23602

AUDIO

JANUARY
1972 60c

The Authoritative Magazine About High Fidelity ® A

THE IDEAL TUNER

Evaluating an FM Tuner

A Novel Acoustic Feedback Loudspeaker

A Tone-burst Generator, Part III

✸ ✸ ✸ New Receivers & Tuners ✸ ✸ ✸

Use it any way you wish; the Scott 433 performs better than any other tuner you can own.

The Scott 433 Digital Frequency Synthesizer FM Stereo Tuner gets you about as close to the actual broadcast as today's technology will permit and with greater convenience than ever before.
Using such space age electronic circuitry as a phase locked loop, a varactor tuned RF section and a quartz crystal reference standard,

Scott engineers have produced the first dramatically superior tuner since they pioneered the silver plated FET tuner in 1965.

You no longer turn knobs or read tuning dials. You insert a program card into a slot and the exclusive Scott Digital Frequency Synthesizer automatically tunes to the center of the channel you select. The tuning error is so small it is actually less than one-third that allowed broadcast stations by the FCC. The 433 tuner comes with program cards for every one of the 100 FM channels available in the U.S.

In addition to automatic card programming, you can scan the entire FM band for either mono or stereo stations, or manually tune to any station of interest by pushing a button. The large digital display tells you

accurately what frequency is being received, and you can read it from across the room.

In short, the Scott 433 Digital Frequency Synthesizer FM Stereo Tuner looks and performs better than any tuner you have ever seen regardless of price. Matched set includes the 490 Integrated Stereo Control Amplifier with 75 watts per channel continuous power RMS into 8 ohms. Model 490 amplifier: $349.90. Or you can play the 433 tuner through any high quality stereo amplifier. Model 433 Digital Frequency Synthesizer FM Stereo Tuner: $549.90. See your Scott dealer or write for full information.

H.H. SCOTT®
where innovation is a tradition
H.H. Scott, Inc., 111 Powdermill Road
Maynard, Massachusetts 01754

Check No. 100 on Reader Service Card

TEAC's AN-80 and AN-180 Noise-Reduction Units:

If Rossini were alive today, he would set their specs to music.

Rossini once made this boast and could probably have delivered. But a recording of the music on the best of today's cassette or reel-to-reel machines with their inherent noise and hiss could never capture the clean, crisp sound of the Rossini laundry list.

With the introduction of TEAC's AN-180 Dolby* Noise-Reduction Unit, Rossini's Laundry Largo and just about anything else you record will have the same brilliance and luster as the original.

Our Dolby circuit removes machine and tape noise with such thoroughness that there is a signal-to-noise ratio improvement of 3dB at 600 Hz, rising to 5dB at 1000 Hz and 10dB at 4K Hz and above.

Because we manufacture the ICs used in our Dolby circuit to extremely tight tolerances, ours operates at distortion levels of less than .3%—lower than many competitive units. So you see there is no question that you should have a TEAC Dolby Noise Reduction Unit.

We designed the deluxe AN-180 not only to Dolbyize fine decks, but to afford them features they might be missing.

AN-180

It's actually a simultaneous record-playback control center with its own record and playback amps. It has built-in mike and line preamps that maintain mixing capability, or add this capability to recorders not so endowed. It has large professional-type VU meters for Dolby level setting as well as record/playback level indicators. AN-180 also incorporates such features as an internal 400 Hz, 100 Mv oscillator level controls, source/tape monitoring and a multiplex interference filter.

Even without Rossini to write a setting for the AN-180 specs, they make such beautiful music.

- Frequency Response, 20-15,000 Hz ±1.5dB • Increased SN Ratio, 10dB at 10,000 Hz • Harmonic Distortion, below 0.3%
- Signal to Noise Ratio, better than 65dB • Channel Separation, better than 55dB

If you just need the best no-nonsense Dolby with none of the frills, ask your dealer about the TEAC AN-80.

*Dolby is a trade mark of Dolby Laboratories, Inc.

TEAC® TEAC Corporation of America, 7733 Telegraph Road, Montebello, California 90640
TEAC Corporation, 1-8-1 Nishi-shinjuku, Shinjuku-ku, Tokyo, Japan • TEAC EUROPE N.V., Kabelweg 45-47, Amsterdam—W.2, Holland
In Canada: White Electronic Development Corp., Ltd., Toronto

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AUDIO

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JANUARY 1972 Vol. 56, No. 1

FEATURE ARTICLES

GUIDE TO TUNERS AND RECEIVERS

EQUIPMENT REVIEWS

THE WORKBENCH

RECORD REVIEWS

AUDIO IN GENERAL

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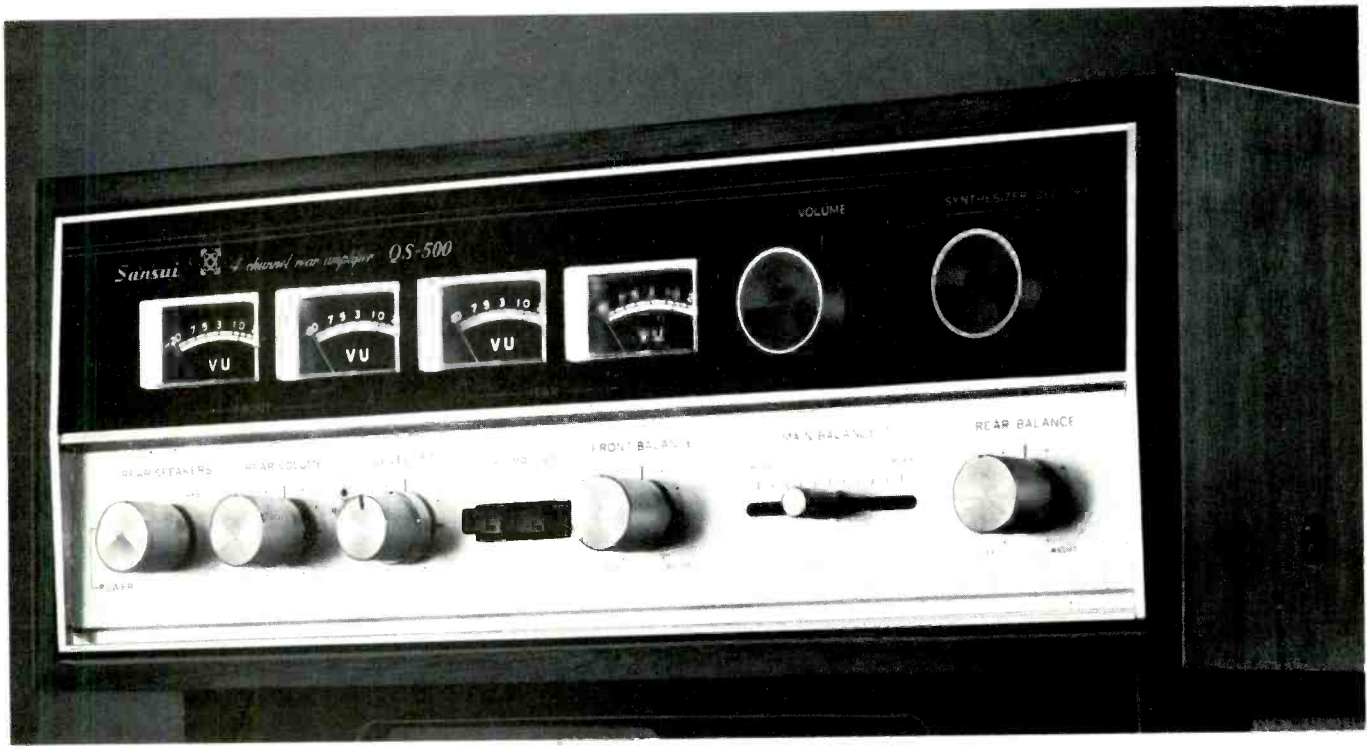
if you go for four channel...



you don't have to go for broke

Buy yourself a miracle for as little as $209.95. That's all it takes to get your conventional two-channel stereo to do anything any total four-channel receiver and control center can do, now or in the future.

The Sansui QS500 and QS100 converters are complete Four-Channel Synthesizer-Decoder-Rear-Amplifier-and-Control-Center combinations that transform standard two-channel stereo totally. The only other equipment you need is another pair of speakers.

You can decode any compatibly matrixed four-channel broadcasts or recordings and reproduce them in four authentic channels. You can detect the ambient signals present in most two-channel recordings or broadcasts and propagate them through the rear channels. In Sansui matrixing, the exclusive phase-shift technique prevents the cancellation of some signals and the change in location of others that occur in many matrixing systems. And the exclusive phase modulators restore the effect of the live sound field.

You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $279.95.

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $209.95.

Sansui®

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coming in February

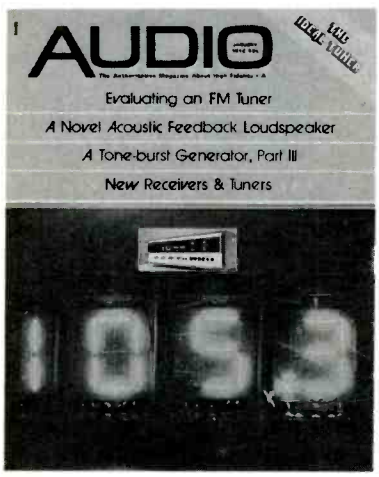
SPECIAL AMPLIFIER ISSUE

Amplifier Design
by Robert Carver

Buyers Guide to the new Amplifiers

The Measurement of Loudness
by Harry Olson

Equipment Reviews
will include:
Wharfedale W-70E loudspeaker
Sony 1130 amplifier
PLUS
Record and Tape Reviews and all the regular features.



About the Cover: Digital readout is becoming quite popular with the more expensive tuners and our cover shows a view of the Sherwood SEL-300 reviewed recently. Other digital tuners are the Scott 433, the SAE Mk VI, and the Mikado QS—with several others hidden in the labs.

Audioclinic

Joseph Giovanelli

FM Reception and Master Antennas

Q. I often listen to FM in my apartment, which is fairly close to several FM stations. I have tried several coupling devices in order to use the apartment building's roof-top TV antenna, which only resulted in poor reception for both the FM and TV sets, no matter what I did.

I am forced to use a T-shaped arrangement which I stretch out on the wall behind my tuner. This looks awful and does not give satisfactory results. The same is true of an adjustable TV dipole (rabbit ears) which I tried.

Nowhere have I read or heard of an FM antenna for people who cannot put up a roof-top installation or project something from a window because of apartment house rules.

Do you know of an adjustable indoor table model which is beyond the dipole stage and specifically designed for FM?—Claudia Grill, Palo Alto, Calif.

A. Unfortunately, no break-throughs have come along in terms of indoor antennas. Fortunately, however, the common dipole does do a reasonably good job for enough people that FM listening is worthwhile to them, but I do realize that not every one will be lucky.

There are rabbit-ear antennas which in addition to having a length adjustment for each element, also provide a system for changing the phase relationships between the two sections. Such antennas sometimes bring about improved reception.

I judge that your master system was not designed to receive FM stations. Such an installation is often set up to reject all but the TV channels. If enough tenants in your building complain, perhaps the antenna system could be redesigned to include the FM band.

On the chance that your master antenna does include provisions for FM reception, the following information may be useful.

Master antenna systems are usually 75 ohm installations. Your FM and TV equipment is, in all likelihood, only equipped for 300 ohm antennas. On top of all this, the master antenna uses unbalanced coaxial line, while your equipment requires a balanced input circuit. To overcome all of this you need to use a transformer which is 75 ohms to 300 ohms. You will also need a 2-set coupler which is designed to interconnect the FM set, TV set and transformer. The connections are shown in Fig. 1 . In addition, instructions are usually provided with both the transformer and the coupler.

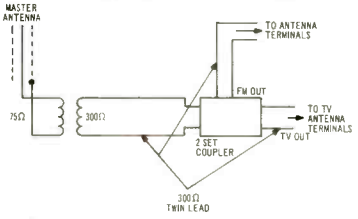


Fig. 1—Interconnection of TV, FM & master antenna.

By the way, the newer variety of couplers are so made that it is no longer necessary to strip the insulation of the 300 ohm twin lead. The screws which secure the wire to the coupler are so made as to cut into the insulation and make firm contact with the conductors.

Oxide Deposits

Q. I have a problem with oxide deposits on the record/playback head. I clean the head, lubricate it, and within four to five hours of use there is oxide visible on the head and there is a noticeable high frequency loss. The pressure pads don't seem to be excessively strong. Would changing tape be a solution to my problem? Is this kind of wear harmful to tapes over a period of time?—Steven R. Wagner, Augusta, Ga.

A. All tapes deposit oxide on the heads (with the exceptions of some special coated tapes); depending on the particular tape machines with which the tapes are used, some may do so more than others. Therefore it is worthwhile following up your thought of trying various brands of tape, particularly those of well-known, reputable manufacturers. If they all deposit excessive oxide, your pressure pads may be at fault and should be checked.

Does your machine have a tape lifter to space the tape away from the heads during rapid wind? If not, this may be the cause of your problem. Then try to wind the tape directly from reel to reel, and not past the heads; or insert a piece of celluloid between the tape and the heads during rapid wind.

Rapid oxide wear on a frequently used reel of tape is apt to harm the tapes and the heads.

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

it really comes alive...

It would be silly to ask if you dig real live sound. Of course you do. The same holds true for **quality** — for things that are **really** made, and **really** perform.

Our objective in developing the B-301 (**Tempo 1**) was to give you the best, most lifelike sound obtainable, in a well-engineered, well-constructed bookshelf system. The fact that performance fully met expectations, and that we could furnish full-fledged BOZAK construction quality for a modest price, were the real measures of its success.

The BOZAK B-301 is a three-way system based on a long-throw, high-compliance bass driver with a solid low-bass response. The high-compliance midrange unit with its well-damped aluminum cone was developed especially for this loudspeaker system: its clear definition, or transient response, is remarkable and we know of no other that can equal it. The latest version of the BOZAK high-frequency driver, originally introduced over twenty years ago, is highly regarded for its wide dispersion and silky-smooth response. All three drivers are of standard BOZAK quality — sturdily constructed, with generous magnet structures and unique BOZAK-made cones assembled on solid cast frames.

You will have to compare this speaker system to really appreciate it. And its price is very modest — especially for a real BOZAK!

the facts:

Bass Speaker: 12″ high-compliance, long-throw/**Midrange:** 4½″, with 2⅝″ damped aluminum cone on high-compliance suspension/**Treble:** 2″, with foam-damped diaphragm and wide dispersion/**Crossovers:** 1200 and 3600 Hz
Frequency Response: 40-20,000 Hz
Impedance: 8 Ohms/**Power Handling:** 40 Watts Program average/**Acoustical-Environmental Switch:** 3-position/**Enclosure:** oiled walnut, 14½″ x 23⅛″ x 11½″ deep
Grille: snap-out/**Weight:** 40 pounds.

Bozak

Bozak, Darien, Connecticut, 06820
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Check No. 5 on Reader Service Card

Tape Guide

Herman Burstein

Separating Transport and Amp

Q. I was wondering if I could take the transport of my tape recorder out of its case and make the wires to the amplifiers longer. Or would I get a distortion? I was planning to build the tape recorder into the wall and to put the tape preamps in a desk.

When recording, how high should the VU pointer go?—Jerry Ubels, New Westminster, B.C., Canada.

A. I suspect that if you change the existing wiring arrangement between your tape transport and the tape amplifiers you may run into problems of hum pickup and treble loss.

If your tape machine's VU meter is properly calibrated, you should ordinarily set recording level so that the pointer does not exceed 0 VU. But this is only a general statement. Depending on the nature of the sound source, you may find that sometimes there is no audible increase in distortion if you allow the pointer to swing as high as 3 VU; and at other times you may find it necessary to keep the meter down to -3 VU or even lower in order to keep distortion from being objectionable. Thus if you were recording a live guitar, with its strong transients, you might have to keep the pointer down to about -10 VU. Experience and judgment must be brought to bear.

Sound On, With, and Over

Q. I am confused by the terms "sound-on-sound," "sound-with-sound," and "sound-over-sound." Could you please explain these terms.—J. R. SanFilipo, APO San Francisco.

A. Sound-on-sound means that you can synchronize two or more sounds on the same track. To illustrate, record track 1; play track 1 and at the same time record the track 1 sound along with a new sound on track 3; play track 3 and record the track 3 sound along with a new sound on track 1; etc. Sound-with-sound permits you to synchronize two sounds on two tracks (not on the same track). Sound-over-sound permits you to record on the same track as a previous recording, but without erasing the previous recording; this is analogous to a double exposure in the case of a camera.

Speed Vs. Quality

Q. I am trying to decide between two tape recorders, one of which operates at 15 and 7½ ips, and the other at 7½ and 3¾ ips. I understand that the faster the tape speed, the better is the tape recording. Your advice would be appreciated.—Ronald Brown, Vietnam.

A. You are correct that the faster the tape speed, the better the recording. However, in today's state of the art, the high quality tape machine can achieve results at 7½ ips that are virtually indistinguishable from those at 15 ips. In fact, a few can even do so at 3¾ ips. For home recording there no longer seems to be much purpose in operating at 15 ips with a really good tape machine. On the other hand, for professional purposes, where a tape may be copied several times, with some deterioration in quality with each copy, the slight advantage of 15 ips operation appears worthwhile.

Improving Treble Response

Q. I like my TEAC A6010, except for its poor treble response at 3¾ ips. At 12 KHz, response is about 10 db down at this speed. What can be done to improve the treble performance at 3¾ ips?—Lawrence E. Root, Sacramento, Calif.

A. Improving the treble response of your tape machine at 3¾ ips may involve one or more of the following measures: (1) installing a playback head with a narrower gap; (2) reducing bias current at 3¾ ips; (3) introducing additional treble boost in recording; (4) adding more treble boost in playback. Which of these measures is required and how much depends upon the characteristics and circuitry of your machine. Also, some improvement may be obtained through choice of tape.

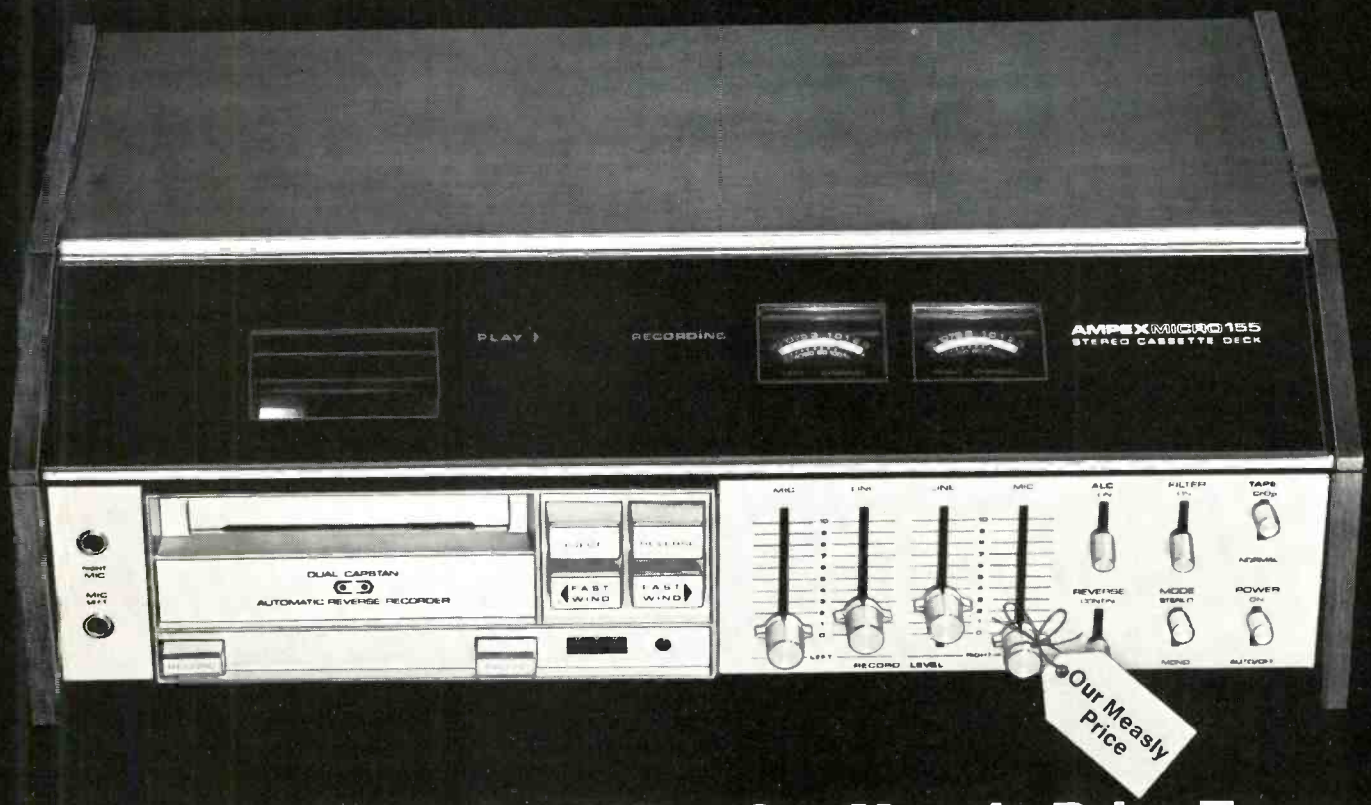
Splitting Half-Inch Tape

Q. I am interested in splitting half-inch tape. Is width extremely critical? What are the width tolerances?—Paul A. Smith, Jr., APO San Francisco.

A. So-called ¼-inch tape actually has a standard width of 0.246 inch with a plus and minus tolerance of 0.002 inch. Exceeding this tolerance may well raise problems of tape skewing or sticking in the tape guides.

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

Our Engineers Didn't Mind Spending Three Long Years Creating Ampex's Bi-Directional Head For The Micro 155, The World's Most Advanced Cassette Unit.



What Got Their Goat Was Our Measly Price Tag.

Put yourself in the shoes of the Ampex engineers. First, you spend three exhausting years and a half-million dollars developing the bi-directional head. The only cassette head in the world that can erase, play and record in *both* directions. And because there is but one Deep-Gap head for all modes, tape alignment is always perfect. It's the biggest recording breakthrough since the cassette itself. That's why Ampex had it patented. And included a three-year warranty.

Then you take this amazing head and build it into the Micro 155 stereo cassette deck.

You include four-source mixing for reel-to-reel versatility.

You add a tape selector switch that adjusts bias and equalization when switching from standard to chromium dioxide tape, which puts the 155's frequency response at a fantastic 40-15,000 Hz.

And solenoid assisted controls for faster, smoother operation.

Dual capstans for perfect head-to-tape interface in both directions.

Plus an Ampex/Starr slot-load system. Pause control. Repeat function. Automatic reverse. Automatic shutoff and eject. Hysteresis synchronous motor. Noise reduction switch. Automatic level control. Two lighted V.U. meters.

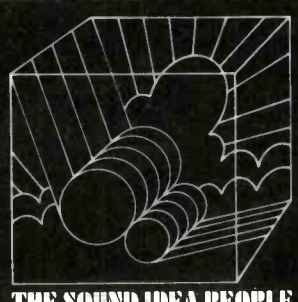
Then you design the most futuristic-looking tape machine in the industry. Because you feel that the best one should look uniquely different.

Finally, the time comes for the ultimate test. You slide a cassette into the machine and turn it on. You listen. And a tear comes to your eye. Because you're experiencing fidelity you never imagined could be achieved by a cassette machine. You've done it!

Then you hand it over to the marketing boys at Ampex. They look over your creation, the result of 36 months of blood, sweat and tears, and say "Hey, not bad. We should be able to move this baby at a ridiculously low price."

You walk out in a daze. Then you cry a lot. Don't those guys know what they've done? They've taken the world's most advanced cassette machine and priced it so *anybody* can afford it. How can anyone appreciate the sophistication and versatility of the Micro 155 at such a measly price? Oh, well. Just hope that the man who buys this machine takes the time to learn about everything that went into it. Then he'll have a greater appreciation of everything he gets out of it.

AMPEX



THE SOUND IDEA PEOPLE

What's New in Audio

Metrotec SD4A-1 decoder-amp

This unit combines an E-V Stereo-4 four-channel decoder with a 10 watts/chan. amp (rms, 8 ohms). Separate front and rear decode channels are offered, providing ambience in the rear channels with no loss of separation for existing two-channel sources. Harmonic and IM distortion are less than 0.8 percent, while power bandwidth is 15 to 50K Hz. S/N is 80 dB. Price: $139.95.

Check No. 7 on Reader Service Card

Communications Co. RT 60 timer

This unit measures reverberation time in real time and does not require a chart recorder for analysis. The timer has a self-contained ni-cad battery and uses one-third octave band pass filters, centered on 250, 500, 1000, 2000, and 4000 Hz. Digital readout is provided. Price: $395.00.

Check No. 8 on Reader Service Card

SSI MM 3000 turntable

This turntable and automatic tone arm feature straight line radial tracking for zero tracking error. A passive analog circuit does not use wires to transmit the signal from the pickup head which is not connected to the support rod by pins or screws and can be easily removed for maintenance. The turntable has automatic reject at the end of each disc, as well as user controlled start, pause and reject. Platter weight is 3 lbs, and its diameter is 12¼ in. The drive motor is a hysterisis synchronous, outer rotor type. Price: $249.95.

Check No. 9 on Reader Service Card

Pansonic SH-8780 demodulator

Designed to work with the CD-4 (RCA, JVC) system, this four-channel disc demodulator is said to have low distortion, high signal-to-noise ratio, and accurate separation. A selector switch is included for the specific cartridge type—semiconductor, moving magnet, or ceramic. A four-channel indicator "eye" lights up when such a record is played. Conventional two-channel discs may be played through the unit. Price: Not yet established.

Check No. 6 on Reader Service Card

THE CRITICS HAVE PUT THE COMPETITION IN THEIR PLACE

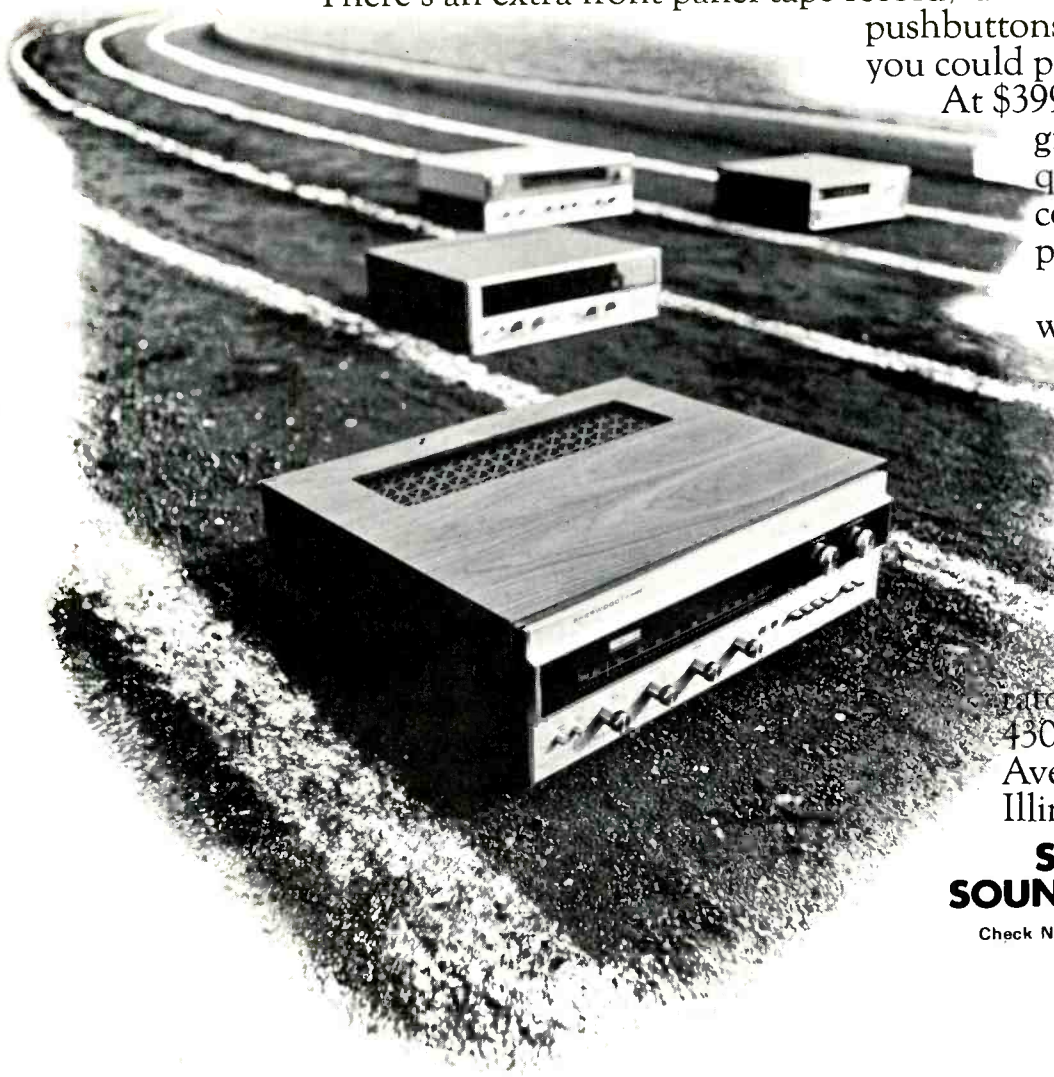
Specifically, the leading consumer testing publications have continually top-rated Sherwood receivers over all others. Our S-8900 shown here leading the pack is no exception.

Of course, we worked hard to get those ratings.

The S-8900 has a powerful 225 watt (± ldB) amplifier (48 watts RMS per channel at 8 OHMS). FM distortion is the lowest in the industry—0.15%. There's an impressive 3 year parts warranty, plus 1 year labor, too.

The S-8900 features solid-state ceramic FM IF filtering. Exclusive FET FM interchannel hush control. A zero-center tuning meter.

There's an extra front panel tape record/dubbing jack. And six pushbuttons for every effect you could possibly want.



At $399.95, our S-8900 gives more top-rated quality than any comparable or lower priced model.

That's what we've always said. Only now you don't have to take our word for it.

For more information and complete specifications, write us today. Sherwood Electronic Laboratories, Inc., Dept. A, 4300 North California Avenue, Chicago, Illinois 60618.

SHERWOOD SOUNDS EXPENSIVE.

Check No. 10 on Reader Service Card

Dear Editor

Dolbyized FM Broadcasts

Dear Sir:

Much has been said in your magazine about the application of Dolby processing to FM broadcasting. The whole whole basis of Dolby (type B) is to boost treble during low-level passages; the response is then flattened during normal or maximum-level passages. A complementary device is supposed to be used to de-process the audio. However, should we assume that there will always be level changes sufficient to derive benefit from Dolby processing?

In my opinion, the typical rock music FM station will not receive a benefit from Dolby sufficient to justify the expense. How many of you have actually watched modulation meters at a rock station (as I have)? Level changes sufficient to activate the Dolby equipment may represent 1% or less of airtime and on some days they may never happen at all!

Many radio stations in this country (rock and otherwise) do not allow drops in audio level; they employ typically 20dB or more of automatic volume-compression and an uncertain degree of manual compression (they "ride the gain"). Such stations pride themselves on being "tight"—which is broadcasting slang for allowing no lapses in audio whatsoever.

Many (if not most) recordings are already highly compressed these days—even many classical recordings. While it is true that Dolby processing may extend the dynamic range of commercial recording, I believe that the final product will always be subjected to compression. This is especially true of rock music where the general rule seems to be to cram in as much subjective loudness as possible.

As a matter of fact, several rock stations on FM in this country are automated and the equipment will automatically reject the very kind of audio which would benefit from Dolby processing! It's called "silence sense" and it's intended to never allow silence on the air because of expired tape or a defective machine. However, this gadget is a troublemaker sometimes because it may reject the occasional soft or slow passage in the music. So, as a matter of self-defense, the tapes for the automation are subjected to lots of automatic and manual compression (and even some clipping) during preparation—then the station compresses it even more on playback. After all this . . . it goes to the Dolby. Do you think there will be many level changes on which the Dolby will operate? I think not!

