of this probe was made to be a function of the cone displacement by virtue of a coat of conducting paint given to the rear surface of the cone. The displacement at any point on the cone surface could thus be found by measuring the variation in capacitance of the probe positioned above that point. Using this apparatus, Corrington and Kidd took measurements of the amplitude and phase (relative to the driving signal) at about a dozen points spaced along a radius of the loudspeaker cone.

Nimura and Kido [19] describe the use of a similar capacitance probe to investigate the motion of the cone and the outer suspension at a few points as a function of frequency. They also describe the investigation of the sound-pressure distribution over the surface of the loudspeaker cone using a probe mi-

crophone in an attempt to identify the modes of vibration.

In the early 1960s Yorke [13] constructed an ingenious apparatus for measuring the cone displacement at a point using a small rectangular light beam. The beam was directed at the point of interest on the cone surface in such a way that it was reflected off the surface into a beam splitter. The two output beams of the beam splitter were directed onto photocells whose electrical output signals were subtracted to yield a voltage dependent on the cone displacement. To facilitate speedy and consistent positioning of the light spot on the cone surface, Yorke constructed servo motor systems to control the radial spot position and to control the distance between the light source and the cone surface. The latter control was made to be automatic such that the sum of the photocell outputs was always optimized. Thus, as the light spot traversed across the cone, the light source and photocell assembly automatically "followed" the shape of the cone surface. Using this apparatus, Yorke took measurements of the amplitude and phase at 18 points along a radius of a 12-inch diameter loudspeaker cone as a function of fre-



quency. Although Yorke's apparatus was the first to enable quantitative measurements of cone vibration to be made without the need to treat or modify the cone surface in any way, it was unfortunately only effective for frequencies up to about 4 kHz due to S/N limitations.

Measurement of the cone displacement becomes more difficult as the frequency of the driving signal is increased because under mass control the displacement amplitude varies inversely with the square of the frequency. The difficulty of making displacement measurements at high frequencies was partly overcome by using holography to record an image of the cone breakup pattern [17, 20, 21, 22, 23]. In one technique the whole of the cone is illuminated with laser light such that the light reflected from the vibrating surface falls on a photographic plate. By also illuminating the plate with part of the incident beam, a continuously changing interference pattern is exposed on the plate (over a period of several seconds). After development, the plate, or "hologram," can be viewed in laser light to reveal a time average of the interference pattern. Cone parts at rest (e.g., nodal lines or circles) appear light, while those parts in motion appear dark. Because the wavelength of laser light is very small (e.g., about 0.6 μm for a helium-neon laser), the holographic technique enables measurement of displacement amplitudes down to the order of 1 μm . This degree of sensitivity means that vibration patterns for frequencies extending above the audible range can normally be obtained. The only major drawback of the holographic technique is the difficulty of obtaining quantitative data of the displacement amplitude from the hologram. While this is possible in theory [21], the correct estimation of the amplitude of displacement at any point relies on one's personal interpretation of the contrast between the light and dark areas surrounding the point. The estimates are thus open to some doubt.

Laser Interferometry

The desire of the B&W research department to make quantitative measurements of the amplitude and phase of the cone vibration at high frequencies was satisfied in 1978 by the purchase of a vibration interferometer developed and built by the Atomic Energy Research Es-

tablishment at Harwell, England [24, 25]. This device also makes use of the interference of laser light but differs considerably from the holographic technique in its principle of operation. A simplified block diagram of the measuring system is shown in Fig. 1. A polarized light beam from a low-power (about 5 mW) helium-neon laser is passed through an electro-optic frequency-shifting device and a lens onto the point of interest on the loudspeaker cone's surface. Scattered light from the cone surface is collected by the same lens and is mixed with a reference light beam derived from the main light beam. The mixed beam is then converted to an electrical signal by a pair of photomultipliers. This electrical signal is in turn fed to a frequency discriminator whose electrical output signal is dependent on the velocity of the cone surface. The electro-optic frequency-shifting device is a type of Kerr cell [26] which allows most of the light passing through the cell to retain its original polarization and frequency, but in addition generates a component whose polarization axis is at 90 degrees to that of the main beam and whose frequency is shifted. This component, which is about 5 percent of the total, is separated from the main beam using a polarizing beam splitter to form the reference beam. The intensity of the reference beam can be controlled by a rotatable polarized plate in the path of the reference beam. An intensity of five to ten times that of the scattered light is generally found to give the best results. The scattered light and the reference beam when recombined have orthogonal polarizations and thus they will not interfere directly. This problem is solved by directing the mixed beam at a polarizing beam splitter whose axes are at 45 degrees to the polarization axes of the scattered light and reference beam components. The two outputs of the beam splitter both have components of the scattered light and the reference beam which are polarized along the same axis, and thus interference occurs in these output beams. The resulting interference signal components in the two output beams differ in phase by 180 degrees. This effect is used to advantage by converting the two output beams to electrical signals using two separate photomultipliers (see Fig. 1) and then subtracting these electrical signals using a difference amplifier to form

the input signal to the discriminator. The balanced arrangement so formed has the advantage of being less sensitive to fluctuations in the intensity of the beams than a single detector arrangement.

In normal operation of the interferometer, a constant shift in frequency of about 5 MHz is applied to the reference beam. When the cone surface is stationary, the scattered light and the reference beam differ in frequency by the value of the shift frequency only. The output of the difference amplifier thus contains a 5-MHz beat signal arising from the interference of the scattered light and the reference beam. If the cone surface is in motion, the frequency of the scattered light is frequency modulated as a function of the surface velocity because of the Doppler effect. This modulation of the scattered light gives rise to modulation of the 5-MHz beat signal output from the difference amplifier. Conversion of the frequency of the beat signal to a corresponding voltage (by the discriminator) yields a signal voltage which is proportional to the velocity of the illuminated part of the cone surface.

The use of a constant shift in the frequency of the reference beam enables the interferometer to sense the direction in which the cone surface is moving (i.e., away from or towards the light source). Without such a shift in frequency, the velocity output waveform from the discriminator would appear as if it had been "full-wave rectified." The ability to sense the direction of movement of the surface also enables the displacement of the cone surface to be obtained by counting the cycles of the beat frequency and the cycles of the shift frequency and finding their difference by subtraction. The subtraction can be done virtually continuously and the difference converted to an analog voltage. In the Harwell system the "zero crossings" of the cycles are counted, and thus the limit of resolution of the measuring system is about a quarter of the wavelength of the laser light, i.e. about 0.16 μm for a helium-neon laser.

Mechanical Considerations

Meaningful measurements of displacements as small as 1 μm or less can only be obtained if the laser source and associated optics and the loudspeaker driver under test are solidly mounted onto a common base. Where only veloci-

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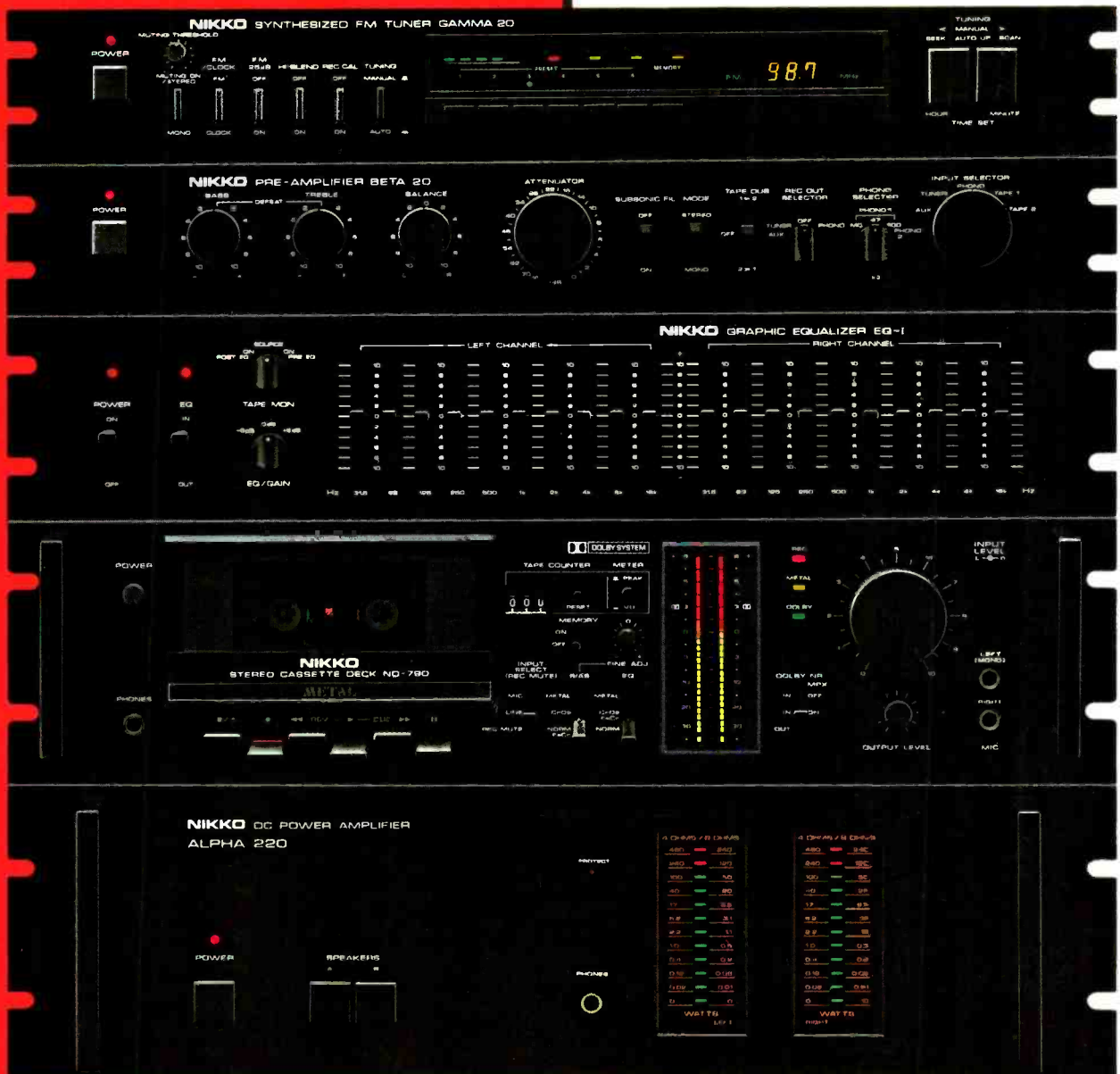
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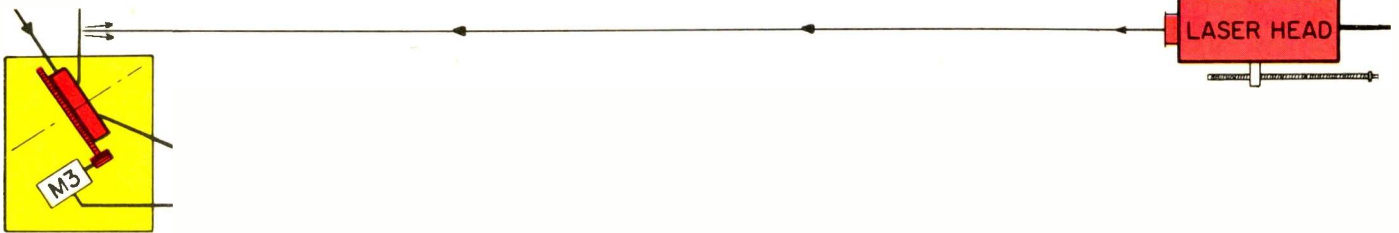
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ty measurements are of interest, the mounting requirements are somewhat less important, although the use of a solid base does offer some improvement in the signal-to-noise ratio of the velocity output signal by virtue of the increased positional stability of the scattered light relative to the laser.

The main optical components of the Harwell laser are mounted in a head assembly measuring approximately 150 mm square by 500 mm long. The electronics and power supplies required are mounted in a separate housing connected to the laser head via several meters of cable. A solid base for the laser head and loudspeaker was constructed by casting a block of concrete approximately 0.5 m square by 1.3 m long. A number of lag bolts were set into this block during the casting process to enable firm fixing of the laser head and loudspeaker. To isolate the block from ground vibration noise, the block is positioned on vibration isolators whose stiffness was se-

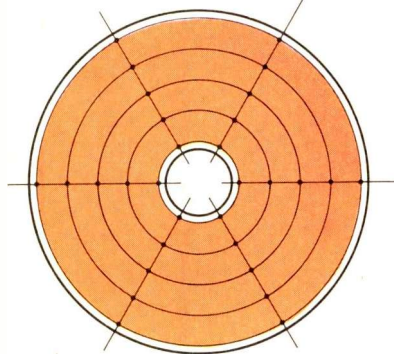


Fig. 3 — A grid of points on the cone at which the motion is to be measured can be conveniently defined by a set of imaginary radial lines and concentric circles.

lected to give a resonance with the mass of the block of about 10 Hz. Figure 2 shows the completed block.

Both the laser head and the loudspeaker driver are mounted onto the block via precision lead screw-type slide assemblies in which the lead screws are driven by stepping motors. These slides allow adjustment of the laser head-to-cone surface distance and the radial position of the point of illumination on the cone surface. The former adjustment is required for focusing of the laser beam; this adjustment is not critical within a few centimeters and is thus normally required only at the commencement of taking a set of measurements. The circumferential position of the light spot on the cone surface is made easily adjustable by mounting the loudspeaker driver onto the radial slide assembly via a rotary positioning table. The latter is also controlled by a stepping motor. The rotary table is provided with a three-jaw chuck-type of arrangement to enable drivers of different shapes and sizes to be clamped in position with little effort. The maximum driver diameter that can

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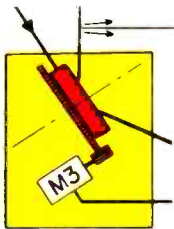
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be accommodated is about 350 mm. The mounting base of the rotary positioning table is provided with a rotary adjustment about a vertical axis so that the part of the cone surface which is under examination can be placed approximately at right angles to the incident laser beam. This ensures that the scattered light is directed mainly back towards the laser head, and that the measurements

3, the intersections of imaginary radial lines and concentric circles drawn on the cone surface. This type of grid is convenient because the point of illumination on the cone surface can be moved along a line or circle by driving the motors of the radial slide assembly or the rotary positioning table respectively. The spacing of the lines and circles defining the grid defines the "resolution" of the measured breakup pattern; thus complicated breakup patterns require a finer spacing for good definition than do simple breakup patterns. Because the complexity of the breakup pattern generally increases with increasing frequency, the minimum number of measurement positions required to correctly define the cone motion will depend on the highest frequency of interest. By way of example, a 16-cm diameter paper cone would probably require about 300 measurement positions for frequencies up to about 3 kHz. Bearing in mind the need to repeat such a number of measurements for each discrete frequency of interest, it soon becomes clear that the quantity of data to be recorded can become rather excessive. This is where the computer proves to be an invaluable aid to the measurement system.

The PDP-11 computer system installed at the B&W research department is equipped with data acquisition facilities together with the software required to enable the measurement and storage of time-varying voltages. Both the input voltage to the loudspeaker voice-coil and the velocity output voltage of the laser measurement system are interfaced to the computer system. Simultaneous acquisition of the input and output signals is possible for a sampling rate of up to 50,000 samples per second. Measurement and storage of the cone breakup pattern by the computer can be carried out using sine-wave excitation as described previously; however, the time taken to store measurements for a large number of frequencies can be reduced considerably by measuring the velocity impulse response at each position on the cone surface. This single measurement contains information about the amplitude and phase of the cone surface motion at all frequencies. A modified form of this impulse response can be measured by exciting the loudspeaker with a narrow (10-25 μ S wide) rectangular input voltage pulse, as shown in Fig. 4. Both this

input pulse and the velocity output pulse of the measuring system are sampled and stored in the computer. The transfer function between the input voltage to the loudspeaker and the cone surface velocity can then be found by transforming the pulses to the frequency domain using a Fast Fourier Transform (FFT) program installed in the computer, and performing a division of the output pulse

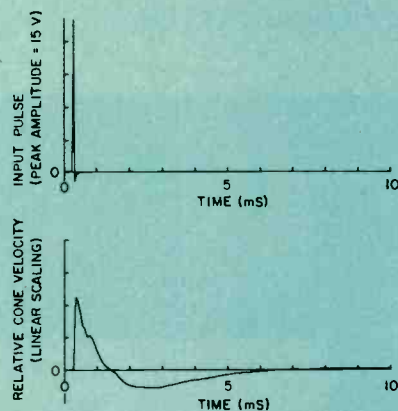


Fig. 4 — The input voltage pulse, top, applied to the loudspeaker and the output voltage pulse of the interferometer measured at one position on the loudspeaker cone.

of displacement or velocity taken are the transverse (i.e., perpendicular to the cone surface) values of these quantities.

Interface to Computer

The system described so far enables the motion at any point on the cone surface to be measured as a function of the excitation (or driving signal) applied to the voice-coil of the driver. Where the cone surface motion is of interest at discrete frequencies, the driving signal can be a sine-wave voltage. At any particular frequency the cone breakup pattern can be observed by noting the variation of the amplitude of the cone motion as the point of illumination is moved over the cone surface. To make a more thorough investigation of the cone behavior requires that the motion be measured and recorded at a number of discrete frequencies for each of several positions defined by, for example as shown in Fig.

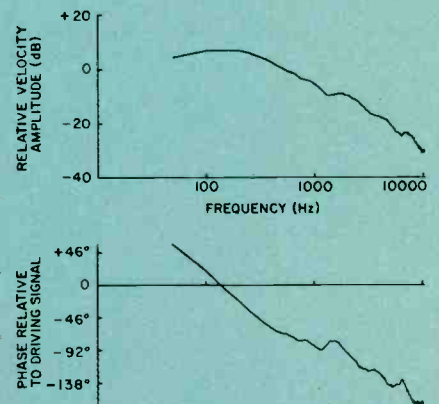


Fig. 5 — The amplitude-frequency response and the phase-frequency response of the cone velocity calculated from the pulses shown in Fig. 4 using an FFT computer program.

spectrum by the input pulse spectrum. To improve the signal-to-noise ratio of the measurement technique, the input pulse can be repeated (at a rate of, say, 1 Hz) and the output pulses measured and stored as an average in the computer. If n pulses are averaged, any random noise present in the pulse signal is reduced by a factor of \sqrt{n} relative to the main signal content.

The FFT program produces frequency response data at a number of discrete frequencies determined by the number of samples of the input and output pulses which are stored and then transformed to the frequency domain. The considerable time-saving advantage gained by using a computer to measure and store the frequency response data can be seen from the following example. Figure 4 shows the averaged input voltage and output voltage pulses of the measurement system taken for one posi-

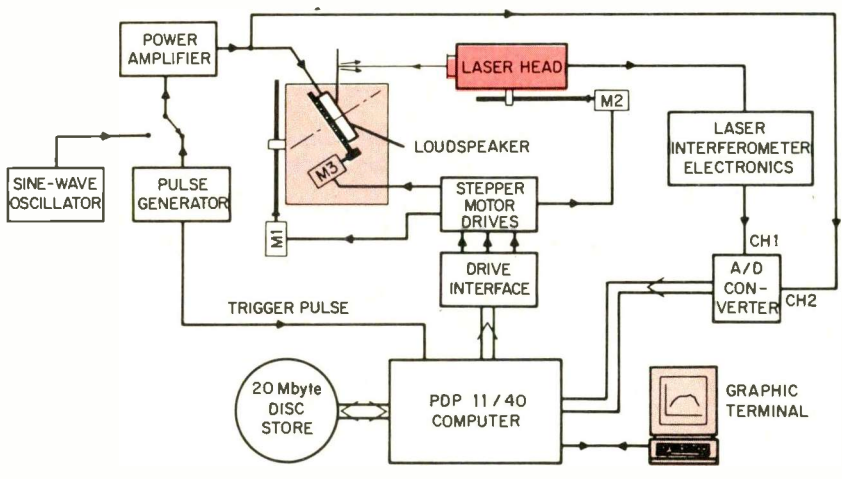


Fig. 6 — Block diagram showing the main components of the complete measuring system. The input voltage applied to the loudspeaker and the velocity output voltage of the interferometer are interfaced to the computer via an analog-to-digital

converter. The stepping motor drives, controlling the position of the point of illumination on the cone surface, are also interfaced to the computer to enable them to be controlled by a computer program.

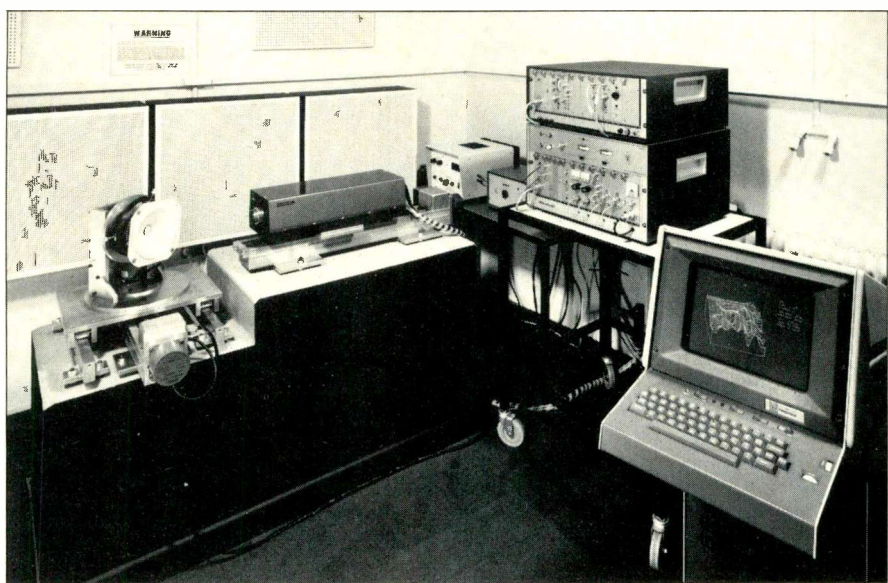


Fig. 7 — The complete laser interferometry system, from left to right, includes the loudspeaker and the laser head mounted on the concrete block, the stepping motor drives and interface, the interferometer electronics, and the computer terminal.

tion on a loudspeaker cone. The pulses were sampled at a rate of 50,000 samples per second for 1024 samples and were repeated at a rate of about one per second for just over half a minute. During the following minute the FFTs were performed, the division carried out to determine the transfer function, and the amplitude and phase of the cone surface velocity calculated and displayed on the computer terminal for over 500 discrete frequencies.