Too many of us are guilty of thinking of FM as it used to be. Classical music with wide dynamic range was once FM's specialty. I would like to see a poll taken to determine how true this is today.

I do not believe in the rationalization which says that FM benefits from Dolby even if the complementary receiver circuit is not used. (You could install *any* kind of "black box" and *some* people would swear it sounds good.) If the de-processing is not used the response will not be flat at all times. Isn't a flat response one of the primary objectives of FM in the first place? FCC regulations specify more flatness on FM than on AM.

If the FCC rules that Dolby can be used at all times, then they will require that all manufacturers build-in the Dolby circuits in all new receivers. This will render obsolete thousands (perhaps millions) of FM receivers already in use. Nine out of ten receivers in use cannot easily be converted. Those with seperate tuners and preamplifiers could do it easily, but that kind of set is in a *very* small minority today.

Is all the expense and bother really worthwhile? This change would be made for the sake of a *minority* of listeners with border-line reception. Let me point out that the FCC (for good reason) limits the range of a station by limiting the power which may be used. It is not logical to use a gadget such as Dolby to extend the range—that's an attempt to bypass the reasons for limiting power.

Clyde E. Wade, Jr.
Little Rock, Ark.

The basic advantage of the Dolby system is the increased signal-to-noise ratio, and in the recent tests by Chicago's WFMT, a classical music station, listeners in fringe reception areas reported a dramatic decrease in background noise. Listeners without *Dolby decoders were told to adjust their treble controls and the majority of these people said the overall sound quality was improved.*

In theory, the service area of a Dolbyized station is increased by a factor of three, and even if we cut this in half, it still leaves quite a sizable minority. As for distorted program material from many FM stations, Clyde is absolutely right. But if those stations will not derive any benefit from a Dolby system, presumably they will not spend the money!—Ed.

Pro Playboy

Dear Sir:

Only one word on "Hi-Fi at the Playboy Mansion"—fantastic.

T. T. Niyaoka
Fremont, Calif.

And Con

Dear Sir:

The Playboy article read like a story in a women's (or men's) magazine.

Bjorn H. Lambrightsen
Los Angeles, Calif.

Allison Revisited

Dear Sir:

In his November, 1970, article, "The Loudspeaker/Living Room System." Mr. Allison makes several unwarranted assumptions.

It is true that concert-hall music recordings are closely miked, thereby creating an effect unlike that which the audience normally hears. It is also true, however, that the recording engineers who mix the eight or 16 channels down to two, use monitor speakers to determine the final balance and tone coloration. The result is, in their opinion, a *realistic* sound. Incidentally, given the combination of different models of monitor speakers and differences in human judgment, the same set of master tracks may come out quite differently when released by two different recording companies.

Another unfair assumption is that all music to which one will listen is concert music. Will *all* recordings benefit by superimposition of concert-hall acoustic curves? Jazz and chamber music, for instance, are generally heard in intimate surroundings, not concert halls.

Related to these points, however, is the emphasis on natural ambience to allow for derived four-channel sound. If recordings already possessing con-

(Continued on page 82)

The end of the fidelity gap between cassette and open reel.

Our RS-275US brings the low-noise, wide-response performance of open reel to a cassette deck. Frequency response: 30-15,000 Hz. Signal-to-noise ratio: better than 45 dB. Those are numbers you've probably never seen before in cassette.

The biggest reason for our lower noise and wider response is also the smallest. Panasonic patented a Hot Pressed Ferrite head with one of the world's narrowest, most precise gaps. You get a 25% broader frequency response with ten times the life of conventional heads.

A separate fast-forward and rewind motor means we don't have to spin wheels with our drive motor. The motor that drives the tape drives it directly. No belts to give you the slip. No gears to start fluttering and wowing. The speed is constant. So is the lack of noise. Our patented drive motor is DC and brushless. No AC hum. No brushes to spark up static.

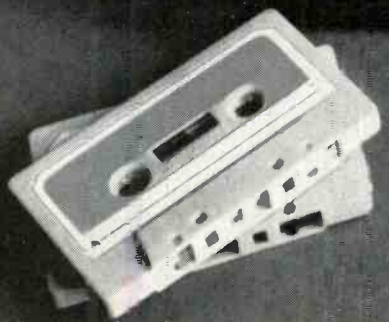
We're quiet in other ways, too. There's a special noise suppression circuit with its own switch. And a tape equalization switch for the newest low-noise super tapes.

Nobody else has all these low-noise, wide-response features in one great cassette deck.

And that's just for starters.

You'll find solenoid push-button operation for electrical, not mechanical switching. A "memory rewind" button that pre-sets the tape to stop right where you want it to. Two big VU meters. Separate output volume level controls before the signal goes into your amplifier. Optional remote control. And a walnut base as part of the deal.

When you're ready to get serious about a stereo cassette deck, see your franchised Panasonic Hi-Fi dealer for the RS-275US. The one that gives you reel sound.



Panasonic

just slightly ahead of our time.

Behind The Scenes

Bert Whyte

I BEGAN to write about four-channel stereo in 1969. Now, writing this first column for 1972, it comes as a mild shock to realize that this major advance in sound reproduction is still in its gestation period. However, there are many signs and portents which lead me to feel that sometime during this year four-channel stereo will finally come to term and become a viable entity in comsumer audio.

I think it is important to understand that when four-channel stereo becomes a commercial reality, it will appear in a number of configurations. The term "four-channel stereo" is very loosely used these days. Consider these permutations for example: whether the format is discrete open reel tape, discrete Q-8 cartridge or matrix disc, if the music is of the pop "surround sound" type with equal amplitude fore and aft, it is, strictly speaking, four-channel monophonic sound. Discrete open reel tape and discrete Q-8 cartridge can give us true four-channel stereo with the rear channels reproducing ambient information. The matrix disc cannot of course give us true discrete four-channel stereo. However, the rear channels can carry somewhat compromised ambient information, which from a psychoacoustic viewpoint may present a fairly effective simulation of stereo. I personally feel that the tape formats and the disc will co-exist. The suggestion put forth by some people, that tape utilize the matrix system, is patently ridiculous. Why take the ideal format for four-channel stereo and subvert it with a matrix, just to save on tape? Sure, discrete open reel tape is the purists' medium. Those who can afford and appreciate the advantages of this format, should not be penalized with a compromised product.

Speaking of matrix systems, I'm sure you all have read the advertisements about various decoders. You have also read about the Dyna system. You have heard terms like "derived four-channel stereo" and "ambient extraction" bandied about. The gist of these ads is that you can feed your ordinary garden-variety two-channel stereo discs into a decoder (with amplifiers and speakers for the rear channels of course) or in the case of the Dyna system, one or two extra speakers, and obtain "four-channel stereo effects." Well, with all due respect to all involved, this is not even a simulation of four-channel stereo. In the first place, the recovery of "sum and difference" information is strictly a matter of happenstance. In other words, you encounter this information on a random basis; it is not a constant factor in all recordings. In the second place, if the record does have some left minus right information, it is reproduced in the rear speakers without the time delay characteristic of a true four-channel stereo recording. In other words, in a typical four-channel stereo recording, depending on hall acoustics, the "rear" microphones pick up the multiple reflections from the walls, ceiling, and floor some numer of milliseconds after the onset of the initial wavefronts of the instruments of the orchestra. Ideally, the delay should be no more than 33 to 35 mS, which is the limit of sound fusion in the brain. More than that, and you encounter echo and "slapback." Now don't get me wrong! The word "enhancement" covers a lot of ground, and I know quite a few people who are very pleased with this "derived four-channel stereo." It is just not the "McCoy," not the "real thing." For those who enjoy this kind of sound, especially the Dyna advocates, here is a tip for you: In the early years of the stereo disc, from 1958 through 1963, London, Angel, and Deutsche Grammophon were using the European "MS" (middle/side) stereo recording technique. This utilized a cardioid and a figure-eight microphone placed together, with the cardioid facing forward and the figure-eight at right angles to the cardioid with the "loops" of the "eight" to the left and right. The mikes were hung at an appropriate height and distance from the orchestra on the centerline of the hall. (A bit later special stereo mikes with the two patterns in a single housing were evolved for this task.) This "MS" mike technique produced a lot of left minus right information, and with your Dyna hookup you can extract this information on virtually every record made during that era. With our American "spaced array" mike technique (which is now used by almost every recording company here and in Europe), finding the difference information is mostly a matter of luck. So dig out all of those older stereo recordings made by the companies I mentioned if you want practically guaranteed results!

One can readily understand that people who have a lot of money invested in a large stereo record collection would opt for any technique that offered a simulation of four-channel stereo. Most of the techniques available rely heavily on psychoacoustic phenomena, such as the well-known Haas precedence effect. The thing one must accept is the evidence of one's ears, in spite of the fact that intellectually you know you are being fooled. If the techniques are sophisticated enough, such as the Eargle process tapes I described some months ago, the four-channel stereo simulation is virtually perfect. As you may remember, Mr. Eargle used a combination of time delay, plus reverberation and selective equalization in his process. His was strictly a studio technique, but one of the most important aspects of the process, the time delay, can be applicable to four-channel stereo simulations in the home. It goes without saying that whether real or simulated, four-channel stereo requires four channels of amplification and four speakers.

The most readily available and the least expensive form of time delay available to the audiophile are the well-known spring reverberation units. There are a number of units on the market, differing mainly in the length of the spring and in damping methods. Some units use multiple springs. In any case, while this type of delay can be surprisingly effective, these units are all easily over-driven, and even with moderate input they produce a characteristic "boinnggg" sound which is distinctly artificial and unpleasant. There is one spring unit, a joint development of Harman-Kardon and the ParaOrban company, which not only affords delays as long as 7 ms (quite a bit for these devices) but has a very low residual "boinnggg" noise. At the moment, plans to market the unit are sort of up in the air.

One of the most simple, but most effective means of time delay was devised by Madsen of the Danish Bang and Olufsen company. On a standard tape deck he mounted a special playback head with a double gap, with separate playback pre-amps for each gap. (Bad nomenclature here because what we are really dealing with is a double head.) The distance between the first and second gaps determines the delay, in this case, 10 ms. In practice, the signal from the first gap goes to the front amplifiers and speakers, the signal from the second gap, is the same information delayed 10 ms and sent to the rear amplifiers and speakers. This technique restricts one to the use of tape . . . but is that bad? Unfortunately, as far as I know there are no plans to market the device at the present time.

There are two electro-acoustical devices for the generation of time delays. One is a Japanese product (whose brand name I've sworn not to reveal at this time) which is sold every-

Pioneer's new SE-L40 stereo headphones flabbergasted the experts.

High fidelity dealers are probably the most blase guys in the world. They've seen everything. They've heard everything. You really have to have something extraordinary to impress them. So when we introduced the new Pioneer SE-L40 stereo headphones at a recent home entertainment electronics show for dealers, we were overwhelmed at its enthusiastic reception. We expected applause. We received an ovation.

These super critics marveled at the new open-air design which enhances the intimacy of personalized listening. They enthused over the incomparable bass reproduction achieved by a combination of technological advances and newly developed speakers nestled into each earpiece. They lauded the extreme light weight, nearly one third less than present headphones. Their conclusion: the SE-L40 is a complete departure from conventionality.

If you're still skeptical and believe that Pioneer high fidelity dealers went overboard with their acclaim for SE-L40, there's only one way you're going to be convinced.
Visit a Pioneer dealer and listen.

SE-L40 stereo headphones, $39.95, with carrying case. Other quality Pioneer headphones from $24.95.

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

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when you want something better

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where in the world . . . except the United States! Basically a quadraphonic preamplifier, the unit has within it, a honeycomb type of plastic extrusion which is actually a continous air passage of some 58 feet in length. At the beginning of the tube a tiny mylar-dome transducer is sealed in place. A third of the way down the tube, a tiny microphone is inserted in the tube and sealed. Another third of the way down the tube is a similar mike and at the end of the last third of the tube, still another mike. These mikes are connected to standard mike pre-amplifiers, with control pots. The positions of the mikes in the tube give delays of 15, 30 and 45 ms, the amplitude of each being separately adjustable. Used with restraint this unit is capable of some interesting simulations. The drawbacks are a certain "honkiness" a nasal sound to the delay, a considerable attenuation of high frequencies, and rapid increase in distortion if driven too hard. I think with some modifications to correct these deficiencies, this unit has considerable potential.

A much more sophisticated electro-acoustical delay tube has been devised by the very clever Professor Duane Cooper of the University of Illinois. A full description of the device was presented by the inventor in the April and May 1971 issues of AUDIO. Essentially a looped copper tube is used, with appropriate driver and pick-up elements and an equalizer circuit. The delay obtained with this unit is on the order of 14 to 16 ms, and is said to be wide band, with low distortion and a good signal-to-noise ratio. Mr. Bill Putnum of United Recording in Los Angeles has concluded an arrangement with Prof. Cooper to manufacture the delay tube as a commercially available product, and I have been promised an early production prototype with which to experiment. The anticipated price of the unit is around $600.00.

For the ultimate in delay devices and for those with Texas oil baron pocketbooks, we have the Delta T, the invention of two MIT professors. This is a totally solid-state device which accepts analog signals, converts them to digital and stores them in a memory core, and then reconverts to analog with delays available up to 320 ms in 5 ms increments. The Delta T is distributed by the well-known professional audio firm, Gotham Audio Corp., of New York. Mr. Eli Passen of Gotham was kind enough to furnish me with a Delta T unit, and I have spent many hours experimenting with this fascinating instrument. Most high quality pre-amps have sufficient output to drive the Delta

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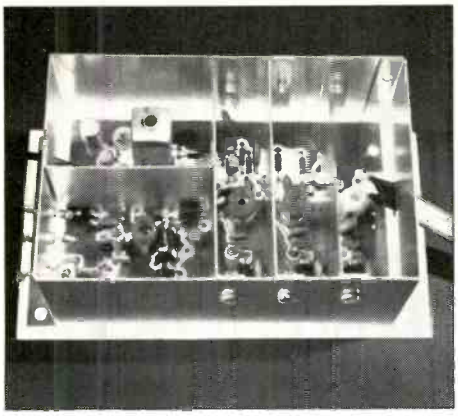
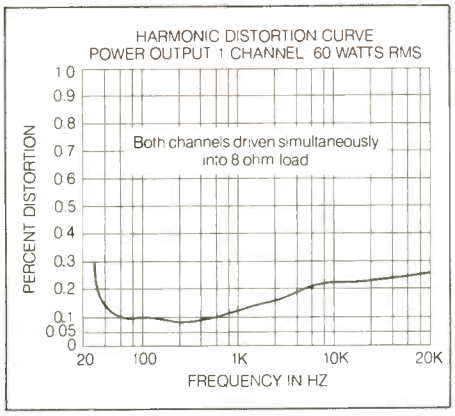
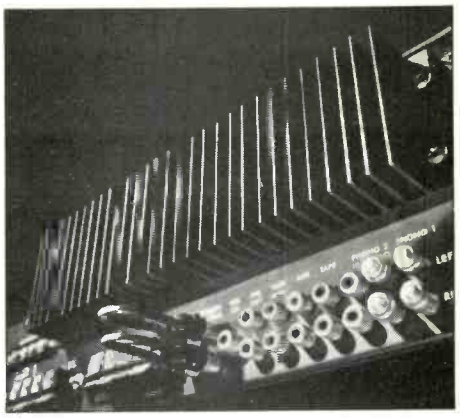






It's the only receiver with the Varitronik™ FM tuner—with 4 FET's and balanced Varicap tuning for lower distortion and for higher sensitivity. By using 4 FET's instead of ordinary bi-polar transistors, cross modulation problems are virtually eliminated. And by using 4 double Varicaps instead of a conventional mechanical tuning capacitor, a better balanced circuit performance is achieved with perfect linear tracking. The 725A's FM tuner also uses a combination of Butterworth and crystal filters for better selectivity and stereo separation. And, it features an advanced muting circuit with full muting at 2.5 μV for quiet tuning without loss of stations. Specifically, here's how the new Altec 725A receiver performs. Harmonic distortion is a low 0.3%, IHF sensitivity is 1.8 μV and capture ratio is 1.3 dB.

Altec's new 725A AM/FM stereo receiver gives you 60/60 watts of RMS continuous power. The 60 watts of power per channel you hear with the new Altec 725A receiver is not IHF music power at 4 ohms for just an instant. It's not music power (plus or minus 1 dB) either. And it's not peak power, or EIA power or any other rating. Instead, it's 60 watts of RMS continuous power per channel with both channels driven simultaneously at 8 ohms from 30 to 20,000 Hz—rated in the same manner used exclusively by the professional audio field and by quality testing labs. With this much power you hear clean, accurate sounds at all frequencies from even the lowest efficiency speakers. And you always have enough power in reserve to hear that extra-low bass.

Built a little better.

ALTEC LANSING

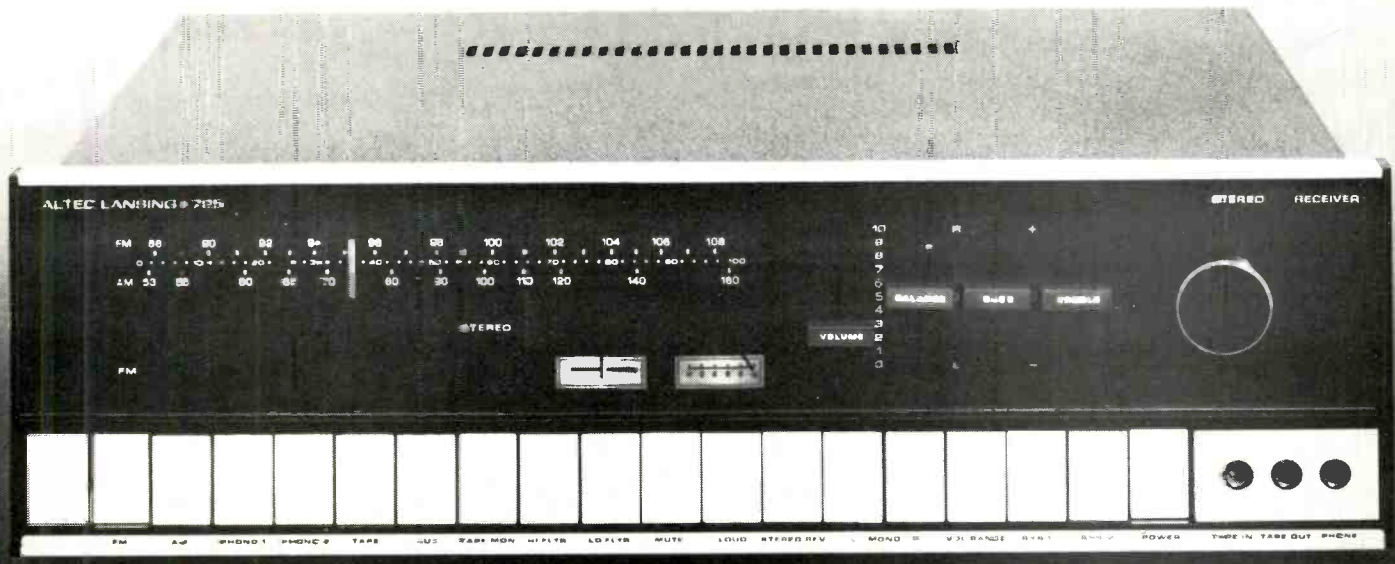
A QUALITY COMPANY OF LTV LING ALTEC, INC.

Check No. 16 on Reader Service Card

And it includes many extra features to make it the most versatile receiver on the market. The new Altec 725A receiver includes a long list of standard features like 2 separate tuning meters, spring-loaded speaker terminals, and 100 percent modular construction. In addition, it includes these "extras" for more versatility and convenience.

- Pushbutton controls for stereo reverse, mono L & R, low and high filter.
- Indicator lights on all functions—AM, FM, phono 1 & phono 2, tape, auxiliary, tape monitor and FM stereo.
- Tape recorder input & output on front panel.
- A heavy-duty fluted aluminum heat sink.
- Accessory jacks for the Altec Acousta-Voicette Stereo Equalizer.

Altec's new 725A AM/FM stereo receiver sells for $699.00. It's built a little better than anything else you can buy. Hear it at your Altec dealers. Or, write for a new, complete 25-page catalog. Altec Lansing, 1515 S. Manchester Ave., Anaheim, CA 92803.



Altec's new 725A receiver. It's built a little better.

Editor's Review

A NEW LAW, passed by President Nixon on October 15th, confirms that a sound recording may be subject to statutory copyright protection if "the sounds constituting the sound recording as published were fixed on or after February 15, 1972, and that the sound recording is first published on or after February 15, 1972 with copyright notice in the form specified by this law." Application forms for registration of claims to copyright in sound recordings can be obtained from the Copyright Office, Library of Congress, Washington, D.C. 20540.

Meanwhile, Viewlex, Inc., a company active in the audio-visual industry, has announced an ingenious new system designed to prevent record and tape piracy. The basis of the system, which was developed in conjunction with the United States Banknote Corp., is a visible stamp affixed to the record cover. This would contain magnetic particles interspersed throughout the ink mass to form a unique magnetic field. Thus, the authenticity of the record could be checked visually or by a magnetic verifier, which can be used by the retailer. Now, all this may sound like an elephant straining at the proverbial gnat but in this case the gnat is worth some $100 million—the amount the industry loses every year to piracy of one kind or another!

Quadraphonics

In May, 1971, the vice president of Motorola said, "The report that Motorola was abandoning the discrete four-channel system in favor of matrix is completely erroneous . . . We are completely convinced of the superiority of the discrete four-channel systems as contrasted to systems which use synthesizers or matrix techniques. Our committment and confidence in the discrete concept is total." That confidence appears to be a little shaken because in November Motorola said they would offer a combination matrix-discrete system later this year. On the other hand, RCA seems firmly committed to discrete and has joined the JVC, Panasonic line-up. Preliminary press reports mentioned a "hard substance" for the MPX records which was supposed to come from Yugoslavia. This was denied by RCA—the reporter was probably carried away by the fact that the Yugoslav president was over here at the time, possibly after a different kind of hard stuff . . . .

Headphones

Doubters who went almost into hysterics over the "impractical" four-channel headphones described in our June, 1970 issue are now reminded that there are at least three similar phones on the market-including one from E-V with built-in matrix.

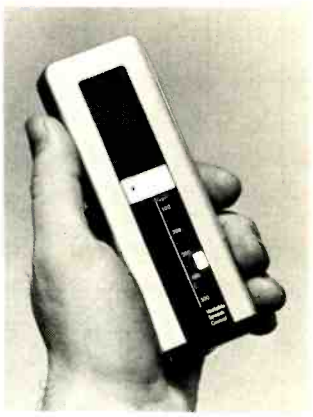
Show Dates

The IHF is planning at least five high fidelity shows this year, and the first one will be held at the Royal Inn, Anaheim, California, from January 28th to the 30th. It will be followed by the Atlanta show on February 18th to the 21st at the Merchandise Mart. Teresa Rogers, who was responsible for the successful Washington show is the organizer.

The third event is scheduled for March and it will take place either in Philadelphia or Cleveland. Dealers in this city of Brotherly Love are far from being enthusiastic, so Cleveland is the most likely venue.

30,000 Words per Minute

One of the most interesting devices on show at the recent AES exhibition was a variable speed control which enables a tape to be speeded up to almost 500 words per minute without changing pitch and producing that "Donald Duck"effect. It works by removing parts of the waveform in proportion to the speed —something like the old German *Hellschreiber*. It is intended for educational purposes, particularly for blind people who can assimilate material faster than most of us. Inventors are the Cambridge Research and Development Group, Bridge St., Westport, Conn. 06880.



Humor in Advertising—

"Put your ladybug wherever your like. Wall-mounting is perhaps most common, but why not experiment a bit? Put it on the table, the floor, a shelf in the corner. Keep trying . . ." As you might have guessed by now the ladybug is a loudspeaker, and it comes from Sinus of Sweden. The leaflet goes on to say, "You never have to plague it with excessive power." Heaven forbid . . . . But perhaps the largest system would suit more of our readers . . ."designed for those whose listening tastes have been honed to perfect pitch." Right on!

G.W.T.

Playing records with some cartridges is like listening to Isaac Stern play half a violin.

The trouble with some stereo cartridges is that they don't offer even reproduction across the entire musical spectrum.

In the important upper audio frequencies, some cartridges suffer as much as a 50% loss in music power.

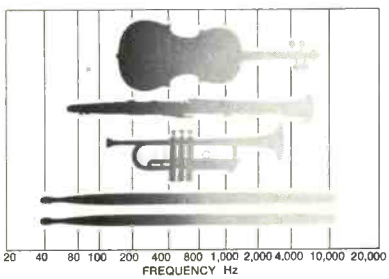
So, there's a lack of definition in the reproduction of violins, as well as clarinets, oboes, pianos, the organ and other instruments which depend on the overtones and harmonics in the upper frequency range for a complete tonal picture.

The Pickering XV-15 cartridge delivers 100% music power 100% of the time. Which is why we call it "The 100% Music Power Cartridge." At 100% Music Power, *all* the instruments are distinct and clear, because the XV-15's have no music-robbing output drop anywhere in the entire audio spectrum. It makes an enormous difference!

Pickering XV-15 stereo cartridges are priced from $29.95 to $65.00, and there's one to fit anything you play records with. For more information write: Pickering & Co., Inc., 101 Sunnyside Blvd., Plainview, Long Island, New York 11803.

Cartridge power does this to the instruments:

A 50% music power cartridge can mask some musical instruments.



The Pickering XV-15 gives you 100% Music Power 100% of the time.

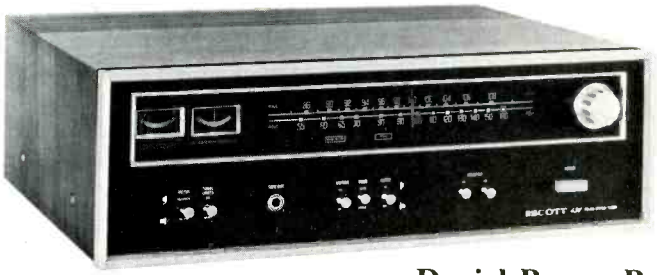
Pickering. The 100% music power cartridge.

"for those who can hear the difference"

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

Check No. 17 on Reader Service Card

How to evaluate FM stereo tuner performance



Daniel R. von Recklinghausen*

EVERY YEAR buyers' guides are published which present a summary of the performance characteristics of tuners and receivers. Every month magazines publish reviews of this equipment in which they present the findings of their tests. Seemingly every week advertisements, in newspapers or magazines, in catalogs or through the mail, vie for the prospective buyer's attention. Once the prospect is ready to buy a tuner or receiver, he may receive advice from his friendly salesman in addition to the advice he has gotten from his friends, neighbors, and relatives. How can he assimilate all this and then make a rational decision?

There should be several factors influencing a decision. Broadly, they may be classified as convenience factors (or "features"), cost, and performance capabilities.

The most important convenience factor which may influence a decision to select a tuner or receiver is the desire to have all operating controls on one piece of equipment. In this case a receiver (or tuner-amplifier combination) is the obvious choice. If little space is available to install the electronics, the same choice should be made.

Tuners, without the added audio controls of an amplifier, generally permit greater flexibility in connecting a high fidelity music system and permit equipment of various manufacturers to be used. This simplifies the up-grading or modification of such a system at a later time.

Tuners often duplicate some controls of an amplifier, such as noise filters or level controls. They also require their own chassis and enclosure with panel and knobs, as well as power supply components to operate the receiving circuits. Since many of these parts are also required in an amplifier, this duplication makes the combination of a separate tuner and a separate amplifier more costly than a receiver. In the early days of high fidelity equipment, when only tube circuits existed, there was the feeling that the tuner portion might be of a lower quality in receivers than in tuners. Principally, the heat generated by the vacuum tubes was thought to cause the tuner circuits to drift. Even back in the "tube" days, the designers were able to lick this problem, which now, in the "solid state" days, is no longer of any consequence. Tuner performance in receivers can be and is fully as good as found in separate tuners.

The last, hardest and the most important step remains: The evaluation of the performance capabilities of a tuner. Only one question really need be answered: How many stations' programs will the tuner reproduce and how well? It is often impossible to compare all tuners under consideration side-by-side in one's home, comparing the quality of each station's signal, because for a complete listening test, signal quality and interference susceptibility must be compared for each tuning position—a truly imposing task.

The majority of high fidelity equipment users live either in the city or its suburbs. The majority of the 4350 AM stations in the United States, the majority of the 2750 FM stations, and the majority of the 900 TV stations are located in metropolitan areas. The local AM and FM stations will most likely carry different programs since the Federal Communications Commission (FCC) ruled that AM and FM stations under the same ownership may not duplicate more the 50% of their programs if they are assigned to the same city of more than 100,000 population. Unless all the AM programs are of no interest to the listener, or he has enough AM radios, it is wise to consider the purchase of an AM/FM receiver or tuner rather than the FM-only variety.

Even though AM broadcasting stations have to provide at least 5000 Hz frequency response, and many of them provide as much as 15,000 Hz response, interference from other stations and many electrical appliances will make wide frequency range listening difficult in most locations. For this reason the FM reception capabilities of a receiver are considered more important.

Again, keeping the metropolitan FM listener in mind, the FM tuner will have on the average three or four strong local signals (and perhaps as many as 24) picked up by its antenna. These signals will tend to intermodulate with each other in the RF amplifier and converter stages of the tuner, causing spurious signals and crossmodulation products to be generated. These stray signals will usually appear on frequencies other than those occupied by the local signals. They may masquerade as "other" stations but really are nothing but a repetition of the local signals. If these signals were to appear only on unoccupied channels they would cause no harm except that of repetition. More than likely, these stray signals will interfere with weaker, more distant signals and may even obliterate them. Consequently, the number of listenable FM stations is reduced from what it could be.

In choosing a tuner it is wise to select one which resists overload due to strong signals, i.e., a tuner which has good crossmodulation rejection. Crossmodulation rejection (or spurious response rejection) is measured in dB in accordance with the standard of tuner measurement published by the Institute of High Fidelity. The number may be thought of as representing the "dynamic range" of r.f. signals the tuner is capable of accepting without problems.

At least 70 dB crossmodulation rejection should be available for metropolitan FM reception if other than local stations only are considered as program sources. Higher numbers are, of course better, with each additional 6 dB permitting signals of twice the field strength (corresponding to approximately one-half the distance to a transmitting antenna) to be available to the tuner without trouble.

Since the IHF crossmodulation measurement is performed with only one interfering signal, and since interference may be caused by several signals of varying strengths, a high cross-

*Technical Director, H. H. Scott, Inc.

modulation figure is not an absolute guarantee against all forms of tuner overload due to strong signals but it is still the best available performance indicator. A set of interference measurements on one tuner under all possible signal conditions would take a very long time. A full report might be the size of one volume of an encyclopedia and would be harder to interpret.

An abundance of strong and weak FM signals are the typical conditions in a metropolitan area. In the writer's home (in a suburb of Boston) 41 different listenable FM signals were recently counted using a high-quality tuner operating from a folded dipole antenna located indoors on the ground floor of a frame building.

To receive this many FM stations (when available) requires a tuner of high selectivity. FM stations are assigned by the FCC to 100 channels 200 kHz apart, ranging from 88.1 to 107.9 MHz. In any one locality, stations are assigned to channels 800 kHz or more apart. Stations in nearby areas are assigned to frequencies in between. These may be assigned to the adjacent channel (200 kHz away), the alternate channel (400 kHz away) or perhaps the third channel (600 kHz away).

Selectivity for an FM tuner is measured for the interference experienced when tuned to the desired channel, with a stronger interfering signal fully modulating the alternate channel. It is measured in dB, with a higher number indicating better performance.

Selectivity and bandwidth of a tuner are linked together. While selectivity may be thought of a measure of rejection of signals away (in frequency) from the desired signal, bandwidth may be thought of as denoting the width of the signal spectrum of the desired station accepted by the tuner.