Figure 5 shows the calculated amplitude and phase responses at different frequencies that are obtained from the pulses shown in Fig. 4. The values of the amplitude and phase calculated at each discrete frequency are stored in the computer (on a magnetic disc) for use at some later date.

The positioning of the point of illumination on the cone surface can be carried out by manual control of the stepping motor drives. While this is satisfactory when only a small number of positions are to be investigated, the task becomes rather laborious for large numbers of positions. To ease this task, an interface between the stepping motor drives and the computer was constructed. This enables the three drives controlling the focusing and the radial and circumferential movement of the point of illumination to be controlled by software statements, which can be executed directly by typing them into the computer terminal or can be included within a computer program. Thus, for example, a program could be written to acquire a number of input and output pulses at one position, compute and store the transfer function for this position, move the point of illumination a certain distance in a radial direction, compute and store the transfer function for this position, and so on.

A block diagram showing the main components of the measuring system and the interface to the computer is given in Fig. 6. The complete measurement system and interfaces are illustrated in Fig. 7. The interfaces and the computer terminal are connected to the computer which is located in a nearby room.

In the second and last installment of this article, I will cover some analysis of the displays of the breakup patterns, distortion, and calculation of the sound-pressure response. References will be given at the end of the article.

1

PIONEER MODEL F-9 TUNER

Manufacturer's Specifications

Fm Tuner Section

Usable Sensitivity: 10.8 dBf; 1.9 μ V, 300 ohms.

50-dB Quieting: Mono, 15 dBf; stereo, 37 dBf, 39 μ V, 300 ohms.

S/N Ratio: Mono, 90 dB at 85 dBf; stereo, 85 dB at 85 dBf.

Mono THD: Wide, 0.03 percent at 100 Hz, 1 kHz, and 10 kHz; narrow, 0.05 percent at 1 kHz.

Stereo THD: Wide, 0.05 percent at 100 Hz and 1 kHz, 0.1 percent at 10 kHz; narrow, 0.5 percent at 1 kHz.

Capture Ratio: Wide, 1.0 dB; narrow, 2.5 dB.

Selectivity: Wide, 40 dB; narrow, 85 dB.

AM Suppression: 65 dB.

I.f. Rejection: 80 dB.

Subcarrier Rejection: 70 dB.

Spurious Rejection: 60 dB.

Muting Threshold: 25.2 dBf; 10 μ V, 300 ohms.

Stereo Separation: Wide, 55 dB at 1 kHz, 48 dB at 100 Hz and 10 kHz.

AM Tuner Section

Sensitivity: 10 μ V, 300 μ V/m, ferrite antenna.

Selectivity: Wide, 10 dB; narrow, 50 dB.

S/N Ratio: 50 dB.

Image Rejection: 60 dB.

I. f. Rejection: 80 dB.

General Specifications

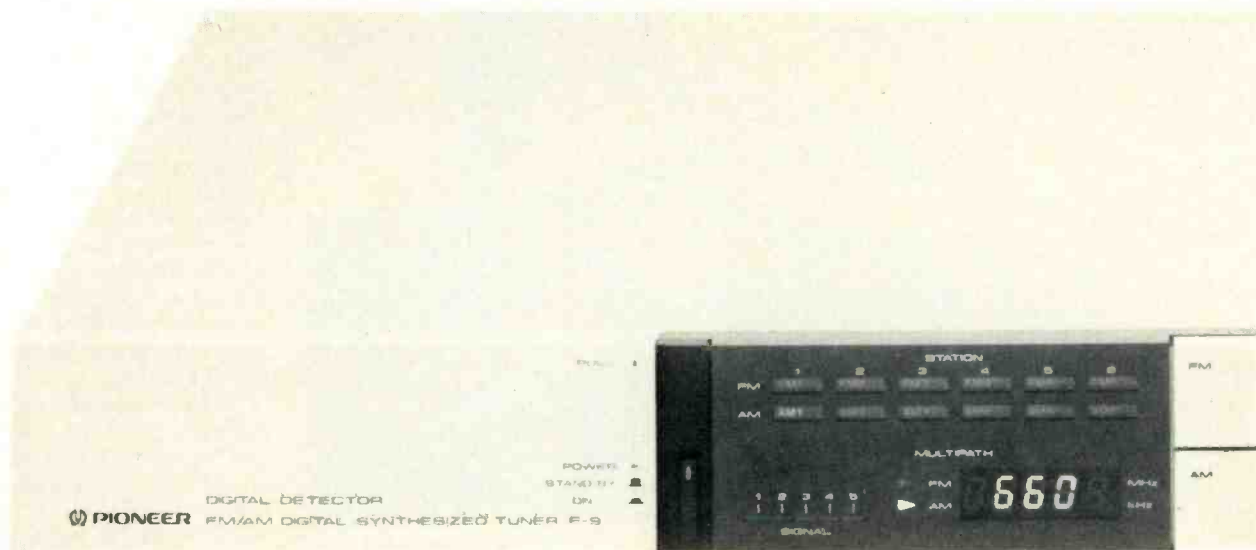
Audio Output: 650 mV, FM, 100 percent modulation; 200 mV, AM, 30 percent modulation.

Power Requirements: 120 V, 60 Hz.

Dimensions: 16½ in. (41.9 cm) W x 2¾ in. (6.0 cm) H x 15 in. (38.1 cm) D.

Weight: 9 lbs., 15 oz. (4.5 kg).

Price: \$425.00.



Suddenly, several of the major tuner manufacturers (or at least two of them, so far) have discovered how to make frequency synthesizer FM/AM tuners that *do not* sacrifice performance in return for tuning accuracy and ease of tuning. Readers may recall our April 1981 Equipment Profile concerning a Sony tuner which accomplished this hitherto unrealizable feat. Now Pioneer has done it too, and the raves that we gave the tuner from the competition apply to Pioneer's F-9 in just about equal measure. In at least one way, Pioneer has even gone beyond its competition. The F-9 features wide and narrow i.f. bandwidth positions; useful for those situations where the listener lives in a crowded metropolitan area where station frequencies are so close to each other that a wideband i.f. system, while ideal for low-distortion stereo FM reception, may well lead to audible adjacent and alternate-channel interference.

For all its tuning facilities and special features, the front panel of the F-9 is simple and clean looking. Less often used switches are hidden behind a small swing-down door at the left end of the panel. These controls include a record-calibrate switch (which delivers a tone at 330 Hz, equivalent to 50 percent modulation in FM, at the outputs), wide and narrow AM and FM i.f. buttons (yes, the AM circuitry also has selectable i.f. bandwidth), "up"

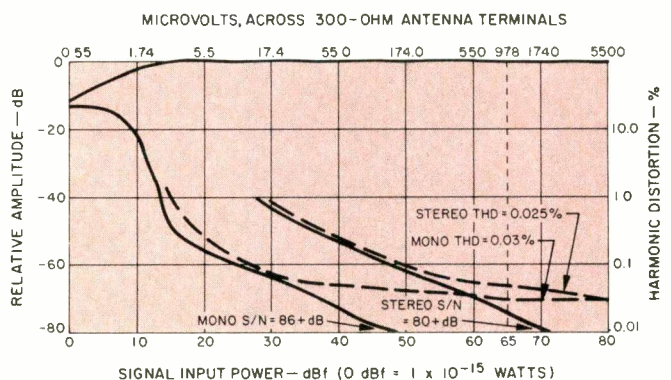


Fig. 1—Mono and stereo quieting and distortion characteristics, wide i.f. setting.

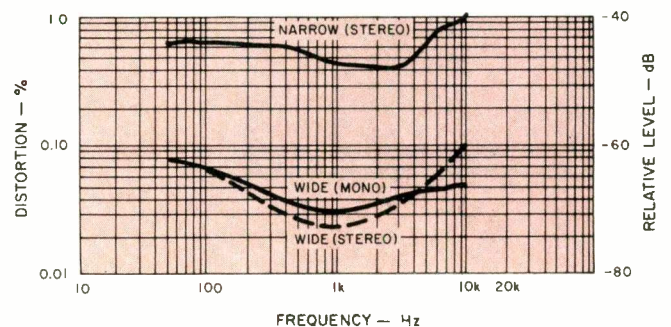


Fig. 2—Distortion vs. frequency, FM section.

and "down" tuning buttons, a memory button (which is used when entering favorite AM or FM station frequencies into any of the six available preset memory positions), and an auto/manual tuning mode selector. When the auto mode is chosen, touching the up or down tuning buttons causes the tuner to scan until a signal is intercepted. In the manual mode, touching these buttons alters frequency in 100-kHz increments (9 or 10 kHz in the AM mode). My only thought about this control layout is that the up and down tuning buttons might have been better off on the normally exposed surface of the front panel, since, in many areas of the U.S., there are so many listenable FM signals (and AM ones, for that matter) that six "memorized" settings may not be enough for most listeners, who will have to get behind that door panel to use the scanning or manual tuning modes.

The six station preset buttons are located at the right end of the panel, while the center third of the panel is largely dedicated to a series of illuminated displays, AM and FM selector buttons, and the power on/off switch. A digital readout of tuned-to AM or FM frequency is augmented by "AM" and "FM" lights, stereo and multipath indicator lights, a five-LFD signal strength indicator, and 12 tiny windows (six for AM and six for FM) into which

Pioneer's frequency-synthesizer F-9 is one FM tuner which does not sacrifice performance for tuning accuracy or preset station memories.

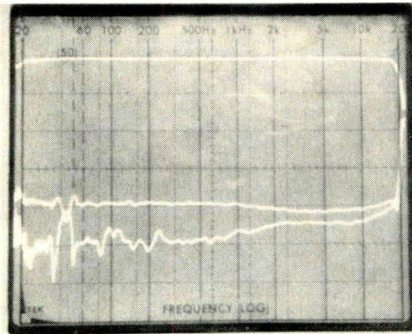


Fig. 3—Stereo FM frequency response and separation in narrow and wide i.f. modes.

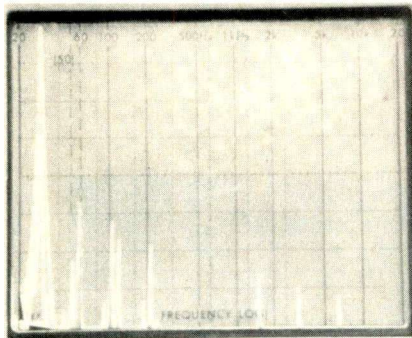


Fig. 4—Stereo FM crosstalk and distortion products in narrow i.f. mode.

can be slipped the frequencies of the corresponding favorite stations which have been permanently stored in the tuner's "memory" circuits. All possible AM and FM channel frequencies are supplied on four accessory cards so that the user can insert appropriate notations in the little windows on the front panel. These windows are numbered 1 through 6 (for AM and FM), corresponding to the similarly numbered station preset buttons at the right.

The rear panel of the F-9 is equipped with a 75-ohm coaxial connector and 300-ohm FM antenna terminals, external AM and ground terminals, a pivotable ferrite AM loopstick, the required pair of audio output jacks (whose output level is fixed), and a couple of farsighted features which you probably have not encountered before. The first of these is an AM stereo-out jack, which is basically a connection to a buffered AM i.f. stage. The jack is provided in anticipation of an FCC approval of one of several proposed systems for stereo AM broadcasting and would presumably accommodate stereo AM adaptor add-ons in the future. Another unusual feature on the rear panel is a slide switch which can be set for either 9-kHz or 10-kHz frequency steps when tuning the AM band. Much of Europe and Asia has already adopted the 9-kHz channel spacing, while the U.S., Canada, and the rest of the countries in this hemisphere continue to use channel assignments that are 10 kHz apart. However, at some future date we may also agree to change to a 9-kHz channel spacing system, and it would only be necessary to flick the switch on the back of the F-9 to allow the frequency-synthesized AM tuner section to tune in 9-kHz steps. Clearly, Pioneer has tried its best to offer a tuner that is obsolescence proof.

FM Section Measurements

Figure 1 shows the quieting and distortion characteristics of the FM tuner section of the F-9 when the bandwidth switch is set to the wide position. Again, our signal generator was not up to the task of measuring the 90 dB (at 85 dBf) of S/N claimed by Pioneer (nor, for that matter, is our standard graph form), but we have every reason to believe that it is quite true (I measured 86 dB, as low as my generator has ever gone) for mono reception. Note that both for mono and stereo, the noise line hasn't begun to level off as we drop off the bottom of the graph! My stereo noise measurement capability also falls short of being able to verify the 85-dB S/N claimed by Pioneer, though again I suspect that the tuner easily reached that level of quieting, judging by the slope of the curve in Fig. 1.

The quieting characteristics of the tuner, in both mono and stereo, are essentially the same whether the tuner is placed in



Two farsighted features are on the back panel — an AM stereo-out jack and an AM channel-spacing switch in case the FCC changes to 9-kHz spacing.

the wide or narrow modes. Distortion, however, increases in the narrow mode, as might be expected. Figure 2 is a plot of mono and stereo THD versus frequency in the wide mode (two lower curves) and of stereo THD in the narrow i.f. mode. It should be noted, however, that even in the narrow mode, THD remains low enough so as not to be audibly bothersome. But in the narrow mode, selectivity measured a very high 85 dB as claimed, high enough to preclude any interference from stations operating at frequencies close to the desired one.

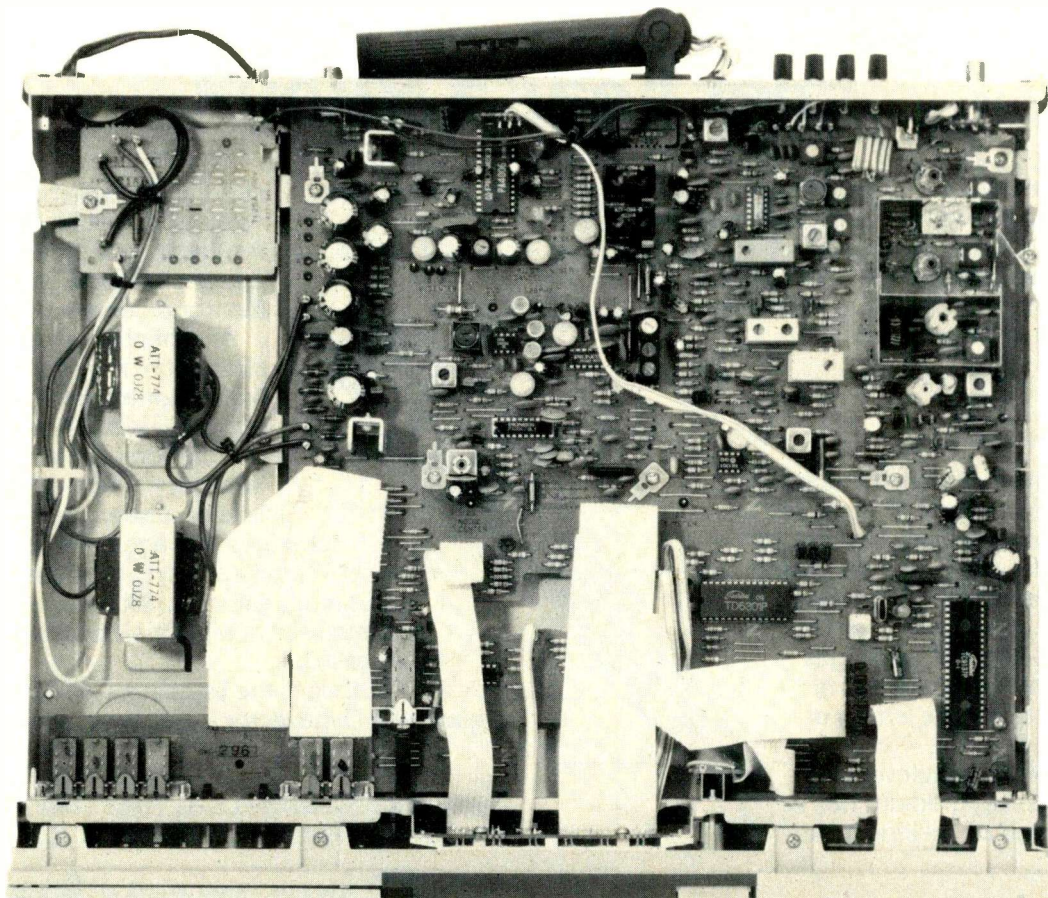
Frequency response deviated from flat by no more than 0.2 dB at the high end (15 kHz), as can be seen from the upper trace of Fig. 3, which also depicts stereo FM separation (two lower curves in Fig. 3) in the wide and narrow modes. The lower curve (best separation) was obtained when the tuner was operated in the wide mode, with separation readings of 52 dB at 1 kHz and at 100 Hz and 46 dB at 10 kHz. When the tuner was operated in the narrow mode, separation decreased but was still a relatively high 40 dB at mid-frequencies, 38 dB at 100 Hz, and an impressive 42 dB at 10 kHz.

More subtle forms of distortion arising in the FM section when it is operated in the narrow mode may be seen by examining Figs. 4 and 5. In Fig. 4, I operated the tuner in the narrow mode while modulating the signal generator with a left-only stereo sig-

nal at 5 kHz. This is represented by the tall spike at the left (the horizontal sweep in these two figures is *linear* from 0 to 50 kHz or 5 kHz per linear division). A second sweep, taken at the output of the unmodulated channel, shows the crosstalk component of 5 kHz (contained within the tall spike, lower in amplitude) plus a series of crosstalk distortion components and subcarrier components. Comparing the results obtained in Fig. 5 (tuner operating in the wide mode) with those of Fig. 4, it is easy to see how much cleaner the crosstalk components are when the tuner is operated in the wide mode, not to mention the higher stereo separation observed.

Spurious response rejection was more than 90 dB, much better than claimed. AM suppression measured 65 dB as claimed, while image, i.f., and subcarrier rejection measured 73 dB, in excess of 100 dB, and 72 dB respectively. Muting threshold was set a bit higher than published specs suggested, at around 15 μ V (28.7 dBf), and this point also corresponded to stereo switching threshold.

AM frequency response of this tuner was not unlike that of most tuners and receivers manufactured as "high fidelity" components: Not very good. However, this tuner at least has the advantage of being able to extend the high-end response slightly when the tuner is operated in the wide AM mode; it also has



Pioneer specifies 90 dB for the F-9's S/N; I could only measure 86, the limit of my signal generator.

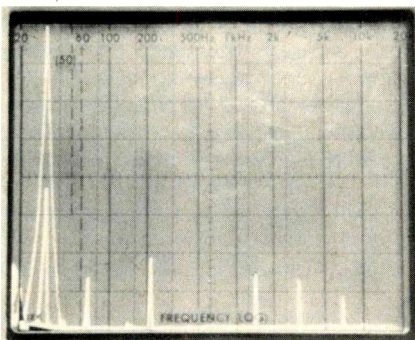


Fig. 5—
Same as Fig. 4,
but wide
i.f. mode.

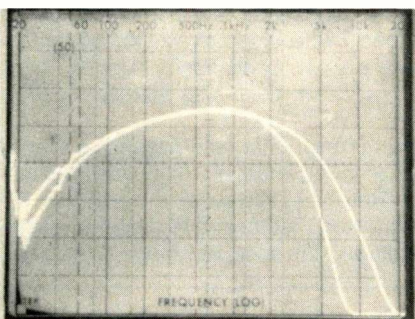


Fig. 6—
AM frequency
response in wide
and narrow
modes.

the ability to zero in on closely spaced stations (especially at night) when operated in the narrow mode. Frequency response is shown for both modes in Fig. 6.

Use and Listening Tests

The high quality and reception capability of this new Pioneer tuner is, of course, difficult to assess while listening to typical FM stations. Accordingly, the listening tests included a comparison of the sound of some audiophile records "transmitted" over my own closed-circuit setup to the F-9 versus the sound of these same records played directly over my reference component system. In addition, I did some listening to the single radio station in my area which continues to put out a first-rate signal. In both cases I was reminded of how good FM radio really can be. I suspect that when true digital audio program sources become available, and as more and more tuners such as the F-9 appear on the marketplace, more radio station operators will have to re-examine their practices and, in most cases, improve them. With a tuner such as this new Pioneer F-9 and live or digitally recorded program sources, the weakest link in the FM chain is surely the radio station. And, best of all, this incredible tuner performance is available at a fraction of what the best non-frequency-synthesized performance used to cost just a few years ago.

Leonard Feldman

Enter No. 90 on Reader Service Card

Ever hear a Ruby?

It takes more than a ruby cantilever to make a moving coil cartridge capable of excellent sound reproduction. It takes imagination, engineering knowledge and dedication to perfection.

The Dynavector DV/Karat series is the culmination of these efforts.

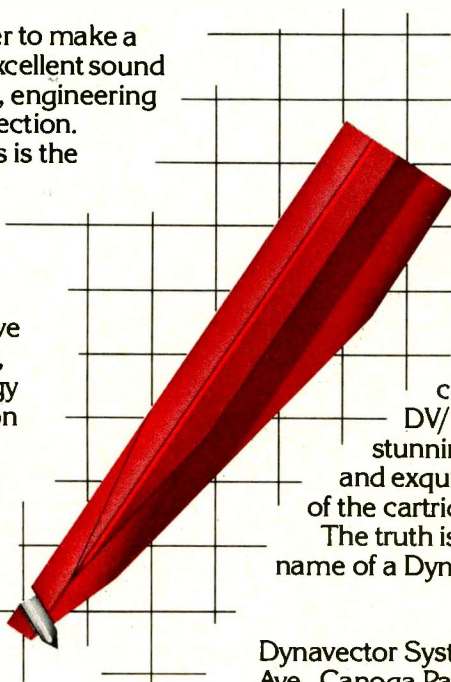
$$C_B = \alpha \sqrt{2\pi f} \left[1 - \frac{1}{4} \beta \frac{2\pi f}{\alpha^2} + \frac{1}{4} \delta (2\pi f)^2 + \dots \right] \dots (2)$$

$$\alpha^4 = \frac{EI}{m}, \quad \beta = \rho \alpha^4 \left(\frac{1}{E} + \frac{\gamma}{G} \right), \quad \delta = \frac{\rho^2 \gamma \alpha^4}{EG}$$

Dr. Noboru Tominari, the creative genius and founder of Dynavector, developed a radical new technology taking into account wave dispersion and cantilever vibration theories.

Dr. Tominari reasons that the "soft" sound of most cartridges was due to the various delays of frequencies along the length of the cantilever.

The role of the cantilever as a sound dispersing medium has been mitigated by making it as



short and as hard as possible. As a result, a solid laser cut synthetic ruby cantilever only 2.5mm in length with a diamond contact tip is utilized.

Another benefit of the short/hard ruby cantilever is the high resonance frequency above 50 kHz. Therefore, the elimination of rubber damping.

Without the "creeping time effects of rubber" (temperature changes and age deterioration), the DV/Karat's ability to produce sound with stunning realism, brilliant tonal balance and exquisite detail is maintained over the life of the cartridge.

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Morning Concert



You've driven to the end of the world. Alone.
The engine is still warm.

Amid the roar of the waves and the cries of the gulls, you fire up your mobile high-fidelity system for a morning concert.

What will it be? Bach? Mozart? Perhaps some Keith Jarrett.

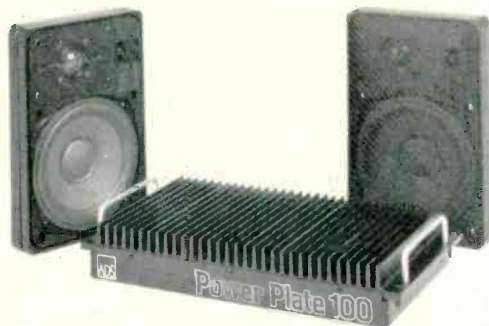
Whatever you choose, your system is equal to the task because you've chosen ADS.

The ADS Power Plate 100 Automotive Amplifier and the ADS 300i Automotive Loudspeaker System deliver the kind of power it takes to be heard above road noise, engine noise, and ocean waves. And it's not just brute power, but power with performance, subtlety and nuance — qualities collectively known as musical accuracy.

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The more time you spend with your automobile, the more you owe it to yourself to listen to ADS.



Audio for the critically demanding

2

**ONKYO
CP-1150F
TURNTABLE**

Manufacturer's Specifications

Drive Motor Type: Direct, quartz controlled; separate motor for tonearm.

Speeds: 33 1/3 and 45 rpm.

Wow and Flutter: Less than 0.025 percent, wtd. rms.

Rumble: Better than -75 dB, DIN 45-539 "B."

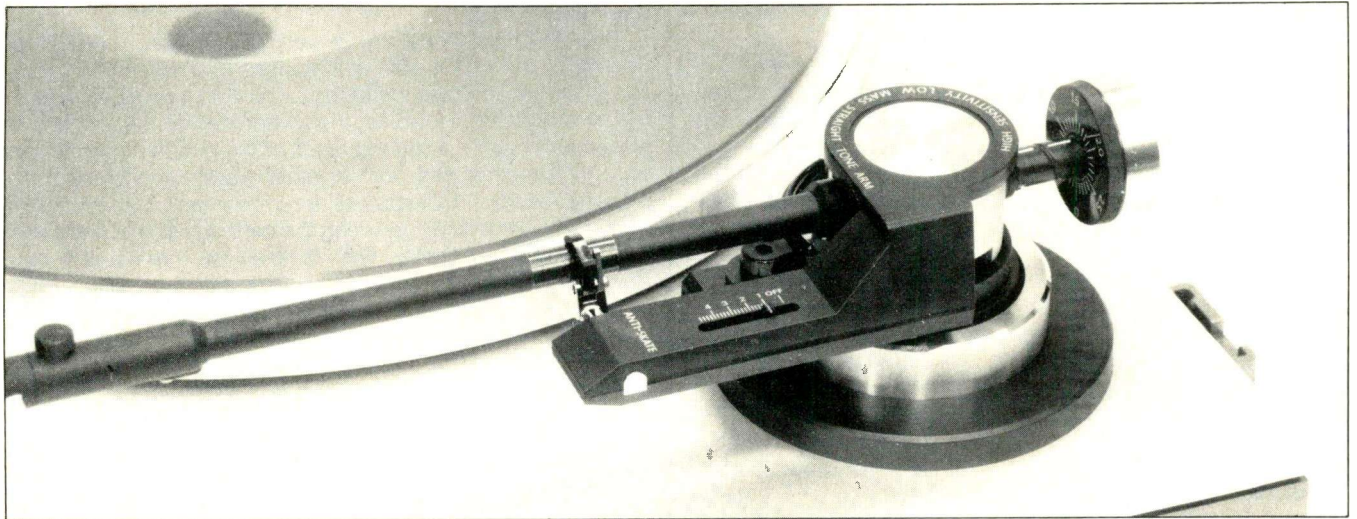
Cartridge Weight Range: 5 to 9 grams.

Dimensions: 16 1/2 in. (41.9 cm) W x 15 in. (38.1 cm) D x 5 in. (12.7 cm) H.

Weight: 14.3 lbs. (6.5 kg).

Price: \$329.95.





The Onkyo CP-1150F is a fully automatic turntable with some rather unusual features which make it a little different from the run-of-the-mill designs. For example, there is a *Repeat* function which allows a record to be played continuously from any selected point to disc end and, probably more useful, a button marked *Search* which activates a motor to drive the arm in either direction. At the desired point, the arm is then lowered by the cue button — the arm motion is so smooth that you can almost move it groove by groove. Another interesting idea is the provision of a jack for an optional remote unit which can control most functions. This remote unit is designated the RC-5T.

Perhaps the most striking feature is the platter mat. Instead of the black rubber material we are used to seeing, this one is made from a transparent plastic, but more about that later. The unit itself has the current low-profile styling with all the controls disposed on a narrow shelf-like projection at the front where they are accessible with the dust cover closed. There are three push buttons on the left; number one is the power on-off switch, the second selects the speed, while the third is the record size (7 or 12 inches) selector. A light behind a bezel near the center shows when the power is switched on, and way over on the right-hand side are four more push buttons, *Repeat*, *Search*, *Cueing*, and *Play/Reject*.

The arm is a statically balanced type, measuring 8 7/8 inches from pivot to stylus. It is made from tubular carbon fiber, as is the headshell. The words "High Sensitivity Low Mass Straight Tone Arm" are inscribed around the pivot trim, and the anti-skating slide dial projects forward on the right and also forms the arm rest. The tracking force scale on the counterweight is calibrated from 0 to 3 grams, while the anti-skating slide has markings up to 4.8 grams.

The motor is a direct-drive type with quartz-lock servo control, and it turns a 3-lb. platter which is an aluminum die casting. As with many present-day turntables, a high-impact plastic is used for the base. The four insulated feet use a combination of felt, coil springs, and rubber to give acoustic isolation — needed because the arm and motor are solidly mounted on the top board. The unit is finished in a metallic gray and silver and comes complete with an overhang gauge plus some hardware.

Measurements

For test purposes, an Osawa MP-30 MM cartridge was mounted on the low-mass headshell which, by the way, is fitted with a locking screw. This represents something of a "worst case" combination in that this arm and cartridge combination is about as far from optimum as it's possible to get. This is not the fault of either the arm or the cartridge, of course, but simply represents one of the few places left in hi-fi where two perfectly fine components can produce a less-than-optimum result. The Onkyo arm showed up rather well in this test, where the effect of the mismatch is seen in the resonance — a rise of 3.5 dB at 8 Hz. The optimum point for this resonance is generally thought to be in the 11 to 15 Hz range, below any recorded information and above the warp frequency range of 4 to 6 Hz.

As mentioned earlier, the platter mat is made of plastic, and it is described as a "transparent amorphous plastic." This mat fits on a "diamond-cut plane platter," so it lays perfectly flat with no air spaces in between. At one time, it was thought that the only function of a platter mat was to damp out some of the motor vibrations, but we now know that a mat must also absorb vibrations generated by the stylus in the record without introducing resonances. We know, too, that some mats with heavy ribs can cause problems because the air pockets act as miniature Helmholtz resonators, while mats with reflective surfaces can have a poor interface and increase the change of airborne acoustic feedback. So what it amounts to is this: The design of an ordinary platter mat is not at all simple. Some manufacturers rely on soft, absorbent materials, sometimes aided by a separate weight, while others prefer materials having a relatively high density. Onkyo's choice is an amorphous kind of polyethylene, plus an absolutely flat platter.

As far as rumble is concerned, the figures are comparable with other high-quality units, and changing over to a rubber mat made no significant difference. However, the Onkyo mat was clearly superior in recovery from shock excitation pulses which caused some subsonic ringing with the softer mat. To be honest, I don't know how important this is, but I suppose it could have an effect on some kinds of feedback. The four triple-insulated feet do a good job in isolating the unit from vibration, and

The most striking feature is the transparent platter mat of amorphous plastic which did a good job of reducing shock pulses.

acoustic feedback is unlikely to cause problems. Overall, the unit is clearly well thought-out in this regard.

Wow and flutter was 0.04 percent (DIN 45-507), and rumble measured a low -62.5 dB using the ARRL weighting. Both vertical and lateral arm bearing friction were insignificant. Calibration of the tracking force dial was about 5 percent high above one gram. The optimum tracking force for the MP-30 cartridge was found to be 1.8 grams with the anti-skating set a trifle higher. Speed was less than 0.2 percent fast on both ranges and was unaffected by a.c. line changes.

Using the gauge supplied by Onkyo, the offset angle was 21 degrees with an overhang of half an inch, giving maximum tracking error of +3 and -1 degrees. By increasing the overhang to $\frac{7}{8}$ inch and angling the cartridge slightly in the mount, the error was modified to +2 and -1.25 degrees. For this exercise, a Cart-A-Lign protractor gauge was used. This ingenious gadget has the null points at 2.6 and 4.76 inches, and the built-in mirrors make it one of the most accurate of the inexpensive gauges now available.

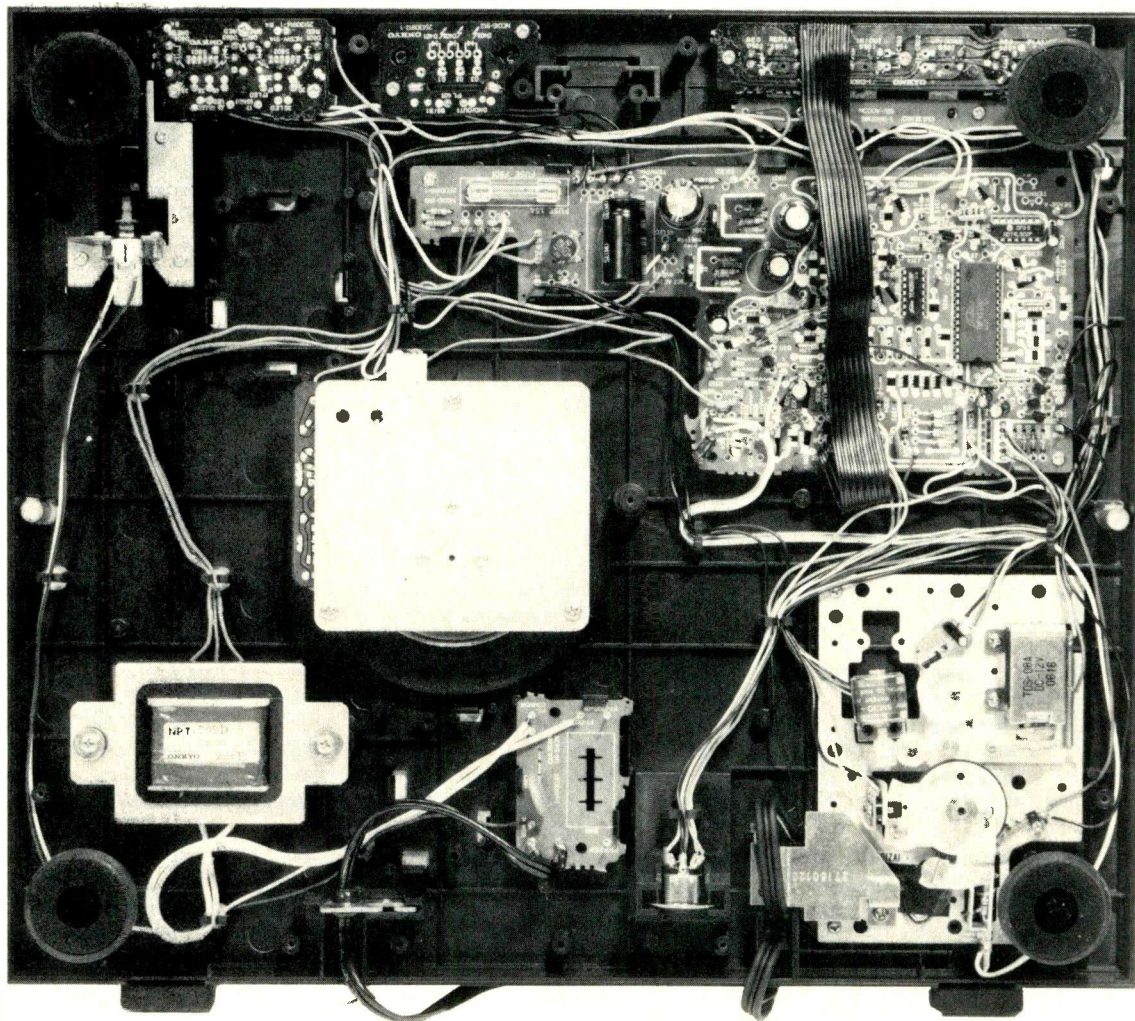
Use Tests

The CP-1150F proved to be very easy to use, although the Search control took a little getting used to. Depressing the button sends the arm over the record, where it stops as soon as the button is released. However, if you then decide the arm has not moved far enough, a second touch of the button moves the arm back in the other direction! In other words, sequential button pressing results in bidirectional arm movement. The cue control works very well indeed, lowering the cartridge slowly and gently. As to the Repeat facility, well, it obviously has its uses but it would be even more useful if a single selection anywhere on the record could be repeated — not just the last band or bands. I do prefer having some method of repeat play, however, and this one worked well in my tests.

All in all, the Onkyo CP-1150F is a nicely styled, well-engineered unit which is likely to make a special appeal to those who desire the convenience of a special cueing system like this one.

George W. Tillett

Enter No. 91 on Reader Service Card



Dual Capstans— The answer or the problem?

Nakamichi Spoken Here.

The advantages of two capstans are obvious; the problems are not! Capturing the tape between supply and takeup capstans isolates the "active" portion from the reels. Thus, sticky cassette hubs, grabbing clutches, and surging reel motors have less effect on tape motion.

Great, but let's not miss the forest for the trees! While dual capstans do help isolate the tape from the reels, they generate problems of their own—problems that often go unrecognized. Bodies that rotate at the same rate are in resonance; thus they magnify vibration which, when it enters the tape path, increases flutter and modulation noise. The overall performance of a dual-capstan transport often is worse than that of a single-capstan drive!

Nakamichi faced this problem years ago and developed an Asymmetrical, Diffused-Resonance Transport that is unique in the industry. When you purchase a Nakamichi—any Nakamichi—you will find supply and takeup capstans of different diameters rotating at different rates. You'll find flywheels of different moments of inertia—machined from solid stock for perfect balance. This "Asymmetry" eliminates common-mode resonance. And, Nakamichi transports are fabricated from materials that have been especially selected and treated to absorb motor vibration and prevent its transference to the tape.

The piece de resistance is our unique pressure-pad lifter. In a Nakamichi transport, tension is controlled so accurately, and heads are contoured so precisely that pressure pads are not required to maintain head-to-tape contact. Since the pad creates more problems than it solves—scrape flutter, modulation noise, and tape skew—it's better off out of the way!

The proof of Nakamichi technology is in the listening. Specifications, while important, do not tell the whole story. Scrape flutter occurs at a very rapid rate; it is not included in "weighted" flutter measurements—even those made in accordance with DIN specifications. Modulation noise goes unspecified entirely! But compare the sound of a Nakamichi recorder with any other. You'll hear clarity of reproduction that is unique—music with detail! Experience Nakamichi sound today—at your Nakamichi dealer.



To learn more about Nakamichi's unique technology, write directly to:
Nakamichi U.S.A. Corporation, 1101 Colorado Avenue, Santa Monica, CA 90401.

3

AKAI GX-F90 STEREO CASSETTE DECK

Manufacturer's Specifications

Frequency Response: 25 Hz to 17 kHz, 25 Hz to 17.5 kHz with CrO₂ tape, 25 Hz to 21 kHz with metal tape

Harmonic Distortion: 0.6 percent for 1 kHz at meter zero with metal tape.

Signal/Noise Ratio: 62 dB with metal tape.

Erase: 70 dB.

Input Sensitivity: Mike, 0.25 mV; line, 70 mV.

Output Level: Line, 410 mV; head-
phone, 100 mV into 8 ohms.

Flutter: 0.03 percent wtd. rms, 0.08 percent wtd. pk.

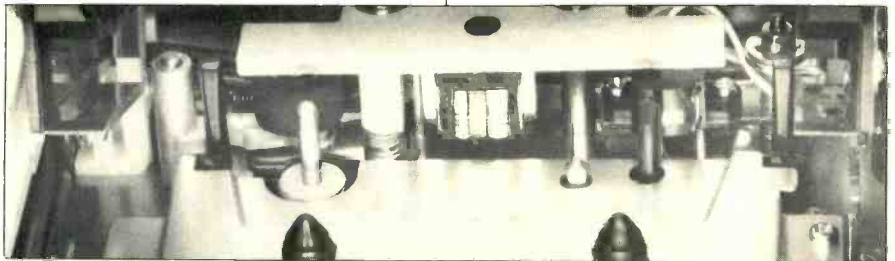
Tape Speed: Within ± 0.5 percent.

FF & RWD Times: 60 S with C-60.

Dimensions: 17.3 in. (440 mm) W x
4.1 in. (105 mm) H x 14.6 in. (370
mm) D.

Weight: 21.6 lbs. (9.8 kg).

Price: \$675.00.



The Akai GX-F90 cassette deck provides excellent performance and has many features of interest, including three long-life heads, fluorescent bar meters, and a logic/solenoid system. The front panel is an attractive brushed aluminum with black designations. There are separate push-button switches for *Memory*, *Repeat*, *IPLS* (Instant Program Location System), *Cal Tone*, *MPX Filter*, *Dolby NR*, and *Monitor*, *Tape* or *Source*. Each of these has a green light which immediately answers any question about deck status. Use of IPLS allows fast winding to the beginning or end of a particular selection, with automatic stop at that point. *Cal Tone* injects a 400-Hz tone for record calibration to ensure accurate Dolby tracking. There are also similar buttons for resetting the counter and ejecting a cassette, and a larger

one for power on-off. There are two rotary switches with bar knobs for *Timer Start (Rec-Off-Play)* and *Tape Selector*, which has an adjacent illuminated window to show *LN*, *LH*, *CrO₂* or *Metal*.

Eject causes the cassette carrier to move out and tilt down. The door/cover can be removed to facilitate any maintenance tasks. The light-touch tape-motion buttons are logic controlled with substantially any change in mode allowed — including adding record while in play, going into record from fast wind, etc. The *Rec Mute* is right in the same line, as are *Rec Cancel* and the *Peak/VU* meter-mode switches. With the exception of *Stop*, all of the transport control buttons are illuminated: Yellow for the two wind functions, green for *Play*, red for *Rec* and *Rec*

Mute, and orange for Pause. This nice feature is made even better with Play flashing when in Pause, rewinding with Repeat or winding with IPLS, and Rec Mute flashing when it is in operation — each one "saying" what must be done next to return to the previous mode. Rec Cancel is an unusual feature that will be of definite use to some. If you begin recording what you don't want, a push of this one button puts you back at the start in Rec and Pause, ready for another try.

The Peak/VU switch selects the dynamics of the bar-graph meters, and there are handy status lights to make certain the user doesn't get confused. The bar segments are a light blue up to meter zero and a sort of light brown from there up to the maximum of +8. The Dolby-level reference is at +4 dB. There are two segments for each level step, 24 sets in all, with single-dB steps from -3 to +8 dB, where the best resolution is needed. The peak-level calibration is 7 dB lower than that for VU, which is actually a very good idea because then the maximum meter indications will be about the same for both meter modes. There are dual-concentric level pots for both mike and line, allowing mike-line mixing. The knobs are of a good size and have clear indices, and the friction is just right for making single-channel adjustments.

The screwdriver-adjust, center-detent record-calibration pots are just below the level pots, and the mike phone jacks are just to the right. Use of the left-channel mike jack only will feed that signal to both channels. The knob of the output pot is small, but it is adequate for controlling the level to the headphones and to line out. The line in/out phono jacks are on the rear panel, as is a socket for the optional remote control. Access to the interior was gained with the removal of the steel top and side cover, securely held in place with several machine screws — a touch of quality. The soldering on the p.c. boards was generally very good with little flux residue. The large signal p.c. board, just

Table 1—Record/playback responses (-3 dB limits).