The width of the signal spectrum depends not only on the maximum deviation of the instaneous station frequency from its average (and assigned) carrier frequency, but also on the modulation frequency. The FCC defines 75 kHz deviation as 100% modulation for an FM broadcasting station. Since audio signals have both plus and minus values the station frequency varies both above and below its average value, resulting in instantaneous frequencies spread over a range of 150 kHz. The actual spectrum occupancy of the transmitted signal is larger because the actual transmitted frequencies are not instantaneous but involve an infinite number of "sidebands" (of the carrier) when the carrier is deviated at a modulation frequency rate. These sidebands decrease in strength at frequencies further away than the "deviation" from the carrier, yet the tuner must process all of them for truly distortion-free reception. This could not permit any selectivity because of the requirements for "infinite" bandwidth. The elimination or attenuation of sidebands away from the carrier causes distortion. Calculations for a special ideal (and therefore mathematically treatable) filter indicate bandwidths of 265 kHz and 225 kHz if harmonic distortion of 1% and 3% respectively may be tolerated at certain modulation frequencies. Practical, well-designed filters produce less distortion than these figures for the same bandwidths. Since such a bandwidth includes some of the channel space assigned to adjacent-channel stations, and since selectivity is measured with a 100% modulated signal, it is evident that very little selectivity is obtained for adjacent channel signals. The figure may even be negative, indicating the need for a stronger desired signal compared to the interfering signal. For this reason, selectivity is measured for alternate channel signals.

The full story of selectivity is not found in a single selectivity number, but in a selectivity curve as seen in Fig. 1. Here, the desired signal is indicated by a cross, denoting its strength and relative frequency. The interfering signal is represented by a curve. This curve shows the frequency of the interfering signal and its strength adjusted so that the desired signal predominates in the audio output and therefore "captures" the interference. This selectivity curve (made according to the procedure outlined in the IHF tuner standard) is a dynamic selectivity curve and does not show the response of a selective filter measured in the conventional manner.

At a frequency difference of 0 kHz a special selectivity point is measured—it is the capture ratio. This ratio indicates the ratio of signals required for the tuner to reproduce the stronger of the pair while rejecting the weaker.

In the example shown, the selectivity curves are shown for a desired signal equal to that giving IHF usable sensitivity and for a desired signal 20 dB stronger. For weak signals, the residual noise provides a second interfering signal, resulting in the slightly wiggly curve shape between ± 100 kHz. At stronger signals, the noise influence is eliminated and the true two-signal selectivity curve emerges. The measured "capture ratio" is also improved.

From these curves, it can also be seen that weak adjacent channel signals may be received if the receiver is tuned off to the side so as to discriminate against the interfering signal. Of course, detuning causes distortion, but detuning is usually made so as to minimize the total of audible distortion and interference products.

Selectivity, when reported as a single number, denotes the point on the selectivity curve which is 400 kHz from the desired (center) frequency. For asymmetrical selectivity curves, the center frequency is assumed to be located halfway between the two (low and high frequency) intersections of identical selectivity spaced by a total of 800 kHz.

Selectivity curves of practical tuners are always slightly asymmetrical because coupling of the selective elements is generally by some reactive rather than a resonant elements. Selectivity curves of tuners which use mechanical elements, such as quartz crystal or ceramic resonators, as selective elements usually show substantially reduced selectivity at the higher frequency portion of the selectivity curve and also show a substantial reduction of the slope at selectivities in excess of, say, 45 dB. This is usually caused by a combination of electrical and mechanical coupling and by other than desired resonant modes of the ceramic or crystal elements.

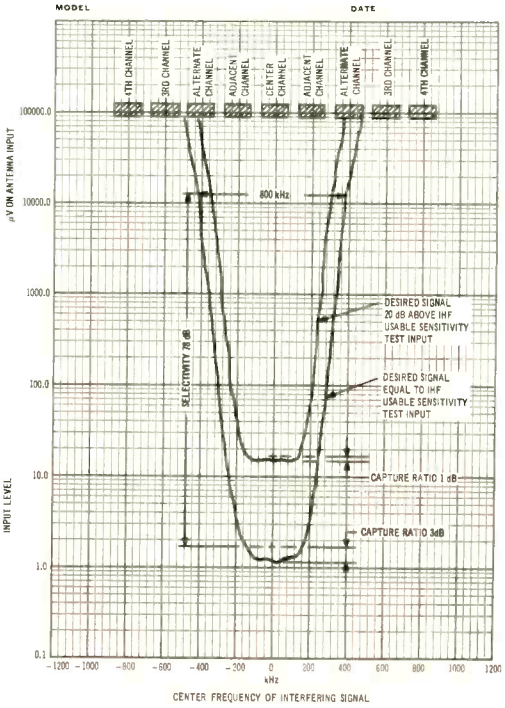


Fig. 1—Selectivity curves and level of desired signal.

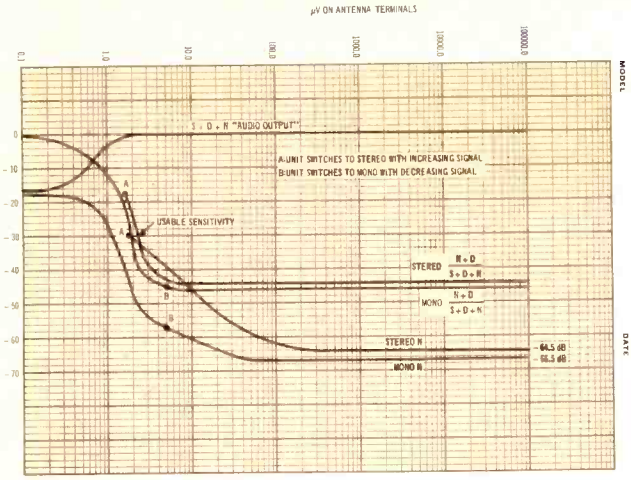


Fig. 2—FM performance.

Overload of the input circuits of a tuner will also cause this widening of the selectivity curve.

The next set of curves which should be examined when selecting a tuner are those often published under the general title of FM characteristics. An example of these is shown in Fig. 2. The first curve of interest is the "audio output" curve, showing total tuner output voltage due to 400 Hz, 75 kHz deviation monophonic modulation with respect to the (300 ohm) antenna input signal. This output contains the audio signal, its distortion, and whatever noise there may be; it is labelled "S+D+N."

The ideal tuner shows this output to be constant for input signals in excess of approximately 5 μV. At the signal level corresponding to IHF usable sensitivity, the audio output will have decreased by approximately 1 dB and in the absence of any input signal will be approximately 15 dB lower than its "normal" output value. These figures assume that the limiter is fully limiting with the random noise generated in the first amplifying stage of the tuner. Only by this action can one be assured that the tuner is sensitive to frequency modulation only and does not respond to amplitude modulation.

At this point it should be noted that the term "full limiting" has been misused—often denoting some arbitrary relative audio output or signal-to-noise ratio rather than its proper meaning—the removal of amplitude modulation.

Practical FM tuners approach the ideal S+D+N curve very closely. Tuners which show markedly lower (by more than 6 dB) audio output at 0 input signal probably have inadequate gain for weak signal processing and may not be fully adequate for critical listening. Tuners which show a variation in audio output of more than 2 dB for signals stronger than their usable sensitivity signal, may be inadequate for many high-fidelity installations because the normal audio output may vary audibly during moderate signal fading experienced when aircraft cause the received signal to vary (a phenomenon known as "airplane flutter") by adding a varying multipath reflection to the direct station signal.

The second set of curves, labelled "mono N" and "stereo N" show the residual noise output of the tuner when subjected to an unmodulated ("mono N") carrier signal or one modulated with a 19 kHz stereophonic pilot signal ("stereo N").

At moderate to high input signals, these curves will be horizontal, showing the total residual noise of the tuner and generator circuits. The "stereo N" curve may also contain residual amounts of the 19 kHz and 38 kHz signals passing through the audio filters of the tuner and some stereo modulator and demodulator noise.

The distance in dB of the "mono N" curve to the S+D+N curve shows the monophonic signal-to-noise ratio of the tuner, and the distance of the "stereo N" curve to the S+D+N curve shows the stereo signal-to-noise ratio. The rated values are usually found at the 1000μV level.

It should be noted that the "N" curves merge with the "S+D+N" curve for a 0 input signal.

In the range of the IHF sensitivity input, the "mono N" curve for the ideal tuner shows its steepest decent, with the noise output decreasing in the steepest portion as much as 6 dB for a 1 dB increase in signal level. Non-ideal tuners will show a lesser figure.

Once the mono signal-to-noise ratio has reached about 48 dB, the noise level will decrease proportionally to the signal increase (a 1 dB signal increase causes a 1 dB noise decrease) until the ultimate signal-to-noise ratio has been reached. The 48 dB point shows the "knee" for mono performance, while the 25 dB point of the stereo signal-to-noise ratio is the "knee" of the stereo performance.

The third set of curves show the total relative undesired output of the tuner, i.e., the total of noise and distortion with respect to the total output. They are labelled "mono N+D/S+D+N" and "stereo N+D/S+D+N". In the absence of any signal, these curves approach 0 dB, and at moderate to high inputs they show the total distortion of the tuner. At all levels, these curves have a higher value than the corresponding "mono N/S+D+N" and "stereo N/S+D+N" curves (which are not shown). In the steep transition region, the corresponding mono or stereo curves should be no more than a few dB apart. Otherwise, the tuner may be suspected to be of narrow bandwidth—which should also be reflected by relatively high stereo distortion.

The signal level at which the "mono N+D/S+D+N" curve crosses the –30 dB line is the point of IHF usable sensitivity—and the rated value for this is the highest number of microvolts found at the carrier frequencies of 90, 98, and 106 MHz.

As may be imagined, listening to programs at the usable sensitivity input is not a hi-fi listening experience, but measurement at this level can be repeatedly performed and is valuable as a basis for comparison. For example, enjoyable mono listening requires signal-to-noise ratios in excess of 50 dB. Some tuners may reach this at the IHF input level, and others may require as much as 6 dB higher signal level. Here, the shape of the curves will help decide this fact.

Enjoyable stereo listening also requires at least 50 dB signal-to-noise ratio. As can be seen, substantially higher signal levels are required—from 10 dB to over 20 dB above the IHF test input.

These figures illustrate that substantially more useful information can be obtained from a few sets of curves than from a list of numbers.

How can a metropolitan listener evaluate the various sensitivity curves? If he lives in the middle of the city in a tall steel-and-concrete building without access to an outdoor antenna he faces most difficult signal reception conditions. Not only will he not be likely to be able to receive the direct unreflected signal, but he will be subject to a conglomerate of signal reflections, varying considerably in signal strength from fairly weak to very strong. His signals will be often pure "multipath" and laced with pulse noise interference from automotive traffic and other sources. Such a listener should choose his tuner to have good spurious signal (crossmodulation) rejection and to have good performance for signals of weak to high intensity. Extreme sensitivity is not required because signals below 5μV may be riddled with man-made noise. The selectivity requirements in the city are usually moderate (30 dB or more), because distant signals will be severly attenuated and often buried in noise.

The suburban listener usually has better signals available; generally all of them, local and distant, are stronger than those "downtown." His tuner still must have excellent spurious response rejection. Since listenable distant signals are available, a prime requirement should be good selectivity (40 dB or

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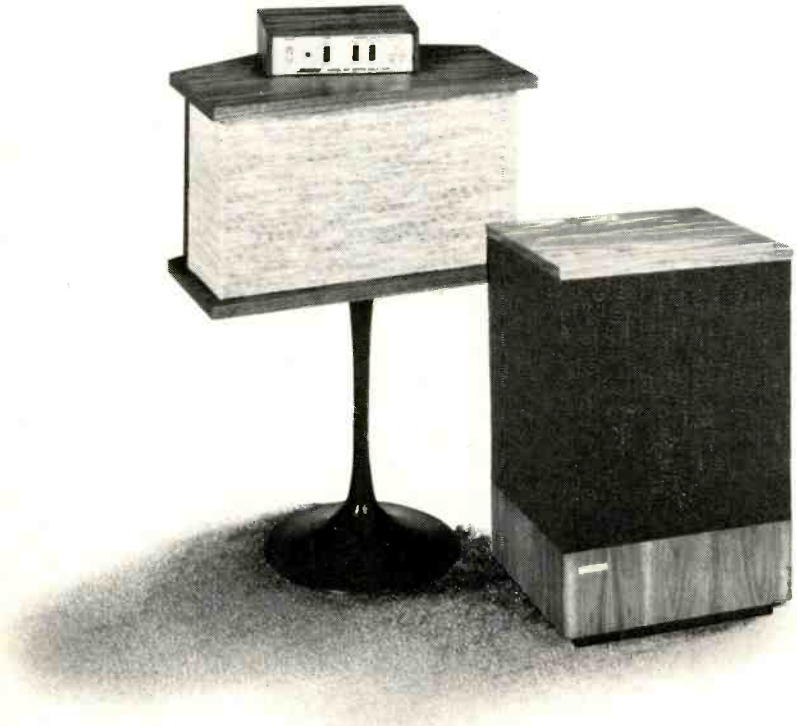

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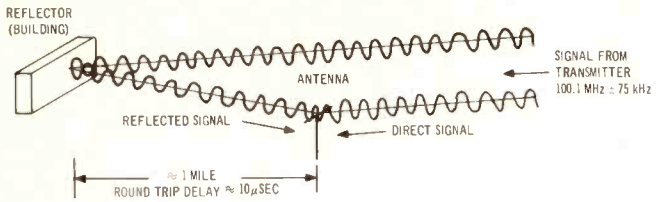

Fig. 3a—Simple multipath caused by one reflected signal and one direct signal.

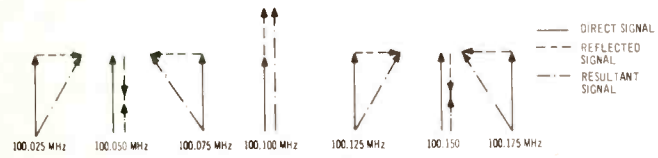

Fig. 3b—Vectorial addition of direct and reflected signals vs. frequency.

more). Sensitivity of a tuner need not be extreme, but must not be sacrificed at the expense of spurious responses. Since the man-made noise is lower than in the city, good signal-to-noise ratio with moderate to strong signals should be sought.

The minority of rural listeners should place sensitivity of a tuner high on the list, followed by good signal-to-noise ratio. Most important is a good installation of a high-gain directional antenna to capture as much as possible of the little signal available. An antenna rotator is a "must."

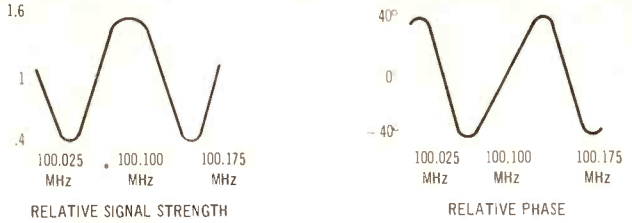

Fig. 3c—Amplitude and phase response of total transmission path containing one reflection.

Two very important FM tuner characteristics are usually not reported in curve form and one of them is even difficult to express as a number. The first of these is the AM suppression.

The signals broadcast by the FM station are modulated by varying the transmitter's frequency while keeping its power output constant. All the tuner circuits in the transmitter and its antenna system are usually adjusted to minimize any output variation. The tuner circuits in the receiver usually are of narrower bandwidth than those of the transmitter since they have to select the desired signal and reject signals on other frequencies.

For this reason, the received signal at the input to the limiter stages will be attenuated by 0.5 to 3 dB (in typical tuners) as the signal varies from its center frequency to the

maximum deviation. This in effect is incidental amplitude modulation of the FM signal, occurring at twice the audio modulation frequency. If the tuner were fully sensitive to this amplitude modulation, its detected signal would experience 3% to 17% distortion. Fortunately, the limiter circuits (along with the detector circuit) remove most of the amplitude modulation, and low distortion reception is possible. The effectiveness with which these circuits remove this amplitude modulation is known (and rated) as amplitude modulation rejection and is measured in dB. Any high fidelity tuner worthy of the name should have at least 40 dB AM rejection when measured with 30% AM. Claims of AM rejection in excess of 60 dB are within the realm of the possible, but are difficult to verify since normal laboratory test equipment is generally not capable of generating AM signals sufficiently free of incidental frequency modulation.

Good AM rejection in a tuner is required not only for removal of incidental amplitude modulation generated within the selective circuits but also for removing as much audible distortion as possible when receiving signals under multipath signal conditions.

As the name indicates, multipath means that the signal reaches the receiver's antenna by a multitude of paths, each having a different loss, and because of their length, a different delay. The effect may be demonstrated as shown in Fig. 3a. Here, just two signal paths are considered, a direct path and a path involving a reflecting obstacle (a hill or a group of tall buildings) located about one mile away. This would cause the reflected signal to have a delay of approximately 10 microseconds. The direct and reflected signals add vectorially in amplitude and phase as shown in Fig. 3b. The resultant now has neither the amplitude nor the phase of the original signal. As the frequency of the signal changes, the relative phase of reflection to direct signal changes 360° for every 100 kHz of signal change. Thus, there may be as many as two instantaneous signal maxima or minima within the normal ±75 kHz modulation range in this example. The resultant amplitude modulation may now include strong components of fourth harmonic distortion of a strength determined by the ratio of direct-to-reflected signal.

The limiter circuits will probably remove most of the incidental amplitude modulation, but they will not affect the phase of the resultant. This phase now varies with deviation of the carrier. Since the carrier is deviated by the modulation signals, the resultant also phase modulates the signal.

This in turn is an incidental frequency modulation of the signal—but one increasing with modulation frequency and containing practically pure distortion. Consequently, under multipath reception conditions, distortion increases with modulation frequency and is most serious at the highest modulation frequencies—those which contain the stereo sub-channel. This is the main reason for stereo reception in cities being often unacceptable when monophonic signals sound much better.

No high fidelity tuner can remove multipath signals. (Extremely complex circuits may be able ot minimize multipath

problems, but they require laborious adjustment, and so far only the military services have been able to experiment with them). The best cure for multipath problems is the use of a directional antenna along with careful orientation and adjustment. Even indoor antennas of the "rabbit ear" kind can be used with good effect and may be most practical when readjustment is required for each signal.

To minimize multipath problems requires one additional tool, the multipath indicator. As shown above, the increased high-frequency distortion or stereo distortion may be used with the ear acting as an indicator. Unfortunately, the ear is not a reliable tool, particularly when the broadcast station does not "cooperate" by playing music containing a lot of high frequencies or by playing stereo material.

The best results can be obtained when a multipath indicator is connected to the tuner. An oscilloscope may be connected to many tuners to display multipath. Essentially, these connections involve vertical trace deflection with an output containing a signal proportional to signal strength, and horizontal deflection with the FM detector output. Detailed information for connections will have to be obtained from the manufacturers of these tuners, or their representatives or dealers.

Other tuners may have these connections already provided and some of them contain built-in multipath indicators such as oscilloscopes or meters. By just being able to adjust the antenna for the best signal, these tuners will be able to give results superior to other installations when difficult multipath reception conditions exist. These difficult conditions can be predicted with good accuracy in most any city having tall buildings, and in any hilly or mountainous area. Flat country or over-water signal paths are rarely subject to serious multipath problems.

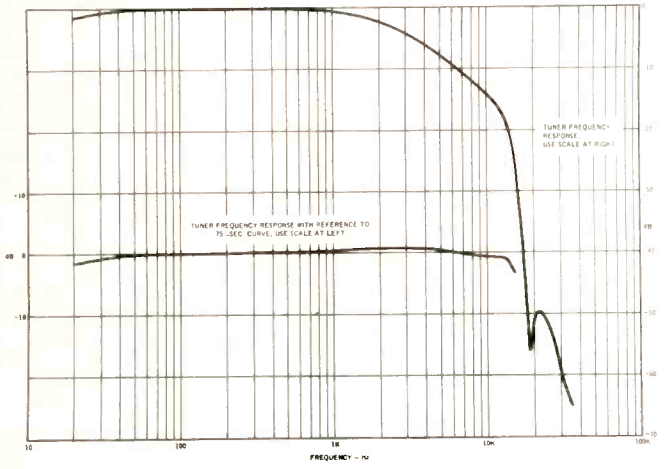

Fig. 4—Tuner frequency response.

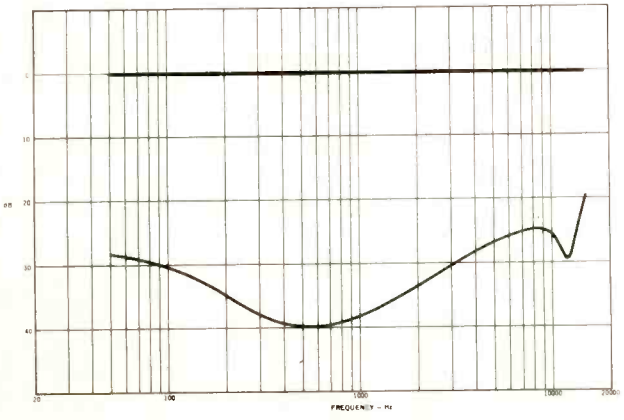

Fig. 5—FM stereo separation.

The next important tuner characteristic not reported as a curve (or even a number) is the tuner's pulse noise rejection. As shown above in the section on selectivity, the capture ratio indicates the tuner's ability to have the stronger of two signals predominate in its output while suppressing the weaker one.

When a tuner is subjected to a noise pulse, the pulse should "capture" the signal from the station for the length of time in which the pulse is stronger than the signal. The strength of the pulse in the FM band caused by a passenger automobile ignition system may be 1000 microvolts per meter at a distance of 500 feet. This is 20 times stronger than the old "grade B" service contour of 50 microvolts per meter of an FM broadcast station.

It is important that the pulse cause no worse problems than capture of the signal. As soon as the pulse becomes weaker than the signal, the signal should predominate and no transient due to previous pulse overload should remain. A single pulse should sound as a "tick" pretty much regardless of its strength and not as a "pop". In particular, a pulse or a series of pulses, should not be audible with the receiver tuned off-station. If pulse noise were audible under this condition, listening quality for other than local stations may be impaired.

All the previous tests and curves have documented the important aspects of tuner performance from antenna to the final FM detection. The group of curves in Figs. 4 and 5 describe the performance of the circuits which handle the detector output.

Figure 4 shows the audio frequency response of the tuner circuits. It is shown as a normal frequency response, including the response above 15,000 Hz, the maximum audio frequency broadcast by a stereo FM station. The region above 15 kHz shows how well the 19 kHz pilot signal and the 38 kHz re-insert carrier signal are removed from the tuner output. These frequencies may cause intermodulation with the bias oscillator in tape recorders and the recording of whistle frequencies.

The frequency response is also shown with respect to the standard 75 microsecond de-emphasis curve. It shows how accurately the signals are reproduced. This error should be less than ± 2 dB between 50 Hz and 15 kHz, the limit frequencies for FM broadcast stations.

Figure 5 shows the stereo separation of a tuner. As may be appreciated, more information can be gleaned from a curve than from a single figure, say, 30 dB separation and without specification of frequency.

For good listening, the tests performed by the Bell Laboratories and by General Electric show that at least 20 dB separation be available over the range of 100 to 8000 Hz. Most tuners are capable of exceeding this figure-but only a curve will prove it.

There are many more tests which can be and are performed on tuners. They may deal with more refined aspects of the characteristics discussed above, or they may deal with squelch performance, tuning indication, drift, or many other factors. In all cases, the basic characteristics analyzed here should be considered most when choosing a tuner or receiver. Only after these have been evaluated with respect to the expected signal conditions for city, suburb, or country should other convenience features not discussed here be analyzed.

Last, but not least, reliability and reputation, leadership in technology, and soundness of design should be evaluated. The tuner bought today should give years of good service. AE

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The Perfect FM Tuner

The following is a partial transcript of Harry Maynard's *Men of Hi Fi* program, which is now presented each week from 10:00 to 10:55 p.m. on New York City radio station WNYC-FM. Mr. Maynard, Contributing Editor of AUDIO, writer and hi-fi buff, had as his guests for this program Leonard Feldman, another Contributing Editor of AUDIO, and Dick Sequerer, designer of the Marantz 10B.

MAYNARD: Good evening, ladies and gentlemen. Tonight we're going to talk about the ideal FM tuner, and what such a tuner consists of. Dick, I understand that you're designing a tuner which will sell for $1500.00 and be the state of the art. What will be this tuner's fundamental components? When we last talked on this program, you mentioned some of this new tuner's virtues. But just how do you visualize it. I asked you last time whether or not it would be a digital tuner and you said let's leave that to the next program.

SEQUERER: Digital tuning, in and of itself, is just a way to *readout* the station that you are tuned to. Behind the digital tuning is an extremely stable type of tuning system, so that this is really what makes digital tuning valuable. It's not the numbers that you readout; it's just as easy to read a sliderule dial, for instance. But you now, without spending a fortune for the type of ganged capacitors that were used, let's say, in the Marantz 10B, can make a device which is extremely stable and very long lived, with modern circuits, no mechanical or moving parts. And, of course, when you do away with moving parts, you make a device which is going to last longer, that's going to be more predictable, and essentially going to give better service. So, in terms of what I'm making now, I frankly will tell you that I haven't made up my mind as to whether to have a digital dial, sliderule dial, or even both.

MAYNARD: How would you vote for

this, Len? We're talking about the *ideal* FM tuner, with cost no question.

FELDMAN: Yes, but it is after all a trade off. In other words, given the option of having a digital readout versus superior performance, I would forego the digits in favor of the performance, because, as Dick points out, you can read a sliderule dial and the stations do identify themselves, even if the dial is off a hairline. So, I'd rather see the money put into performance, rather than readout.

SEQUERER: I don't think I made myself very clear. Actually the digital dial concept, as it is considered by most lay people in the business, really is better performance. It's a more stable system, a more predictable system.

MAYNARD: Why, because it uses crystal controls?

SEQUERER: Yes, that's right.

FELDMAN: In that light, I would prefer it, for its other virtue, not for the fact that I'm getting a nixie tube readout.

SEQUERER: Len is exactly right. The readout is actually a derivative of what the thing is really doing.

MAYNARD: Now, Len, suppose you were talking to Dick and saying, "Here are some of the things I'd like to see, with no reference to cost?" What would you tell him you'd like to see.

FELDMAN: Well, we haven't yet discussed selectivity. I'd like to hear a little bit from Dick on this subject, because it's been a bugaboo with me.

MAYNARD: I have had other people on this program, who have claimed that too much emphasis has been put on sensitivity, too much money has been put into a tuner to give these great sensitivity readings, and it might be better to invest some of the money that has been put into achieving these great sensitivity readings into some other aspect of the tuner.

SEQUERER: If you look at sensitivity in the proper frame of reference, I think you can really understand its importance or unimportance. High fidelity or high quality broadcasting or music-listening type systems need signal-to-noise ratios of almost 60 dB. And *that* should be the real criterium of the sensitivity. In other words, where the tuner really has

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a quieting and a rejection of all noise components and distortion components at the 60 dB level.

FELDMAN: That is why I've said that the IHF's standard is meaningless as it's presently written, because you don't know what happens after that 1.8 μV, as you go from there to 5 or 10 μV.

SEQUERER: Let me defend part of the standard, at least so that it can be better understood. All tuners have what is called a quieting slope or characteristic behavior beyond the point that the IHF has determined is the sensitivity measurement. Unfortunately, there are no tuners which are around that follow the ideal or the theoretical quieting curve, and therein lies the problem.

MAYNARD: This would be a very rapid drop-off.

SEQUERER: It's a drop-off, right. Now, this ideal quieting curve, if it were followed along its theoretical performance by all tuners, then the sensitivity figure would be valid at any point, whether it's the IHF or anything else you wanted. However, as Len properly points out, these curves do not follow the ideal because of vagaries and inadequacies in conventional designs. Therefore, a more meaningful number for the actual listener would be the point at which the quieting had reached 55 or 65 dB. And I'm using that broad a spread on purpose. This includes all hum, noise, and distortion components. This would then be the point at which you have a usable signal, and that's what we're talking about, a usable signal for high fidelity.

MAYNARD: Well, now, what are you going to put into the tuner? I assume that this is going to be the very latest in design, the state of the art. What's going to be in it that no other tuner's going to have?

SEQUERER: It's going to have a multipole Butterworth-type filter, similar to the one that was in the Marantz 10B, but more elaborate. Very frankly, we compromised with the Marantz 10B, and it's strictly a question of money.

MAYNARD: That tuner sold for about $700.00.

SEQUERER: It was $750.00 and it turns out that we probably could have sold it for more, but we did compromise.

MAYNARD: I remember a funny story. I was standing next to Saul Marantz at a hi-fi show once and a man came up to him and said, "Mr. Marantz, I just bought one of your tuners for $750.00." And Saul turned around to him and said, "And that was less then it cost us to make it."

SEQUERER: Well, that's not altogether true, but it depends on *when* he bought it. If he bought one of the very first,

I would suggest that it was true. It was a very expensive undertaking for a small company. We did learn a great deal in the process. It doesn't seem that anyone else picked up where we left off.

MAYNARD: What have we learned since the Marantz 10B was designed?

SEQUERER: I don't think we've learned anything, but I'm prejudiced.

MAYNARD: If you're going to go beyond the Marantz 10B, how do you do it?

SEQUERER: We're going to lower the distortion by a slug, as we say in the business. You can't lower the distortion at mid-band over the 10B, because that was probably close to theoretical but you can lower it at 15KHz. We're going to improve the 15 KHz separation. We're going to improve the selectivity. And we're going to make probably the largest improvement in the AM rejection. We're looking for something that can reject 80 percent AM.

MAYNARD: Would you agree that this is a step in the right direction, Len?

FELDMAN: Absolutely!

MAYNARD: What kind of a standard figure are you hoping to achieve in this AM rejection area, as compared with the way it's given now?

SEQUERER: Well, this becomes complicated because now we have to talk about how to measure it, and how to generate AM that is similar to the envelope modulation of multipath.

MAYNARD: Would you explain envelope modulation to our listeners?

SEQUERER: Everyone is familiar with the situation of listening to FM and having a plane fly over and getting flutter. This flutter is amplitude modulation, fundamentally, of the FM signal, that is, of the wanted signal by the unwanted signal. This is called envelope modulation.

MAYNARD: Len, would you sum this up for our listeners?

FELDMAN: What Dick is saying is that the signal which started out as all FM becomes, in fact, a partly AM signal. That's oversimplifying, but what you want is pure FM and what you're given is—unfortunately—a combination of FM and AM modulation, which leads to the distortion products we've been talking about.

SEQUERER: Let me say one other thing, for the more technically minded in the audience. All of the information necessary to FM is contained in what we call the zero axis crossings. Everything else is extraneous. If I add to this AM, and the set still cannot process the AM, I have not affected a thing. Unfortunately, if the set will demodulate the AM components, they add to the information that was on the zero axis and form serious distortion. And to put this more practical terms, these components are all audible. The tuner we are envisioning will sound better to the average listener because of its significantly better AM rejection.

MAYNARD: Just the way the Marantz 10B sounded better, although on some laboratory specs, sensitivity figures for example, the 10B was not extraordinary, was it?

SEQUERER: Those specs were no better than anybody else's.

MAYNARD: Why did the Marantz 10B sound better as it seems to me it often did?

SEQUERER: For one thing, the selectivity and the shape of the i.f. passband as it was achieved then, was probably better than anything else that had been done before. It led, for one thing, to a phase linearity over the i.f. system, which was important for mono and particularly for stereo.

MAYNARD: And this is going to be terribly important for matrixing systems, where you have a lot of out-of-phase information, isn't it?

SEQUERER: It could enter the picture, yes, providing that matrixing in fact does become the system of FM four-channel broadcasting.

MAYNARD: At least we know—you and I and a lot of so-called experts—have agreed that for at least the next three or four years, if we're going to get four-channel via FM radio without any change in FCC regulations, we're going to have to listen to it via some matrixing system. Dick, what are you going to do about four-channel? I hope you're going to have a design whereby, no matter what system is adopted, Dorren or whatever, one would slip in a simple IC and there won't be any obsolescence in this $1500 "ideal" tuner. Is that correct?

SEQUERER: This is correct. I certainly hope that we're not going to have any obsolescence in this tuner.

MAYNARD: This doesn't constitute any problems, do you feel, Len?

FELDMAN: No more than the problem we faced when stereo was just around the corner and everybody was providing detector outputs or building in a facility for plug-in modules.

SEQUERER: More than that, I think if the system is truly phase linear in terms of its FM capability, and it has the low distortion, and the low AM response, and the great stability that we're talking about, it can process anything over the allocated band. And that's the whole key. There are many tuners on the market which will not be able to precess anything.

MAYNARD: Would you agree with that, Len?

FELDMAN: Yes. I have just one question. I'm sure you're familiar, Dick, with the Dorren proposal and that it may involve extension of modulation out to perhaps 100 KHz. What will happen with your tuner?

SEQUERER: Basically in my design work, I do not measure harmonic distortion with de-emphasis in the system. I make a system which will indeed go to 100 KHz, in terms of its audio modulation.

MAYNARD: Dick, will you sum up the basic points about your $1500 "ideal" tuner?

SEQUERER: I think the most important thing is that this tuner will be ultra-stable. It is an instrument, and it will give many, many years of predictable performance. That's about all you can say.

MAYNARD: Entirely solid state?

SEQUERER: Mostly integrated circuits.

FELDMAN: What is the projected timetable, Dick?

SEQUERER: I am estimating deliveries of these tuners to selected people, since this is a very limited production thing—sort of a hand-crafted Rolls Royce, if you will—sometime in March.

MAYNARD: I certainly want to be on the list to receive one of these tuners. What do you feel the market is?

SEQUERER: Well, I think there is a market.

FELDMAN: I agree. In fact, we were talking about this earlier. I believe that with a superior product such as this, that if anything Dick is going to find that his edition is too limited, because once the word gets out that such a product exists, I have the feeling that he'll have to increase his production plans.

MAYNARD: What about the market from FM radio stations? Do you see that?

FELDMAN: There's a natural market right now, even before you talk about the consumer.

MAYNARD: Well, the Marantz 10B is selling right now—there's no depreciation on 10B—you have to pay $750 right now to get one.

SEQUERER: They don't make them anymore.

MAYNARD: Right; that's what I'm pointing out.

SEQUERER: I think that you'd be hard pressed to find one. I know I was when I had to get one recently.

MAYNARD: Dick, I want to thank you for giving us some of the very interesting history of the Marantz 10B and for telling us something about your new design. Len, thank you too, for being on the program and for your always interesting comments on FM tuners and broadcasting. Good night.

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Sony offers you a choice of two SQ adapters. For the more demanding, there's a new SQD-1000 decoder. Its logic circuit enhances front-back separation by up to 6 db, so that front-center soloists (or rear ones, for that matter), stand out more clearly. The SQD-1000 lets you listen to four-channel sound from SQ records, or to discrete four-channel tapes on auxiliary players. It also lets you listen to normal stereo, or to stereo broadcasts and recordings enhanced with SQ ambience. Just plug the SQD-1000 into your tape monitor jacks (the SQD-1000 has its own), and add your choice of rear-channel amplifier and speakers.

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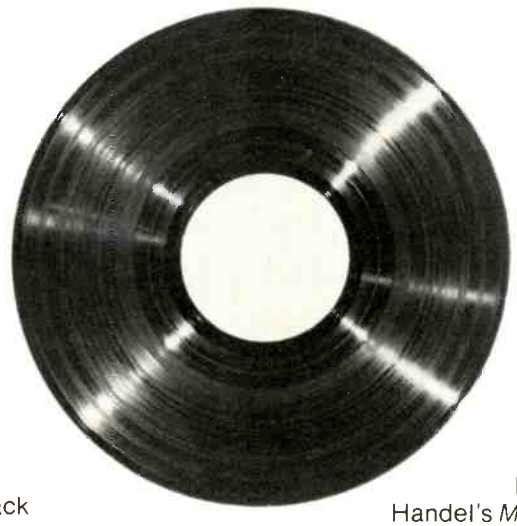
New SONY SQ*

Musically, it's starting out with 52.



Columbia Records

Popular

Lynn Anderson, *Rose Garden*
Blood, Sweat and Tears II
Johnny Cash at San Quentin
Chase
Ray Conniff, *Love Story*
Al Cooper, Mike Bloomfield & Steve Stills, *Supersession*
Miles Davis, *Bitches Brew*
Bob Dylan, *Nashville Skyline*
Percy Faith, *Romeo and Juliet*
Funny Girl, Original Sound Track
Janis Joplin, *Pearl*
Kris Kristofferson, *Silver-Tongued Devil and I*
Johnny Mathis, *You've Got a Friend*
Jim Nabors, *Help Me Make It Through The Night*
No, No, Nanette, Original Cast
Poco, Deliverin'
Ray Price, *For the Good Times*
Raiders, *Indian Reservation*
Santana, *Abraxas*
Sly and the Family Stone, *Greatest Hits*
Ray Stevens, *Greatest Hits*
Barbara Streisand, *Stoney End*
Ten Years After, *A Space in Time*
Andy Williams, *Love Story*
Tammy Wynette, *We Sure Can Love Each Other*

Classical

Bach, *Switched-On Bach* (Carlos)
Bernstein, *Mass* (Bernstein, Original Kennedy Center Cast)
R. Strauss, *Also Sprach Zarathustra* (Bernstein, N.Y. Philharmonic)
Morton Subotnick, *Touch*
Verdi, *Requiem* (Bernstein, Arroyo, Veasey, Domingo, Raimondi, London Symphony)

Vanguard Records

Popular

Joan Baez, *Blessed are...*
Larry Coryell, *At the Village Gate*
Country Joe and the Fish, *From Haight-Ashbury to Woodstock (2 LP)*
Buffy Sainte-Marie, *Moonshot*

Classical

"P.D.Q. Bach," *The Stoned Guest* (Schickele)
Berlioz, *Requiem* (Abravanel, Utah)
Handel's *Messiah* (Price, Minton, Young, Diaz, Somary, English Chamber Orch.)
Handel, *Messiah highlights*
Mahler, *Symphony No. 3* (Abravanel, Utah)
Mozart, *Divertimenti* K287/138 (Blum, English Chamber Orch).
Tchaikovsky *Symphony No. 4* (Stokowski, American Symphony)
Tchaikovsky, *Serenade Op. 48;* Prokofiev, *Classical Symphony;* Arensky, *Variations* (Somary, English Chamber Orch.)
The Virtuoso Trumpet of Martin Berinbaum (Somary, English Chamber Orch).

Ampex Records

Popular

Anita Kerr Singers *Grow to Know Me*
Anita Kerr Singers with Royal Philharmonic, *A Christmas Story*
Bob Hinkle, *Ollie Moggus*
Melting Pot, *Fire Burn and Cauldron Bubble*
Mason Profit, *Last Night I had the Strangest Dream*
Purlie, Original Cast
Cris Williamson
Rome Philharmonic, *Classical Movie Themes*

four-channel record system

The Acoustic Feedback Loudspeaker System

Curtiss R. Schafer

THE CORRECT APPLICATION of negative feedback in amplifiers has produced low-distortion, wide-range response that is pleasant to listen to. Until recently loudspeakers have not been able to incorporate inverse feedback.

The classic attempts to apply feedback to a loudspeaker are described by Olson[1]. They use either a secondary voice coil and magnetic structure (with the secondary coil rigidly coupled to the primary coil), or a microphone mounted in front of the speaker. In either case, the output of the microphone or secondary voice coil is connected to the input of the amplifier and out of phase with the input signal.

Another attempt by Holdaway and Denby in 1963 used negative velocity feedback, with the feedback voltage derived from a bridge in the voice coil circuit. The paper by Holdaway[2], and another by de Boer[3], present very interesting discussions of motional feedback[4].

These attempts have not been entirely successful because of the loudspeaker loads[5] and the modes of vibration of loudspeaker cones[6]. The typical cone moves as a piston over a relatively narrow frequency range and usually vibrates in at least eight different modes over the range from 50 to 10,000 Hz. These modal vibrations involve changing radial and annular sections of the cone, and thus, most of the time, the voice coil literally does not know what the cone is doing.

For these reasons, I decided on a purely acoustical form of negative feedback. Judging by the studies cited above, it seemed that both the speaker unit driven by the amplifier and the unit used as a microphone would have to possess very similar characteristics. This immediately suggested another idea: If two similar speakers were to be mounted back-to-back in a small enclosure and their voice coils phased so that both cones moved either in or our at any given instant, an internal pressure wave would be generated by one cone that would be 180% out of phase with that generated by the other cone. This would, in essence, be acoustical negative feedback and the magnitude of the feedback could be controlled by the resistive and reactive parameters of the air path between the two cones and also by the use of a T-pad to increase or diminish the signal supplied to one voice coil. EDITOR'S NOTE: *A "push-pull" system was developed by the British G.E. Company in 1959. As might be expected only even harmonic distortion was significantly reduced*[4].

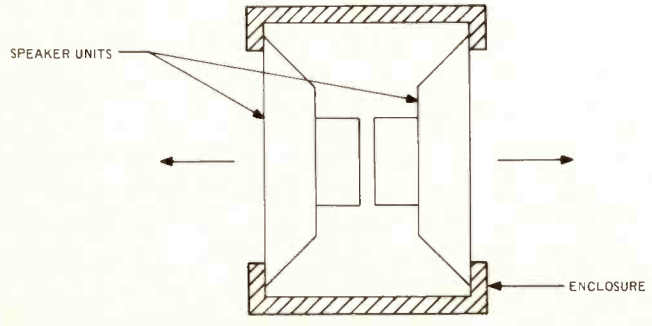


Fig. 1—Schematic diagram of the system.

To test this concept, two 12-inch speakers were mounted in a 15 by 15 by 11 in. case as shown in Fig. 1. The interior was lined with two-inch pads of polyurethane foam wherever possible.

After a half hour of listening to FM program material, it was apparent that the bass response went about an octave lower than that of the acoustic suspension speaker usually used and the transient response seemed better. These first impressions were confirmed by several hours of listening to records.

With this encouragement, I decided to design a wide-range speaker system that would embody my concept of acoustical negative feedback using the double speaker arrangement.

Several factors seemed important, first a wide frequency response (at least 20 to 20,000 Hz), since the widest range systems always sounded the best if modulation distortion is low; second, freedom from excessive resonant peaks and valleys; and third, enough acoustic power output for a large living room.

Other considerations were a reasonable physical size, the use of a low crossover frequency, only one crossover frequency since the dividing networks produce transient and phase distortions, and a high proportion of direct rather than reverberant sound.

I have always considered the highly reverberant acoustics of a large concert hall to be a necessary nuisance rather than a quality to be enjoyed. When reverberance predominates, it becomes for me a "mud factor." Recently I listened to a computer-designed loudspeaker system which used one unit to produce direct sound but eight units for reverberant sound. It was like listening to a symphony orchestra in a hall with bad acoustics; mind and ears are continually straining to bring some order out of confusion. Under such conditions, the matter of speaker transient response becomes irrelevant.

Several weeks were spent listening to speaker systems in dealer showrooms and attempts to get distortion vs. acoustic power data from the prominent speaker manufacturers. Finally the JBL LE-15A was selected as the woofer because it sounded best and because the manufacturer supplied a photograph showing the acoustic waveform produced by an input sine wave of 60 watts at 40 Hz, which indicated harmonic distortion of only about 5% under these conditions. The LE-15A has a long voice coil and can maintain excellent lineraity at cone excursions up to $\pm$½ inch from the center position (one inch peak to peak).

Judged second best were the lower priced Wharfedale models W15/RS and W12/RS with ceramic magnets. Use of a ceramic magnet results in a "shallow" woofer design, which is preferred in this system because it permits the cones to be closer to each other. These models also have long voice coils; the W15/RS is linear for excursions of ¾-in. peak-to-peak. (*Wharfedale speaker units are not now available in the U.S. They can only be purchased in cabinets as completed systems.—Ed.*)

An evaluation of treble units resulted in the purchase of a 511-B sectoral horn and a 802-D driver; a PM-7 wide

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range, double diaphragm unit of English manufacture, and a Wharfedale Super 10 RS/DD. The PM-7 is designed for horn loading but I felt that its use as a treble unit would not require much greater cone excursions than its use as the single driver in a wide range horn system.

When I took the sectoral horn out of its carton, I noticed that it rang like a bell whenever I rapped it with my knuckles. Thinking it may have been cracked in shipment, I returned it, and then found that the replacement did the same. The bell-like resonances were quite audible on most program material. Since that time, I have found that most 500- or 800-cycle sectoral horns have this fault. (*This ringing is normally tamed when the horn is mounted but some engineers use heavy tape or "Mortite" to kill any resonances.—Ed.*)

Fig. 2—The completed system, with a mirror showing the back side, which is identical to the front.

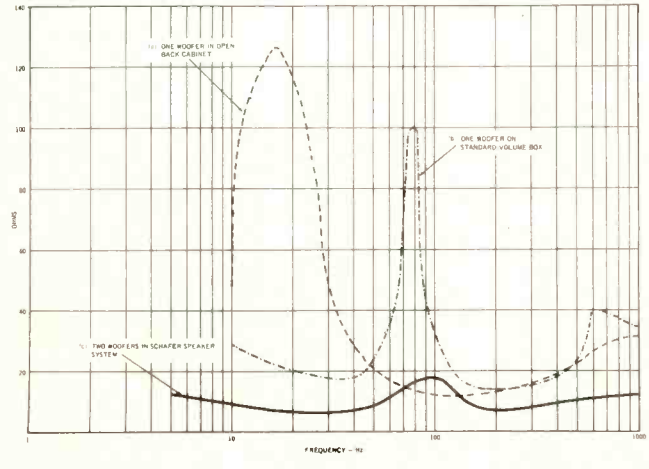

Fig. 3—Impedance curves. **A**, one woofer with open-backed enclosure; **B**, one woofer with standard-volume enclosure, and **C**, in Schafer feedback enclosure.

The completed acoustic feedback speaker system is illustrated in Fig. 2. A mirror was placed to show the back of the cabinet (which is just like the front). The cabinet is 36 inches high, 27 wide, and 14 deep (front to back). The usual principles of good construction were followed: the top, bottom, sides, and compartment divider are made of two-inch-thick black oak; the speaker mounting panels are of one-inch particle board; all speakers are mounted from the outside of the panels. The interior of the enclosure is lined with pads of two-inch polyurethane foam. The whole structure is nonresonant, of course.

The two woofers were connected in parallel internally and phased with a flashlight cell so that both cones move outward simultaneously. The two treble units were connected in a similar fashion. The two pairs of leads were brought out to the dividing network. Several commercially available networks were tried, and I found that an Altec N-500! I gave the least phase shift in the crossover region of 500 cycles.

Our speaker system was then played through an FM tuner and one channel of a Dynaco Stereo 120 amplifier. From the very first moment it sounded good. It has all the qualities I had hoped for, excellent transient response, a tremendously solid bass, and good balance between bass and treble. As I had surmised the effects of negative acoustic feedback are most evident at the bass end of the range. The impedance curves to illustrate this are shown in Fig. 3.

After the cabinet had been completed, the foam pads were put in place and one woofer was installed. The other speaker panel was left off, so that the enclosure resembled an open-backed radio cabinet. The impedance of one woofer was measured under these conditions, with the results shown in Fig. 3a. The free air resonant frequency of this woofer is 18 Hz. The impedance was checked with the unit laid on its face on the standard-volume test box used in designing ducted-port bass-reflex enclosures[7], with the results shown in Fig. 3b.

With both panels and both woofers in place again, the impedance curve of Fig. 3c was obtained. (The crossover network was omitted for this measurement.)

The nominal impedance of one woofer is 16 ohms, although the actual impedance at 200 HZ was found to be about 14 ohms. Thus the two woofers in parallel give an impedance of about 7 ohms at 200 Hz. In the double speaker system, this impedance shows a relatively small increase at the fundamental resonant frequency and does not show the usual rapid drop below this frequency.

The overall frequency response of the system has not been measured, but apparently ranges from about 10 Hz to a little over 20,000. Acoustic power output for the two woofers together is estimated at about 0.5 watt. This output is not adequate for a large concert hall or auditorium, unless more than one speaker system is used. However, for a small hall or large living room, its response is as good (15 Hz) as that of a hyperbolic horn 20 feet long with a mouth 5 by 7 feet[8]. It has been A-B tested against several top-rated commercially available systems, and its superiority was apparent after a few minutes of listening.

Two other acoustic feedback speakers have been built. One uses a pair of Wharfedale W15/RS woofers and a pair of Super 10/RS/DD treble units; the other uses W12/RS woofers and Super 10/RS/DD tweeters. For each of these combinations, JBL LX5 dividing networks give the minimum phase shift. These systems were put into smaller cabinets and used less expensive speaker units, but the results, except for power-handling capability, are similar and almost as good.

(Continued on page 73)

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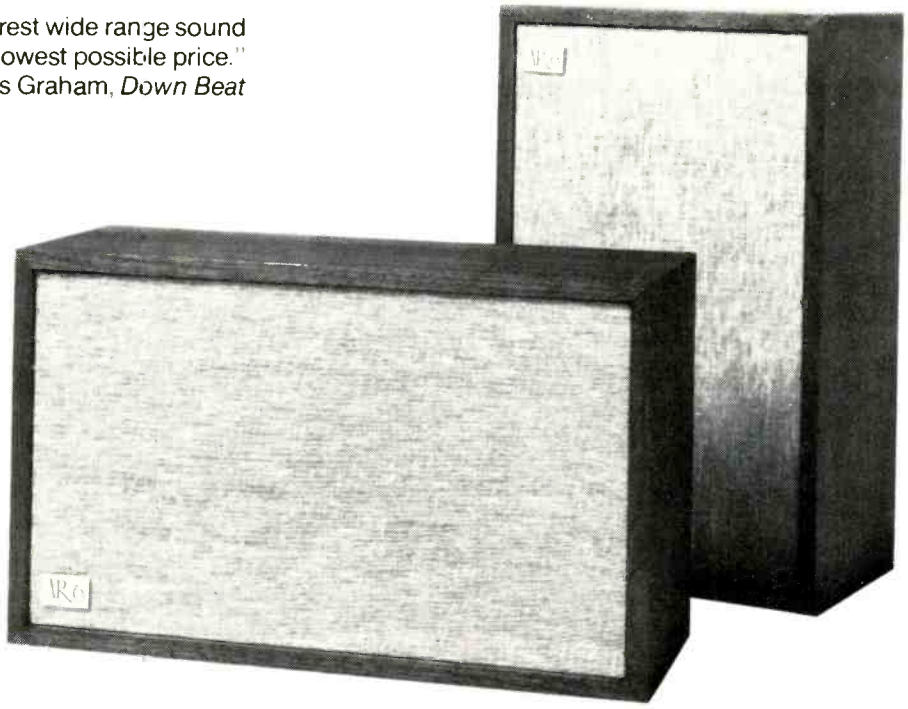
Charles Graham, *Down Beat*



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Hirsch-Houck Laboratories, *Stereo Review*

"I am unable to get over the sheer quality represented by the AR-6. To put my wonderment in perspective, perhaps the most telling thing I could add is that I never expected to be saying of any speaker in this price range that it deserves only the finest possible associated components. The AR-6 *does*, and that says a great deal about this product."

Larry Zide, *The American Record Guide*

The price of the AR-6 is $81 in oiled walnut, $72 in unfinished pine. Five percent higher in West and Deep South.

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On October 7, 1971, the Maker of the Microphone Award was presented to Garrard Engineering, Ltd., to recognize "an outstanding contribution to the world of sound" – the development of a zero tracking error tone arm for disc record reproduction.

The Award

The "Maker of the Microphone Award" was established in 1963 in memory of Emile Berliner, the great inventor who developed the microphone, the disc record, the gramophone, the method of mass-producing records from a master; and created the trade mark, "His Master's Voice."

The previous winners, recognized for the special significance of their contributions to audio, have been Roland Gelatt, Goddard Lieberson, Dr. Harry F. Olson, The Bell System, Audio Magazine, KTBT Radio / Telaudio Centre, NARAS, and the National Library of Canada. This year, Garrard is particularly honored, because 1971 marks the first time the award has been bestowed on a manufacturer.

Emile Berliner 1851-1929

The Zero 100 Tone Arm

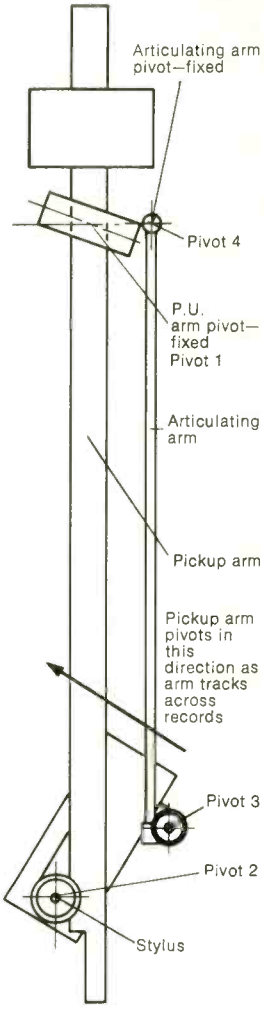
In making the award, Emile Berliner's grandson, Mr. Oliver Berliner stated..."Probably the most elusive problem in disc record reproduction has been that of tracking error. Many attempts have been made to overcome this. The solution created by this year's award winner is a marvel of simplicity, yet deceptively so, for many considerations are inherent in what has resulted in a rugged, low-cost, reliable and near-perfect solution that is revolutionary and pace-setting in its effect."

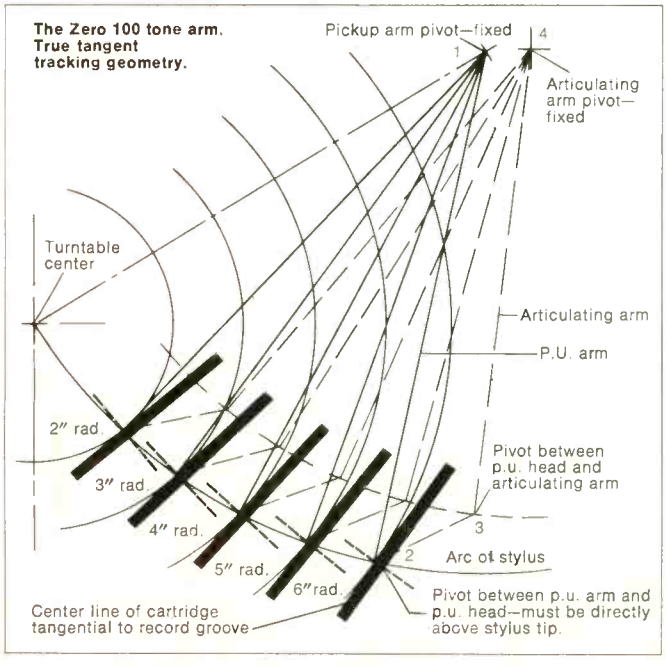
A comparison of the tracking error measurements of any conventionally pivoted tone arm with those of the Zero 100, indicate the breakthrough which Garrard has achieved.

Consider that there are 3,600 seconds of arc in a degree... and that a conventional tone arm may produce tracking error as high as 4 degrees, or 14,400 seconds at its full playing radius. The tracking error of the Zero 100 tone arm is calculated to measure a remarkable 90 seconds —160 times as small per inch as the error of conventional tone arms.

The drawing on the right shows the unique tone arm construction; the diagram below shows how the arm articulates, constantly adjusting the angle of the cartridge, and keeping the stylus tangent at 90° to the grooves throughout the record. Thus, space-age pivotry and computerized design have now made it possible to play the record at exactly the same angle at which it was cut. Reproduction is truer, distortion sharply reduced, record life lengthened.

The Zero 100 is the only automatic turntable achieving zero tracking error. Modestly priced at $189.50 – it has an impressive array of innovations above and beyond the tone arm. These include the patented Synchro-Lab synchronous motor; variable speed control; an illuminated strobe; magnetic anti-skating; viscous-damped cueing; 15° vertical tracking adjustment; and 2-point record support in automatic play. See your high fidelity dealer for a personal demonstration, or write for test reports and literature to British Industries Company, Dept. A12, Westbury, N. Y. 11590.





GARRARD ZERO 100

A genuine step upward in automatic turntables

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

CIRCLE 103 ON READER-SERVICE CARD

New Receivers □□□

All figures quoted are those supplied by the manufacturers.
* Power output refers to continuous power (rms) at 8 ohms, both channels driven.
* Power bandwidth refers to the extreme frequencies where the power falls by half.
* FM sensitivity is the IHF rating. Anything less than 3 μV is good with the best measuring less than 2.0.
* Capture ratio defines the ability of a tuner to select the stronger of two stations when both are on the same frequency. Anything below 4 dB is very good. Note that all receivers are AM/FM unless otherwise stated.

B & O 3000-2 FM only.
Power Output: 30 W per ch.
THD: 0.6%
Power Bandwidth: 10-30,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 3.0 dB
Features: Preset tuning for 6 stations, slide controls, spkr. switch, 2 phono inputs, filters.
Price: $330.00

BIC/LUX 71/3R
Power Output: 50 W per ch.
THD: 0.2%
Power Bandwidth: 15-30,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 2.5 dB
Features: Variable x-over tone controls, spkr. switch, filters, 3 FM pre-sets.
Price: $550.00

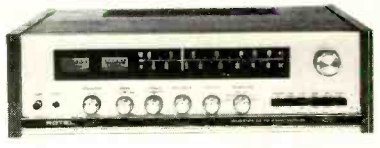
Fisher 401
Power Output: 45 W per ch.
THD: 0.5%
Power Bandwidth: 25-20,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 2.8 dB
Features: Electronic tuning, wireless remote control, spkr. switch.
Price: $449.95.

KLH 51
Power Output: 20 W per chan.
THD: 0.5%
Power Bandwidth: 15-30,000 Hz
FM Sensitivity: 2.5 μV
Capture Ratio: 2.5 dB
Features: Step-type tone controls. Hi-filter, spkr. switch.
Price: $239.95.

Sherwood S-7100
Power Output: 30 W per chan.
THD: 1.0%
Power Bandwidth: 25-25,000
FM Sensitivity: 1.9 μV
Capture Ratio: 2.0 dB
Features: Spkr. switch.
Price: $199.00 (inc. case)

Olson RA 290
Power Output: 22 W per chan.
THD: 1.0%
Power Bandwidth: 20-25,000 Hz
FM Sensitivity: 2.8 μV
Capture Ratio: 2.0 dB
Features: Slide controls, spkr. switch, filters.
Price: $300.00

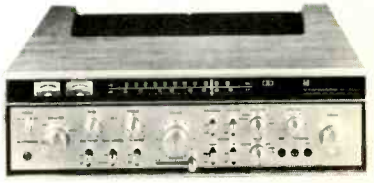
VM 1532
Power Output: 25 W per chan.
THD: 0.5%
Power Bandwidth: 9-33,000 Hz
FM Sensitivity: 1.9 μV
Capture Ratio: 2.5 dB
Features: Ceramic i.f. filters, spkr. switch.
Price: $229.95.



Rotel RX-600
Power Output: 42 W per chan.
THD: 0.1%
Power Bandwidth: 12-40,000 Hz
FM Sensitivity: 2.2 μV
Capture Ratio: 2.0 dB
Features: Spkr. switch, tone control cancel.
Price: $299.95.

Nikko STA-8010
Power Output: 26 W per chan.
THD: 1.0%
Power Bandwidth: 30-15,000 Hz
FM Sensitivity: 1.8 μV
Capture Ratio: 3.0 dB
Features: Variable x-over tone controls, spkr. switch, filters, 3 FM station presets.
Price: $239.95

Radio Shack STA-18
Power Output: 7 W per chan.
THD: 1.0%
Power Bandwidth: 30-20,000 Hz
FM Sensitivity: 3 μV
Capture Ratio: 2.5 dB
Features: Dial pointer lights on stereo.
Price: $129.95

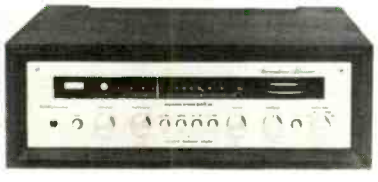


Standard SR-4500
Power Output: 100 W per chan.
THD: 0.3%
Power Bandwidth: 5-50,000 Hz
FM Sensitivity: 1.5 μV
Capture Ratio: 1.5 dB
Price: Not yet fixed.

Kenwood KR 7070A
Power Output: 90 W per chan.
THD: 0.5%
Power Bandwidth: 10-30,000 Hz
FM Sensitivity: 1.5 μV
Capture Ratio: 1.5 dB
Features: Auto tuning, remote control, spkr. switch, filters, auto muting.
Price: Not yet fixed.

Toshiba SA-15Y
Power Output: 30 W per chan.
THD: 0.8%
Power Bandwidth: 20-40,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 2.0 dB
Features: Spkr. switch, filters.
Price: $299.50

Heath AR-1500
Power Output: 60 W per chan.
THD: 0.1%
Power Bandwidth: 8-30,000 Hz
FM Sensitivity: 1.8 μV
Capture Ratio: 1.5 dB
Features: Spkr. switch, blend, tone control cancel.
Price: $349.95 (kit)



Marantz 28
Power Output: 20 W per chan.
THD: 0.5%
Power Bandwidth: 20-30,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 2.0 dB
Features: Gyro-touch tuning, filters.
Price: $229.00

Panasonic SA-4000 FM only
Power Output: 60 W per chan.
THD: 0.1%
Power Bandwidth: 20-30,000 Hz
FM Sensitivity: 1.5 μV
Capture Ratio: 1. dB
Features: Slide controls, 2 phono inputs, tone control x-over switches, auto tuning, preset controls behind front panel, spkr. switch. blend control.
Price: $919.00

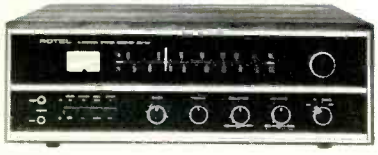
Harman-Kardon 630
Power Output: 30 W per chan.
THD: 0.1%
Power Bandwidth: 10-45,000 Hz
FM Sensitivity: 2.3 μV
Capture Ratio: 2.5 dB
Features: Dual power supplies, hi-filters, spkr. switch.
Price: $259.95

New Quadraphonic Receivers

Note that all these receivers have built-in matrix circuits but will also operate with four separate or *discrete* signals. Power output refers to each channel with all four driven.

JVC 4VR-5414
Power Output: 20 W per chan.
THD: 0.5%
Power Bandwidth: 15-35,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 2.0 dB
Features: CD-4 matrix, 5-position tone control system, spkr. switch, remote control jack.
Price: Not yet fixed.

Benjamin R4x40
Power Output: 40 W per chan.
THD: 0.5%
Power Bandwidth: 17-30,000 Hz
FM Sensitivity: 1.7 μV
Capture Ratio: 2.0 dB
Features: Spkr. switch, filters, sep. rear spkr. controls.
Price: $450.00



Rotel RX-154
Power Output: 10 W per chan.
THD: 0.35%
Power Bandwidth: 35-30,000 Hz
FM Sensitivity: 5 μV
Capture Ratio: 8 dB
Features: Matrix.
Price: Not yet fixed.