Tape Type	With Dolby NR				Without Dolby NR			
	Dolby Lvl		-20 dB		Dolby Lvl		-20 dB	
	Hz	kHz	Hz	kHz	Hz	kHz	Hz	kHz
Maxell UD-XL I	30	7.2	31	17.0	30	7.3	31	19.3
BASF Studio II	30	7.2	29	18.0	30	7.1	29	20.0
TDK MA-R	30	12.8	29	20.3	30	12.8	29	20.5

Table II—Signal/noise ratios with IEC A and CCIR/ARM weightings.

Tape Type	IEC A Wtd. (dBA)				CCIR/ARM (dB)			
	W/Dolby NR		Without NR		W/Dolby NR		Without NR	
	@DL	HD=3%	@DL	HD=3%	@DL	HD=3%	@DL	HD=3%
Maxell UD-XL I	62.0	65.0	53.4	56.4	61.5	64.5	51.3	54.3
BASF Studio II	63.0	65.0	54.7	56.7	62.5	64.5	52.5	54.5
TDK MA-R	63.9	66.4	55.3	57.8	63.0	65.5	52.5	55.0

above the logic board, had all parts identified, including adjustments. Interconnections were made mostly with wirewrap, with some direct soldering and some multi-pin connectors. There were three fuses in clips on the power supply p.c. board. The dual-solenoid, two-motor drive system was judged to be of good construction. The large power transformer was surrounded by a shield, and it and other components were well supported within a rigid chassis frame.

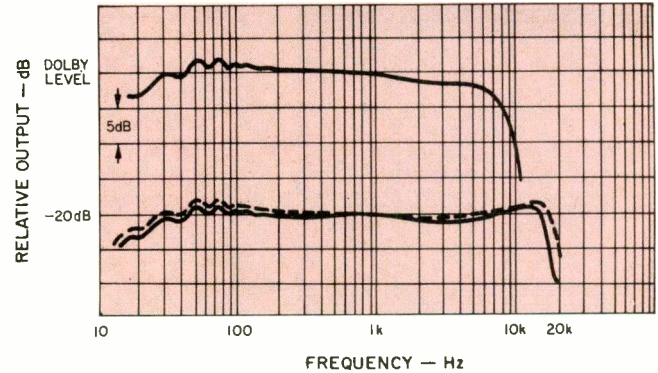


Fig. 1—Frequency responses with and without (---) Dolby NR using TDK AD tape.

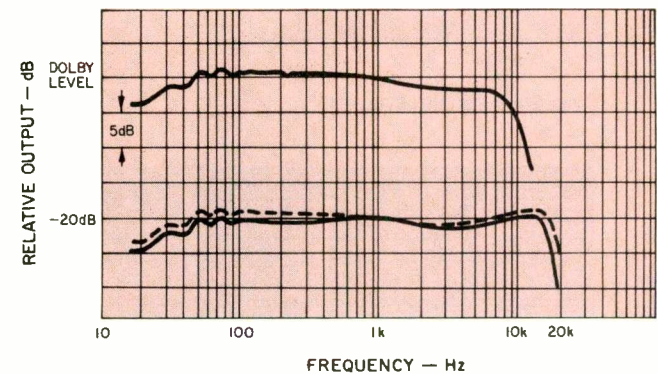


Fig. 2—Frequency responses with and without (---) Dolby NR using Maxell UD-XL II tape.

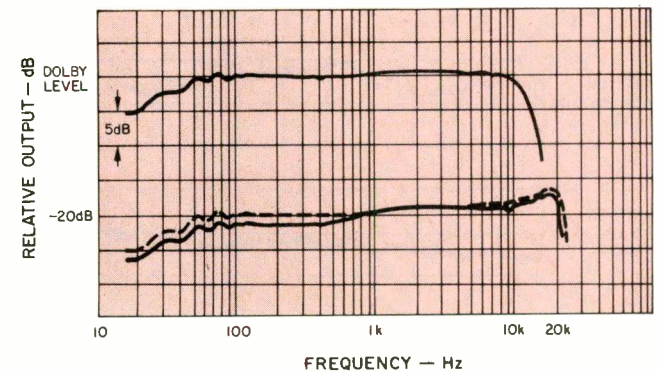


Fig. 3—Frequency responses with and without (---) Dolby NR using Ampex MPT tape.

The Akai GX-F90 cassette deck has many useful features and very good to excellent performance in every area.

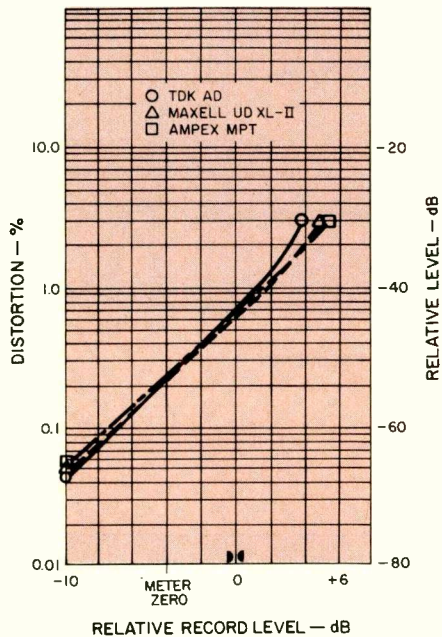


Fig. 4—Third harmonic distortion vs. record level in Dolby mode at 1 kHz using TDK AD, Maxell UD-XL II, and Ampex MPT tapes.

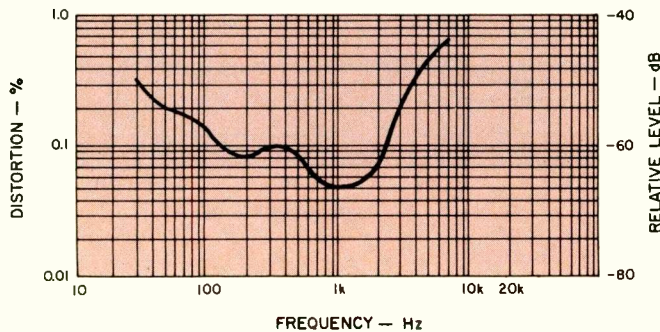


Fig. 5—Third harmonic distortion vs. frequency in Dolby mode at 10 dB below Dolby level using Ampex MPT tape.

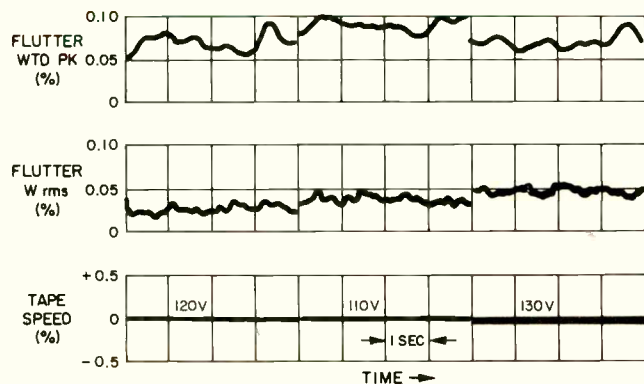


Fig. 6—Tape play speed vs. line voltage and wtd. pk. flutter, rms and wtd. pk. flutter, three trials each.

Performance

The first step in the testing was to check the GX-F90 with standard alignment tapes. With both equalizations (120 and 70 μ S), responses were very good at the lower frequencies but were down 3.5 to 4 dB at the highest frequencies. Tape play speed, on the other hand, was very accurate: 0.05 percent slow at most. The level indications on the meters were both within a dB of the standard. Pink noise and a 1/3-octave RTA were used, as usual, for fast surveys of a large number of possible formulations for use in testing. Akai is to be praised for listing both recommended tapes and the standard reference tapes they use for setting up the deck. I found very close agreement with their list although my tapes for test (TDK AD, Maxell UD-XL II and Ampex MPT) were not their reference tapes. Figures 1 to 3 and Table I show the swept-frequency response results with and without Dolby NR, both at Dolby level and at 20 dB lower. With the AD and UD-XL II tapes, there appeared to be a possible influence from the drooping play response mentioned earlier, including the little saddle (droop) around 4 kHz, 1.5 dB at most. The responses with the metal tape are different, being elevated slightly from about 1 kHz out. Nonetheless, all of these results are quite good, and if the deck had bias trim, the responses could have been made smoother, gaining better Dolby tracking.

The 400-Hz (441 Hz actual) calibration tone had about 0.8 percent THD, quite acceptable for the purpose. With Maxell UD-XL II tape, the record calibration pots had a range of adjustment of about ± 5 dB. With a 10-kHz test tone, there was a 70-degree phase discrepancy between tracks — typical for the combination head design used. There were 25 degrees of phase jitter, better than most cassette decks. The output polarity was in phase with the input signal. The multiplex filter was 3 dB down at 16.1 kHz, and it was a good 34.8 dB down at 19 kHz. With a 1-kHz test tone, erasure was greater than 80 dB, and separation was 43 dB. Crosstalk was down at least 60 dB, with larger and more desirable figures at times. Erasure of the metal tape at 100 Hz was greater than 70 dB, very good performance. Bias in the output during recording was very low, though there were some beat notes at the very highest frequencies of the swept test tone used for the responses.

HDL₃ (the level of third harmonic distortion) was measured for a 1-kHz tone from 10 dB below Dolby level to the point where the distortion reached 3 percent for each of the three tapes (Fig. 4). The curves are quite linear, with just a slight upward curving at the distortion limit. The 0.05 percent distortion figure at -10 dB shows that there was very low distortion in the electronics, as well as in the magnetic process. The signal-to-noise ratios with both IEC A and CCIR/ARM weightings were measured with and without Dolby NR, and the excellent results are shown in Table II. HDL₃ was also measured over a range from 30 Hz to 7 kHz with Ampex MPT tape at 10 dB below Dolby level (Fig. 5). The results are excellent in the mid-frequencies, and the increases at the frequency extremes are less than with many recorders.

Input sensitivities were 0.23 mV for mike and 65 mV for line, both a little bit better than spec. The input overload points were very high: 56.9 mV for mike and 30 V for line, where waveform rounding first appeared. The output clipped at +18.1 dB relative to meter zero. The two sections of both input level pots tracked within a dB from maximum down about 60 dB, excellent performance. The output pot tracked within a dB down about 45 dB. The 100-mV headphone drive to 8 ohms was fine for most

The GX-F90 has three heads, fluorescent bar meters, and a logic-controlled solenoid transport system.

phones, though the volume was on the low side with an AKG 600-ohm set. The line outputs were 414 mV, and they dropped just slightly (to 410 mV) with the IHF 10-kilohm load.

In VU mode, the bar-graph meters had a response time of 240 mS, slightly fast, and there was no overshoot. In Peak mode, the response times were substantially to IEC Standard 268-10, actually being slightly fast: Only 2 dB down with a 3-mS burst, where the standard calls for -4 ± 1.0 dB. The fall time was 1.0 second, slightly short for easy reading. All of the scale calibrations were exactly accurate, from -20 dB to +8 dB, much better than most meters. The meter response was not polarity sensitive in either mode, and the increased level from a sine wave with d.c. offset (or a single-polarity peak, if you will) was correctly shown. This is additional evidence of excellent design by Akai.

The speed characteristics of the GX-F90 were also impressive. The tape speed at 120 V was one of the most accurate ever measured. Variations with time were very low, and there was just a slight lowering of speed at 130 V. There were the expected variations in flutter with trial and cassette, but typical figures were 0.035 percent wtd. rms and 0.075 percent wtd. pk., certainly better than most decks. Wind times averaged 69 seconds with a C-60, which is over spec, but still fast enough. Run-out to stop time was 2 S, and any change in transport mode was made in 1 second or less.

In-Use Tests

Tape loading and unloading was simple and convenient, and

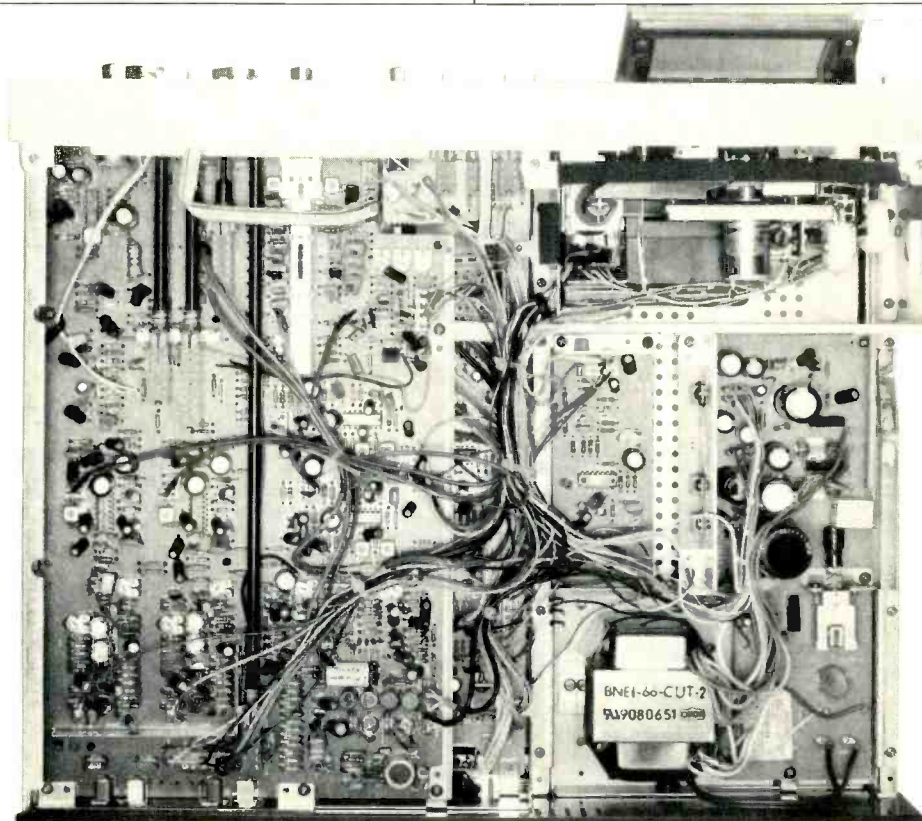
there was easy access for maintenance, especially with the door/cover removed. It was a distinct pleasure to use the Akai deck with the many helpful status lights, particularly the flashing *Play* and *Rec Mute* buttons, calling attention to what needed to be done. Setting record levels accurately was quite easy with the good pots and the peak/VU metering. Everything was completely reliable, including IPLS and timer-start functions. The trilingual owner's manual provided sufficient detail in most respects, but the text was confusing on the use of peak metering. There was also a reference to "occasional motor lubrication," which is not as clear as, say, "every XXXX hours of operation."

Record/playback listening was done first with pink noise as a source, and then several records, which included Haydn's *Symphony No. 59* and Bach's *Suite No. 2*, both with Marriner and the Academy of St. Martin in the Field, Diahann Carroll with the Ellington Orchestra (Orinda Records), and the Maxell samplers. The results were really very good, but it was possible to detect some dulling with the noise source and TDK AD and Maxell UD-XL II and some brightening with Ampex MPT. With the music, changes were more subtle, but there were some similar indications, mostly with the vocal by changes in presence. Record, pause, and stop noises were very low, just detectable at times.

Overall, the Akai GX-F90 deck has many useful features and very good to excellent performance in every area. It is most worthy of comparison to any of the other decks in its price range.

Howard A. Roberson

Enter No. 92 on Reader Service Card



4

TECHNICS SA-424 FM/AM STEREO RECEIVER

Manufacturer's Specifications

FM Tuner Section

Usable Sensitivity: Mono, 10.8 dBf, 1.9 μ V.

50-dB Quieting: Mono, 13.7 dBf, 2.7 μ V; stereo, 37.2 dBf, 39.7 μ V.

S/N: Mono, 75 dB; stereo, 70 dB.

THD: Mono, 0.15 percent at 1 kHz and 100 Hz, 0.3 percent at 6 kHz; stereo, 0.2 percent at 1 kHz and 100 Hz, 0.3 percent at 6 kHz.

Frequency Response: 20 Hz to 15 kHz, +1, -2 dB.

Selectivity: 75 dB.

Capture Ratio: 1.2 dB.

Image Rejection: 55 dB.

I.f. Rejection: 75 dB.

Spurious Rejection: 82 dB.

AM Suppression: 55 dB.

Stereo Separation: 45 dB at 1 kHz, 35 dB at 10 kHz.

Subcarrier Suppression: 19 kHz, 38 dB; 38 kHz, 50 dB.

AM Tuner Section

Sensitivity: 30 μ V, external antenna; 300 μ V/m, internal loopstick.

I.f. Rejection: 40 dB.

Image Rejection: 50 dB.

Selectivity: 55 dB.

Amplifier Section

Power Output: 45 watts per channel, 8 ohms, 20 Hz to 20 kHz.

Rated THD: 0.007 percent.

Rated SMPTE IM: 0.01 percent.

Dynamic Headroom: 1.6 dB.

Frequency Response: Phono, RIAA \pm 0.5 dB; high level, 5 Hz to 80 kHz -3 dB, 20 Hz to 20 kHz \pm 0.2 dB.

IHF Input Sensitivity: Phono, 0.4 mV; high level, 23 mV.

IHF S/N: Phono, 74 dB; high level, 80 dB.

Phono Overload: 130 mV, 1 kHz.

Bass and Treble Control Range: \pm 10 dB at 50 Hz and 20 kHz.

Subsonic Filter Cutoff: 30 Hz, -6 dB per octave.

High-Cut Filter Cutoff: 7 kHz, -6 dB per octave.

50-Hz Damping Factor: 40 into 8 ohms.

General Specifications

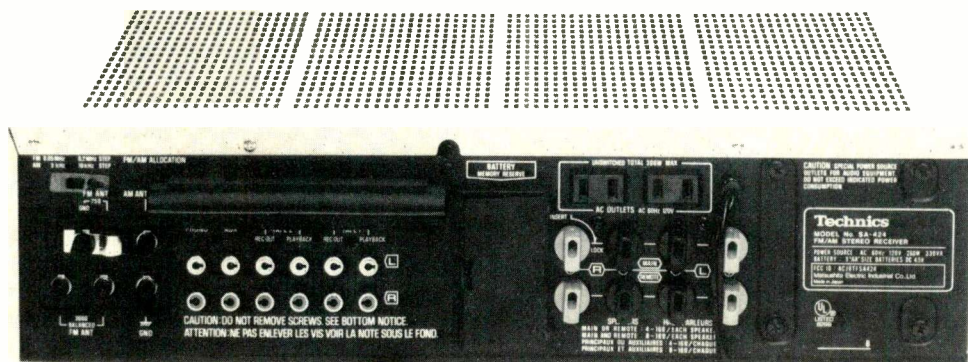
Power Requirements: 120 V, 60 Hz, 260 W.

Dimensions: 16-15/16 in. (43 cm) W x 4 3/8 in. (11.1 cm) H x 13 3/8 in. (34 cm) D.

Weight: 15.5 lbs. (7.04 kg).

Price: \$420.00.





It has often been said that high-fidelity components are among the very few consumer products which have resisted inflation and the eroding value of the dollar. An excellent example of this truism can be found in the Technics SA-424 integrated receiver, a 45-watt per channel, fully frequency synthesized unit carrying a suggested list price that is lower than what you might have had to pay for a frequency synthesized tuner-only component just a couple of years ago.

The front panel of this receiver is relatively small, and yet there is enough control to satisfy the audio enthusiast who seeks a degree of sophisticated features even in an all-in-one receiver. A slim power on/off push button is at the upper left. Despite the

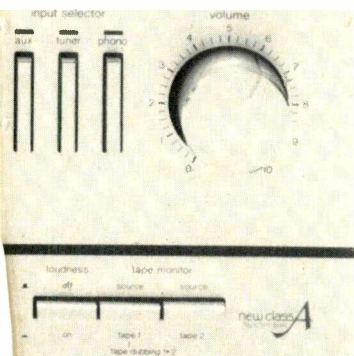
fact that AM or FM frequencies are displayed in digital form near the center of the panel, the designers of this receiver have added an analog "frequency meter" to the left of the major digital display area which resembles a conventional calibrated dial scale. The analog scale does not seem redundant in this layout and gives the user a sense of where, on the overall FM or AM band, he or she is. Indicators within the adjacent digital display area show signal strength, stereo FM signal reception, FM, MHz, AM, kHz and "memory." The memory light illuminates when the memory button, just below this display area, is pushed preparatory to entering a favorite station frequency into one of the seven available presets. Up to 14 station frequencies (seven AM and seven FM) can be stored in this way for instant recall at any time later on, as desired.

To the right of the digital and signal-strength display areas are the input selector buttons (for selecting AUX, tuner, or phono program sources) and the master volume control of the receiver.

Additional touch switches below the display area include a pair of interactive AM and FM selector buttons, up and down manual tuning buttons, and the previously described memory and preset buttons. Along the lower section of the front panel are a headphone jack; a pair of speaker selector buttons (main and remote); center-detented bass and treble rotary tone controls; an auto-scan/manual tuning selector; FM muting/mode, subsonic filter, and high-cut filter touch switches; a rotary balance control; loudness switch, and two tape monitor circuit switches.

The rear panel of the SA-424 receiver is equipped with novel speaker connection terminals, each of which has a relatively large hole into which speaker wire is easily inserted. The terminal is then given a simple quarter-turn clockwise, which action locks the wire in place and creates good electrical contact. It would be next to impossible to create any amplifier output short circuits when using these terminals. Above the speaker terminals are a pair of a.c. convenience outlets (one switched, the other unswitched), while to the left is a battery compartment designed to house three AA-size batteries which are needed to keep the station memory "alive" and to insure that the unit tunes to the station previously listened to after the unit has been turned off and turned on again. The usual tape input and output jacks, an AM ferrite built-in antenna stick, a ground terminal, and external FM and AM antenna terminals are located at the left

This receiver is fairly small yet has enough sophisticated control features to satisfy most audio enthusiasts.



In terms of price, features and performance, the Technics SA-424 is, to my way of thinking, a true bargain in today's audio component market.