Fisher 801
Power Output: 44 W per chan.
THD: 0.5%
Power Bandwidth: 20-25,000 Hz
FM Sensitivity: 1.7 μV
Capture Ratio: 1.5 dB
Features: Wireless remote control, 2 position matrix.
Price: $749.95

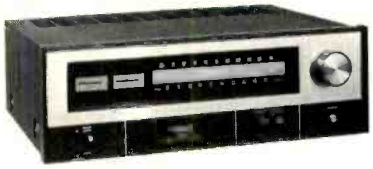
Lafayette LR440
Power Output: 25 W per chan.
THD: 0.8%
Power Bandwidth: 10-30,000 Hz
FM Sensitivity: 1.65 μV
Capture Ratio: 1.5 dB
Features: CBS matrix, spkr. switch.
Price: $378.60

Sansui QR-4500
Power Output: 27 W per chan.
THD: 0.5%
Power Bandwidth: 20-30,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 2.0 dB
Features: 3-position matrix, spkr. switch, filters.
Price: $579.95; Model QR500 (4x15W), $289.95

Scott 444
Power Output: 25 W per chan.
THD: 0.5%
Power Bandwidth: 25-20,000 Hz
FM Sensitivity: 1.9 μV
Capture Ratio: 2.5 dB
Features: Matix, spkr. switch, filters.
Price: $449.95

Pioneer QX-8000
Power Output: 20 W per chan.
THD: 1.0%
Power Bandwidth: 15-35,000 Hz
FM Sensitivity: 2.0 μV
Capture Ratio: 3.0 dB
Features: Phase-Shift and Quadralizer matrixing, filters, spkr. switch.
Price: $499.95

New Tuners



TEAC AT-100 (FM only)
FM Sensitivity: 2.0 μV
Capture Ratio: 1.5 dB
Separation, 1000 Hz: 40 dB
THD: 0.5%
AM Suppression: 50 dB
Tuning Indicator: 2 meters
Price: Not yet fixed.

Revox A76 (FM only)
FM Sensitivity: 1.0 μV
Capture Ratio: 1.0 dB
Separation, 1000 Hz: 40 dB
THD: 0.02%
AM Suppression: 54 dB
Tuning Indicator: 2 meters
Features: Multipath indicator, adjustable trigger control.
Price: $499.00

Scott 433 (FM only)
FM Sensitivity: 2.0 μV
Capture Ratio: 1.8 dB
Separation, 1000 Hz: 35 dB
THD: 0.8%
AM Suppression: 70 dB
Tuning Indicator: Digital readout
Features: Card program or manual selection.
Price: $549.90

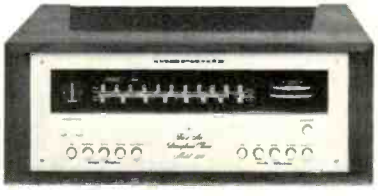
Nikko FAM 1200 (AM/FM)
FM Sensitivity: 1.5 μV
Capture Ratio: 1.5 dB
Separation, 1000 Hz: 25 dB
THD: 0.6%
AM Suppression: 45 dB
Tuning Indicator: 2 meters
Features: Headphone output with level control, multipath indicator.
Price: $239.95

Pioneer TX-1000 (AM/FM)
FM Sensitivity: 1.7 μV
Capture Ratio: 1.5 dB
Separation, 1000 Hz: 25 dB
THD: 0.5%
AM Suppression: 55 dB
Tuning Indicator: Two meters
Features: 2 X-tal filters, output socket for headphones with level control.
Price: $279.95

JVC 5109 (AM/FM)
FM Sensitivity: 1.7 μV
Capture Ratio: 1.7 dB
Separation, 1000 Hz: 35 dB
THD: 0.6%
AM Suppression: 55 dB
Tuning Indicator: Meter
Features: Provision for 4-chan. adaptor.
Price: $199.95

Standard TU-108 (AM/FM)
FM Sensitivity: 5.0 μV
Capture Ratio: 6 dB
Separation, 1000 Hz: 36 dB
THD: 1.1%
AM Suppression: 45 dB
Tuning Indicator: Meter
Features: AFC switch, built-in AM antenna.
Price: $69.95

Dynaco FM-5 (FM only)
FM Sensitivity: 1.75 μV
Capture Ratio: 1.5 dB
Separation, 1000 Hz: 40 dB
THD: 0.5%
AM Suppression: 65 dB
Tuning Indicator: Meter
Price: $249.95



Marantz 120 (AM/FM)
FM Sensitivity: 2.3 μV
Capture Ratio: 1.6 dB
Separation, 1000 Hz: 42 dB
THD: 0.3%
AM Suppression: 65 dB
Tuning Indicator: Oscilloscope
Features: Scope display for multipath, center channel, separation, phasing.
Price: $395.00

IC Tone Burst Generator

Part III: Check Out and Operation

Walter Jung

THIS MONTH we turn on the tone burst generator, check it out, and begin to put it to use. Note the term "begin." The uses we'll cover here are far from complete, and when you finish your unit, you'll probably think of some new ones too! But first let's set it up and see that it does what it is supposed to do.

Checkout and Alignment Procedure

It is recommended that portions of the unit be checked sequentially to aid in pinpointing any possible trouble areas. Build and check stage by stage, this way you'll nail down any circuit gremlins before they get a chance to cause grief. Let's start with the power supply.

Last month's Fig. 5 was the complete power supply section. You may check it for operation very quickly by removing all loads before firing up and very closely verifying your circuit's conformity with the schematic. Watch diode and capacitor polarities and the index tab on the 723 regulators. For the TO-5 type can, the tab is adjacent to pin 10. When all is determined to be well, install a fuse in the fuse holder and monitor the d.c. voltage across C6. With power applied it should rise to a positive 18-22 volts. The voltage across C7 should be the same with a negative polarity. If these are OK, check the $\pm$12 V outputs across C12 and C13. They need not be precisely 12 volts, ($\pm$0.5 volt OK) but the a.c. ripple should be low, less than 1mV. Check the +5 volt output at Q6-Q7. This should be between 4.5 and 5.5 volts.

If all the above tests are OK, you can hook up power to the rest of the generator. **But** don't plug in IC4-IC8 yet. The first stages to check are the input buffer and the synchronizer, as we need the timing signals to make things happen elsewhere. Apply a 10 V p-p, 1 KHz sine wave to J1 and check to see that it is duplicated undistorted at IC1's output. There should be no d.c. offset, peak clipping or spurious oscillation. If this is true, reduce amplitude to 1V p-p.

Now check limiter stage IC 3 by monitoring the junction of R36 and R37. The wave form should appear similar to Fig. 1, bottom trace. Rotate fine phase control R26 and the duty cycle of the square wave should shift. Reduce signal to 50 mV p-p and "peak" R26 for max sensitivity. Raise signal level to 10 V p-p and note that the relative phase change of the square wave is a minimum. This checks the limiter and phase control circuits and Figs. 1 and 2 demonstrate the dynamic range.

Plug in IC 4 and check for a sharp, clean 4 volt p-p signal at pin 3. Rise and fall time should be 100 nanoseconds or less, and there should be no trace of oscillations or spurious glitches as phase control R26 or the input level is changed. Check for a negative 4 microsecond pulse at pin 11 of IC 4. This pulse should be clean and sharp with no evidence of double pulsing. Check that this same pulse is being applied to pin 1 of IC 5 and IC 7.

Now you may start the counters operating by plugging in IC 7 and IC 8. This check is very simple—look for a two–times division in each binary with an overall 16–times division for the set. Not much can go wrong here save a wiring error or sick chip.

Things start to get interesting when next you fire up the timer circuits. This operation demands some care. Set S4 for the 1-10 microsecond range and rotate Rt 1 to minimum resistance. Insert IC 5 and check for a negative pulse at IC 5 pin 6. Vary Rt 1 from MIN to MAX and verify a timing range from slightly under 10 microseconds to slightly over 100 microseconds. A similar check can be made of the remaining ranges, progressing upwards in time until the longest range is reached. If a range should fall short of its maximum, pad Ct1 with an additional capacitor until the spread is reached. There should be more than a 10-1 range with overlap between adjacent ranges of S4. When the pulse length of IC5 exceeds the period of the input frequency (1 millisecond in this case), it will begin to "drop" input pulses. Check to see that this is in fact being done and the pulse width is stable up to and after the point where it drops the second trigger pulse at pin 1.

In a similar manner IC6 can be checked out and its timing ranges verified. Set S4 for a range of 1000 μs or less and insert IC6. Check for a negative pulse at IC5-3 and 4. The width of this

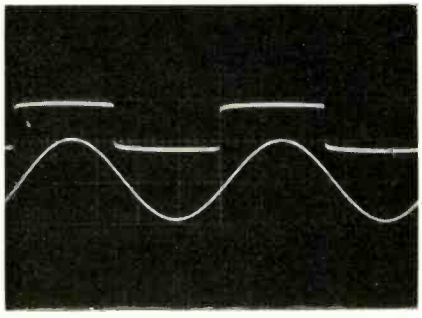


Fig. 1—Operation of limiter at low signal level. Upper trace is 1KHz input signal at 50 mV/cm; bottom is limiter output at 2 V/cm; d.c. zero is second line from bottom. R26 is set for symmetry and time base is 200 μS/cm.

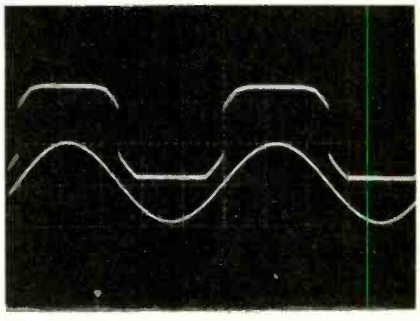
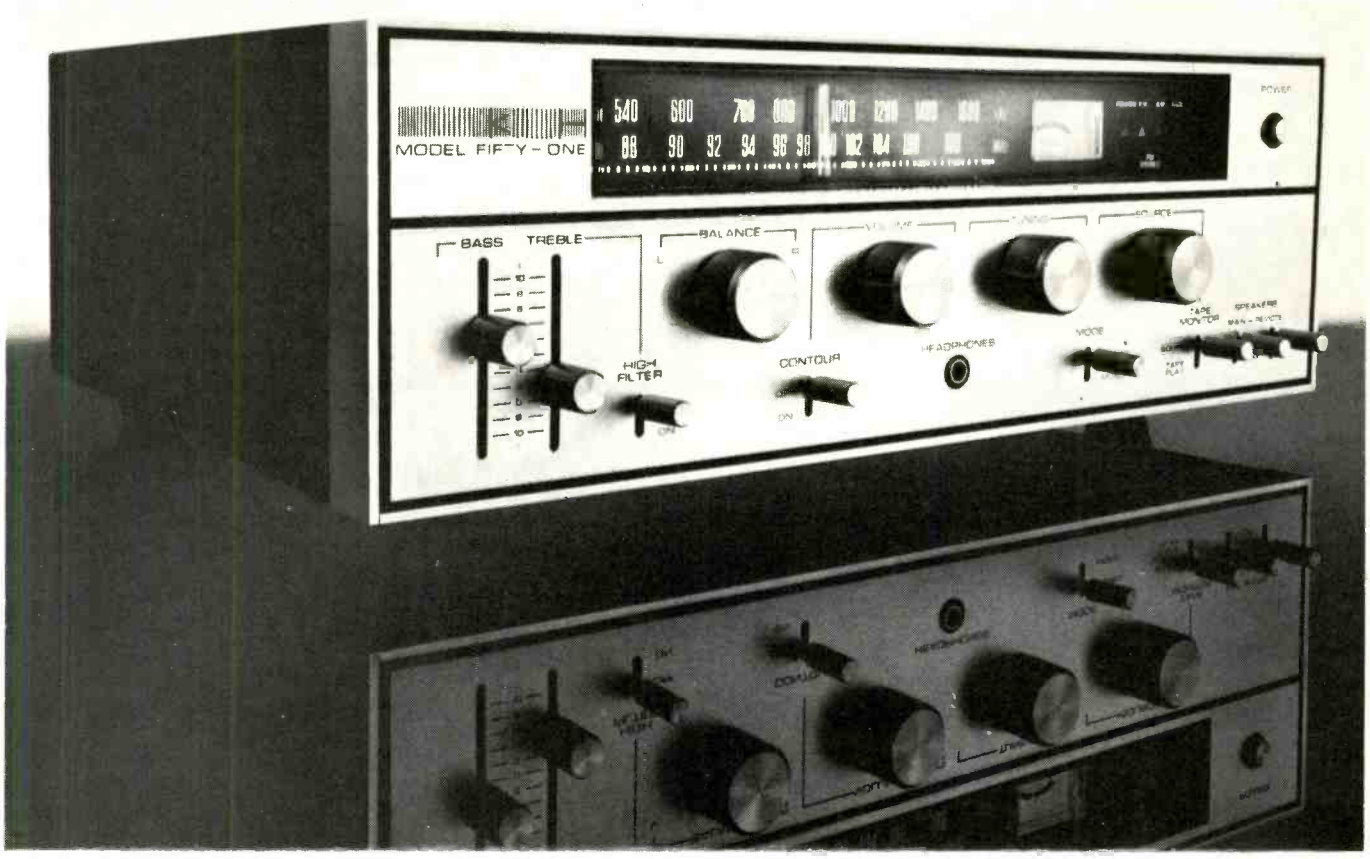


Fig. 2—Operation of limiter at high signal level. Upper trace is 1KHz input signal at 5 V/cm; bottom is limiter output; same scale as Fig. 1. R26 is unchanged from Fig. 1, as is time base.

For $239.95* we think you deserve something more than just another stereo receiver.

KLH introduces something more.



Most stereo receivers that cost between $200 and $250 don't sound half bad. Some even look kind of nice, if not exactly sexy. And they usually work more times than not. Perhaps they can best be described as predictably adequate.

To us, that doesn't sound too thrilling.

We figure a couple of hundred dollars or so entitles you to something more. Something like our new Model Fifty-One AM/FM Stereo Receiver. For one thing, it has big dependable power; it'll drive loudspeakers that leave lesser instruments gasping. It looks more expensive than similarly priced stereo receivers. And it *feels* more expensive too. Each knob, switch and sliding control gives you a real sense of authority. Stations literally lock in when you turn the dial. The controls are crisp and flawless. No mushiness here. Also, *both* the AM and FM sections will pull in stations you didn't even know were on the dial. But most important, the Fifty-One has the overall quality that most people expect from KLH. And you get it all for just $239.95† (including walnut-grain enclosure).

Make sure you see and hear the Fifty-One soon. It's at your KLH dealer now. You'll recognize it immediately; it's the sexy one that sounds great.

For more information on the Model Fifty-One, write to KLH Research and Development, 30 Cross St., Cambridge, Mass. 02139. Or visit your KLH dealer.

A Division of The Singer Company

†Suggested east coast retail price; suggested retail price in the south and in the west $249.95
*A trademark of The Singer Company

Check No. 42 on Reader Service Card

Fig. 3—Operation of offset control R8. Upper trace is correct setting with switching occurring at negative peak, OFF level equals 100% (or equal to ON level). Lower trace shows incorrect setting of R8 with d.c. level of OFF level lower than ON level. Scales are 1 V/cm vertical and 20 μS/cm horizontal, input 10 KHz.

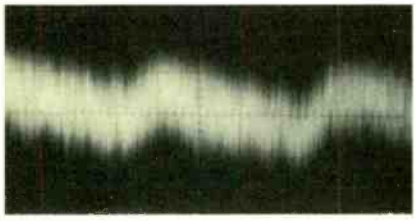


Fig. 4—Residual hum and noise of tone burst generator with input shorted. Scales are 1 mV/cm vertical, 2 mS/cm horizontal.

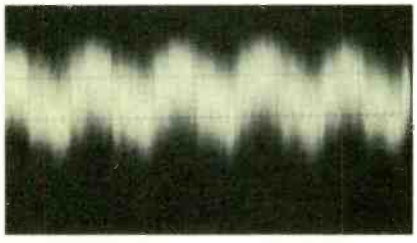


Fig. 5—Residual crosstalk of generator with gate OFF by switching to EXT with no EXT input. Signal input is 10 V p-p at 1 KHz. Scales are 1 mV/cm vertical, 500 μS/cm horizontal.

pulse should vary in a manner as was described above for IC5's output. Run through the ranges of S5 and check for overlap and 10-1 range of Rt2. This completes the synchronizer circuit checkout.

At this point you should be able to verify complete synchronizer operation by monitoring SYNC OUTPUT at J3. In the COUNTED position of S2 you should get a variable frequency square wave from ½ to 1/16 the input frequency as S3 is rotated from 2 to 4, 8, and 16. In the DIRECT position of S3 you should get a "squared up" version of the input signal with phase adjustable by S1 and R26. In the TIMED position of S2 you should get the variable pulse length of IC5 effected by S4 and Rt1, while S5 and Rt2 will determine the spacing between pulses.

Now we are ready to check the switch for operation. If everything is wired correctly you may see a gated tone burst at J4 already, but it may not yet make proper sense. Rotate R5 (OFF level) to MINIMUM (max counterclockwise) and set R8 to the center of its range. With a high gain d.c. coupled scope or the lowest range on your VTVM or VOM, set R3 for zero volts d.c. at IC2 pin 2. This biases IC2 for zero input d.c. offset. Then set R15 for a output d.c. baseline of zero volts observed at J4. Set Mode switch S2 to COUNTED and Count Ratio S3 to 2. With Override switch S6 in NORMAL you should see a gated tone burst with ON level equal to the INPUT level and OFF level ZERO. Depress S6 down momentarily and the OFF period should fill in. The generator is now working and all that now remains is to set R8 for minimum offset. Bring up OFF level control R5 until the p-p level during the OFF level is equal to the ON p-p level. You can reduce input level to 1 p-p or less and expand scope sensitivity to see this effectively. Switch to the timed mode and set S4 and Rt1 to switch at a peak of the sine wave. You will probably see an offset between the peaks like Fig. 3, bottom. Rotate R8 until this offset is nulled, as in the waveform directly above. Now you should be able to operate R5 from MIN to MAX and gradually "fill in" the OFF period of the burst. At the maximum position of R5 the OFF level may be slightly over or slightly shy of the ON level. If it is short you can trim RE6 to a slightly lower value to make up the difference. Once this is done you should not have to adjust R8 or R3 again.

Now rotate R15 from MIN to MAX and check for ±5 volts of d.c. baseline shift. Reset R15 for zero volts baseline and adjust the input for 10 volts peak output ON level. Load output with 500 ohms and check that waveform is undistorted. By either raising the input further or shifting R15 plus or minus you should see the Q4-Q5 output current limit at slightly above ±5 volts. This completes the setup and checkout, and the generator will now perform as per the specification objectives listed in Part I.

Operation

Now that you have your tone burst generator operating, you will quickly become fascinated by the wide variety of waveforms it can produce. Spend a few minutes familiarizing yourself with the operation of the controls. Run each control in each mode through its range and observe the effect on the output waveform as you change the settings. A few examples illustrating operation are shown in the waveform photos. These you should be able to reproduce easily. All were taken with a Tektronix 545A scope with a type W plug-in.

Uses of the Tone Burst Generator

Much has been written on the various uses of tone burst generators. Its main

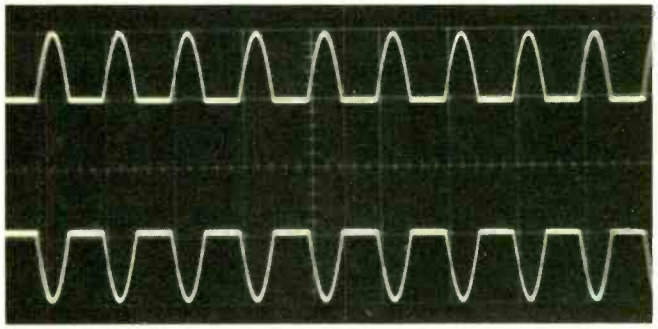


Fig. 6—Operation of COUNTED-DIRECT mode with 1 KHz input at 10 V p-p. Upper trace is coarse phase 0 degrees with R26 centered, d.c. zero is second line from top. Lower trace is coarse phase 180 degrees with R26 centered, d.c. zero is second line from bottom. Scales are 5 V/cm vertical, 1 mS/cm horizontal.

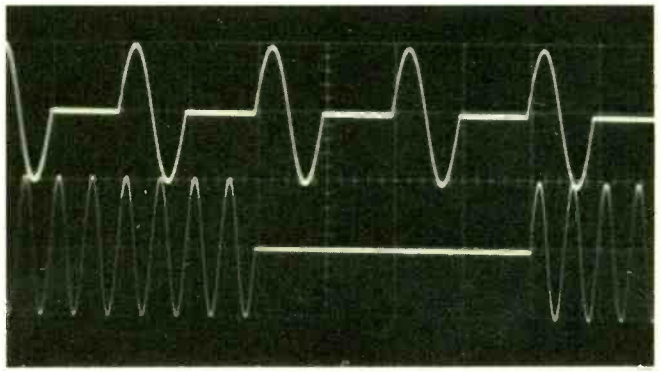


Fig. 7—Operation of COUNTED-DIVIDE by 2 and 16 with input 1 KHz at 10 V p-p. Upper trace is 2 (1 ON, 1 OFF) at 1 mS/cm, d.c. zero second line from top. Lower trace is 16 (8 ON, 8 OFF) at 2 mS/cm, d.c. zero second line from top.

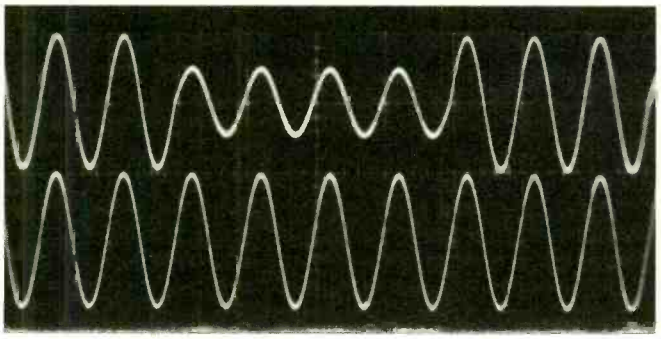


Fig. 8—Operation of TIMED mode with override. Input is 10 V p-p at 10 KHz. Upper trace is 3 cycles ON, 4 cycles OFF, 50% OFF level. D.c. zero is second line from top. Lower trace is same input signal but overriden with S6. D.c. zero is second line from bottom. Scales are 5 V/cm vertical, 100 μS/cm horizontal both traces.

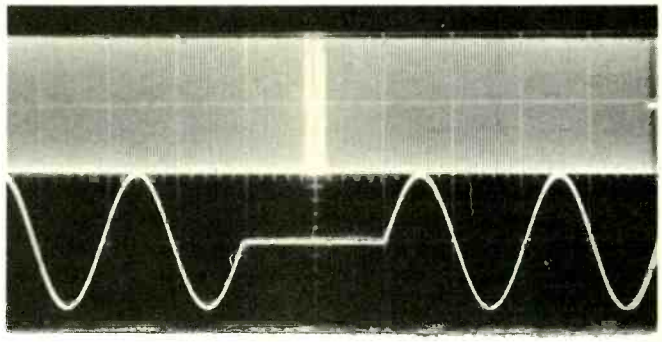


Fig. 9—Operation of TIMED mode with high duty cycles. Input is 10 V p-p at 10 KHz, timing set for 99 cycles ON and 1 OFF. Upper trace is gated output at 2 mS/cm horizontal sweep with OFF time intensified. Lower trace is the intensified portion expanded to 50 μS/cm to show 1 cycle of OFF time. Vertical scale factor for both traces is 5 V/cm.

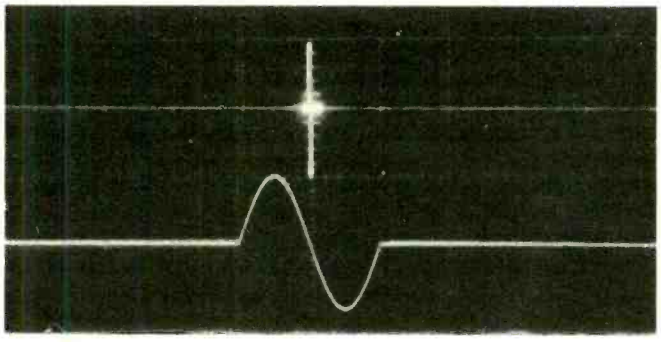


Fig. 10—Operation of TIMED mode with low duty cycle. Input 10 V p-p at 10 KHz. Timing set for 1 cycle ON, 99 OFF. Upper trace is gated output at 2 mS/cm horizontal sweep with ON time intensified. Lower trace is intensified portion expanded to 50 μS/cm to show 1 cycle of ON time. Vertical scale factor is 5 V/cm for both traces.

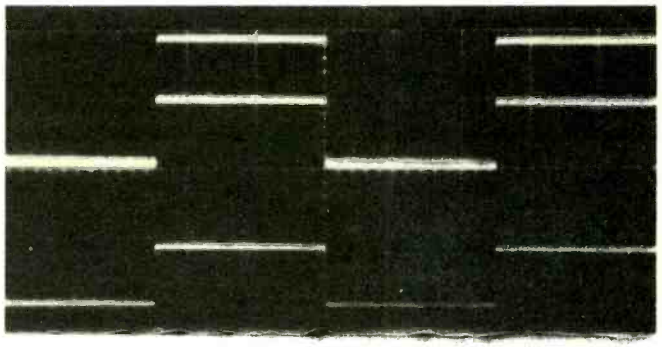


Fig. 11—Using the tone burst generator as a variable frequency, variable duty cycle oscillator with logic level and variable output. Mode control set to TIMED, S4 and S5 on 1-10 mS ranges, Rt1 and Rt2 adjusted for 5 mS. IC6 pin 8 jumper to J1 input. Upper trace is double exposure of J4 output at two different settings on OFF level control. Vertical scale is 2V/cm and d.c. zero is center of graticule. Bottom is J3 output (sync) at 5 V/cm. Horizontal scale is 2 mS/cm for both.

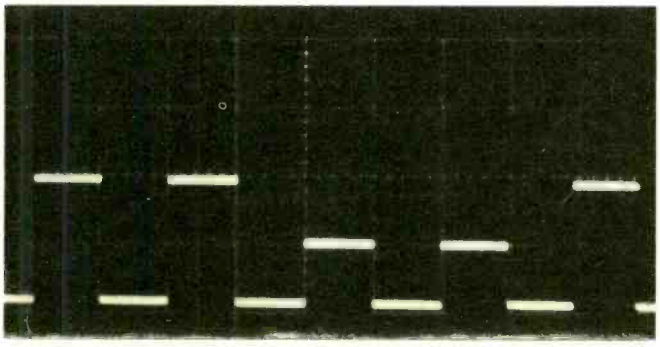


Fig. 12—Use as an oscillator with variable COUNT and variable OFF level in alternate group periods. Oscillation frequency as set in Fig. 11, but output switching done in COUNT Mode 4. ON for two periods, and OFF for two periods. OFF level is set to 50%, d.c. zero is bottom of graticule. Vertical scale is 2 V/cm, horizontal 5 mS/cm.

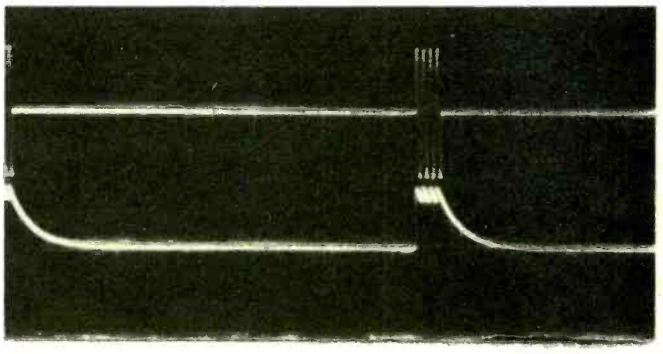


Fig. 13—Tone burst with low duty cycle used to check a half wave rectifier time constant. Four cycles of 10 KHz space 6.5 mS. Scales are 5 V/cm vertical and 1 mS/cm horizontal for both scales. D.c. zeros are second lines from both top and bottom respectively. Top is input to rectifier, bottom is output.

flexibility is in the fact that it is a bridge between steady state sinusoidal tests and pulse or rectangular wave tests. It produces a controlled transient waveform of wide usefulness in loudspeaker tests, amplifier music power checks, acoustic work, sonar work, testing of filters and tuned networks, rectifier response, meter ballistics, and many others. These and other applications are well covered by Skilling (2) (3) (4) in the General Radio literature, and more recently Annes (6) has illustrated practical uses of the device. All of these uses are well served by this version also, as well as some more which will now be described.

The classic portrait of a tone burst is a gated sinusoid. Although this is indeed a tone burst, the association of only the sinusoid with burst testing is a severe mental limitation of the techniques available. Any periodic waveform can be gated with this tone burst generator—square, triangular, pulse, saw-tooth—you name it. As a pulse gate you can use the device as a variable divider of ratios up to 100 with excellent stability. You'll get a divided logic compatible output from the J3 sync output and a variable level output from the main output with the added feature of variable d.c. offset.

The output of this unit is intentionally designed to drive IC logic stages as well as linear amplifiers. The d.c. baseline offset may be used as one limit of logic level and the OFF level control as the other. In this manner logic stages can be checked dynamically with no further equipment. The current rating of ±10 mA allows several stages to be driven without distortion of the voltage waveform. And the fact that there is complete control over the baseline, level and polarity will allow it to interface with most popular logic families such as DTL, TTL, RTL and ECL. Thus the device can be used as variable period digital word generator with the ability to generate a wide variety of output pulse shapes. An additional feature beyond the division capability is the variable OFF level. By using the variability of the OFF level in conjunction with the baseline control, you can simutaneously test the ON and OFF levels of a logic stage for instance.

The flexibility of this instrument goes beyond the division of an input waveform. You can use the timer circuits as a variable frequency and duty cycle oscillator. To do this it is necessary to jumper IC6 pin 8 to the input J1. This closes an oscillating loop through IC1, IC3 and IC4 to IC5 and IC6. The ON and OFF timers IC5 and IC6 serve as independently variable timers which comprise the two portions of an oscillating cycle. An example of this operation is shown in Fig. 11. Here the times of IC5 and IC6 are set for equal lengths of 5 mS, thus setting up a symetrical 100 HZ square wave. In Fig. 3 both logic level and variable outputs are shown. The variable output occurs from the action of the square wave gating itself ON and OFF, thus OFF level control R5 serves as a linear gain control. Since there are no limitations on duty cycle on the timers, you can generate pulse or square waveforms over the entire range of IC5 and IC6 timing circuits.

A variation on this is to set up a basic oscillation with the timer, and switch the output to COUNTED. This will give an alternate pattern of ON-OFF levels. The number pulses in a group are determined by the Count Ratio, and the OFF level set by R5. An example of this is Fig. 12, which shows the osciallation of Fig. 11 gated by the dividers operating as DIVIDE-BY-FOUR.

You may want to add an auxiliary jack on the back connected to IC6 pin 8 to enable this hookup or wire in an extra switch to perform the same function.

Obviously a description of the uses of this tone burst generator could go on and on. But at some point we have to stop and turn the controls over to you. It is probably a safe guess that builders of this generator will discover many more applications. Towards that end we have included a list of background references which should be helpful both in general and for application ideas. It will be interesting to hear of the diversity of applications which fellow AUDIO readers will find for this tone burst generator. I'm sure we can entice our friendly Editor into sharing the best of them through the *Letters* column. Have fun with your tone bursts and Happy New Year. AE

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5. Kelly, Stanley, "Design of a Tone Burst Generator," *Journal of the Audio Engineering Society,* Volume 18, #4; August, 1970.
6. Annes, Tom, "14 Ways to Use R-E's Tone Burst Generator," *Radio Electronics,* Volume 42, #8; August, 1971.

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To begin with, it is generally agreed that the first consideration in choosing a cartridge should be low mass. And as you may have guessed by now, the LM in our model designation stands for low mass.

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*We guarantee (to the original purchaser) this ADC cartridge, exclusive of stylus assembly, to be free of manufacturing defects for a ten year period from the date of factory shipment. During that time, should a defect occur, the unit will be repaired or replaced (at our option) without cost. The enclosed guarantee card must be filled out and returned to us within ten days of purchase, otherwise this guarantee will not apply. The guarantee does not cover damage caused by accident or mishandling. To obtain service under the guarantee, simply mail the unit to our Customer Service Department.