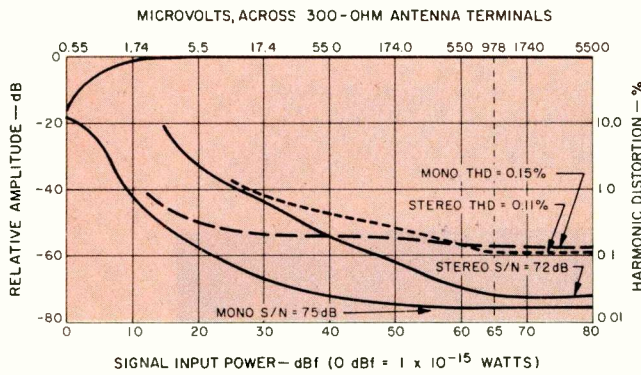


Fig. 1 — Mono and stereo quieting and distortion characteristics.

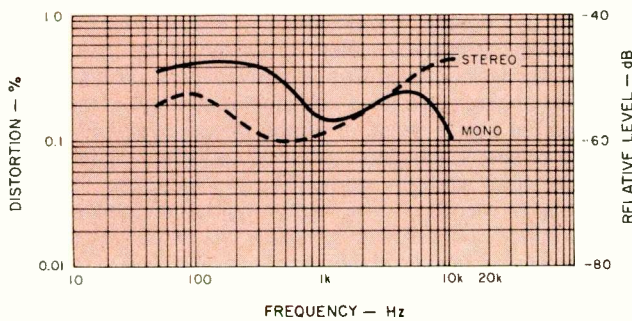


Fig. 2 — THD vs. frequency, FM section.

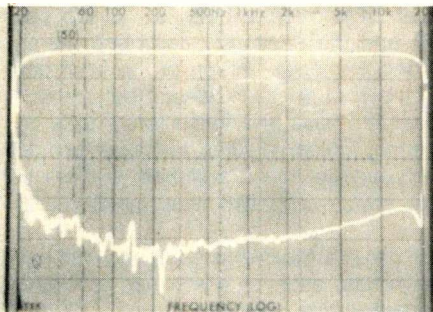


Fig. 3 — Stereo FM frequency response, upper trace, and separation vs. frequency.

end of the rear panel. Either 75-ohm or 300-ohm twin lead transmission line may be connected from the FM antenna to the receiver.

No technical information regarding circuitry is provided in the owner's manual (though the booklet does an adequate job of instructing even a neophyte user regarding correct installation and operation of the set), but I surmise from a notation on the front panel of the receiver that the amplifier section of the SA-424 uses the new Technics "New Class A" circuitry, a system which is said to offer the advantages of ultra-low distortion normally found in Class-A amplifiers (which never switch signals from one conducting transistor to another) together with the higher efficiency and lower thermal dissipation of Class-B amplifier designs. This circuitry probably accounts, in part, for the fact that Technics was able to keep the size of this receiver so small without encountering any thermal problems whatsoever.

Tuner Measurements

Usable sensitivity in mono FM measured 11.2 dBf (2.0 μ V), close enough to the claimed 1.9 μ V (10.8 dBf) so that the difference can be attributed to measurement equipment. In stereo, usable sensitivity measured 17.6 dBf (4.2 μ V/300 ohms). The 50-dB quieting sensitivities measured 2.6 μ V in mono and 37 μ V in stereo (13.5 dBf and 39 dBf), both marginally better than claimed by Technics. Mono S/N measured 75 dB as claimed, while in stereo we measured a signal-to-noise ratio of 72 dB or fully 2 dB better than claimed. Mid-frequency harmonic distortion measured 0.15 percent in mono and was actually a bit better in stereo, with measured results of 0.11 percent. Quieting and mid-frequency distortion characteristics as a function of signal strength are shown in Fig. 1, while in Fig. 2 I have plotted harmonic distortion versus FM modulating audio frequency, for both mono and stereo reception.

Figure 3 is a 'scope photo of two composite frequency sweeps taken with a spectrum analyzer to show FM frequency response (upper trace) and stereo FM separation (lower trace). The sweep is logarithmic from 20 Hz to 20 kHz and vertical sensitivity of the display is 10 dB per division. At the three specific frequencies which must be measured to be in conformity with the EIA/IEEE Tuner Standard, I read 47 dB separation at 1 kHz, 48 dB at 100 Hz, and 42 dB at 10 kHz — all significantly better than claimed by the manufacturer. The sweeps in the scope photo of Fig. 4 were made linearly and cover a frequency span from 0 to 50 kHz. These displays show the crosstalk components which occur when one channel is modulated with a 5-kHz signal (tall spike at left). Observations are then made at the output of the opposite channel and, relative to the 5-kHz reference signals, we see rather large amounts of 19 kHz, distortion components of the 5-kHz modulating tone, and residual amounts of 38 kHz and its sidebands (the three right-most spikes in the display). Referenced to unde-emphasized low-frequency 100-percent modulating levels, subcarrier rejection levels met published specifications, but those claimed rejection figures are not especially good; if users intend to record "off the air" using this receiver they might do well to activate a MPX filter if such is available on their cassette recorders.

Selectivity measured exactly 75 dB as claimed, while AM suppression measured 56 dB. Image rejection was 57 dB; i.f. rejection measured 75 dB as claimed, and spurious rejection was 85 dB as against 82 dB claimed. Capture ratio measured

High-fidelity components are among the few consumer products which have resisted inflation and the eroding value of the dollar.

1.2 dB as claimed.

As is true of so many stereo receivers and tuners, the AM section of the SA-424 was basically of narrow-band design, as illustrated by the frequency response plot of Fig. 5 (plot is logarithmic, from 20 Hz to 20 kHz). Other published AM specifications were met or exceeded.

Amplifier Measurements

The power amplifier section of the SA-424 receiver easily delivered its rated power of 45 watts per channel at all audio frequencies within its stated power band. Technics claims an almost unmeasurable 0.007 percent THD as the rated distortion of this receiver and, as can be seen from Fig. 6, I did, indeed, measure even a bit lower than that for outputs of 45 watts per channel. SMPTE IM at rated output measured 0.1 percent, as claimed. THD levels were so low in this receiver that I found it difficult to come up with meaningful results at the audio frequency extremes. Indeed, Technics makes a point of the fact that the distortion of this receiver is so low that it had to be measured using a digital spectrum analyzer instead of a conventional distortion analyzer such as I use in my lab.

Perhaps part of the reason why this receiver, during subsequent listening tests, seemed far more powerful than its bench tests suggest is the rather high dynamic headroom of 2.4 dB measured for this sample. (Technics only claims a figure of 1.6 dB for this specification.) In effect, a dynamic headroom of 2.4 dB referenced to a rated output of 45 watts means that, under music signal conditions, this amplifier section could deliver short-term power peaks as high as 78.2 watts per channel without significant clipping!

Damping factor, measured using a 50-Hz signal, measured exactly 40, as claimed (referred to an 8-ohm load). While this may seem to be a bit on the low side these days, it did not affect the quality of bass reproduction when the unit was auditioned and connected to my reference speaker systems.

The preamplifier and control sections of the receiver are well executed. Signal-to-noise in phono (80 dB, "A" weighted, referred to 5-mV input and 1.0-watt output) and for the high-level inputs (82 dB referred to 0.5-volt input and 1.0-watt output) are excellent figures for a unit of this type. Phono overload measured 150 millivolts at 1 kHz, well beyond the 130 mV claimed by Technics. Action and range of the bass and treble controls is pictured in Fig. 7. Action of the high-cut filter is also shown in this 'scope photo. Action of the subsonic filter begins below 30 Hz, and its effect is therefore not visible in the sweeps of Fig. 7, which only extends down to 20 Hz at the bass extreme. Meter measurements confirmed proper operation of this filter, however. I would have preferred to see a steeper slope for both the subsonic and high-cut filters, given a choice, since the 6 dB per octave slope provided only nominal attenuation of rumble and "hiss" frequencies.

Use and Listening Tests

The Technics SA-424 is a receiver whose front panel controls are easy to operate and with which the user will feel comfortable after only a few minutes of use. The tuning system used operated flawlessly, and the preset tuning memories are a worthwhile feature for anyone who listens to FM regularly. Level match, when switching from FM to records, was good, and the phono preamp section did a competent job of equalization and hum-

Fig. 4 — Crosstalk components of 5 kHz, stereo FM section.

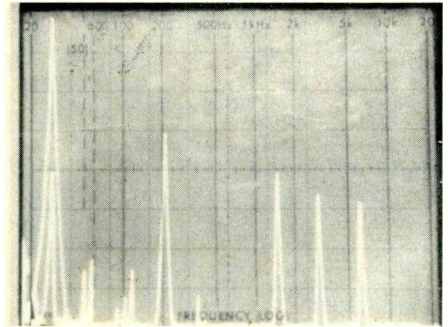


Fig. 5 — AM frequency response.

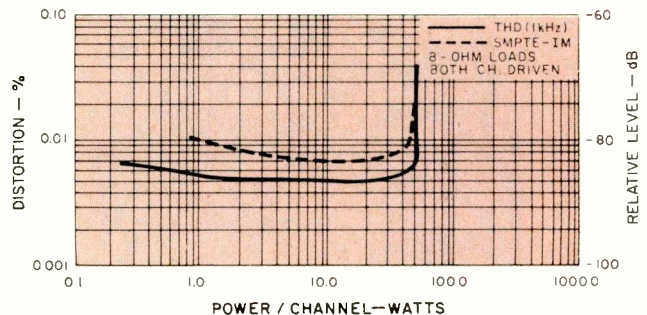
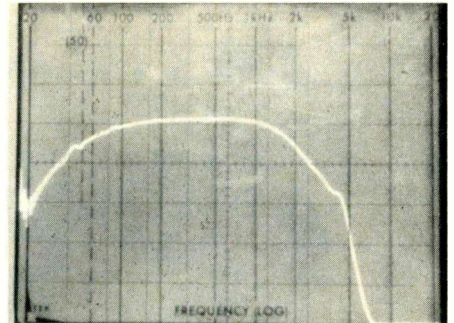
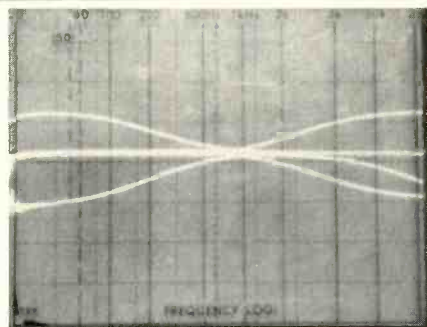


Fig. 6 — Power output per channel vs. distortion.

The suggested list price for this receiver is lower than what you would have paid for a frequency-synthesized tuner only a few years ago.



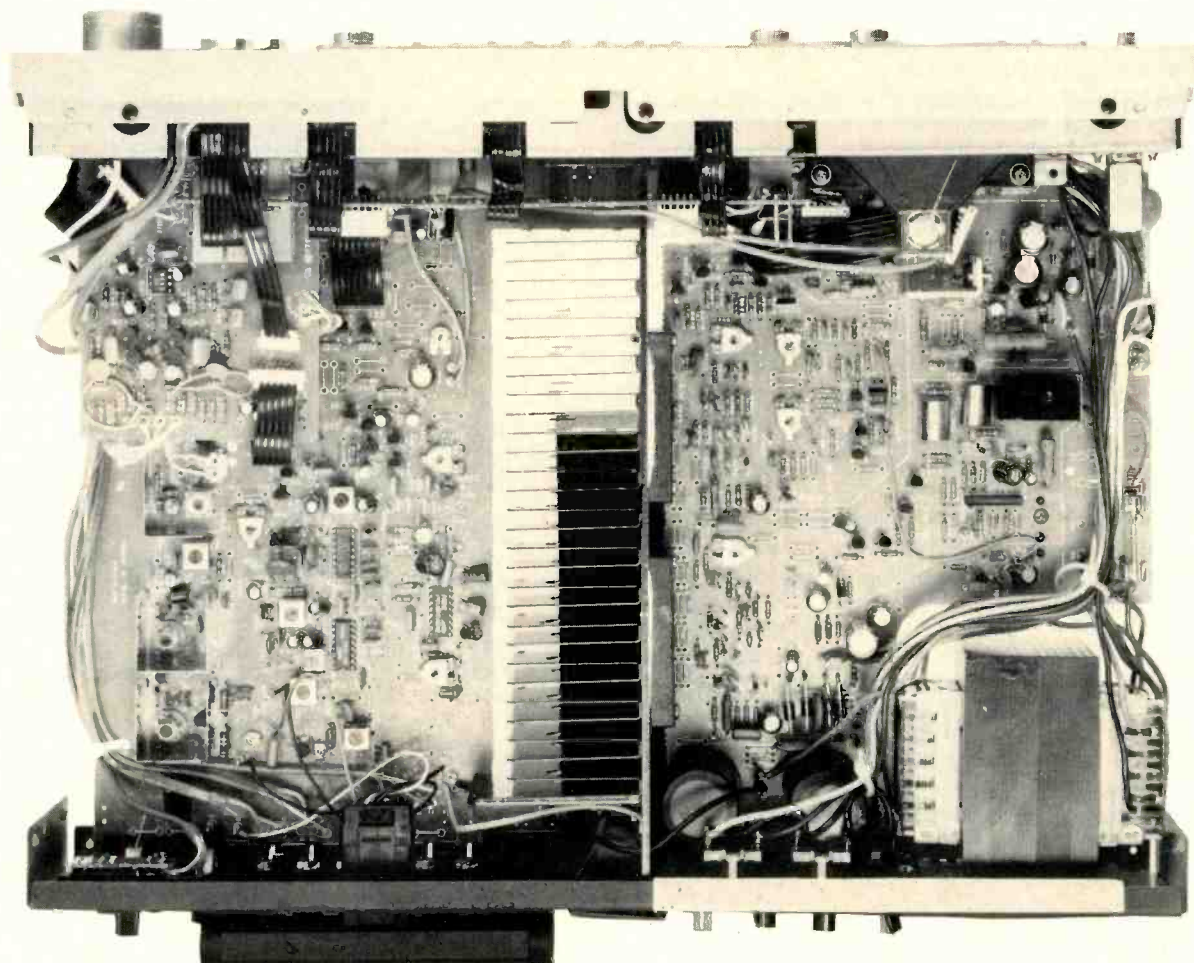
**Fig. 7 —
Tone control
range.**

free low-level amplification. Today's crop of popularly priced, relatively high-efficiency speakers are ideally suited to the power output level available from the Technics SA-424 receiver in typical home environments. As mentioned earlier, the receiver seems able to deliver power peaks that are audibly greater than its FTC power rating might imply.

Of course, there are instances in which a user might require more audio power than the SA-424 can provide, but in terms of its price, features, and performance, the Technics SA-424 is, to my way of thinking, a true bargain in today's audio component marketplace.

Leonard Feldman

Enter No. 93 on Reader Service Card



TECHNICS SH-F101 FM ANTENNA

Manufacturer's Specifications

Antenna Type: Dipole, indoor, electronically tuned.

Frequency Range: 88 to 108 MHz.

Relative Gain: -2.0 dB.

Directivity: Figure 8 pattern.

Half-Power Angle: 90 degrees.

Output Impedance: 75 ohms.

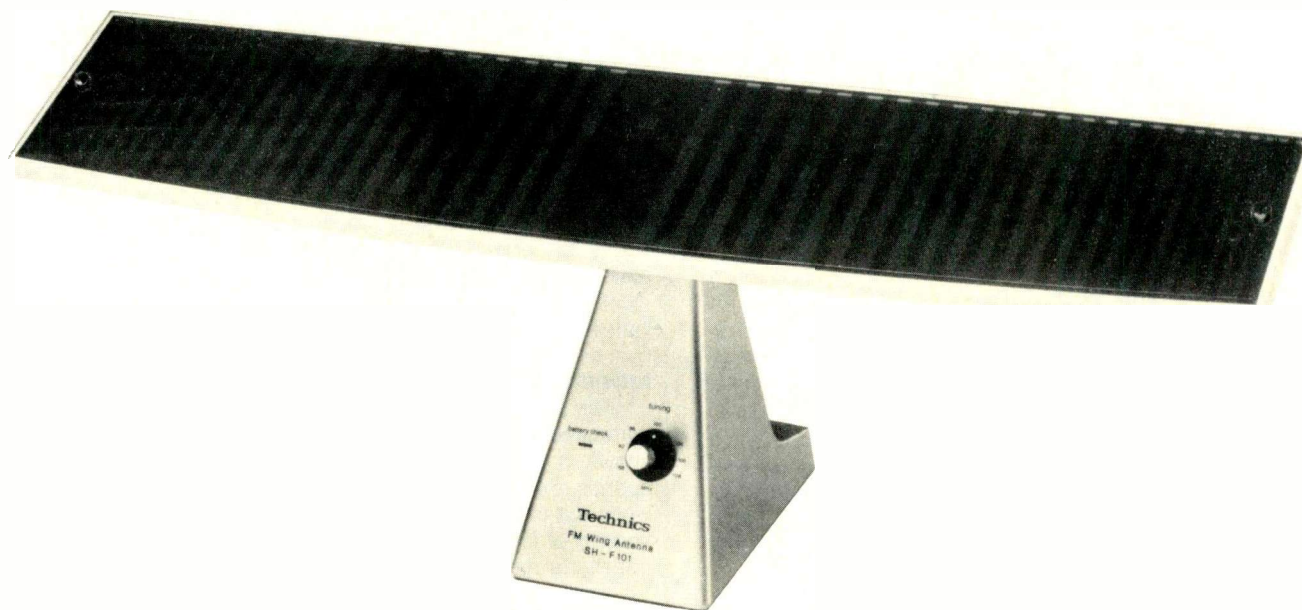
Standing Wave Ratio: 1.2 or less.

Power Requirements: 18 V d.c., two 9-V batteries, not supplied.

Dimensions: 16-27/32 in. (42.8 cm) W x 6³/₈ in. (16.2 cm) H x 4-7/16 in. (11.3 cm) D.

Weight: 1.9 lbs. (0.86 kg).

Price: \$90.00.



Over the years, we have stressed the importance of using a "good" FM antenna with any FM tuner or receiver. All too often, however, FM devotees who are perfectly willing to invest in a directional outdoor antenna are prevented from installing one for some reason or another. Many manufacturers have attempted to design practical indoor antennas that do almost as good a job, but only a few have met with success. The attractively styled SH-F101 antenna which I used in part of my FM listening tests of the Technics SA-424 is a fine example of an indoor FM antenna that *really* works. To compensate for its extremely short length of only 43

centimeters (a standard FM dipole needs to be 1.8 meters long to be tuned to the middle of the FM band), the Technics indoor antenna features a built-in electronically tuned circuit which brings the gain of this diminutive antenna very close to that of a reference dipole. More importantly, the tuned circuit actually improves the effective selectivity of any tuner or receiver with which it is used. The SH-F101 also has an excellent "figure 8" directional characteristic which means that by proper orientation of the device, a user can eliminate much of the problem caused by multipath signal reflections so prevalent in many metropolitan areas.

The Technics SH-F101 is truly the next best thing to a multi-element outdoor antenna — and that's high praise for any indoor antenna.

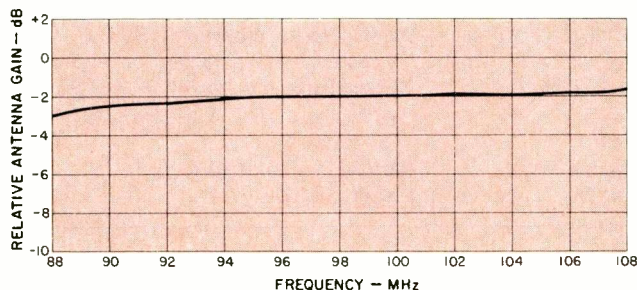


Fig. 1 — Relative gain of Technics SH-F101 FM antenna compared to a standard half-wave dipole cut to 98 MHz.

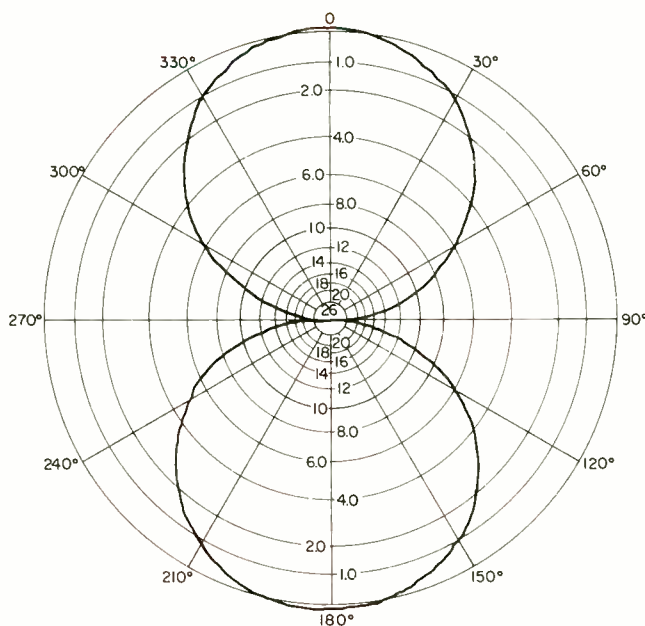


Fig. 2 — Directional characteristics at 98 MHz, Technics SH-F101.

The heavy base of the antenna is made of diecast material. The antenna itself is affixed to the base by means of a ball-joint which allows the antenna element to be rotated and tilted to various angles. A short coaxial cable, supplied with the unit, connects between the antenna section and the base, while a

longer cable, also supplied, connects from the base to the tuner or receiver with which the antenna is to be used. A switch on the surface of the base has three positions, auto, manual, and battery check. The battery check setting causes an indicator light on the opposite surface of the base to illuminate if battery voltage is still adequate. The manual switch setting allows the antenna to be used with any tuner or receiver and requires that the user tune a small knob until its pointer indicates the frequency to which the associated tuner or receiver is tuned. Since frequency calibration is only nominally accurate and somewhat vague, the best way to use the tuning control is to observe the signal-strength meter on the tuner or receiver with which the antenna is used. Once correct tuning of this knob has been accomplished, the antenna element itself should then be rotated and angled for best reception.

When the antenna is used with current models of Technics tuners or receivers, such as the SA-424 tested for this report, the selector switch on the antenna may be set to the auto mode. In this setting, not only are batteries not required for the antenna, but it is not even necessary to operate the little tuning knob on the antenna. Instead, a voltage appearing at the 75-ohm antenna terminal on the associated Technics tuner or receiver varies with the frequency to which the Technics synthesized tuner or receiver is tuned. Under these conditions, the user has only to physically orient the tuner for best reception and the electronic tuning is taken care of by the voltage coming from the associated Technics tuner or receiver. As I pointed out to the folks at Technics, however, the owner's manual for the SA-424 says nothing about this clever antenna tuning method, and I would never have known about it had I not had a conversation with the technical folks at Technics during the course of my tests. It's a very nice feature, but ought not to be kept a secret by its makers!

Laboratory Measurements

Gain of the antenna over the entire FM frequency band was compared with the gain of a reference dipole, and results are shown in the graph of Fig. 1. The "0 dB" in this graph corresponds to the gain which a standard dipole (half-wave exhibited, when cut to 98 MHz, the middle of the FM band). As for directionality of the antenna, it exhibited an almost perfect "figure 8" directional pattern, as shown in Fig. 2.

Summary and Use Tests

Many FM listeners make the mistake of purchasing an indoor antenna in hopes that it will provide them with as much signal power as an outdoor antenna. No indoor antenna I know of will provide this result. More often than not, however, lack of signal strength is not the problem. Usually, FM listeners want to eliminate multipath interference and other noise and interference sources. It is for these purposes that an antenna such as the Technics SH-F101 is ideally suited. The antenna worked very well not only with the SA-424 receiver, but with other tuners and receivers that were in my lab at the time of these tests. The increased selectivity brought about by the tuned circuitry of the antenna was beneficial when I tried to separate closely spaced (in frequency) signals on my normally crowded FM dial. The Technics SH-F101 is truly the next best thing to a multi-element outdoor antenna — and that is quite high praise for any indoor antenna.

Leonard Feldman

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David Hall,
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Stereo Review, October, 1980



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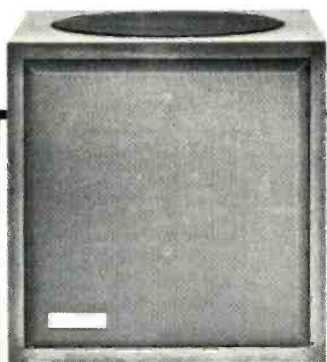
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*Revue du Son, No. 32 (November, 1979).



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Eastside Story: Squeeze
A&M SP4854, stereo, \$8.98

Sound: A- Performance: A-

In the past, Squeeze may have suffered some from a rather schizophrenic presentation, as the melodic pop songs of Tilbrook & Difford never properly meshed with the boogie-woogie of the now-solo Jools Holland. However, Mr. Holland's replacement, Paul Carrack (formerly with pubrocking Ace), not only fits in better instrumentally with the group but adds an interesting vocal touch that is gruff and soulful. As a result *Eastside Story* is Squeeze's most cohesive and entertaining album yet.

Some may attribute this to the production of Elvis Costello, Dave Edmunds, and Roger Bechirian, and certainly this influence is keenly felt: Squeeze sounds not unlike The Attractions, with a dominant rhythm section for the first time ever and a pleasing sparseness that suits their songs. But Squeeze's neo-McCartney/Zombies ap-

proach to songwriting shines through, and although the listener may be bombarded by a zillion chords per song (a new one every four beats, as it were) the lilting melodies always seem to triumph. Lyrics range from the socially obscure "Woman's World" to the mildly perverse "Someone Else's Heart" but rarely even approach anything mundane, thank goodness.

The masterpiece on *Eastside Story* — and that word certainly is earned by the performance here — is a new Tilbrook/Difford tune called "Tempted" which is primarily sung by Paul Carrack in a sort of Stevie Winwood voice, with Elvis Costello (using his bass register) and Glenn Tilbrook joining in alternately on the second verse. This is one of the more thrilling duets — or triets, as it were — in recent rock history, and to these ears it could easily find a home near the top of the AM charts if their record company moves swiftly.

Squeeze has also delivered value for money, as a full 14 songs have found

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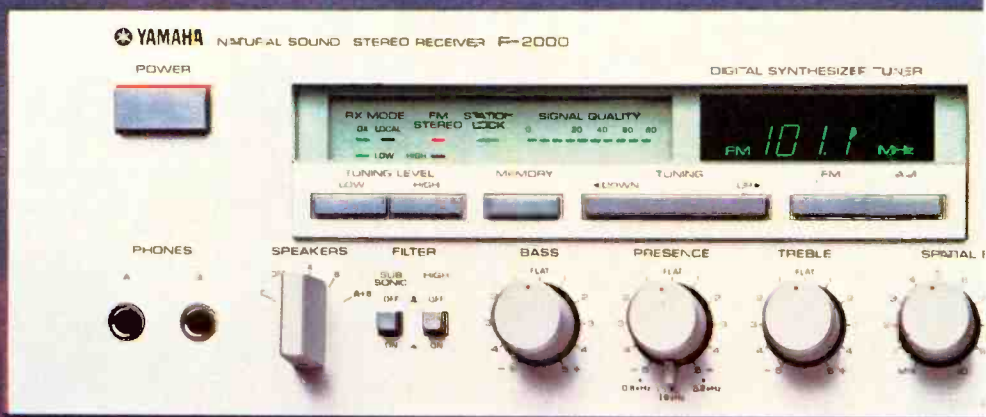
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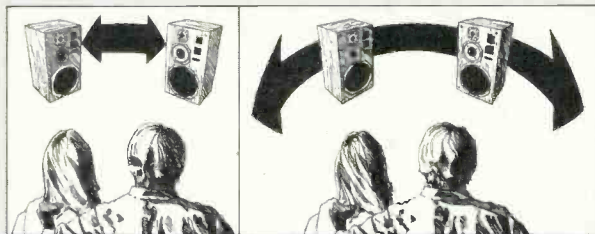
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The R-2000 with our new X-Amplifier is more efficient and

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The new Yamaha X-Amplifier works at low power most of the time. A unique (patent pending) comparator circuit switches the amplifier to high power when a loud passage is detected, and back to low power when the peak has passed.

As a result, the amp runs significantly cooler than conventional designs, which measurably increases component life.

And the X-Amplifier of the new R-2000 is the most powerful we've ever built into a receiver. It delivers 150 watts RMS per channel with 0.015% THD, at 8 ohms from 20 to 20,000 Hz. So the new X-Amplifier will easily handle the wide dynamic range of the newest digital and direct-to-disc recordings.

Yamaha's R-Receivers bring you sophisticated features and unparalleled convenience.

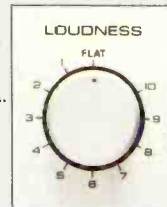
Continuously variable loudness control.

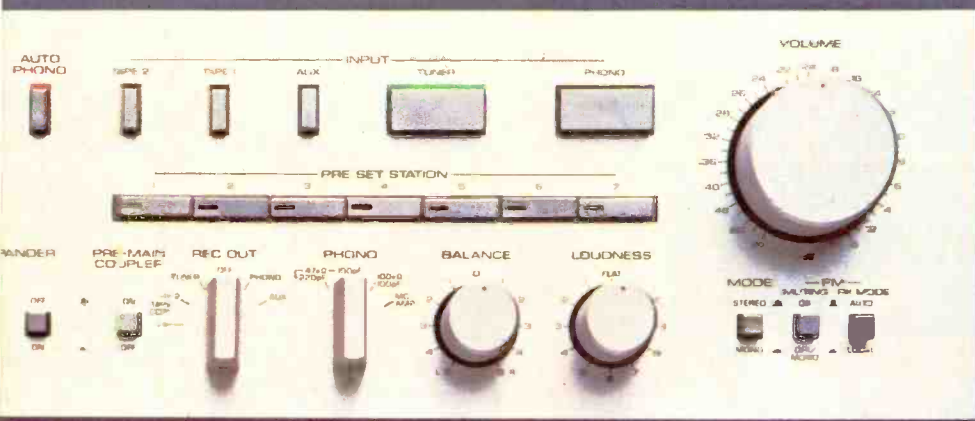
At low levels, music sounds like it's missing something. That's because at low volume your ear loses its ability to hear high and low frequencies.

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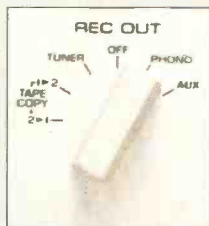


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developed a unique microprocessor chip with a memory. It stores the exact tuning location of every AM and FM station. When you tune a Yamaha receiver, the microprocessor produces exactly the frequency you're looking for instantly... from its memory. Tuning is 100% accurate. All you get is clean music.

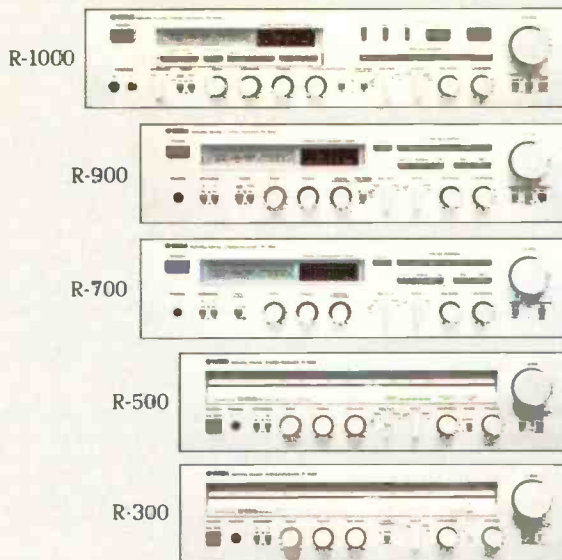
Pushbutton tuning.

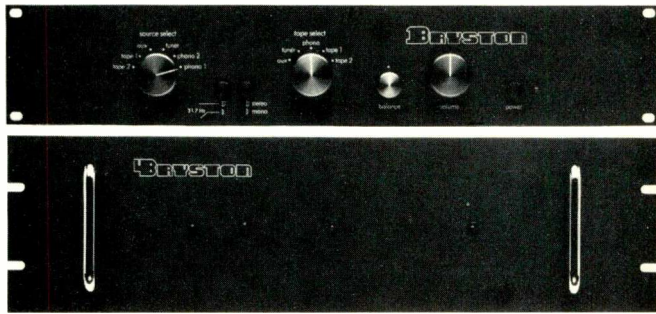
The Yamaha R-2000 virtually tunes itself. At the push of a button, the tuning circuitry quickly sweeps the band in the direction you desire. The receiver locks automatically onto the next station — perfectly. You can also pre-select seven FM and seven AM frequencies for instant access to your 14 favorite stations.

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By popular demand, The Audio Critic is going back to its original format.

The biweekly Bulletin format of The Audio Critic, started in January of this year, has been discontinued after just a few issues. The main reason for this decision was the widely expressed preference of our subscribers for the long-awaited feasts of audio information served up in our original magazine-size format, as against the more frequent snacks provided by the Bulletins, but certain misrepresentations made to us by the post office were a serious contributing factor. In any event, with the new issue about to be published, which will be called #10 (it would have been Vol. 2, No. 4 under the old nomenclature), everything will be back to the old format.

Issue #10 contains, among other things, in-depth reviews of new state-of-the-art components in several categories, including power amplifiers, phono cartridges, step-up transformers and tone-arms. All previous recommendations of The Audio Critic are also reconsidered and updated in this issue, after new listening tests through our \$37,000 reference system and measurements in our superbly equipped in-house laboratory.

Send \$30 for 6 consecutive issues, starting with #10, plus an **immediate free bonus** of all the interim Bulletins published (no Canadian dollars, \$6 extra for overseas delivery) to **The Audio Critic, Box 392, Bronxville, New York 10708.**

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their way onto this album without loss of sound quality. The Costello/Bechirian production team has much more luck here than on Costello's own album, and the one cut produced by Dave Edmunds doesn't sound much different from the rest of the LP. Perhaps Squeeze may be a bit too clever for their own good, but on *Eastside Story* they do such a smooth job of selling their songs that one might even expect the commercial success that they have earned with this album to at last come their way. *Jon & Sally Tiven*

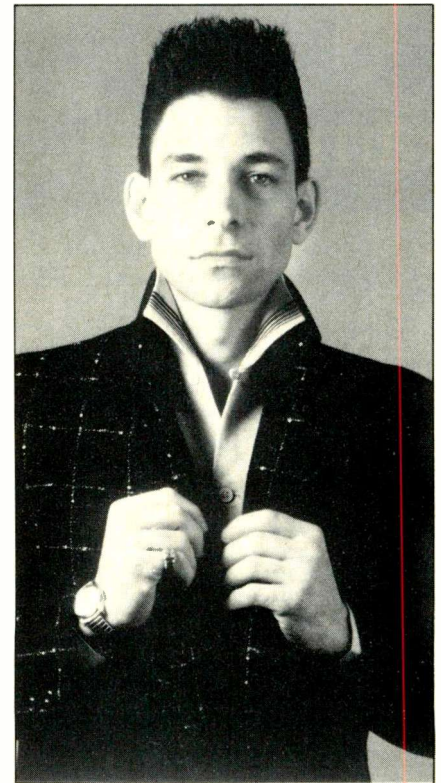
Are You Gonna Be the One: Robert Gordon

RCA AFL1-3773, stereo, \$8.98.

Sound: B+

Performance: C-

When Robert Gordon first jumped into the limelight at Manhattan nightspots like CBGB's, it had nothing to do with being in a rockabilly rut; he was just a Howdy Doody lookalike singing with heavy-metal bands like Tuff Darts or punkers like The Heartbreakers. Approaching his solo career, Gordon was quick to ape his



revered idols, Elvis Presley and Gene Vincent, but in failing to take their musical style one step further, he never became a big star. With his latest album, it's apparent that he realizes the futility of his former attempts and is desperately looking for a new direction but is having a great deal of difficulty synthesizing a new genre.

First off, he's left his former producer and has linked up with the Power Station

heavies, one of whom (Lance Quinn) plays a good deal of the guitar on this record and the other (Scott Litt) engineers. It's a fairly viable marriage; Litt has taken most of the effects off Robert's voice and for once you can hear him sing! His unmasked pipes are not the greatest in the world, but with the proper material it isn't inconceivable that he'd have hits. On this album, "She's Not Mine Anymore" and "Drivin' Wheel" are the outstanding moments.

Unfortunately, much of this album is drivel. The title track sounds like a thinly disguised rewrite of Eddie Rabbitt's "I Love a Rainy Night," and much of the rest is worse. From a non-songwriter without surefire material, we can expect very little.

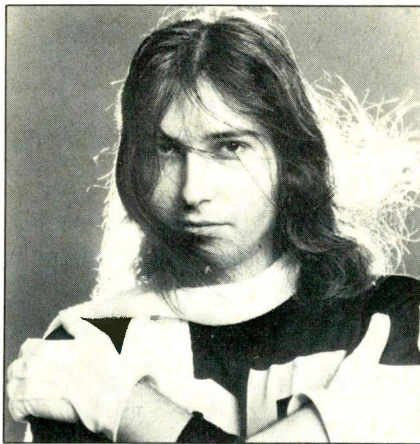
Jon & Sally Tiven

Bad for Good: Jim Steinman

Epic/Cleveland 36531, stereo, \$8.98.

Sound: D- Performance: F-

What is Meatloaf without the Meat? Artificial protein, hardly satisfying, usable only as filler, and this is how Jim Steinman (the man who wrote the songs for Mr. Loaf) will be packaged: Filler fodder for DJs to play in between Meatloaf tracks. But when you get down to music, the album not only doesn't hold, it may stand as the absolute worst album of all time. Steinman can't sing. The songs



are preposterous and ponderous jingles, horrible anthems for the Age of Rejects.

This unlistenable dreck comes to you through the courtesy of Meatloaf's management/production company, which created this album originally as Meat's second LP. When Meat heard it (after over half a million dollars had already been spent cutting the tracks) even his sense of taste prevented him from completing it, so Epic/Cleveland was left with this Todd Rundgren-produced pile of muck that they couldn't complete. They turned it into an *auteur* project, Todd opted out, and Jim Steinman (with noted engineer John Jansen) spent months in the Record Plant finishing it. Three-quarters of a million dollars later,

we have this well-packaged piece of sonic soap, rock opera for dunderheads, the album that defines pretension, and "music" guaranteed to drive everybody out of the room before you're halfway through the first cut. Records like this give rock music a bad name.

Jon & Sally Tiven

Dance Craze: Original Soundtrack
Chrysalis CHR 1299, stereo, \$8.98.

Sound: C- Performance: B+

What The soundtrack album of *The Harder They Come* meant to reggae, the soundtrack of *Dance Craze* is to the ska revival. The 15 selections include three each by The Specials, English Beat, Selector and Madness, two by Bad Manners, and one by The Bodysnatchers. When you catch the bands one track at a time as you do here, several positive things result. Rather than sounding too samey, the differences between the groups become emphasized which in turn gives them all added dimension and context. Recording them in concert has captured these bands at a fever pitch that none of their individual albums, possibly excepting The English Beat, has achieved. What carries *Dance Craze* is the joyous atmosphere and the concert enthusiasm of the bands. It is a delightful album with enough energy to make my stylus perspire.

M.T.

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Now, it's hard to see millions of consumers sitting at home listening to these albums unaccompanied for hours on end, but you'd be surprised how entertaining a good-sounding drum track can be. Personally, we prefer volume five (the hard rock 'n' roll album) which features Gerry Conway (late of Fairport Convention, if we're not mistaken) bashing his brains out; volume one (which has a smattering of everything) is the second best of the bunch, and the other three cater to a somewhat more "tasteful" set. They bill themselves as "The Ultimate Rhythm Machine," and for all intents and purposes they are — we highly recommend them.

Jon & Sally Tiven

Hard Promises: Tom Petty & The Heartbreakers

Backstreet BSR-5160, stereo, \$8.98

Sound: B— Performance: B

At his worst, Tom Petty is still pretty far above what your normal rockstar is capable of, but *Damn the Torpedoes* really marked the beginning of a downward slide in quality for Mr. Petty. Too affected by the Springsteen influence, misproduced for the second time in a row, and letting the band (which is a great combo, no doubt about it) take too much of a back seat to the lead man are three factors which have continued and severely hurt *Hard Promises*.

But more than that, the songs on this album are simply not up to snuff. The comment has been made that it sounds too much like outtakes from the last album, and although this is true, nothing in here rocks as powerfully as even the weaker tunes from *Damn the Torpedoes*. The funny thing is that the best tunes on *Hard Promises* seem to be placed toward the end of each side — as if they didn't have confidence in the premier tunes. One can only hope that Mr. Petty can shed these monkeys on

his back before he blows it completely and degenerates into a minor figure rather than the rock 'n' roll pioneer that he once was.

Jon & Sally Tiven

Drum Drops: David Crigger/Gerry Conway/Eddie Tuduri

Music Tree DD-7777-81, stereo, \$9.95. (Mail orders, contact Music Tree Records, P.O. Box 3000, Woodland Hills, Cal. 91365.)

Sound: A Performance: A

For those music enthusiasts who are either players, composers, or recordists the *Drum Drops* series is a revolutionary and invaluable aid to developing one's skill. What each of these records offers is a dozen or so "tracks" of professionally recorded drumming by a competent (if not inspired) player, slightly tainted with other percussion as well. Perhaps this doesn't sound too thrilling, but consider the possibilities — if one is a composer, one can (with the aid of any tape recorder) now create home demos which sound professional at a minute cost. If one is a guitar or bass player, one can "jam" for hours with a drummer and develop the knack of playing with a live drummer without leaving one's home.

In the World: G. E. Smith

Mirage WTG 16038, stereo, \$8.98.

Sound: A— Performance: B+

When I was younger and more foolish I was the kingpin of America's first New Wave label, and two of the acts (Rue Morgue and The Scratch Band) featured a talented guitarist named George Smith. This was back in Connecticut and although he was an active songwriter and visual aid in these combos, Mr. Smith got the itch to move on to greener pastures. It wasn't long before he was shak'n 'em down with disco Dan Hartman. But this was still in Connecticut (even though it was Fairfield County), and as far as George was concerned Manhattan was where things were poppin'. So he moved on to play lead guitar in New York with the fatally mundane Desmond Child and Rouge, which lasted about one tour due to Hall & Oates' interest in our man Smith. It was within the context of this performing ensemble, coupled with the fact that his marriage to Gilda Radner thrust him into the national spotlight, that record companies began displaying interest in the legendary G. E. Smith, mostly due to his refined stage presence. Little did they realize that they might even have a talented songwriter on their hands. He is.

Jon Tiven

CLASSICAL REVIEWS

EDWARD TATNALL CANBY

Bruckner: Symphony No. 7; Helgoland; 150th Psalm. Ruth Welding, sop., Chicago Symphony Orch. and Chorus, Barenboim.

Deutsche Grammophon 2707 116, two discs, stereo, \$19.96.

Sound: B+ Recording: A Surfaces: A-

Bruckner's enormous works, like those of Berlioz and Mahler, tend to attract ardent loyalists who, paradoxically, know every note — hour after hour! — and every performance. There's so much else in the world that I'm not one of them, and can only speak of Bruckner along with other composers, as is the case with most listeners. I very much enjoyed this big two-record album, rather to my surprise since Daniel Barenboim is not my favorite conductor, or favorite pianist either.

The reasoning is simple. Bruckner does sprawl, and far too many worshipful and dedicated performances only make him sprawl all the more. Barenboim, ever dynamic, will have none of that at all; his energy and vitality never let the music flag for an instant, slow or fast, and the forces at Chicago clearly are impressed and working at their very best. This is anything but a routine performance! I found it terrific.