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Equipment Profiles

Crown IC-150 Integrated Circuit Stereo Console

Crown D-150 Dual Channel Power Amplifier

MANUFACTURER'S SPECIFICATIONS

IC-150:

Frequency Response, High Level: ±0.6 dB, 3 Hz to 100kHz with High Impedance Load. ±0.1 dB, 10 Hz to 20 kHz with IHF load (100 KOhm in Parallel with 1000 pF). **Phono:** ±0.5 dB from standard RIAA response curve. **Phase Response, High Level:** typically +1° to −7°, 20 Hz to 20 kHz with high impedance load; +1° to −12°, 20 Hz to 20 kHz with IHF load; **Phono:** typically ±5° additional phase shift, 20 Hz to 20 kHz. **Total Harmonic Distortion:** Essentially too low to measure. **Intermodulation Distortion:** Less than 0.01% at 2.5 volts out; typically less than 0.002% at 2.5 volts out and less than 0.004% at 10.0 volts output. **Hum and Noise, High Level Inputs:** 90 dB below rated output of 2.5 volts. (Typically, 100 dB below rated output with IHF "A" weighted measurement). **Phono Inputs:** 80 dB below 10 mV input (typically 0.5 μV). **Gain, Hi Level Inputs:** 20.8 dB ±0.2 dB. **Phono Inputs:** Adjustable between 50 and 70 dB by means of input level controls. **Rated Output:** 2.5 volts. **Maximum Output:** 10 volts.

D-150:

Frequency Response: ±0.1 dB 20 Hz to 20 kHz at 1 watt into 8 ohm load; ±1 dB 4 Hz to 100 kHz. **Power Output at Clipping:** Typically 100 watts rms per channel into 8 ohms, 180 watts rms per channel into 4 ohms. **IHF Power Output:** Typically 210 watts rms into 8 ohm loads; 400 watts rms into 4 ohm loads. **IM Distortion:** Less than 0.01% at 75W. THD: Less than 0.05% from 20 to 20,000 Hz, 75W. **Damping Factor:** Greater than 200 up to 1 kHz, 8 ohm load. **Hum and Noise:** 110 dB below 75 watts rms (unweighted band limited from 20 Hz to 20 kHz typically measures 119 dB). **Load Impedance:** 4 ohms or greater. Stable with all speaker loads. **Input sensitivity:** 1.19 volts ±2% for 75 watts into 8 ohm load. **Input Impedance:** 25 Kohms. **Power Response:** ±1 dB, 5 Hz to 20 KHz at 75 watts rms into 8 ohm load.

General Specifications

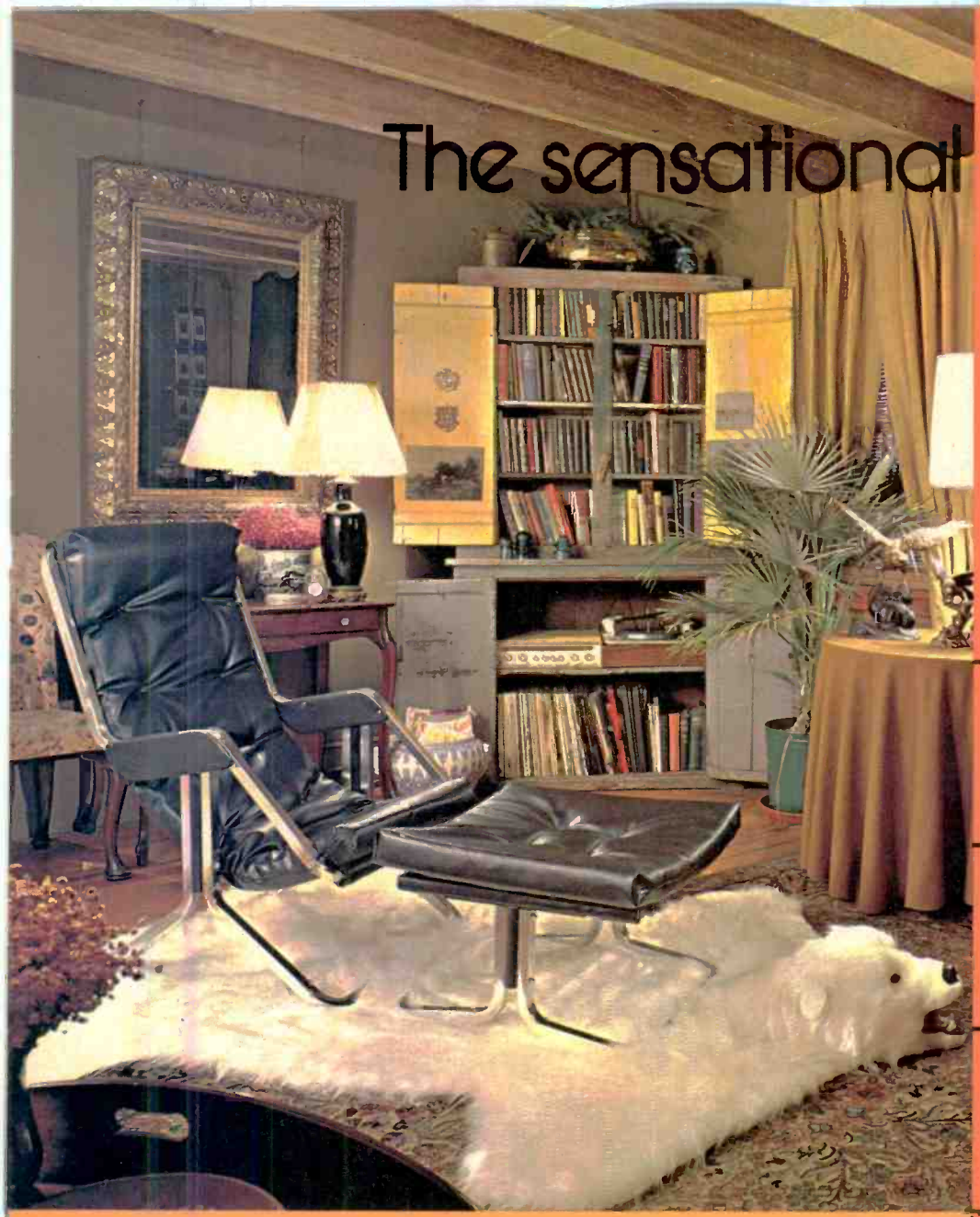
D-150:

Dimensions: 17 in W. x 5¼ in. H. x 8¾ in. D., 19-in. rack mounting hardware available. **Weight:** 24 lbs. with front panel. **Price:** $429.00: less front panel $399.00: optional cabinet available.

Dimensions: 17 in. W. x 8⅝ in. D x 6½ in. H. **Price:** $269.00; optional walnut cabinet, $33.00.

It is rare that the editors of AUDIO will review two important pieces of equipment produced by the same manufacturer in one issue. In the case of Crown's IC-150 stereo console and the matching D-150 power amplifier, the two units are so ideally suited to each other that to discuss one without fully evaluating its companion would be to do both an injustice. One of the few other stereo power amplifiers we have ever measured that could justifiably be used with the IC-150 control unit is Crown's higher powered DC-300, and since not everyone will even consider a 400 watt rms amplifier (or a price tag of $685.00, found on the DC-300) the D-150, at $429.00 plus the IC-150 at $269.00 form a combination at just under $700.00 that will appeal to the serious audio enthusiast who, very simply, wants the *best* specifications that have ever been incorporated in a preamplifier/amplifier component pair.

The IC-150 stereo console is shown in its optional walnut cabinet (Model 5-D), but it can be shelf mounted nearly as attractively without this optional extra. The brushed anodized aluminum and black front panel is relatively simple in layout, when you consider the flexibility of control functions afforded by the thoughtful layout. The top portion of the panel contains six knobs, two of which are really dual concentric types, and two push-push buttons. The rotary knobs include a seven position selector switch (two phono inputs, tuner, two auxiliary inputs and two tape inputs), a volume control, a balance control, a continuous control labelled PANORAMA and dual concentric BASS and TREBLE controls. The PANORAMA control acts somewhat like a MODE selector, except that its action is continuous. When rotated fully counterclockwise, normal stereo reproduction is afforded, with full separation. As you rotate the knob towards its mid-position, left-right blending takes place until a monophonic mix is achieved. Clockwise rotation of this control beyond the center point begins to



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restore stereo separation, this time in a reverse sense (that is, left and right channels become reversed) until, at the extreme clockwise position, full separation is restored. Thus, this one cleverly conceived control offers the advantages of a true BLEND control (a much needed feature which was popular on some equipment in the early days of stereo but which for some obscure reason was dropped from components more recently) plus the needed features of a conventional MODE switch. The two push-push buttons introduce loudness-compensation and serve to by-pass the tone controls when absolutely flat response is desired. The lower portion of the panel contains five rectangular push buttons which are also of the "push-to-make, push-to-break" variety and control such functions as TAPE 1 and TAPE 2 monitoring, low frequency filtering, high frequency filtering, and power on/off.

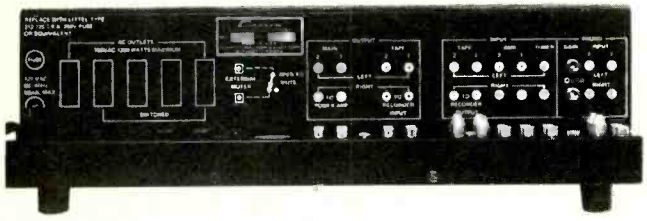


Fig. 1—Rear panel of the Crown IC-150.

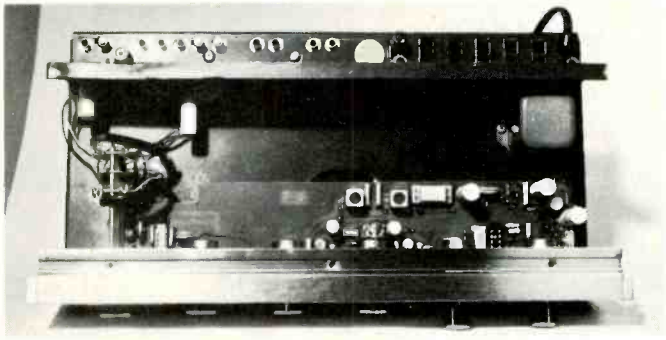


Fig. 2—View from above the Crown IC-150

As can be seen in Fig. 1, all rear panel connections are made in a horizontal plane, but the designations are printed on the vertical back wall, making them easy to read. This arrangement has the additional advantage of avoiding any protrusions from the back of the unit. Starting at the left of the rear panel, we see an a.c. line fuse followed by five convenience a.c. outlets (of which four are switched and one, intended for your phono turntable or changer, is unswitched). A pair of terminal posts come next, and these are for the optional connection of a remote electronic muting switch, which will be described later. There follow pairs of main and tape output jacks, pairs of tape input jacks and the necessary auxiliary, tuner and phono input jacks. The latter are associated with screwdriver-type level adjustments, which are to be set according upon your cartridge output.

Figure 2 shows the deceptively simple looking innards of the IC-150. All major components of small dimensions are mounted on glass (G-10) printed circuit board which is firmly supported mechanically. The magnetically shielded power transformer can also be seen over to the extreme right of the photo. Figure 3, taken from Crown's instruction manual, is a signal flow diagram showing the sequence of events that an input signal undergoes from the input jacks to the outputs. It should be noted, by the way, that the output impedance of the IC-150 is 600 ohms and, if terminated in that impedance (as would be the case in professional use), it will deliver a maximum output of 5 volts. With high impedance terminations (as, for example, when used with the matching D-150 power amplifier) maximum output will be as high as 10 volts rms. The phono preamp circuit board contains a total of nine

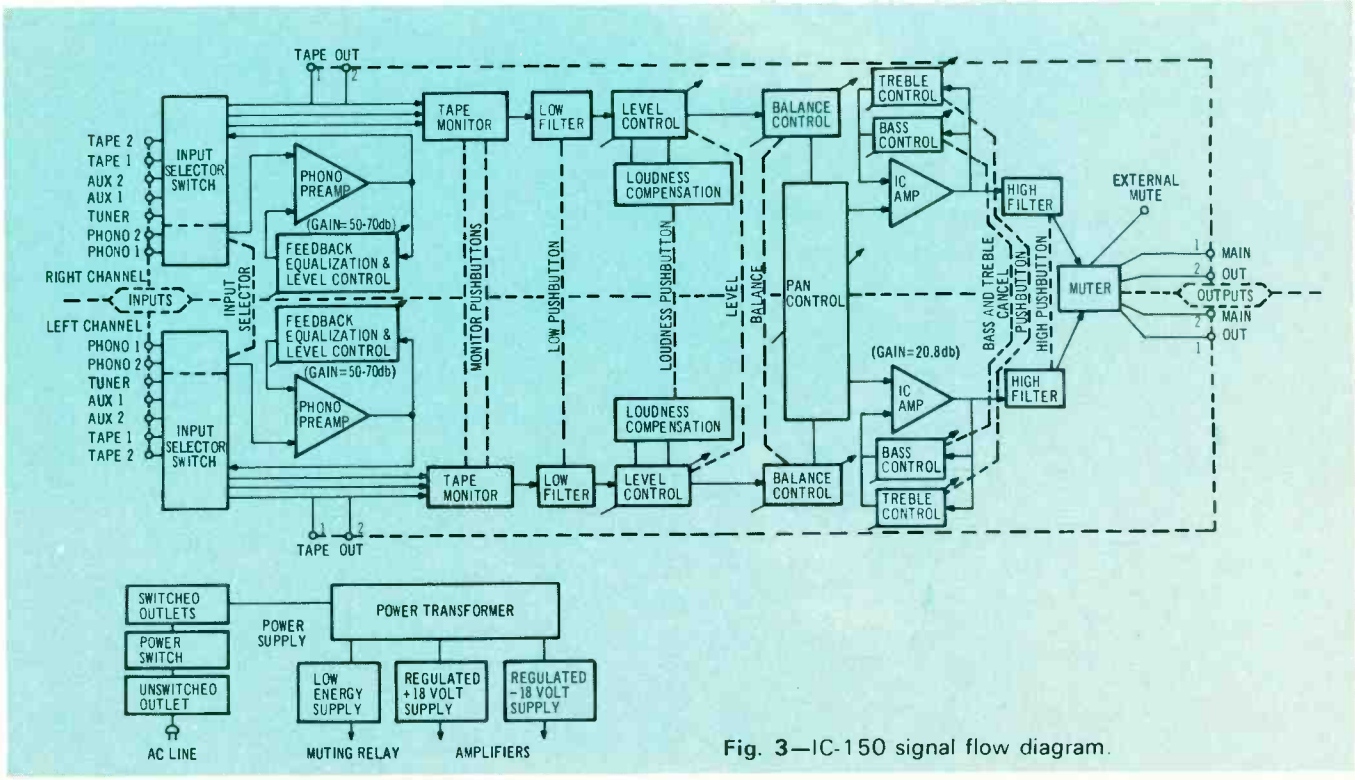
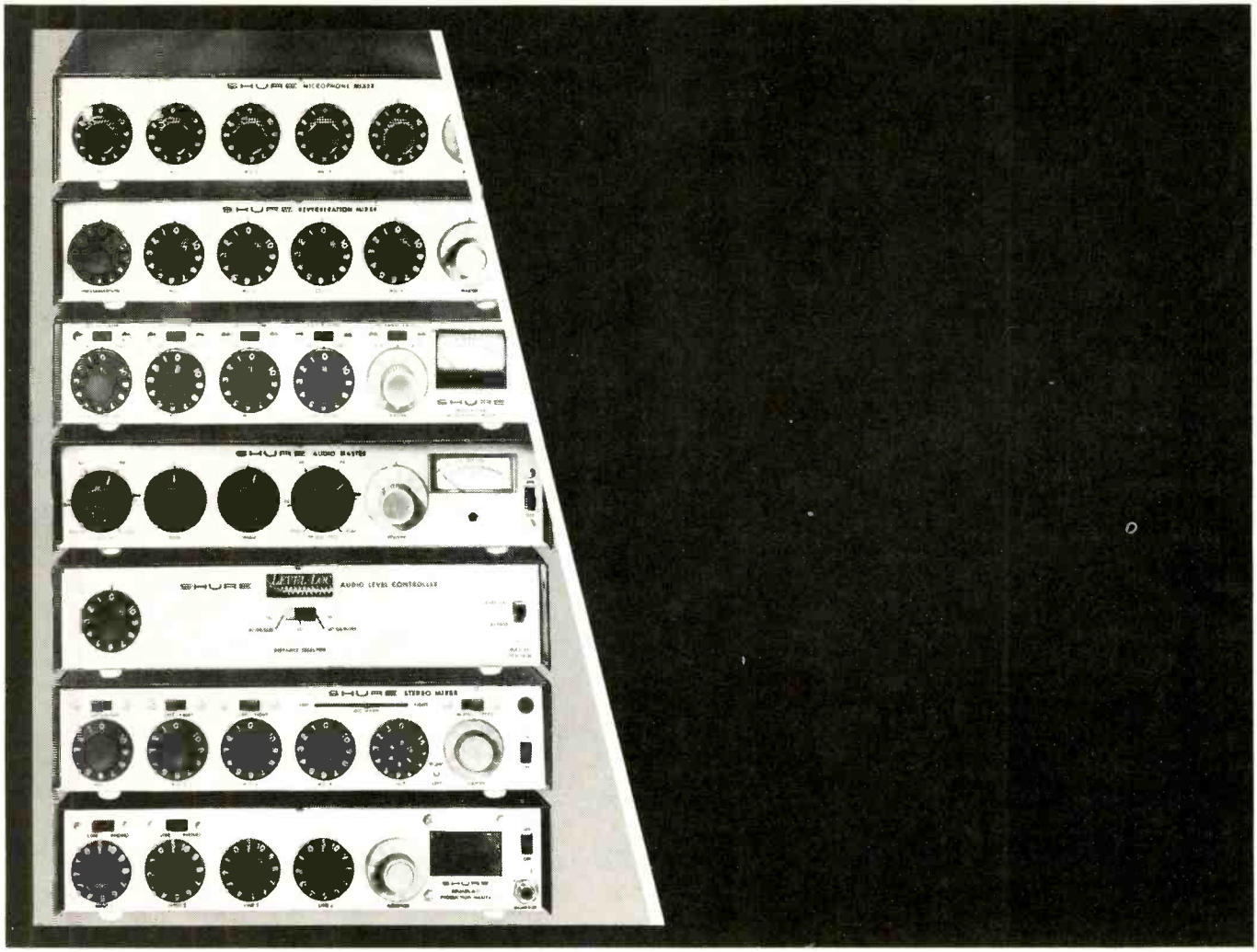


Fig. 3—IC-150 signal flow diagram.



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Mr. Hirsch goes on to say: "The FM tuner section of the AR-1500 was outstandingly sensitive. We measured the IHF sensitivity at 1.4 microvolts, and the limiting curve was the steepest we have ever measured... The FM frequency response was literally perfectly flat from 30 to 15,000 Hz... Image rejection was over 100 dB (our measurement limit)...

"The AM tuner was a pleasant surprise... It sounded very much like the FM tuner, with distinct sibilants and a quiet background, and was easily the best-sounding AM tuner we have had the pleasure of using...

"...all input levels can be matched and set for the most effective use of the loudness compensation. This valuable feature is rarely found on high-fidelity receivers and amplifiers...

"The phono equalization was perfectly accurate (within our measuring tolerances)... The magnetic phono-input sensitivity was adjustable from 0.62 millivolt to about 4.5 millivolts, with a noise level of −66 dB, which is very low... When properly set up, it would be impossible to overload the phono inputs of the AR-1500 with any magnetic cartridge...

"...it significantly bettered Heath's conservative specifications. Into 8-ohm loads, with both channels driven, the continuous power at clipping level was 81.5 watts per channel. Into 4 ohms it was 133 watts per channel, and even with 16-ohm loads the receiver delivered 46.5 watts per channel. Needless to say, the AR-1500 can drive any speaker we know of, and with power to spare...

"At 1,000 Hz, harmonic distortion was well under 0.05 per cent from 1 to 75 watts per channel... The IM distortion was under 0.05 per cent at levels of a couple of watts or less, and gradually increased from 0.09 per cent at 10 watts to 0.16 per cent at 75 watts... The heavy power transformer is evidence that there was no skimping in the power supply of the AR-1500, and its performance at the low-frequency extremes clearly sets it apart from most receiver's...

"Virtually all the circuit boards plug into sockets, which are hinged so that boards can be swung out for testing or servicing without shutting off the receiver. An 'extender' cable permits any part of the receiver to be operated in the clear – even the entire power-transistor and heat-sink assembly! The 245-page manual has extensive tests charts that show all voltage and resistance measurements in key circuits as they should appear on the receivers built-in test meter...

"With their well-known thoroughness, Heath has left little to the builder's imagination, and has assumed no electronic training or knowledge on his part. The separate packaging of all parts for each circuit board subassembly is a major boon...

"In sound quality and ease of operation, and in overall suitability for its intended use, one could not expect more from any high-fidelity component."

From the pages of Audio Magazine:

"...the AR-1500 outperforms the near-perfect AR-15 in almost every important specification...

"The FM front end features six tuned circuits and utilizes three FETs, while the AM RF section has two dual-gate MOSFETs (for RF and mixer stages) and an FET oscillator stage. The AM IF section features a 12-pole LC filter and a broad band detector. The FM IF section is worthy of special comment. Three IC stages are used and there are two 5-pole LC filters...

"...IHF FM sensitivity... turned out to be 1.5 uV as opposed to the 1.8 uV claimed. Furthermore, it was *identical* at 90 MHz and 106 MHz (the IHF spec requires a statement only for IHF sensitivity at 98 MHz but we always measure this important spec at three points on the dial). Notice that at just over 2 microvolts of input signal S/N has already reached 50 dB. Ultimate S/N measured was 66 dB and consisted of small hum components rather than any residual noise. THD in Mono measured 0.25%, exactly twice as good as claimed! Stereo THD was identical, at 0.25%, which is quite a feat...

"...the separation of the multiplex section of the AR-1500 reaches about 45 dB at mid-band and is still 32 dB at 50 Hz and 25 dB at 10 kHz (Can your phono cartridge do as well?)

"The real surprise came when we spent some time listening to AM... This new AM design is *superb*. We still have *one* classical music station that has some simultaneous broadcasting on its AM and FM outlets and that gave us a good opportunity to A-B between the AM and FM performance of the AR-1500. There was some high-frequency roll-off to be sure, but BOTH signals were virtually noise-free and we were hard pressed to detect more THD from the AM than from the FM equivalent. Given AM circuits like this (and a bit of care on the part of broadcasters), AM may not be as dead as FM advocates would have us believe!...

"Rated distortion [0.25%] is reached at a [continuous] power output of 77.5 watts per channel with 8 ohm loads (both channels driven). At rated output (60 watts per channel) THD was a mere 0.1% and at lower power levels there was never a tendency for the THD to 'creep up' again, which indicates the virtually complete absence of any 'crossover distortion' components. No so-called 'transistor sound' from this receiver, you can be sure. We tried to measure IM distortion but kept getting readings of 0.05% no matter what we did. Since that happens to be the 'limit' of our test equipment and since the rated IM stated by Heath is 'less than 0.1% at all power levels up to rated power output' there isn't much more we can say except that, again, the unit is better than the specification – we just don't know *how much* better...

"As for the amplifiers and preamplifier sections, we just couldn't hear them – and that's a commendation. All we heard was program material (plus some speaker coloration, regrettably) unencumbered by audible distortion, noise, hum or any other of the multitude of afflictions which beset some high fidelity stereo installations. The controls are easy to use and quickly become familiar...

"As always, construction instructions are lucid enough for the inexperienced kit-builder and there is enough technical and theoretical information to satisfy even the most knowledgeable audio/RF engineer."

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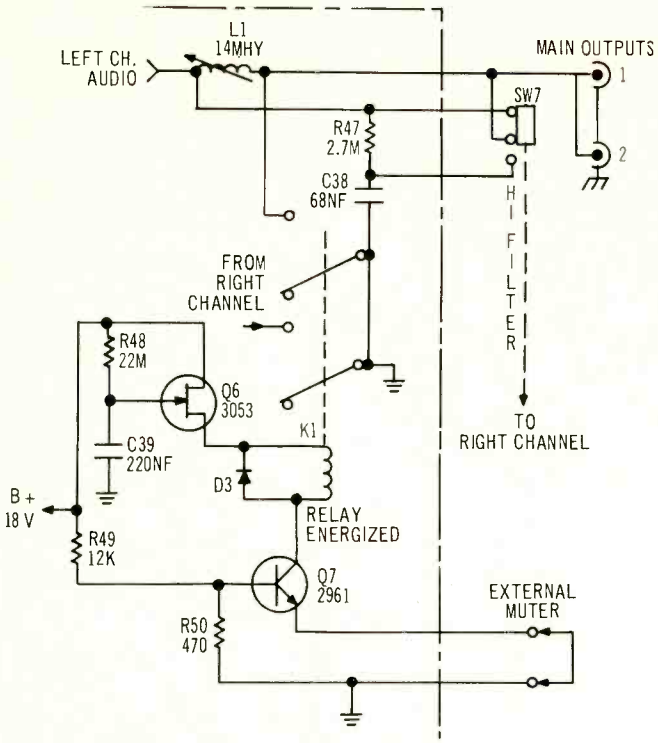

Fig. 4—Partial schematic of the muting circuit in the Crown IC-150.

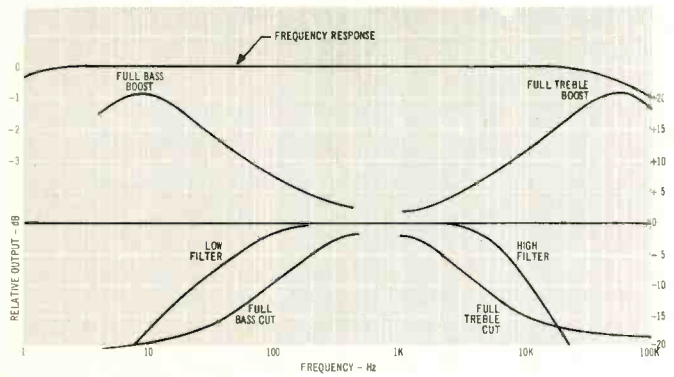

Fig. 5—Frequency response, tone control range, and filter characteristics of the Crown IC-150.

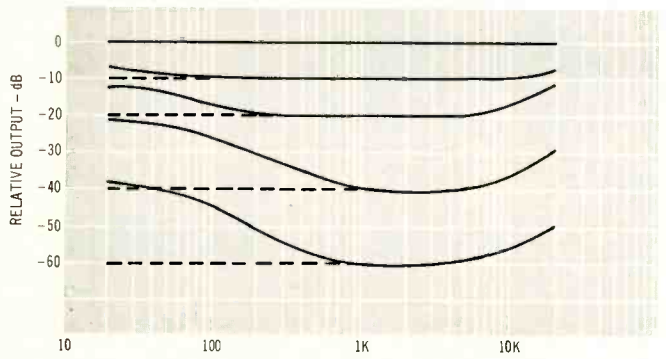

Fig. 6—Loudness-contour characteristics of the IC-150 at various settings of the volume control with loudness circuits ON.

transistors (four per channel plus one voltage regulating transistor) and all resitors involved in the equalization feedback circuits are 1% tolerance components while critical capacitors have a tolerance of 2½%! The electronics of the high-level input amplification circuits is built around two IC's, each of which contains the equivalent of 22 transistors and 14 diodes. In addition, there are 13 more bipolar transistors (nine of which are used in the phono preamp stages), one FET (field effect transistor), two zener diodes and eight diodes.

A partial schematic of the external muting circuit is shown in Fig. 4. When power is initially applied to the IC-150, the muting relay contacts tie the output to "ground." The muting relay remains unenergized until an R-C circuit charges and turns on the FET, which in turn energizes the relay and removes the short from the output. This process takes about five seconds, during which any turn-on transients are permitted to die out before the speakers are connected to the circuit. As can be seen in Fig. 4, removal of the "short" across the external mute terminals opens the emitter circuit of Q7 and prevents the relay from ever becoming energized. Thus, a remote simple SPST switch can serve to mute the system at any time from the comfort of your easy chair.

Electrical Measurements

We had no trouble plotting frequency response and tone control action (shown in Fig. 5), nor was filter response a problem (see same Fig. 5). Loudness contours are shown for various settings of the volume control when the "loudness" switch is depressed (see Fig. 6). We were able to measure hum and noise levels of approximately -93 dB below 2.5 volts output and equivalent phono noise (phono inputs shorted) at about .50 *microvolts* and to confirm RIAA equalization as being as close to perfect as our interpolation of fractions of a dB on our expanded scale a.c. VTVM would permit. However, when it came time to measure IM and THD, our test setup proved to be completely useless. As stated in previous reviews, we are rather proud of our new test equipment lower limits of 0.03% THD and 0.05% IM, but of what use are these new pieces of equipment when we are confronted with an IM figure (for 10 volts output) of 0.002%? In the interest of a complete report, however, we present Fig. 7, which is nothing more than a plot of the IM figures which appeared on the individual test sheet that accompanied our Model IC-150. Please read the scales *carefully*, as they are deliberately expanded beyond anything we normally show and, above all, feel free to take Crown's word for it, as we humbly do.

We shall reserve comment on our listening tests until after the discussion of the D-150 companion amplifier, since, as

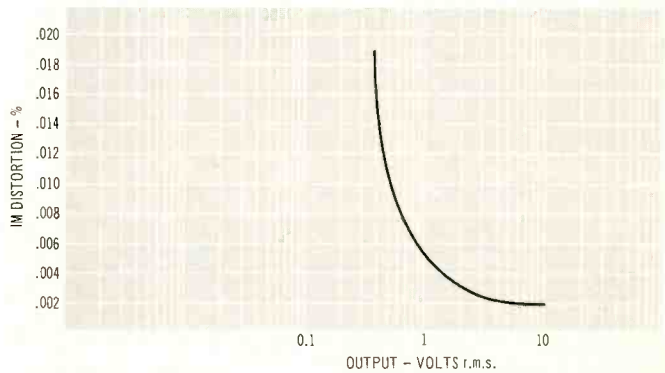

Fig. 7—IM distortion of the IC-150 as measured by the manufacturer. (Note the expanded scale of percentages.)

stated, all listening tests were done using both products hooked up together.

D-150 Power Amplifier

The D-150 dual power amplifier's optional front panel and walnut enclosure, again, need not be used except as dress items, since the power amplifier is fully enclosed as it comes and, in our view, somewhat more awe inspiring at that, as shown in Fig. 8. The major cover shown in the photo (which contains the serial identification label, etc.) is removable and, when removed, discloses the massive power transformer, as seen in Fig. 9. The photo also shows the pair of input jacks (phone jack type), above which are located a pair of screwdriver input level adjustments, and the speaker output terminals which utilize standard ¾-in. center-to-center MDP terminals intended for the dual banana plugs normally associated with test equipment interconnecting cables. These are supplied in the accessory bag with each unit. Also included in the accessory bag are in-line fuse receptacles and cables which are strongly recommended as the right way to connect from amplifier output terminals to speaker systems, in the interest of speaker protection. A handy nomograph in the very complete instruction manual helps you to select the proper fuse size for your speakers based upon their impedance and their peak music power rating.

An "underneath the chassis" view of the D-150 is shown in Fig. 10 which discloses the driver and output transistors. Input stages and associated components are located on a p.c. board which cannot be seen in this view. The D-150 has two direct coupled amplifier circuits which employ a dual IC amp and silicon transistors in all amplifier stages. As Crown explains in their instruction booklet, the dual IC op-amp used is of extremely low noise type and has a large gain-bandwidth. As a result of its use as an input voltage amplifier, a maximum amount of feedback can be applied with resultant reduction of distortion to previously unattainable low values. At a typical full output of 75 watts (8 ohms), IM has been measured by Crown as 0.002%. By implication, THD might be expected to be approximately 0.0005% which *neither* Crown nor we could legitimately measure.

The output stages are essentially in a quasi-complimentary format. In this version of an output circuit, however, the driver transistors carry the bias current, while the output transistors serve only as boosters. The output transistors "sense" when the driver transistors are delivering significant current to the direct coupled loads and then take over and deliver the required large load currents.