Over and above all, one can sense that this indeed is Barenboim's own heartfelt music, unlikely as it may seem considering his not very Germanic background. It can happen!

In addition to the immense symphony, we have two relatively short (but still vast) choral works with orchestra. And here the unfailing powerhouse energy of the professional Chicago Symphony Chorus under the dynamic Margaret Hillis produces exactly the same effect as Barenboim's orchestra. "Helgoland," textually a rather jingoistic affair about Germanic supremacy, is for men's chorus and this is exactly, marvelously right for the Chicago males! They are simply not human — such continuous loud, brilliant, excruciatingly high notes, endless fortissimi without an instant of rest, you can scarcely believe. They, too, never flag and sound as fresh and lively in the final climaxes as at the beginning. An unusual work, and an experience to hear.

The 150th Psalm is more familiar, requiring the whole chorus, women and men, but the same comments apply. A lovely solo soprano is very well recorded against all these forces, and the choral-to-instrumental balance is extraordinarily fine. It's one of the best big-chorus-with-orchestra recordings I ever hope to hear.



Illustration: Rick Tulka

"It is hardly conceivable that a small, inexpensive, lightweight cube such as this could deliver as much clean power as any but a few of the largest conventional amplifiers on the market— but it does!"

Julian Hirsch,
Hirsch-Houck Labs



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As for its sound, Leonard Feldman reported in *Audio*: "Music reproduction was superb and completely free of any false bass coloration or muddiness... none of that brittle quality that one often detects from amplifiers that are beginning to strain."

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A note on the letter ratings. Surfaces have no ticks, but there is a very slight sense of rumble — one is aware of a disc, hence A-. The recording technique is superb but the sound, particularly of the crucial strings, has somehow a very faint edge to it, as I have curiously noticed in such recordings before. Still — a fine sound and worth a B+, that is, better than the strictly current average.

Prokofiev: "Classical" Symphony; Symphony No. 7. Moscow Radio Symphony Orch., Rozhdestvensky.
Quintessence PMC-7138, stereo, \$5.98

Sound: B Recording: B+
Surfaces: A- to B+

No recording date appears on this Melodiya import from Russia but it would appear to be, shall I say, young middle-aged and still very viable. Opulent, huge, rather distant Russian sound-of-the-orchestra, sometimes a bit less clean than we might like but mostly just fine. Pressed on excellent surfaces — a few ticks here, but the overall effect is really good. And all this for a bargain price, as prices go these days.

More important, of course, is the music. (You aren't buying sound for sound's sake here.) Decidedly, the late Seventh is one of Prokofiev's finest works, composed in his last illness, on a grander and more universal scale than the last of the sort from his colleague Shostakovich, a far less taut, bitter idiom. I have heard this piece played with more meticulous detail, notably in those marvelous small ideas, themes, that so catch up the ear in this music, and the fast parts go very fast here, whizzing by too rapidly for the detail to impress. Even so, this conductor has got into the music and understands its greatness. A moving performance, and it left me still awed by Prokofiev's bigness as a musician thinking on a grand scale.

The little "Classical," coming first, is all sparkle but not in the usual high-speed stunty manner; here it is as it should be, winsome and wistful as well as slyly humorous.

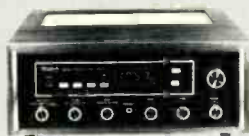
Virtuoso Trumpet. Haydn: Trumpet Concerto in B Flat. Hummel: Concerto in B Flat. Biber: Sonata a 6. Timofey Dokschitser; Moscow Chamber Orch., Barshai.
Quintessence PMC-7135, stereo, \$5.98.

Sound: B+ Recording: B? Surfaces: A-

I am late in getting to a big batch of Quintessence "Critic's Choice" releases that came in some time ago — but they are not to be bypassed; they are good and low priced, one more line of intelligently chosen reissues via license from Europe in the manner pioneered long

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ago by Nonesuch records. This one is straight out of Melodiya, the official Soviet label which has fed material to such as Angel and Columbia in past years; the only difference between those fancier label Melodiyas and such as this is the degree of international celebrity-hood. The big names, natch, go to the big labels. But who ever heard of a "big name" trumpeter — like some famed Russian pianist or fiddler? This one is as big in his field as any, known throughout international trumpet-land.

Easy to sum up. The man with the odd name, Dokschtser, is a 100 percent top pro or the "modern" standard trumpet, which means, of course, the 19th century trumpet. His playing is unctuous, velvety, with a lovely vibrato and, at times, incredible bursts of high-level gymnastics. Terrific — as trumpet playing. And no great matter that the styling doesn't really suit even the familiar Haydn piece, not to mention the longer but similar early 19th century concerto by Hummel. Both were composed for an earlier pre-valve instrument. As for Biber, a splendid composer of the Austrian Baroque and contemporary with Corelli in Italy, luckily it's only six minutes long. Frankly, I was offended. Dreadful. You can't just play *anything* your way, Mr. Dokschtser!

Those who have followed Melodiya through its various American-label outlets will find the familiar sound here. In quality, very good, though with a very slight edge of imperfection here and there in the louder parts; more noticeably, a tendency towards rather close and somewhat dry recording, faint reminiscence of the techniques we used in the 1940s hereabouts. Matter of choice and taste, always, and there is nothing old-fashioned or "obsolete" involved. (But I like the way we do it better.)

The Quintessence discs are well pressed as to surface but look and feel a bit thin to me; there is a tendency to warp in casual storage, perhaps connected with the thinness, which is always risky.

Mozart: Two Duos for Violin and Viola, K. 423, 424. Toshiya Eto, Michael Tree.

Nonesuch N-78005, stereo, \$9.98.

Sound: A- Recording: A- Surfaces: A-

Two remarkably lovely and extended works in an unusual medium by the versatile Mozart, who would try anything and invariably found ways to go further than anyone else could have imagined possible. But this seasoned and dedicated team, half-Japanese, half-American, does not do full justice to the music, not so much in the playing as in the style of each player. Unfortunately, they show

their disparate temperaments.

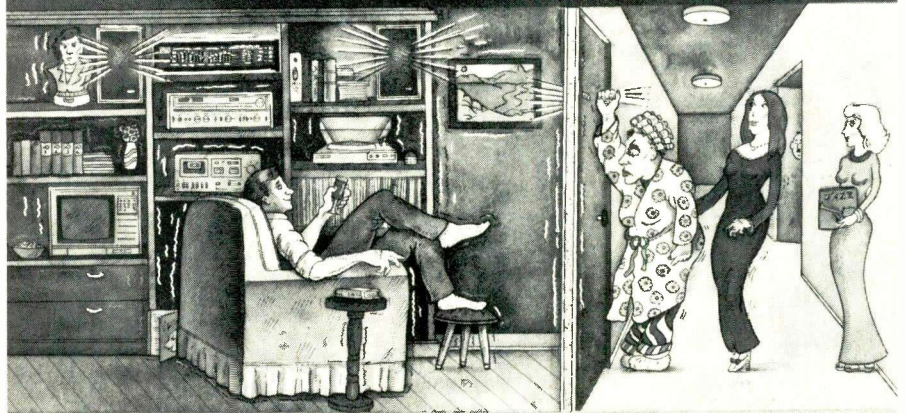
Toshiya Eto is a master fiddler with long experience and, indeed, thorough Western training at Curtis and under Efreim Zimbalist. Yet his playing is nevertheless Japanese, at least for two ears (mine), which means that there is still a lack of stylistic sense for the large body of Western art music — why not? Europeans have had centuries and Americans at least many decades to learn these subtleties of difference. The Eto violin, specifically, plays Mozart more or less as it might play Beethoven or Saint-Saens. Lovely sound. But not very "Mozartean."

Whereas Michael Tree, also out of

Curtis and Efreim Zimbalist, has that instinctive sense for Mozart that is simply a Western tradition. His Mozart is more true to the composer by far than the dominant violin music of Toshiya Eto. Too bad the parts were not the other way around!

Admittedly the differences between these two may simply be of musical temperament. No matter — the results are the same. I enjoyed the two duos, in which the pair of instruments combine in an almost orchestral brilliance of effect. These are major works by the composer, on a scale comparable to the string quartets but with even more searching explorations of the unusual.

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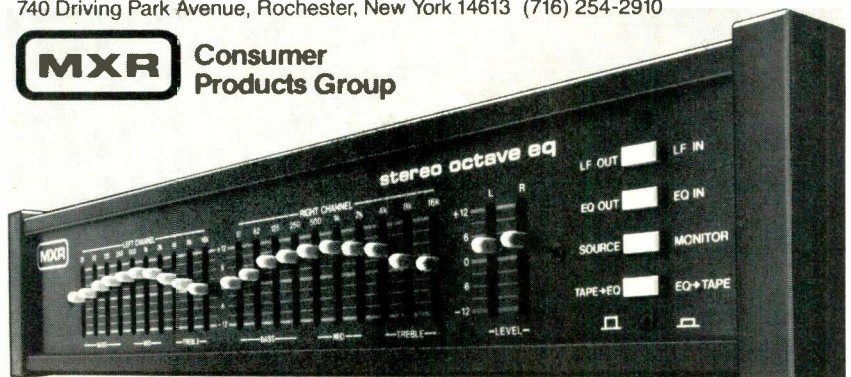
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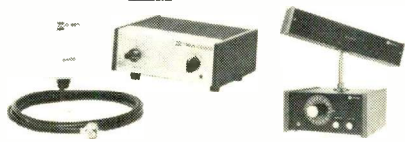
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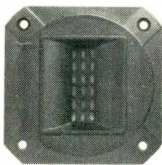
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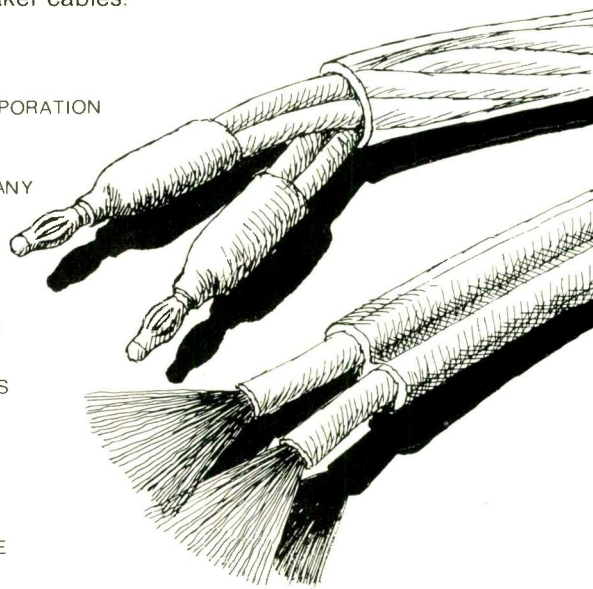
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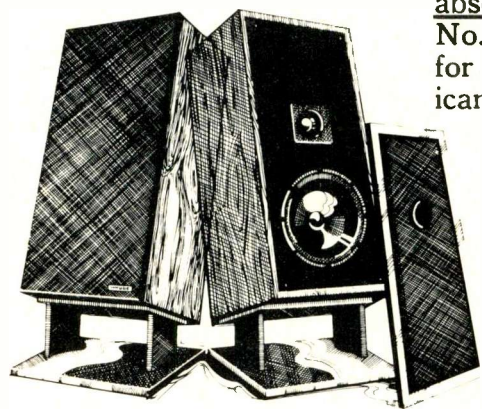
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Audio Amateur is for those who love good sound but who couple that pleasure to another, the savoring of fine craftsmanship as well. We're talking about craftsmanship of two sorts. The more obvious one of making a fine instrument, a well made, hand-crafted device—probably one of a kind. The skills are numerous. Beautiful metal work, exquisite finishes. Careful soldering with silver trace eutectic solder at just the right temperature. Coin silver switches, conductive plastic potentiometers or 23-position attenuators, metal film, close tolerance resistors, only the very best capacitors in polypropylene or teflon. Matched, low-noise transistors and carefully regulated, very low impedance power sources.

The other sort of craft is in the designs themselves. Designs by amateurs who do it because they love good sound passionately. Not something they'd say of course, but a driven, excited, informed imagination which revels in the many remaining unsolved mysteries in reproducing music accurately.

Amateur? Yes. Professionals in their fields of endeavor to be sure—and often trained in engineering, physics, or whatever—but amateurs all the same. People with massive amounts of know-how (and often very sophisticated facilities) who design, write, measure and photograph for their fellow readers.

Audio Amateur is really a quarterly get-together of people with a common passion for know-how in building audio reproduction gear. A place where ideas are shared, mistakes aired, opinions set out, and questions posed.

Small is right. Twenty to one compared with Audio; seventy to one compared with Stereo Review. But Audio Amateur intends to be small. We are not interested in "delivering a mass audience" to advertisers as a way to make a living. We are interested in delivering splendid information about excellent sound: why it is and why it isn't. How to make it better.

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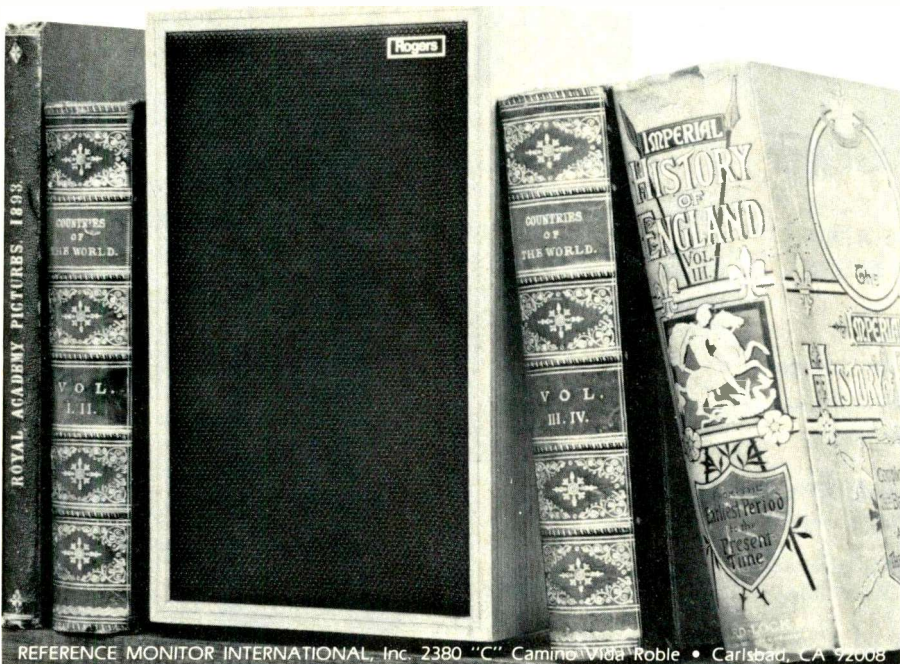
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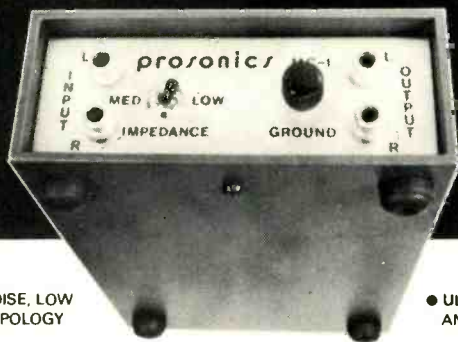
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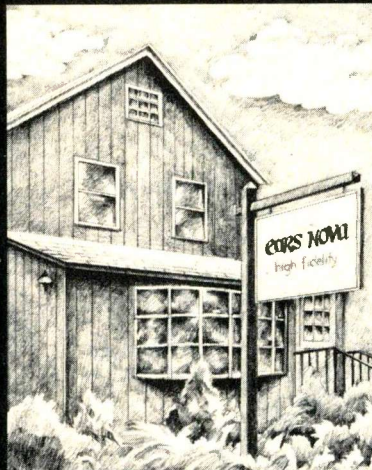
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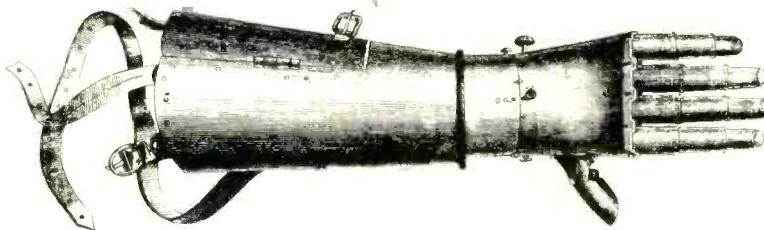
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Well, it has happened. The universal coded LP disc is announced, and sooner than I could have imagined. A compression/expansion disc, played through a decode or expand circuit, and it is explicitly intended to *replace* the standard non-coded LP across the board, worldwide, from audiophile to disco and back. Big order! But by the time this is in print you may be able to buy a few. And play them on your own equipment, perhaps even decoded.

The new system, which promises near-total background silence and greatly increased dynamic range, comes from CBS, no less, out of the same labs that developed the LP itself back in 1948. The name is CX, and evidently CX has been a long while in gestation. But now it is out, and it brings some real surprises with it, as well as a lot of canny market thinking.

In October 1980 I suggested that the final development of the aged LP system, in that "Great Interim" before the all-digital disc finally takes over, would have to be just such a coded LP to bypass the fixed limitations of the LP medium. Dbx has done splendid early spade work in that direction, building up a convincing catalogue of special LPs that play through the dbx II decode circuit. But CBS has thought ahead more

widely. Just as it did with the LP in 1948.

CBS is offering its CX system royalty-free to all comers on a licensing basis. And mindful, perhaps, of some recent disasters, it will sell CX-coded discs at the same price as ordinary LPs. The two types will mix freely and there will be only ONE release of each recording, whether CX coded or non-coded. You may remember that the SQ quadrasonic disc was usually sold at a premium, in special packaging, and there were TWO versions of every item.

Anathema! As we should know, the record dealers can make or break any new development simply by the way they treat the product, and there is nothing they hate more than "dual inventory" — two (or more) versions of each and every release, with all the extra space required for stock and the dismal confusions in selling. So there will be only one release. The market will hardly show a ripple.

But (double take) how can that be? How is it done? Here's the biggest surprise, total compatibility! That is, the new CX records must necessarily play exactly as well as any standard LP on any phono table *WITHOUT* decoder! Crazy. Most of us would have thought it impossible.

Play a CX-coded LP on your regular

table, any grade, and you will hear a standard LP sound, with the usual qualities we associate with our present records in terms of the sound itself, the background or surface noise and the (somewhat limited) dynamic range. The CX coding does not materially affect the regular playback. I will say nothing at this point as to how it is done, though via CBS technical literature I think I can see the trick. Main thing is it works. The CX disc, without a decoder, is simply an LP, of whatever sort.

But play that disc on a table connected through the (inexpensive) CX decode circuit, which will be available in a box or built into audio equipment by summer's end, and presto! CX blossoms forth with near-digital, almost total background silence and a dynamic range you have not heard on any standard LP. It's having your cake and eating it, too.

Those who have heard the dbx records will know what I mean. This is a new sound that simply is not possible without coding, not even on the fanciest audiophile disc. It hits you instantly. I see no reason why the CX sound shouldn't be as good as dbx. Even with quite different circuit details, the effect should be similar in the two systems.

But, alas, the dbx disc is not compatible. Play a dbx disc without the associated decode circuit and it sounds awful. I should know — I keep doing it by mistake, forgetting to push the button. Fact is, the dbx disc was never intended to play minus dbx II circuitry. It is compatible in that it uses the same basic LP playback equipment. But you *must* have a decoder as a matter of course (or dbx II in your tape equipment, which can also do the job). And there are two versions of the music, two records. One coded, the other standard.

Whereas CBS evidently has worked from the beginning towards what they saw as an absolute necessity, a disc that would play like a standard LP when there was no decoder. Some engineering challenge! But also a considerable feat of far-seeing, where others, including dbx, didn't think of looking.

I am not speaking for either company but I think we can see what happened. Dbx, like Dolby, has been mostly and initially concerned with tape and its problems. The dbx compander circuits first appeared in that connection. Dbx II works well with disc and no doubts. But

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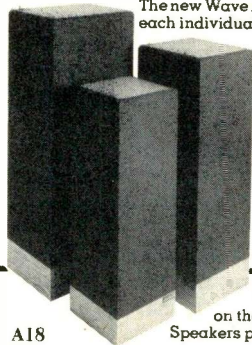
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The new CX system promises near-total background silence and greatly increased dynamic range capability.

it includes, among other things, some high-end equalization optimized for tape. That's OK for disc too, and maybe of benefit. The mirror-image code/decode circuit cancels it out in playback and all is well. But *without* the decoder, the equalization is all too audible! That wasn't part of the dbx thinking. The dbx disc can never make the grade as a standard LP. It wasn't supposed to.

On the other hand, CBS, which sells tapes, has primarily been disc orientated since the earliest Columbia 78s. The CX thinking is entirely disc, removed from tape considerations. And as a big company, CBS automatically worked in terms of the entire LP market. Hi-fi, audiophile, classical are only a small segment of this huge area. CX had to suit the whole of it. So it was indeed "have your cake and eat it," with two equally heavy priorities. Technical perfection in the decoding. AND effortless compatibility. Without any compromise. That was surely the goal.

There are bound to be doubters, of course. Many people distrust all this compression and expansion business and indeed, in the past, the "mirror image" method has not done well for itself, simply because the mirrors, the opposing circuits, are not very good sonic mirrors. No such circuit, you understand, can ever be perfectly mirrorlike. There is, so to speak, "play," and worse, that can be offensive to a musical ear when not controlled with real finesse. You'll find mountains of technical literature on this subject.

But, as I remarked in an earlier column on dbx II discs, things have moved on, these last years. Incredible improvements in circuit accuracy and control and, even more important, a great gain in the use of psychoacoustics, the canny knowledge of how the ear hears or does *not* hear. That's how Dolby did it, using the masking effect of one sound over another. Now, all this has come down to tiny measurements in milliseconds as to what the ear will do with this or that type of near-instantaneous sound. Not only in coded records, of course, or coded tapes. The late improvements in ambience units tie in with such advanced studies of the ear. Astonishing things can now be done, if you wish, to fool the ear into hearing what we want it to hear. Never forget that, in another field, the moving picture and television depend

entirely on the eye's false reading of a series of separate still pictures! That, of course, is the "psycho" power, and it can be applied just as neatly in the area of listening.

I will be very surprised if CX is judged as less than seemingly perfect as decoded from the new discs. Everything says it should work, right through the ingeniously calculated fourfold time-lapse filters that help control the variable gain of the expansion. Devilish clever.


I am more doubtful over the long run as to that equally crucial playback effect, the encoded disc played straight, as an ordinary LP. But the arguments, again, are impressive — the thing should sound LP-like, with no important losses or aberrations. (Anyhow, you'll only have the one version to try.)

A final thought. Assuming that CX does indeed take over in a large way, we will then find CX records being played on every sort of equipment including the vast mass of department store and supermarket non-fi, down to the very bottom. That's part of the plan. What then?

You see how tricky the CBS thinking has been! Suppose, let us say, that 96 percent of these early CX-coded discs never are heard through a CX decoder at all? So what! They cost no more, and they play like any LP.

But what happens when cheapie equipment begins to include a decoder for the by-then ubiquitous coded LP? (That, again, is the intention.) Right now, most such equipment can benefit from the sudden added silence, assuming it isn't drowned out in hum and such. Or by people noises. But the added dynamic range might be a difficulty. Too much. Unless you turn the volume down to near-silence in the softer music, you'll get blasts and buzzes.

And in the future, gradually, the equipment of this sort will be modified, price for price, to adapt more easily to the CX potential. Not difficult! A bit more amp power here (say, from 2 to 5 watts. . .), a sturdier pair of little speakers there, and the deed is done.

So, all in all, CX really has it made, on every front. It might even be so good that the digital disc itself will be postponed even longer while the big boys fight it out! That is exactly what CBS has in mind. They even say so. So watch CX. And we shall see. 

Tom between Super-A, quartz tuning and graphic EQ? Why not get all three.

Choosing a receiver can be a painful experience. Especially when the features you want most don't all happen to come in the same package.

But now there's the JVC R-S77. With the sound purity of Super-A amplification. The precision and beauty of quartz tuning. And the flexible control of JVC's 5-band S.E.A. graphic equalizer.

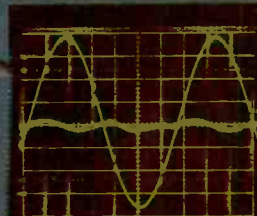
By completely eliminating switching distortion, Super-A allows the subtle details of musical overtones to come through cleanly and naturally. Add a powerful 60 watts per channel into 8 ohms, from 20 Hz to 20 kHz, with no more than 0.005% total harmonic distortion and you have an amplifier that sounds convincingly live on all kinds of music, loud or soft, simple or complex.

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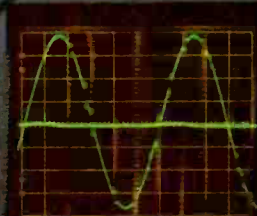
With our built-in S.E.A. graphic equalizer, you can give your system a thousand sound personalities. From flat-accurate for classical. To

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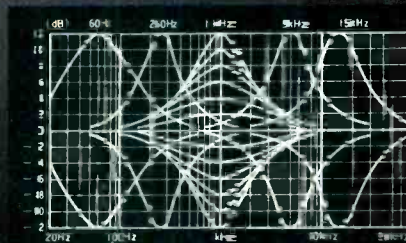
Beauty. Convenience. Control. And stunning sound quality. Now you don't have to choose which you want. Because you get them all in the JVC R-S77 receiver.



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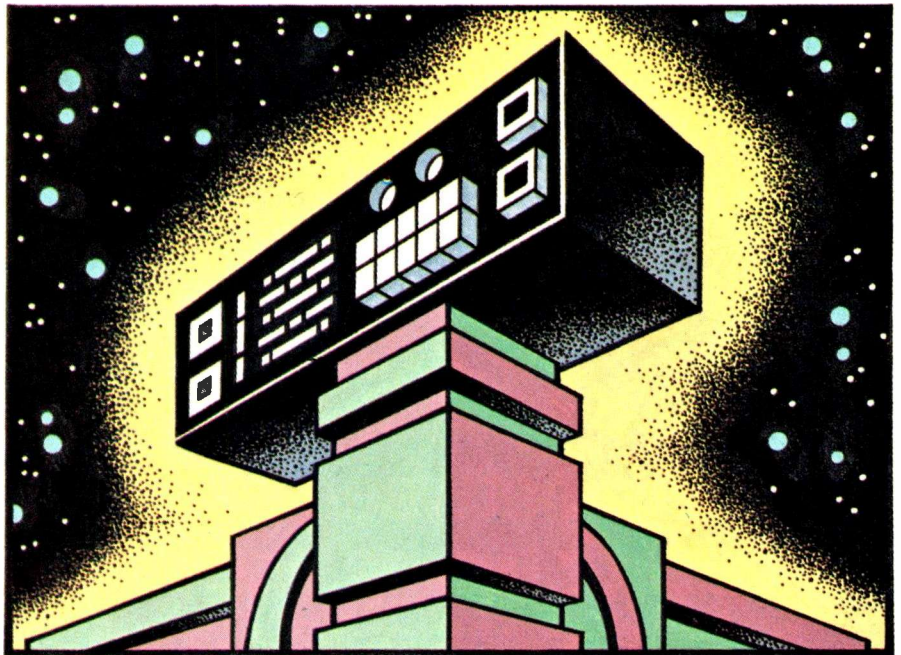
BERT WHYTE

The 69th convention of the Audio Engineering Society was held at the Los Angeles Hilton, May 12 to 15. For the first time in quite a few years, I was not in attendance, having been laid low by a nasty bug. Thus, this report is by way of my splendid surrogate, Dr. Barney V. Pisha, one of *Audio's* Senior Editors and our resident phono cartridge expert.

Barney tells me that although the convention was well attended, things were a bit on the low-key side. Some part of this can be attributed to the poor level of recording business which is virtually epidemic in the Los Angeles area recording studios. It is said that "for sale" signs have been hung in a considerable number of studios. A lot of the smaller fry are really hurting, but even some of the Big Deal studios have had to retrench. The poor business climate seemed to be reflected on the exhibit floors of the convention, with many visiting recording engineers wistfully eyeing all the dazzling new digital recording baubles which were financially out of their reach.

However, digital recording looms ever larger in the scheme of things. There is little doubt that given a more salubrious business climate and some progress in establishing a digital recording standard, this business will boom. Alas, in spite of ongoing meetings of digital committees, little progress has been made, and the more cynical types feel any standard is still a long way off.

Be that as it may, digital recording equipment continues to proliferate. A case in point is Sony's introduction of their PCM-3324, a 24-channel, stationary-head digital recorder. The unit uses half-inch tape, has 16-bit linear encoding, and switchable 44.1 and 50.4 kHz sampling rates. Error correction is by CRCC and cross interleave code. The recorder also incorporates the SMPTE code, and overdubbing and punch-in/punch-out are provided with digital cross-feed characteristics. Sony also introduced the PCM 1610, an updated version of their PCM 1600 unit. The new processor features switchable transformer/transformerless inputs and outputs. Perhaps the most important new feature for many people is the \$12,000 reduction in price from the original PCM 1600 unit. PCM 1600 recorders can be updated to PCM 1610 specifications for a nominal charge. Word also comes from



Sony that they have signed an agreement with MCI to share in the format and technology of the digital recording technology presently shared by Sony and Willi Studer.

Mitsubishi was on hand with their current models of their X-80 two-channel, stationary-head digital recorder, as well as their huge X-800, 32-channel stationary-head digital recorder. Delivery is now slated for late fall of this year at a rather breathtaking \$200,000. Near the same lofty price point is 3M, with their pioneering 32-channel digital recorder. 3M claims there are now more than 50 of these recorders in daily use throughout the world.

A new category of digital recorder has begun to appear. Technics broke ground in this respect with their model SV-P100, an integrated VHS videocassette transport with LSI chips for PCM digital recording and playback. (See June 1981 "VideoScenes.") Quantizing is 14-bit linear encoding to EIAJ standards with a 44.056-kHz sampling rate. Now Hitachi has introduced a similar unit, their PCM-V100, which again uses a special VHS videocassette deck with LSI chips for PCM record and playback. As you might expect, the EIAJ 14-bit linear encoding is used here too, with the ubiquitous 44.056-kHz sampling rate. An interesting characteristic of this new

breed of PCM recorder is that in addition to the standard NTSC VCR format, the units are compatible with the PAL and SECAM VCR formats. Strong rumor has it that several other Japanese companies will be introducing these integrated VHS/PCM digital recorders.

Denon has been in the digital recording field for some time now and has just introduced a new unit, the DN-035R four-channel, rotary-head, digital recorder. Using ¾-inch U-Matic type tape cassettes, the system uses 16-bit linear encoding and a 44.1-kHz sampling rate. The switchable 2/4 channels will appeal to those who want to do digital recording but need more flexibility than the usual two-channel format.

In the analog tape world, which is still very much with us, Technics introduced the latest version of their well-known closed-loop recorder, the RS-10A02. A two-channel, half-track unit for professional and broadcast use, the unit has all bias, EQ, and level adjustments on the front panel, as well as a built-in test oscillator. Also in the analog tape world, 3M introduced Scotch 226/227 mastering tape, which they state is bias compatible with Ampex 456. Among other things, a 2 to 3 dB improvement in print-through characteristics is claimed. Significantly, this permits 3M to sell the Scotch 227 tape, which is one-mil thick, for use in

Sansui. Better turntables for today's better discs.

A RECORD IS ONLY AS GOOD AS THE TURNTABLE IT'S PLAYED ON.

Today, because of sophisticated recording techniques, records are better. There's more and more music in the grooves.

And with digital, direct-to-disc, and half-speed mastering, audiophile discs are nearing perfection.

So your equipment has to be better to meet these tougher, higher standards. That's why Sansui's new line of turntables is designed to play today's audiophile discs — and tomorrow's. We've combined high technology with convenience. Take a look.

The fully automatic, direct-drive XR-Q11 features a microprocessor controlled programmer that lets you choose the playing order of up to seven selections; the quick response quartz-crystal PLL servo system with digital read-out greatly improves turntable accuracy and stability; and the solid BMC base helps elimi-

nate feedback. Result? Wow and flutter reduced to 0.015% and a 78dB signal-to-noise ratio.

Our mid-priced FR-D55 shares many of the outstanding features of the XR-Q11, including direct drive, sequence programmer, and the straight-line, DynaOptimum-Balanced (DOB) tonearm with a separate motor to control its fully automatic operation. The arm tracks only the record, not nearby footsteps or speaker-transmitted vibrations.

Like the FR-D55, the modestly priced FR-D35 has a direct-drive motor, platter and strobe indicator, with $\pm 3\%$ pitch control. Impressive 0.025% wow/flutter and 72dB S/N ratio. And all upfront operating controls, so you don't need to raise the dustcover.

That's only half the Sansui turntable story — there are three other models to choose from:

the XR-Q9, FR-D45 and the FR-D25.

Listen to your better records on Sansui's better turntables. At your local Sansui dealer.



FR-D35

XR-Q11

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Digital recording looms ever larger, and with a better business climate and a recording standard, this area could boom.

longer play mastering.


With the onrush of digital recording, many companies are introducing a variety of "digital-ready" products. Loudspeakers are certainly in this category, and JBL had VP John Eargle explaining the highlights of their big new monitor speakers, Models 4430 and

4435. The speakers are two-way systems employing biradial horns from 1 kHz upwards. The 4430 has a single 15-inch woofer of a new design, while the 4435 employs two of the new 15-inch woofers. Users of either monitor speaker need have no fear of digital dynamics. The 4435 can handle 300

watts from 100 Hz down to 22 Hz. The sensitivity of the 4435 is a brisk 96 dB from 1 watt at 1 meter.

Another digital-ready loudspeaker system (to put it mildly) is John Meyer's new compact subwoofer for his ACD monitor system. Utilizing two special 15-inch woofers in a vented enclosure, this unit can handle a continuous output of 120 watts from 100 Hz down to 30 Hz!

Crown was showing two new professional amplifiers, the PS-400 and the PS-200, with respective output power (4 ohms, full bandwidth) of 260 watts and 135 watts. Also new was their MX 4 mono electronic crossover. Newly repackaged and updated is the Badap BDP-2 audio computer. Now a much more compact 5.25 inches in height and only 35 pounds in weight, it is much more suitable for field use. Price is expected to be around \$5,500.

Needless to say, there were other interesting items at the convention which Dr. Pisha told me about but which would require a personal look-see for any comment I might make. 

The New Polk Audio RTA 12B

It looks like a \$1500 speaker, it sounds like a \$1500 speaker, but it costs less than \$500!

The new Polk Audio RTA 12B is a reference speaker designed for the appreciative listener seeking the finest in sound. While most speakers which offer comparable sound to the RTA 12B are extremely expensive, the 12B offers superb sound and exceptional value at an affordable price.

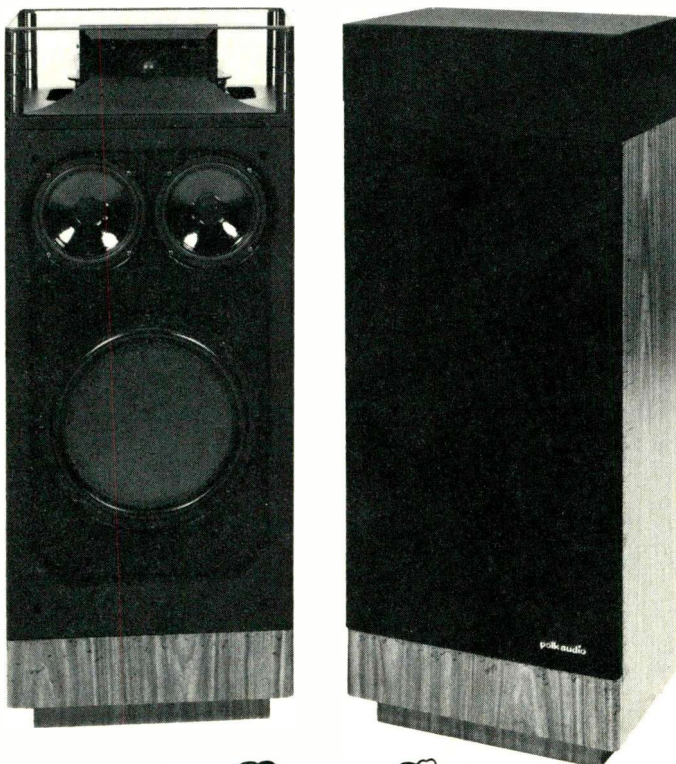
The RTA 12B is a full floorstanding system which is supplied in mirror imaged pairs. It incorporates Polk trilaminate-polymer drivers, a dual isophase crossover network and 12" fluid coupled subwoofer. It was designed using the aid of Polk's newly de-

veloped digital sampling-fast Fourier transform computer testing procedure. The RTA 12B, while costing less than \$500 each, can be directly compared against the \$1500 each and up, super speakers. When you do you'll hear many more similarities than differences. Use the reader service card for full information on the new RTA 12B and our other similarly superb sounding speakers starting from less than \$125 each.

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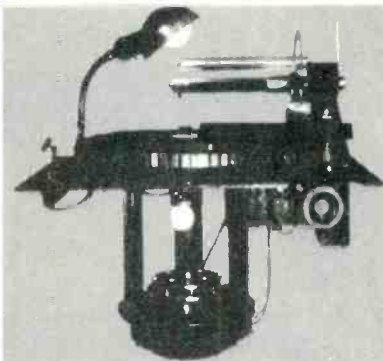
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The Speaker Specialists

AES Moves LA to October, Drops Apple for 1982

The Board of Governors of the Audio Engineering Society has changed the dates of the 1982 Los Angeles Convention from May to October and has cancelled the New York Convention for next year. Plans for the 71st Convention, scheduled to take place in Montreux, Switzerland, March 2 to 5, 1982, remain unchanged. The action came as a result of a day-long meeting of the Board of Governors during the Los Angeles Convention last May.

The Society is interested in hearing from members about this change in timing, and various members of the Board of Governors have noted privately that they are very concerned with the rapidly advancing peripheral costs of attending and exhibiting at the Conventions. They specifically cite air fares, hotel costs, and difficulties associated with bringing key personnel to Conventions. Also mentioned was the increasing number of shows and conventions, as well as the associated timing difficulties. Those who wish to comment should write to the Audio Engineering Society, Suite 2520, 60 East 42nd St., New York, N.Y. 10165.

**•1939...FIRST DIRECT-DRIVE TURNTABLE SYSTEM.
1951...FIRST MOVING-COIL CARTRIDGE.
1972...FIRST DIGITAL (PCM) RECORDING.**



In 1939, while many turntable manufacturers were trying to make the transition from horn phonographs to electrical record players, Denon developed its first direct-drive turntable, (shown above). Denon engineers discovered that only a direct connection between motor and platter — free of the pulleys or belts found in more primitive drive mechanisms — could completely eliminate speed fluctuations that obscure musical detail.

Today, many turntable makers have discovered the virtues of direct-drive. It is now the accepted means of approaching state-of-the-art performance. But only one company has had 40 years to refine the direct-drive principle. It is the same company that 29 years ago developed another technology now in widespread use: the Moving-Coil Cartridge. It is the same company that changed the entire process of recording music by inventing digital (PCM) recording.

The company is Denon.



•1981...DENON'S DP-60L DIRECT-DRIVE TURNTABLE.

The latest stage in Denon's refinement of direct-drive is the DP-60L Semi-Automatic Turntable. It uses a unique AC Servomotor with a quartz "clock" speed-reference to achieve exceptional torque and speed accuracy, while eliminating the corrective speed surges that degrade the performance of other direct-drive turntables. The DP-60L is supplied with two plug-in tonearm wands — one straight and one S-shaped — to assure a precise match-up with the characteristics of any phono cartridge.

The result? Musically cleaner sound, free of sonic smearing.

The Denon turntables for 1981: Six musical instruments from the company where innovation is a tradition.

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THAT'S THE WAY IT WAS

WALTER I. SEIGAL

CBS Correspondent Robert Trout, often called the "Iron Man of Radio" who first used the term "reside chat" when introducing President Franklin D. Roosevelt in 1933, was the best-dressed newsman covering New York City's Easter Parade in March 1937. His ratty attire included a wrist microphone and a 300-MHz UHF transmitter designed to resemble a cane or walking stick. This transmitter was used beginning in 1936 for news and special event pickups.



At last there's a cassette transport that fully exploits the precision of quartz.

You expect precision from quartz-locked direct-drive. But with a wow and flutter specification of 0.019% WRMS, the JVC DD-9 goes beyond your wildest expectations.

Audibly, this means complete freedom from pitch wavering. Plus uncanny clarity in the high frequencies thanks to almost total absence of flutter.

What else can you expect from a deck that's this accurate? Dolby™ C for one thing. It reduces noise by 20 dB (versus 10 dB with the previous Dolby system). And it operates much farther down into the midrange, giving 15 dB noise reduction even at 500 Hz.

Against this newfound background of silence you'll hear a greater resolution of musical details, especially with wide-range source material.

There's other JVC magic in the DD-9, too. Like our computer B.E.S.T. system that automatically measures every tape you use. Then sets bias, EQ and noise-reduction values to achieve ruler-flat response with lowest possible distortion. While JVC's heralded Sen-Alloy (SA)® Heads give you supremely low distortion plus rugged durability, all in a three-head configuration.

* Dolby is a trademark of Dolby Laboratories.

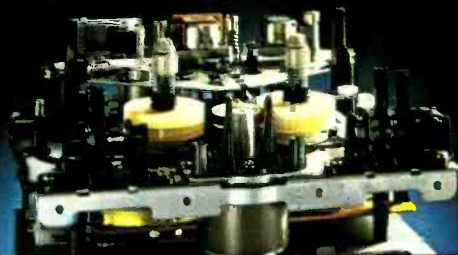
There's also an electronic digital tape/timer counter. Peak/VU fluorescent level meters. Memory and Auto Rewind. And full-logic transport controls.

Is there a place in your system for a deck as accurate as the DD-9? Or the DD-7 or DD-5, both with wow and flutter at 0.021% WRMS? Why not visit a JVC dealer and find out.



DD-7 with quartz-locked direct-drive.

Quartz-locked direct-drive transport.



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Beyond quartz, the world's most precise tuning system, lies a new ability to expand sound.

Imagine you're in a room with Technics SA-828 receiver. What you hear is beautiful stereo. Then you activate Technics variable Dimension Control. Incredibly, the sound begins to move. The stereo image widens to the point where the music begins to surround you. You're intrigued by its richness and depth. You're enveloped by a new experience in sound. That's the wonder of the patented technology in Technics Dimension Control.

Just as wondrous is quartz synthesis, the world's most precise tuning system. That's how the SA-828 quartz synthesizer eliminates FM drift as well as the hassle of tuning. You can even preset and instantly retrieve 7 FM and 7 AM stations, all perfectly in tune.

Another perfect example of Technics technology is our

synchro-bias circuitry. What it does is constantly send minute amounts of power to the amplifier transistors. And since they can't switch on or off, switching distortion is eliminated.

And when it comes to power, the SA-828 has plenty: 100 watts per channel minimum RMS into 8 ohms from 20Hz to 20kHz with no more than 0.005% total harmonic distortion.

The SA-828 goes on to show its sophistication with a super-quiet phono equalizer, soft touch program selectors, fully electronic volume control, and a Dimension Control display that doubles as a power level meter.

Technics SA-828 is part of a full line of quartz synthesized receivers. Hear it for yourself. Beyond its quartz synthesizer lies a new dimension in sound.

Technics
The science of sound

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