The output circuit is protected by a V-I (volt-ampere) limiter which limits the drive to the output configuration whenever the output transistors are overloaded and acts instantly to relieve the overload, acting only so long as the overload exists. In addition, a thermal switch is mounted on the chassis surface which protects the amplifier against insufficient ventilation. If it becomes too hot, a.c. power to the amplifier will be interrupted until the temperature falls back to a safe level, at which time power is automatically restored. The excellently written and organized instruction manual details additional protection schemes which the user might incorporate external to the amplifier but these are primarily directed at speaker protection, since the amplifier itself is deemed "fail safe" under any conditions. Positive and negative power supplies (±45 volts) permit direct coupling to the loudspeaker and the voltage offset at the point of connection is guaranteed to be less than 10 mV. Filtering of each of the supplies is by means of a 9400 μF, 50 volt capacitor of massive proportions. The power transformer, incidentally, is suitable for 240 volt or 120 volt applications and is safe at any power line frequency from 50 Hz to 400 Hz.

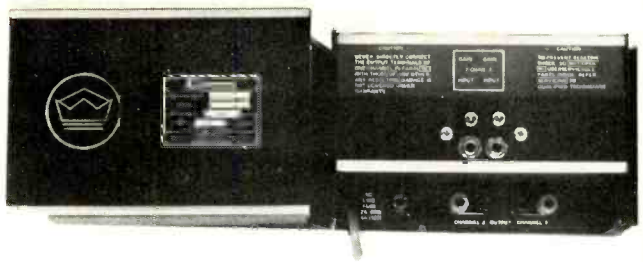

Fig. 8—D-150 amplifier with decorative panel and walnut enclosure removed.

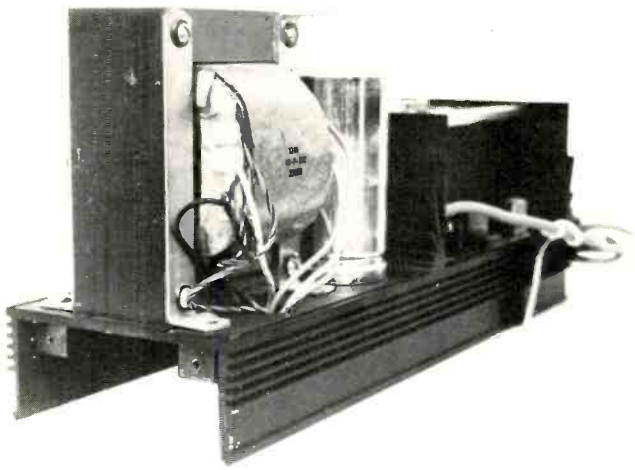

Fig. 9—Close up of the D-150's power transformer and one filter capacitor.

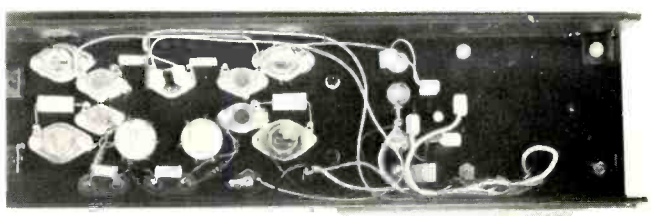

Fig. 10—The D-150's entire chassis acts as a heat sink for the driver and output transistors.

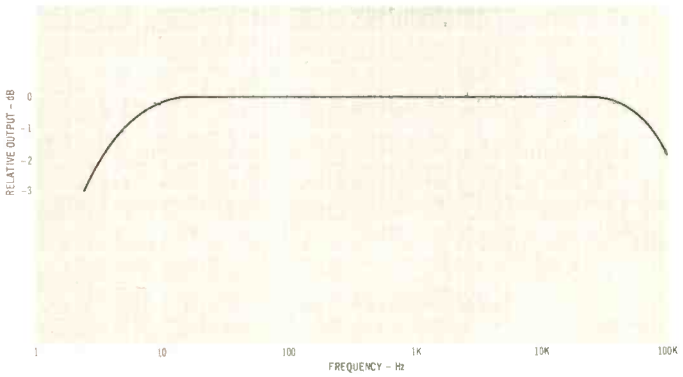

Fig. 11—Frequency response at 1 watt rms, 8-ohm load of the D-150.

Fig. 12—Power response, D-150.

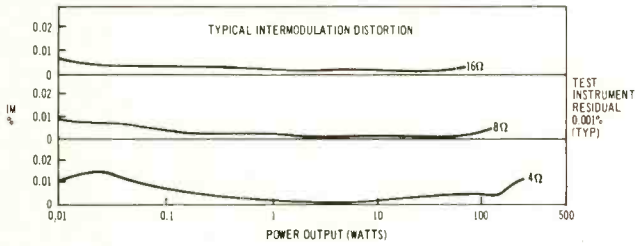

Fig. 13—IM distortion characteristics, D-150. (Supplied by the manufacturer.)

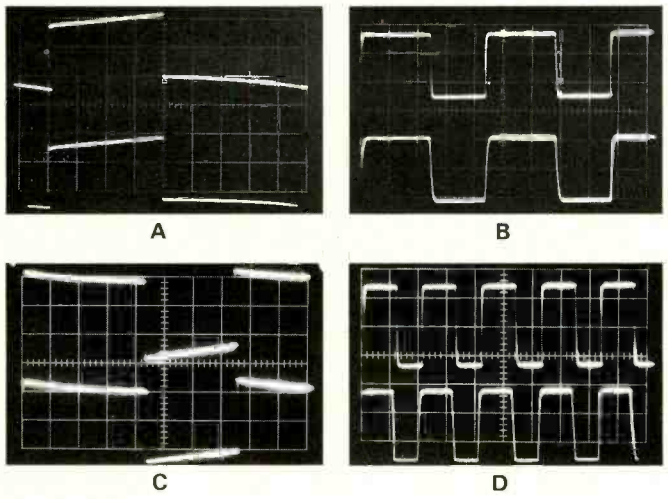

Fig. 14—Square wave presentations, **A**, output of IC-150 with 20 Hz applied; **B**, output of IC-150 with 20 KHz applied; **C**, output of IC-150 and D-150 with 20 Hz applied, and **D**, output of IC-150 and D-150 with 20 KHz applied. (Note that in all cases upper trace is signal source for comparison purposes to output waveform in lower trace.)

D-150 Measurements

Frequency response of the D-150 amplifier is plotted in Fig. 11. The –1 dB point (reference 1 watt, 8 ohm loads) was reached at 5 Hz on the low end and at 75 kHz at the high end. Power response based upon 75 watts output per channel (clipping actually occurred at about 103 watts per channel, both channels driven, 8 ohm loads) extended to below any frequency we could measure (at 5 Hz, full power output was still obtained) and up to at least 30 KHz. A graph of this "straight line" is shown in Fig. 12. Hum and noise were measured at –120 dB with reference to 75 watts rms output, 8 ohm loads and is an unweighted reading (full 20 Hz to 20 kHz bandwidth). For those interested in startlingly small numbers, this means that the hum and noise power contribution to the loudspeakers is 75×10^{-10} watts! (You may prefer to call this 75 pico-watts, or 0.000000000075 watts!) The real point is, YOU CAN'T HEAR IT—even with your ear glued to an *efficient* speaker system.

As for THD and IM measurements, we were again faced with the problem of test equipment. If Crown's claim of a theoretical THD of 0.0005% is correct (and we have no reason to doubt it), then we, along with Crown, have no way to measure it with presently available equipment. Evidently Crown does have an IM Meter capable of reading down to 0.001% and therefore presents a graph of IM versus power output which is reproduced in Fig. 13. Note that at 100 watts per channel into 8 ohm loads, IM distortion is approximately 0.005% and at 10 milliwatts power output (where any cross-over distortion would certainly show up if it were present), IM measured by Crown is just about 0.01%!

A series of square wave photos were taken for both the IC-150 and the D-150 plus the IC-150 (operating together). These are presented in Fig. 14 with explanatory captions for each condition of measurement. The important thing to remember here is that the *upper* trace in each photo is our signal source while the lower trace is, in all cases, the output as observed from the IC-150 or the D-150. Thus, while not all the observed waveforms are perfectly "square," this arises from the fact that our *source* waveform is not always square either. Notice, therefore, how closely the output always resembles the input waveform at all frequencies and conditions shown. Fig. 15 simply represents the condition observed when the amplifiers are driven to clipping levels. At the moment the photo was taken, total power output was approximately 110 watts rms per channel and since both channels were being driven, the amplifier was pumping out about 220 watts of power into our purely resistive loads. Since our resistive loads used in all testing are rated at 100 watts each, we did not keep this up for more than the time required to set up the camera and take the 'scope photo.

Listening Tests

All our listening tests were done using the IC-150 and D-150 as an operating pair of components. Obviously, our speakers (which are low efficiency types selling at around $150.00 apiece) are the limiting factor in any listening tests using equipment such as this, but somehow, a new sense of transparency seemed evident. We *know* that this was not psychological projection because we brought in several experienced listeners who were not told the make or model of amplifier and preamplifier being used. Without exception, all these observers told us that these particular speakers (with which all were familiar) had "never sounded that good before." Now, we sincerely doubt if the IM figures of under .01% could be audibly interpreted as sounding better than, say 0.1% (which competitive equipment often achieves). Perhaps the unusually high damping factor (over 200 at all frequencies below 1000 Hz) was responsible for the audible difference. We're really not sure. This much we do know, however: We monitored the signal delivered to our speakers and there were times when peaks of 90 watts were repeatedly delivered to the voice coil terminals. At all times the music was *absolutely devoid* of any audible distortion. We also discovered how important choice of source material becomes when you're dealing with equipment that is

so perfectly "clean" in its reproduction capabilities. Evidently, less perfect amplifiers can often "mask" the deficiencies of certain types of poorly recorded material (we're speaking primarily of discs). There was, unfortunately, no single source of program that could fully utilize the dynamic range inherent in the IC-150/D-150 combination. That is, any signal source (FM, phono, tape) we tried invariably resulted in reproduced noise and/or hum that was greater than the inherent noise and/or hum which we didn't hear when listening to the equipment alone, with similar gain settings. If that sounds discouraging or suggests the question, "why buy something this good?", bear in mind that over the last decade, tape dynamic range, for example, has been improved by at least 10 dB or more. If such trends continue, it may not be long before you'll be able to feed a signal source to this superb preamplifier and amplifier that is as good as they are. If *you* want the very best control chassis and power amplifier we've ever tested in this power class and can afford the price, our endorsement of the Crown IC-150 and D-150 is completely given without *any* reservations (unless, of course, you feel you need MORE power, in which case there's always the Crown 300!) *Leonard Feldman*

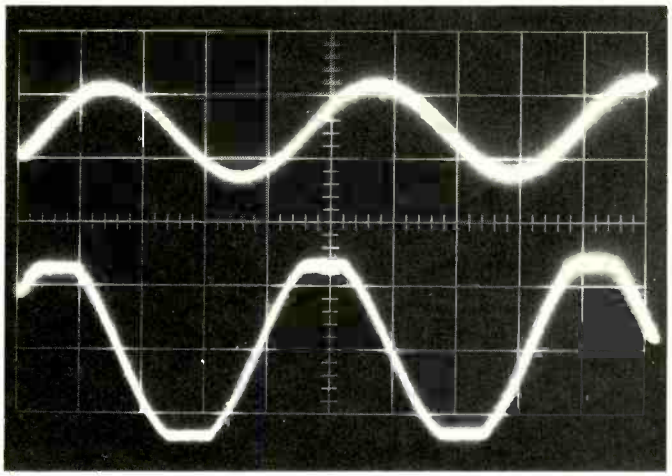

Fig. 15—Scope photo of clipped 110 watt rms signal (per channel) from the D-150 shows perfect symmetry of clipping and no evidence of "power supply collapse."

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Fig. 1

Telex-Viking Quad/Sonic 2 + 2

MANUFACTURER'S SPECIFICATIONS

Speeds: 7½, 3¾, 1⅞ ips. **Motors**: Three, induction type. **Controls**: Directional levers for OFF, STANDBY, and PLAY, and for REWIND, STOP, and FAST FORWARD. Speed selector. **Playback Frequency Response**: 40 to 18,000 Hz ± 3 dB at 7½ ips. **S/N Ratio**: 50 dB. **Crosstalk**: 55 dB at 1000 Hz. **Head**: Four-channel, in line, compatible for two or four channel play. **Wow and Flutter**: Less than 0.2% at 7½, 0.25% at 3¾. **Output**: 1.4 mV at 1000 Hz. **Counter**: Four digit, push-button reset. **Brakes**: Electro-dynamic. **Finish**: Black and silver trim in walnut base. **Size**: 11 by 16½ by 6¼ inches. **Price**: $249.95, with take-up reel, four patch cords, and ground cable.

The Telex Quad/Sonic 2 + 2 is a quadraphonic tape deck intended for use with an amplifier which can also provide the necessary equalization—in other words, output is taken directly from the heads. No recording facilities are provided but the 2 + 2 can also play two-channel stereo as the heads are in-line quarter track. Three motors are used, all induction types, and there is a choice of three speeds, 1⅞, 3¾, and 7½ips.

Looking at Fig. 1, we see a digital counter on the left and just under this is the speed change lever. On the right is the ON-OFF, STANDBY, and PLAY switch, and under that is a similar switch controlling rewind direction. In the center is a pilot light which indicates whether power is on. Figure 2 shows the tape head and capstan, and Figure 3 shows the view from underneath. Note the large, dynamically balanced flywheel which weighs two pounds!

Measurements

The frequency response curves are shown in Fig. 4. Ampex standard tapes were used for the 3¾ and 7½ ips speeds but the response at 1⅞ ips was made with a tape made on a Tandberg recorder. It will be noted that very little, if any, treble boost is necessary for playback compensation and a response up to 20 kHz at 3¾ and 7½ ips should be easily realized with low distortion. It must be remembered that almost unlimited treble boost can be used to compensate for poor heads—at the expense of high distortion and poor signal/noise ratio. This is why (in terms of frequency response) a $99.95 deck can have the same specifications as one costing over $1000.00! The head in the Telex 2 + 2 is a professional-grade type made by Nortronics, which of course is not cheap. Output from the 7½ ips standard tape was 1.1 mV at 1000 Hz (10 dB below operating level). No signal/noise measurements were taken by us, as these will depend on the amplifier, matching, equalization, and so on. Wow and flutter came out at 0.11% at 7½, 0.2% at 3¾, and just under 0.25% at 1⅞ ips—better than the rather conservative specifications.

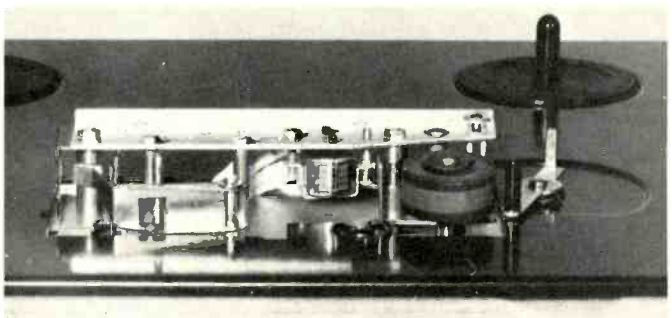

Fig. 2—Showing the tape head and capstan.

Performance

On test, the 2 + 2 came well up to expectations. The controls, which are simple but functional, worked smoothly and were extremely easy to use. Mechanical noise was low and the electro-dynamic brakes were really positive. No four-channel receiver or amplifier with tape head inputs was available so two Fisher 700 receivers were pressed into service, and it was found that equalization was not far out. No actual measurements were made but the standard Vanguard VSS-1 quadraphonic demonstration tape certainly sounded well-balanced with solid bass and silky-smooth treble. The Vanguard recording of the Mahler 9th was also most impressive. Some conventional two-channel tapes were played, with every satisfaction. Summing up, the Telex 2 + 2 can be recommended for the attention of those who want a relatively inexpensive deck for playback only. *T.A.*

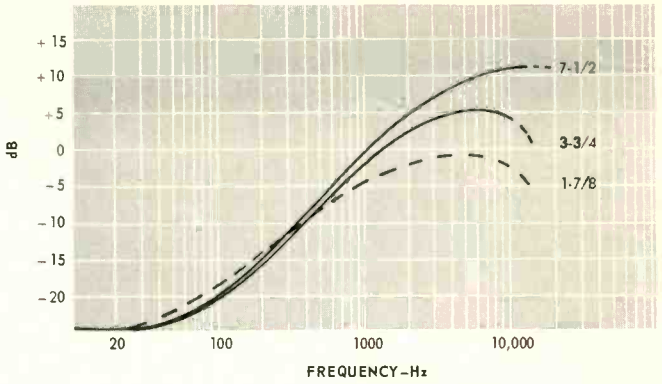

Fig. 4—Frequency response at the three speeds.

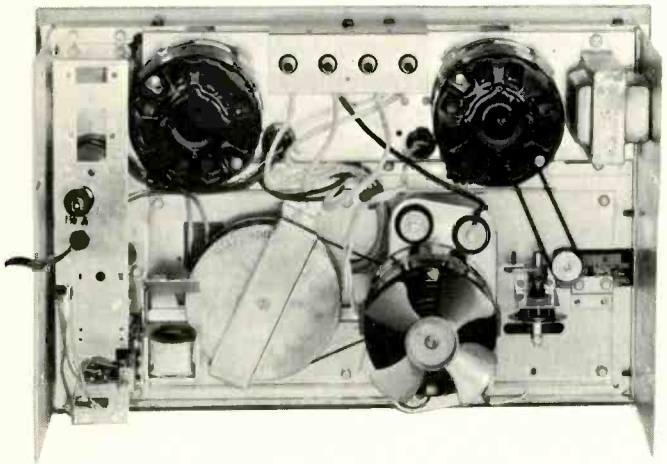

Fig. 3—Underneath view.

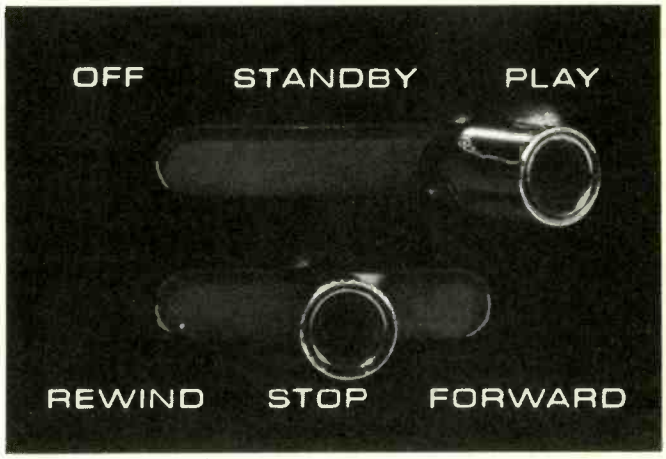

Fig. 5—Close up view of some of the controls.

Dual Model 1218 Automatic Turntable

MANUFACTURER'S SPECIFICATIONS

Speeds: 33⅓, 45, and 78 rpm; adjustable ±3%. **Platter Diameter:** 10⅝ in. **Maximum Tracking Error:** 0.5 deg. **Wow and Flutter at 33⅓ rpm:** 0.80%. **Pivot-to-stylus Distance:** 8¼ in. **Dimensions:** 13 x 10¾ in., 2⅝ in. below motor board, 5 in. above. **Weight:** 10 lbs. **Price:** $139.50.

There are many locations for automatic record changers that will not accommodate the larger units, such as the Dual 1219, but the user still wants the same performance obtainable with the top-of-the-line model, or as near that performance as possible. And therein lies the advantage of the 1218, which is very similar in performance, yet just a little smaller, and therefore can often be utilized in locations which preclude the use of the larger model.

The 1219 was profiled in these pages in December, 1969, and most of what was said in that profile could apply to the 1218. The newer—and smaller—unit still uses the two-ring gimbel mounting for the tonearm, with the elastically damped counterbalance which rotates on fine threads for fine balance, once the coarse balance is set by positioning the counterbalance shaft for approximate balance and tightening the thumb screw which keeps it in place. Stylus force is then set by a calibrated dial which applies the desired force through a long spiral spring which acts directly around the pivot of the tonearm.

Adjacent to the arm mounting is a knob which controls the amount of anti-skating force applied to the arm. The scale associated with this knob is calibrated for both conical and elliptical styli, with the graduations in black for elliptical styli, and in red for conical ones—indicative of the almost unanimous acceptance of the elliptical in high-quality installations. A hole in the chassis just in front of the arm mounting gives access to an adjustment for varying the tonearm cueing height over a range of ¼ inch. The bearings for the two degrees of motion of the turntable are of the low-friction pivot type,

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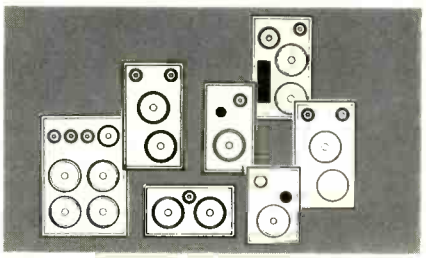

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Two 3½" mid-high speakers, perfectly balanced within our complex system for the smooth sound of clear, stable stereo images that let you pick out one instrument from another.

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Two 5" mid-range speakers for twice the response in the area most critical for "presence." No peaking. No "canned" sound. But wait 'till you hear those woodwinds.

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Six, yes, six heavy-duty 8" woofers instead of the conventional single 12" or 15". For good reason. True fundamental sound is reproduced with greater efficiency and less distortion with our unique multiple driver design.

SIX SEPARATE SOUND CHAMBERS...
extending behind these three ports make a difference you'll have to hear to believe.

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Fig. 1—Most adjustments are found near the arm mounting—coarse and fine counterbalance, stylus force, anti-skating, and tonearm cueing height. Note record spindle for single-play use—it rotates with the platter to avoid wearing the center hole and to ensure concentricity.

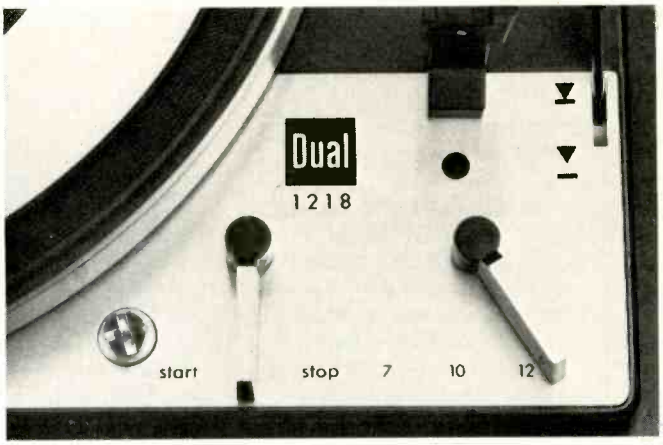

Fig. 3—The right front of the chassis accomodates the three most-used operating controls—the cueing lever, which extends out of the photo at the upper right, the record-size selector with positions for 7-, 10-, and 12-in. records, and the start-stop lever. The hole above the record-size lever gives access to an adjustment for the set-down position for 12-in. records.

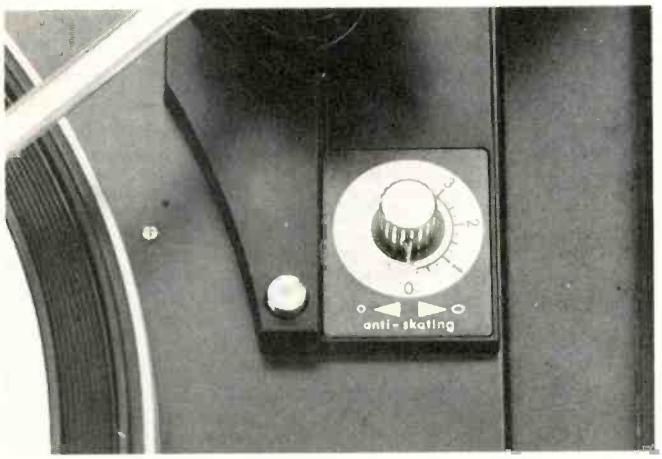

Fig. 2—Anti-skating adjustment knob, with its two scales—the one for conical styli adjusts for as much as five grams, while the one for elliptical styli adjusts only to three grams, which is, of course, about as high a force as should ever be used for these popular styli. The slotted screw head to the left of the knob adjusts the tonearm cueing height.

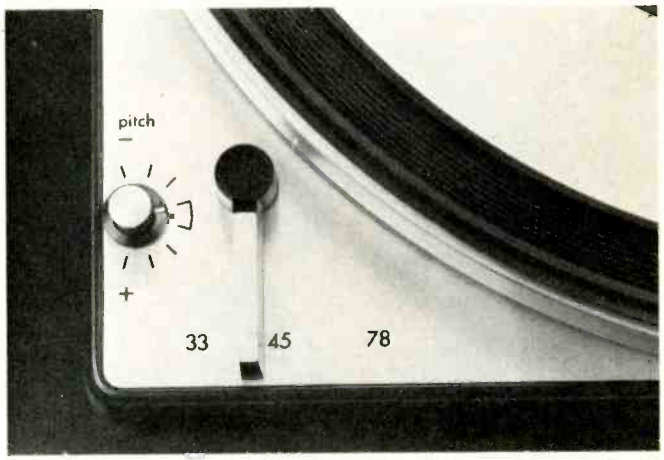

Fig. 4—The left-front corner accommodates the speed controls—the lever for the three nominal speeds, and the knob for vernier adjustment of turntable speed over a range of ±3%.

and the manufacturer claims bearing frictions of less than one-hundredth of a gram in the vertical direction, and less than two-hundredths in the horizontal.

The cartridge mounts on a holder which is locked to the tonearm head by a single lever. One advantage of this cartridge holder is that the screw head fits into slots in the holder and the cartridge is held by nuts on the cartridge end of the screws, so it is not necessary to choose the exact length of mounting screw to avoid excessive length which would inhibit the proper seating of the holder in the head. In some cartridge mounts, the screw threads directly into the plastic mount, and again the exact length must be selected to avoid interference with the placement of the holder into the head. Furthermore, threads into the plastic often wear with several changes—as some of us are wont to make in the search for the best cartridge for our systems. In the 1218, the vertical tracking adjustment is built into the head, with a small knob extending to the right to permit setting for single- or multiple-record use. This knob turns 90 deg. to either the "S" position for single-play use, and to the "M" position when several records are stacked on the spindle. This control adjusts for 15-deg. tracking for either one record, or for the middle records of a stack of six.

The arm rest is fitted with a lock which secures the arm to the post and should normally be released before starting to play. However, if you should fail to release the lock, you have

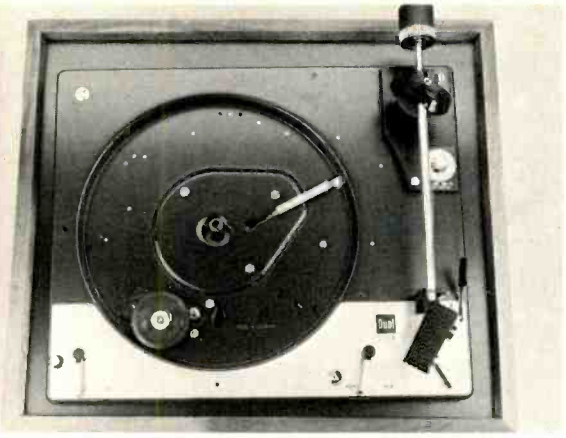

Fig. 5—Top view of the unit with the platter removed, showing the simplicity of *this* side of the chassis. The idler wheel, shown at the lower left of the turntable well, retracts from the stepped and tapered motor shaft when the STOP position.

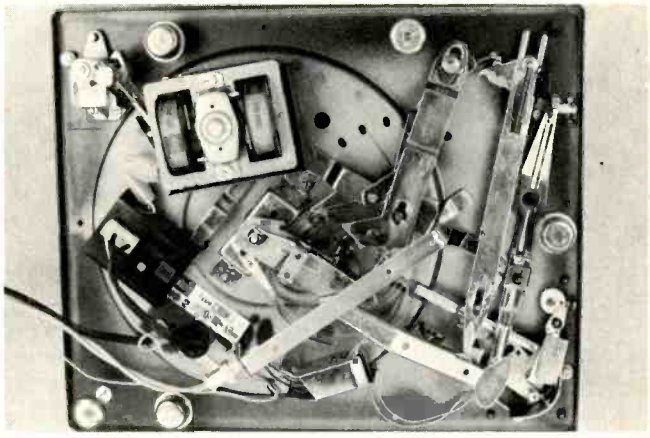

Fig. 6—The underside of the chassis is where the complexity is—and it is remarkably similar to the top-of-the-line 1219.

only to wait until the unit goes through its cycle and the operating lever returns to the center position. No harm will occur. You simply release the lock and start again.

The right front corner of the chassis is where the action is—the lever to the right controls the point at which the arm sets down—for 7-, 10-, or 12-inch records. The other lever has a rest position at the center, and start and stop positions. To initiate playing, you press the lever to the left, and the mechanism takes over: starting the motor, raising the arm from the rest and positioning it over the lead-in groove of which record size you have selected, lowering the arm gently to the record, and returning the lever to the center position. If you prefer, you simply lift the arm from the rest and position it over the record anywhere you like—the motor starts and you can either place the stylus on the record by hand or you may use the cue-control lever to lower the arm automatically. You can interrupt the play at any time by moving the cue lever forward—the arm will lift up, but the motor continues running, and you can continue playing from the same place by moving the cue lever back.

If you are playing a stack of records, you operate the start lever and let the mechanism take over—the entire stack will be played through the unit will stop, returning the arm to the rest and shutting off the motor. To reject a record and change to the next one on the spindle, you move the lever to the start position. You can even play one record continuously by using the automatic spindle and placing the 45-rpm adapter disc on the spindle platform.

over at the other corner of the chassis are the speed controls—a lever to select the nominal speed of either 33⅓, 45, or 78 rpm—and a knob which varies the speed up or down by three per cent as desired to match the pitch to an instrument, for example.

Performance

The 1218 is an especially easy turntable to use. The controls are foolproof, and no harm results from changing a control setting during a change cycle, for instance, or for forgetting to release the arm lock before starting the playing. It has all the features needed for controlling its action, and appears to be well constructed. It is, of course, the most recent of a long line of changers and record players which have been improved continuously since the introduction of the first Dual in 1927, when the name came from a combination of both spring drive and an electric motor in the same turntable.

The platter is die cast of non-ferrous material and weighs four pounds—always a desirable feature to ensure constancy of speed. The black and chrome appearance of the unit is attractive, simple, and functional.

We measured its performance characteristics and found a signal-to-noise figure of 44 dB, using the old NAB method. With a standard "A" weighting network, this figure increases to 62 dB—in itself considerably better than the average "hi-fi" single-play turntable of a decade ago. Wow—the speed variation below 6 Hz—was measured at 0.1 percent—while flutter was 0.05 percent measured from 5 to 250 Hz. Cycling time was measured at 13 seconds when operating at 33⅓ rpm, 11 seconds at 45, and 8 seconds at 78. Well do we remember when a changer that cycled in 25 seconds was considered acceptable—as, of course, it was if you compared it to the early models of the Capehart, for instance.

The synchronous motor showed no speed variation whatever over a voltage range from 85 to 135 volts, but being synchronous, it was susceptible to frequency variations in the supply. This is of little concern to anyone in this country, since electric companies must maintain a close tolerance over frequency to make interconnections between areas possible. If the unit were to be used in other countries, it would require a change of the motor pulley, since the United States and Canada are just about the only places where 60 Hz is the prevailing frequency of power lines. However, this problem would arise with any synchronously driven equipment, and it can be cured, fortunately.

For those who long for a fine turntable but who cannot get up the scratch for the 1219, the 1218 is a logical choice, and it will certainly give long and satisfactory service for the average user. *C. G. McProud*

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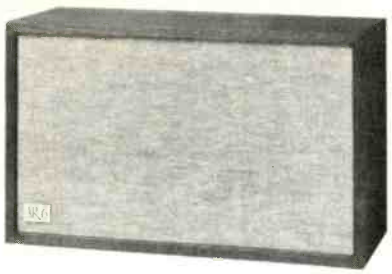
Acoustic Research AR-6 Loudspeaker System



MANUFACTURER'S SPECIFICATIONS

Speakers: Two; 8-in. woofer, with 56 Hz resonance in system, and 1½-in. diameter cone tweeter. **Enclosure Type**: Acoustic Suspension. **Crossover Frequency**: 1,500 Hz. **Impedance**: 8 ohms. **Size**: 19½ in. W. x 12 in. D. x 7 in. H. **Weight**: 20 lbs. **Price**: $81.00.

Acoustic Research's Model AR-6 has deceptively similar specifications to the AR-4x. Both are two-way systems, having 8-in. woofers, crossover between 1 and 2 KHz, and their enclosures have virtually the same volume.

Dimensions of the AR-6 are 19½ by 12 by 7 in., and thus it is one of the few bookshelf loudspeakers truly deserving the name. These proportions, besides being practical, are aesthetically more pleasing as well. It is supplied with instructions for hanging and fusing, as well as hook eyes and feet pads.

The tweeter uses the magnet structure of the AR-4x but it has a cone diameter of 1.5-in. instead of 2.5 in. A ⅝-in. dome is in its center with a viscous damped voice coil behind. See Fig. 1.

We compared the AR-6 and the AR-4x speakers with a variety of program material and the AR-6 quickly established itself as the superior speaker. This is not to say that the AR-4x is not any less of a bargain at $63.00, but to our ears, the additional $18.00 that the AR-6 costs is clearly audible.

The greatest improvement is in the performance of the 1.5 in. tweeter. Better dispersion, coupled with smoother and wider response, are responsible for the spacious stereo image. Woofer response is good down to 40 or 50 Hz with very little harmonic distortion, a hallmark of all AR speakers.

After our listening tests, we went to the more objective measurement procedure. System input consisted of ⅓ octave pink noise at 1.6 volt. This gave 84 dB S.P.L. at 40 in. on-axis, high frequency control set at maximum.

Figure 2 shows the system's frequency response. The dotted line is speaker response minus room interference. The most notable feature of Fig. 2C, which incidentally is most representative of what a listener will hear, is its unusual smoothness and excellent high frequency power response.

The lack of harmonic distortion, even at levels in excess of 100 dB, was equally gratifying. See Fig. 3.

Impedance stayed close to its rated 8 ohm value, and with the high frequency control at normal, never went below 6.75 ohms, as shown in Fig. 4. At maximum setting of the high frequency control, the impedance dipped briefly to 5 ohms at 8,000 Hz—still quite safe for any decent amplifier, but an unlikely balance setting for all but a Victorian living room.

Tone burst response, as shown in Fig. 5, reveals excellent transient response at all test frequencies. Efficiency was what one would expect from an acoustic suspension loudspeaker, medium to low. Twenty to 40 watts is sufficient power to drive this speaker system, depending on one's musical taste.

After listening to the AR-6 on and off during a three-week period and comparing it with its biggest brother, the AR-3a, we had no reason to change our initial high opinion of it. We predict that the AR-6 will supplant the AR-4x on the best seller list and probably establish itself as the standard for other loudspeakers in the under-$100.00 class. *Alex Rosner*

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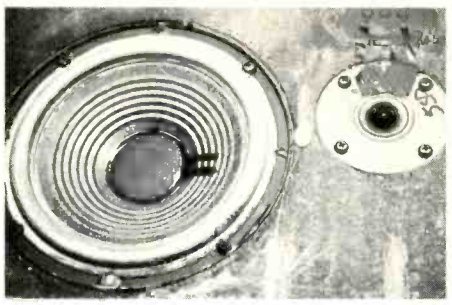

Fig. 1—Front view of the speaker elements, with the grille removed. Note the relative sizes of the drivers.

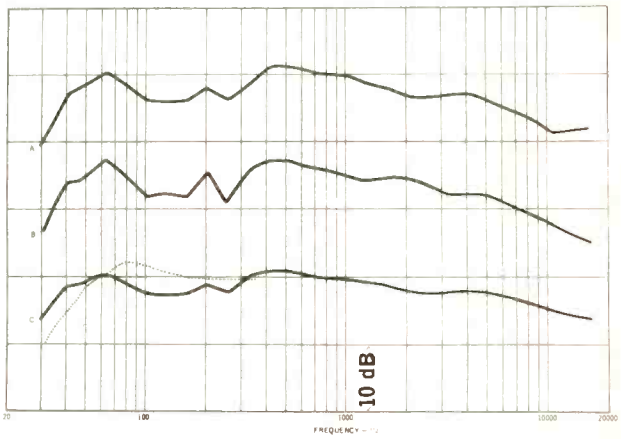

Fig. 2—Frequency response of the AR-6 loudspeaker to ⅓-octave pink noise, **A**, on-axis; **B**, 45 degrees off axis, and **C**, average of five readings. The dotted line compensates for room interferences.

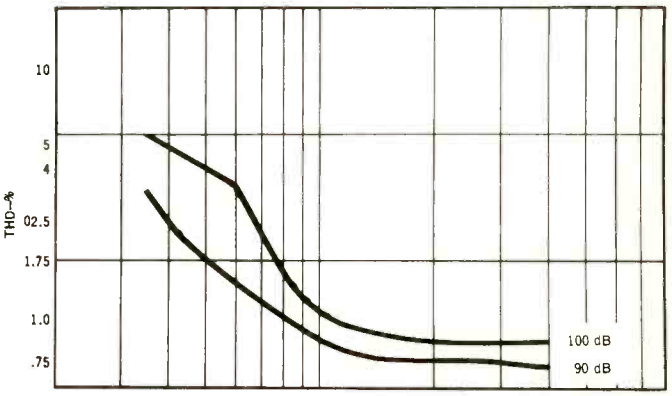

Fig. 3—Harmonic distortion at 90 and 100 dB S.P.L.

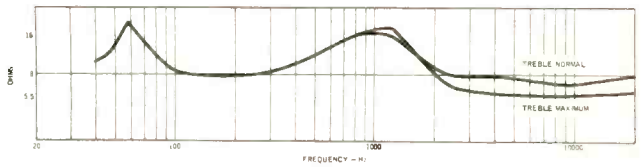

Fig. 4—Impedance curves at two settings of the unit's treble control.

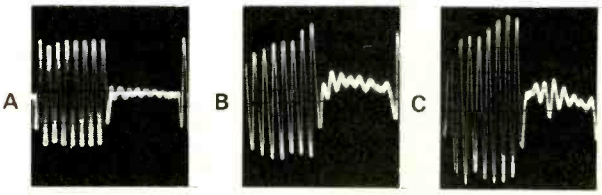

Fig. 5—Tone burst response at **A**, 500 Hz; **B**, 8000 Hz, and **C**, 10,000 Hz.

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$299.50 *includes walnut cabinet or rack mount for commercial installations*

PATENT-PENDING design combines the best features of expensive commercial equalizers: ***Toroidal*** *and ferrite-core inductor passive circuitry, plus active transistor circuits and active master level control circuits, provide accurate linear response in "problem" listening areas. Allows a* ***full 24 db*** *range of equalization for* ***each*** *of the 10 octave-bands per channel, plus an* ***additional 18 db*** *range of full-spectrum boost or cut to compensate for acute response non-linearities in the entire recording-reproducing process.*

SPECIFICATIONS and SPECIAL FEATURES

TOROIDAL *and ferrite-core inductors, ten octave-bands per channel.*
FREQUENCY *response: ±½ db from 20-20, 480 Hz at zero setting.*
HARMONIC DISTORTION: *Less than .1% THD @ 2 v., Typ: .05% @ 1 v.*
IM DISTORTION: *Less than .1% @ 2 v., Typ: .05% @ 1 v.*
SIGNAL-TO-NOISE RATIO: *Better than 90 db @ 2v. input.*
INPUT IMPEDANCE: *Operable from any source 100K ohms or less — (any Hi-Fi Pre-amp, Receiver or Tape Recorder.)*
OUTPUT IMPEDANCE: *Operable into 3K ohms or greater — (any Hi-Fi Amp, Receiver or Tape Recorder.)*
CIRCUIT BOARDS: *Military grade G-10 glass epoxy.*
RESISTORS: *Low-noise selected carbon-film.*

RANGE: *12 db boost and 12 db cut, each octave.*
MASTER OUTPUT LEVEL: *"Frequency-spectrum-level" controls for left and right channels, continuously variable 18 db range, for unity gain compensation from minus 12 db to plus 6 db.*
MAXIMUM OUTPUT SIGNAL: *variable Master "frequency spectrum level" Controls allow adjustment of optimum output voltage for each channel, to exactly match amplifier capability, up to 7 v.*
SIZE: *designed to coordinate with receivers, comes installed in handsome walnut-grained wood receiver-size case, (5⅛" x 17¾" x 11").*
WARRANTY: *2-year parts and labor.*

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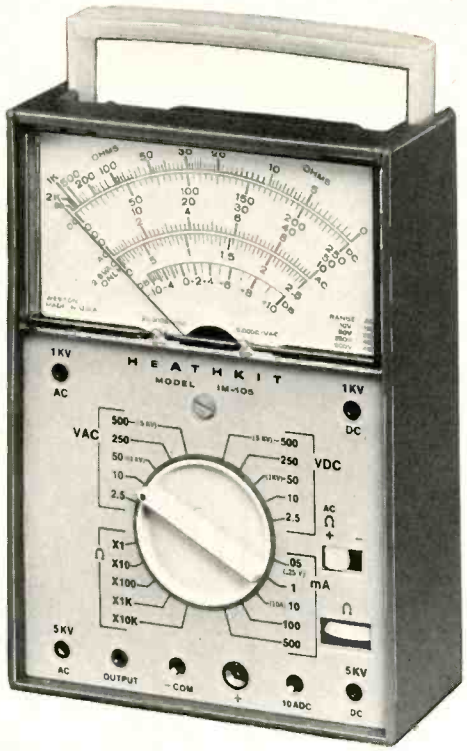
Workbench



Heath IM-105 VOM

MANUFACTURER'S SPECIFICATIONS

D.c. Volts: 0 - 0.25, 2.5, 10, 50, 250, 500. **D.c. μA**: 0 - 50. **D.c. mA**: 0 - 1.0, 10, 100, 500. **D.c. Amps**: 0 - 10. **A.c. Volts**: 0 - 2.5, 10, 50, 250, 500. **High Voltage**: 0 - 1000 and 0 - 5000. **Accuracy**: ± 3% d.c. volts, d.c. amps, d.c. milliamps; ± 2% d.c. microamps; ± 4% a.c. volts, all full scale deflection. **DB**: Five ranges, −10 to +56. **Price**: $47.95.

Vacuum-tube voltmeters (VTVM's) are extremely useful—no doubt about it—but there are times when a simple, rugged battery operated multimeter, or VOM like the Heath IM-105, will do the job just as well. VTVM's have a higher input impedance and are usually more sensitive, but for general use around the workshop or for servicing the IM-105 takes some beating. Input resistance is 5000 ohms per volt on the a.c. ranges and 20,000 Ω/V for d.c.—thus the loading effect is negligible for most applications. For instance, the resistance of the instrument is no less than 5 megohms for the 250 volt range, which compares quite favorably with many VTVM's.

Circuit Details

Figure 1 shows the basic configuration of the d.c. measuring circuit. RT1 is a thermistor which compensates for meter resistance changes caused by temperature variations. It has a negative temperature coefficient and the meter has a positive one, so the net result is a high degree of accuracy maintained over a wide temperature range. The two rectifiers connected across the meter are to protect it from overloads. The movement has a full scale deflection of 50 microamps and the taut-band method of suspension is used. The current measuring circuit is fairly conventional and Fig. 2 shows the potentiometer arrangement for resistance measurements. Note that a 15 volt battery is used for the highest range (R × 10K).

How It Went Together

Figures 3, 4, and 5 show stages in the assembly which mainly involved mounting the switch on two printed boards with the rest of the components. As always with Heath manuals, the instructions were well thought out and easy to follow. The boards were clearly marked and the whole thing went together in less than four hours. I believe it could be done much more quickly, but, well, I didn't hurry. The calibration instructions were divided into two sections, one using the power line voltage, an ordinary 1.5 V cell, and a 1.35K resistor (supplied); the other employing precision standards. I used a variable voltage supply with two standard 1% lab meters, but I *did* check with the basic Heath procedure. The low voltage ranges were pretty accurate but the high voltages ranges were out by 5% as my line voltage was lower than I expected. (All those air-conditioners!) However, the instruction book *does* point out

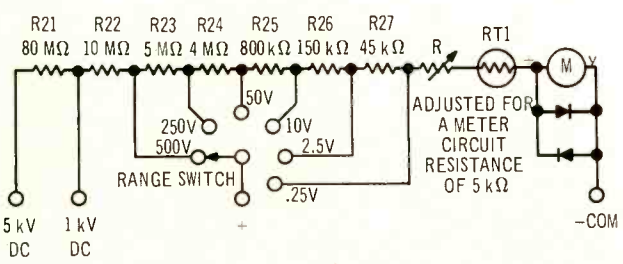


Fig. 1—Basic d.c. voltage measuring circuit.

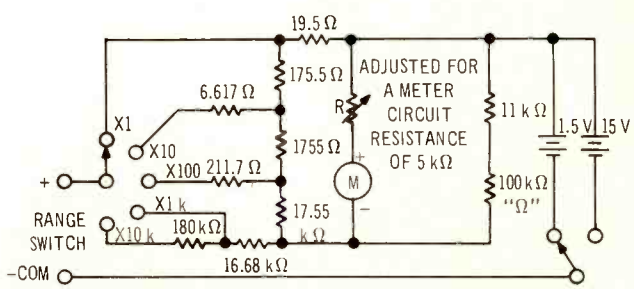


Fig. 2—Basic resistor measuring circuit.

that the line calibration can be used as a temporary expedient and the controls readjusted when you have access to a known voltage.

Measurements

The chart shows how the IM-105 compared with the lab standard and it will be seen that it was well within specifications on all ranges. That is, on all the ranges tested, as I do not have an accurate high voltage standard, I did not check the 1000 and 5000 volt ranges. The frequency response of the low a.c. ranges was within 1 dB from 7 Hz to 100 Hz—which includes all the dB scales likely to be used for audio measurements. Accuracy of the resistance ranges is quoted as being "within 3 degrees of arc," but even greater accuracy can be obtained by using precision resistors for comparison; in fact, calibration instructions are given for use with the 1.35K resistor supplied. I found the 4½-in. scale easy to read with a minimum of parallax error, and I was pleased to see the inclusion of a polarity reversing switch. Both positive and negative voltages are used by so many transistor amplifiers these days that such conveniences are very much worthwhile. I also liked the low voltage (0.25 V, FSD) calibration of the 0.05 mA range—invaluable for measuring those low emitter or base voltages. All in all, the Heath IM-105 is a first-class, versatile instrument capable of a high degree of accuracy and, like all Heath products, excellent value for money. *T.A.*

Scale	Bold Face listing is input; Light Face is IM-105 reading.					Max. Error %, F.S.D.
A.C.V.						
2.5	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	1.2
	0.47	0.98	1.5	2.0	2.52	
10	**2.0**	**4.0**	**6.0**	**8.0**	**10.0**	1.5
	1.85	3.95	6.0	8.0	10.1	
50	**10.0**	**20.0**	**30.0**	**40.0**	**50.0**	2.5
	9.0	19.8	27.9	40.0	50.1	
250	**50.0**	**100.0**	**150.0**	**200.0**	**250.0**	2.0
	45.0	98.1	149.5	201	252	
500	**100**	**200**	**300**	**400**	**500**	2.0
	90	193	293	404	506	
D.C.V.						
2.5	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	1.2
	0.47	0.99	1.5	2.0	2.51	
10	**2.0**	**4.0**	**6.0**	**8.0**	**10.0**	1.0
	1.9	3.95	6.0	8.0	10.1	
50	**10.0**	**20.0**	**30.0**	**40.0**	**50.0**	1.0
	9.5	19.9	29.9	40.0	50.1	
250	**50.0**	**100.0**	**150.0**	**200.0**	**250.0**	2.0
	47.0	98.0	150.0	203.0	255.0	
500	**100**	**200**	**300**	**400**	**500**	2.0
	94.0	196.0	302.0	405.0	510.0	
mA						
0.05	—	—	—	—	**0.05**	0
(0.25V.)	—	—	—	—	0.05	
1.0	**0.2**	**0.4**	**0.6**	**0.8**	**1.0**	2
	0.18	0.38	0.59	0.8	1.0	
10	**2.0**	**4.0**	**6.0**	**8.0**	**10.0**	2.0
	1.8	3.95	5.9	8.1	10.1	
100	**20.0**	**40.0**	**60.0**	**80.0**	**100.0**	2.5
	17.5	39.1	59.0	82.0	102.2	
500	**100**	**200**	**300**	**400**	**500**	3.0
	99	205	309	412	515	

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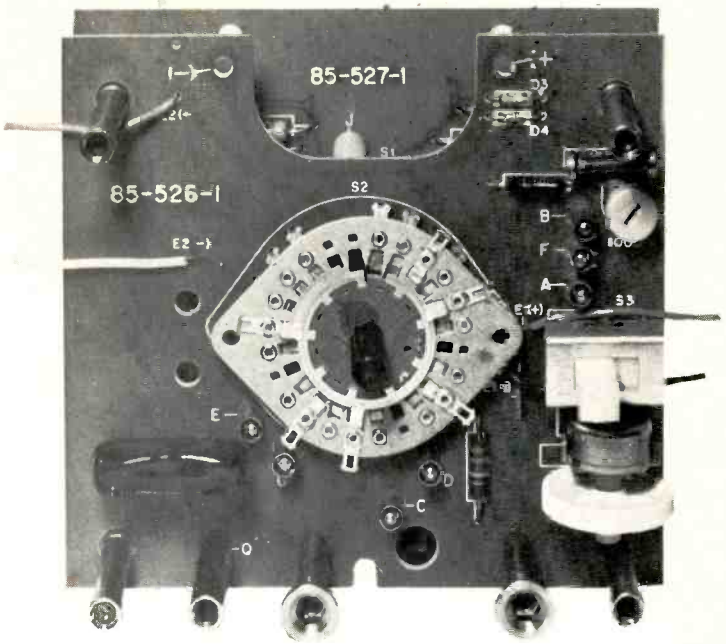

Fig. 3—Showing front view of boards with switch.

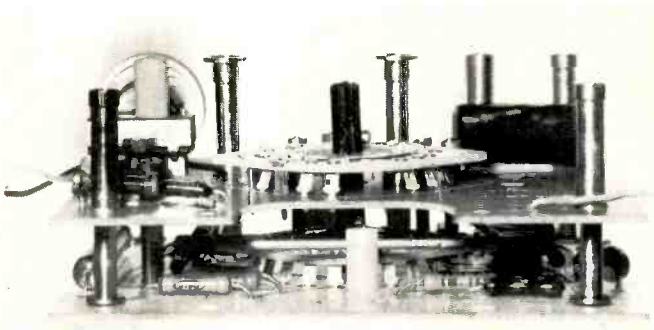

Fig. 4—Showing side view.

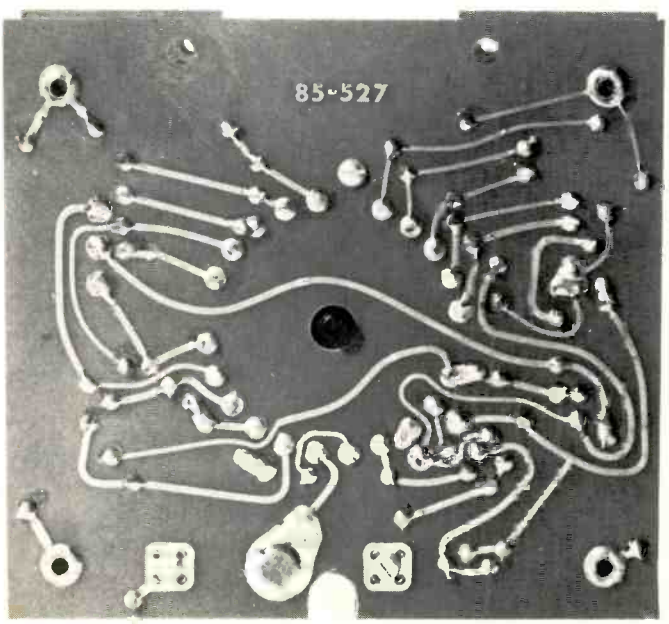

Fig. 5—Rear view.

EICO 955 Capacitor Bridge

MANUFACTURER'S SPECIFICATIONS

Range: 0.1 to 50 μF at ±10% accuracy. **Short Test:** As low as 1 ohm, 60 Hz test frequency. **Reliable** up to 2000 μF. **Open Test:** As small as 15 pF. **Shunt Resistance:** As low as 35 ohms for capacitors above 100 pF. **Controls:** Short, capacity, open, RC balance, with on-off switch. Indicator dial range switch. **Indicator Tube:** Electron-ray with bright bar pattern. **Size:** 8½ by 5 by 6 inches. **Price:** $29.95 (kit).

The EICO 955 is a capacitor tester which can measure capacitors in or out of circuit. Not only that, it can give a positive indication of open circuit conditions! Capacity range is from 0.1 to 50 μF using a Wien bridge and the open circuit test will go down to 15 pF or less. A novel shunt balancing circuit enables capacitors to be measured with a parallel resistance down to about 35 ohms. How does it work? Let's take a look at the basic circuit as shown in Fig. 1. V1 and V2 form an indicator circuit and any voltage at C7 will cause the fluorescent bars on the V2 tube to close accordingly. A 6.3 a.c. voltage is applied to the control R9 which forms a Wien bridge with R6, R10, R11, and C3. Figure 2 shows the circuit redrawn in the more familiar bridge arrangement. To simplify matters, the indicating circuit (V1 and the V2 tube) is shown as a block diagram. The potentiometer R10 is in parallel with the standard capacitor C3 for measuring capacitors having low values of RC—shunting resistance or equivalent resistance. For high values, the switch S2a, b changes the circuit to put C3 in *series* with another control as shown in Fig. 3.

Open Test Circuit

The open test circuit is shown in Fig. 4, and it has some unusual features. The section shown in heavy lines is a Hartley oscillator and when it is oscillating, the grid of V1 is negative and the anode current is small. This means that the V2 indicator tube bars stay open. But what happens when there is *no* oscillation? The grid of V1 then becomes the same potential as the cathode, the anode current increases considerably and so the indicator bars close. Now, oscillation depends on the impedance connected across the test leads, and here is where the designer shows ingenuity. The test leads plus L2, R12, and C4 form a quarter-wave line at the oscillator frequency (about 22 Mc). So when this line is open at the test lead end, it represents a short at the input and part of the coil L1 will appear shorted. This will kill the oscillation in the Hartley circuit and keep the tube indicator bars closed. An impedance connected across the test lead input will maintain the oscillations and cause the indicator bars to open. Simple?

Short Circuit Test

The parameters of the amplifying tube V1 are now arranged that a short across the test leads will close the indicator tube

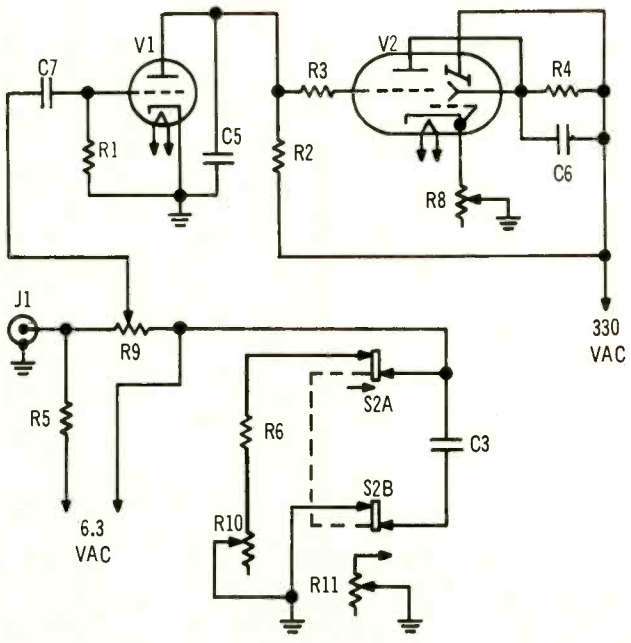

Fig. 1—Capacity measurement circuit.

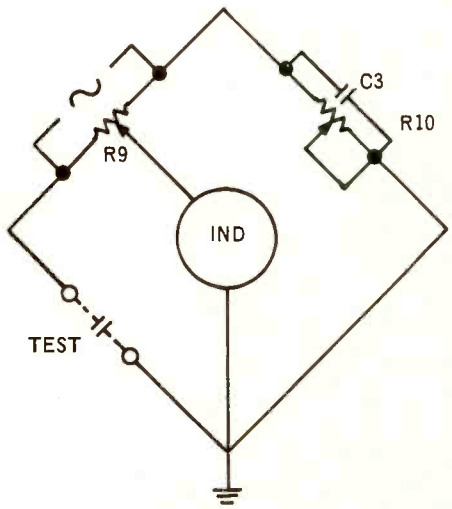

Fig. 2—Figure 1 redrawn to show the bridge.

bars and an impedance of between 1 and 10 ohms will keep the bars partially open.

How It Went Together

No printed boards are used and the components are mounted direct to the chassis or to tag boards and wired in the old-fashioned way. Quite straightforward and the instructions are easy enough to follow. Figure 5 shows most of the parts in position and Fig. 6 shows it fully wired. Total time is approximately four hours.

Performance

Accuracy is claimed to be ± 10% at any point on the dial for in-circuit or out-of-circuit measurement. This is more than adequate for the usual purposes and even closer accuracy can be obtained by using precision standards for comparison. Basic accuracy is not affected by shunt resistance but low values tend to spread the null point on the indicator. Poor power factors can cause inaccurate readings for electrolytic capacitors, but tolerances are usually wide anyway. The open circuit test gave a clear indication for capacitors as low as 10 pF and the short test worked beautifully. The dial is a four-inch lucite disc, and it is easy to read. Summing up: A useful (and inexpensive) instrument for the engineer or the experimenter. The in-circuit test facility may save a lot of unnecessary work and bad language. Removing a capacitor from an almost inaccessible printed board is bad enough, but to find it was OK anyway is frustrating to say the least! *T.A.*

Check No. 67 on Reader Service Card

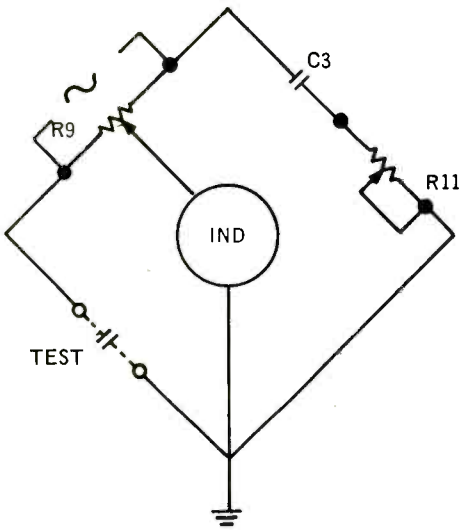

Fig. 3—Bridge connected for high capacitor values.

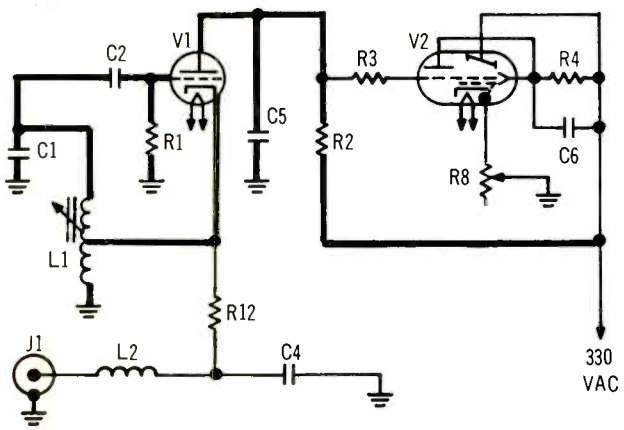

Fig. 4—Open test circuit.

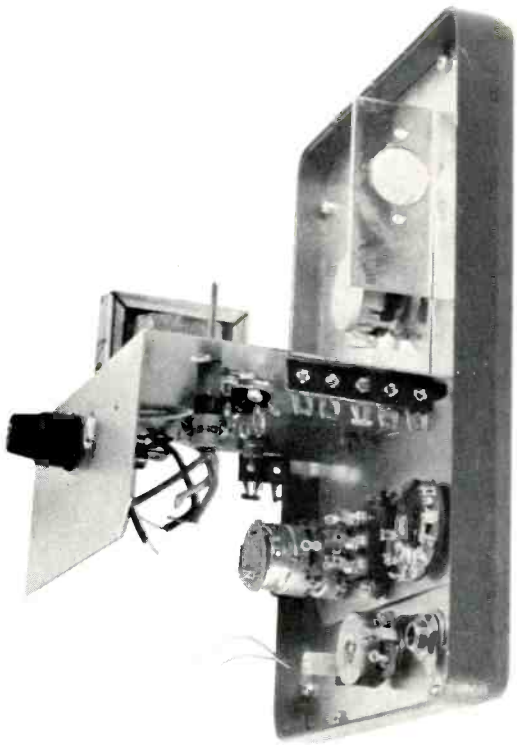

Fig. 5—Showing parts mounted ready for wiring.

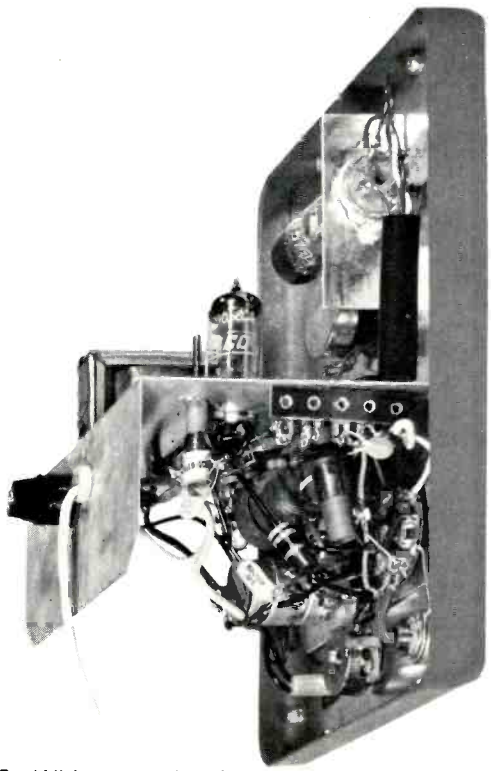

Fig. 6—Wiring completed.

Classical Record Reviews

Edward Tatnall Canby

Modern and Semi-Modern

Bartók: Sonata for Solo Violin (1944), Second Sonata for Violin and Piano (1922). Gabriel Banat, with Lawrence Smith, piano. **Cutty Wren CWR 102,** stereo, $5.98.

Two major violin works by the great Hungarian, with and without piano, both big pieces, mature, potently expressive. And a youngish fiddler who was a protégé of Bartók himself as a child, and comes from the same geographic region. There should be splendid listening. There is, at the least, very good listening.

Gabriel Banat is obviously at home in Bartók's idiom. He has a sweet tone, a bit on the gentle side, and his feeling for pitch, as well as his understanding of its supreme importance in this music, is beyond reproach. No violinist without this basic musical gift could hope to make sense of the difficult Solo Sonata, which he does with ease.

The only trouble, as I hear it, is simply a matter of temperament. Mr. Banat just doesn't have the sheer gall, the all-potent rhythmic drive, to project the more furious parts of these works as they must be projected. The understanding is there. But the superhuman, daemonic drive isn't daemonic enough. It's just a bit too polite in the sound, this performing—but on an immensely high plane, mind you. Bartók was in truth a daemon when he took to the fiddle. His writing turns that elegant instrument into a screaming, gutteral, hoarse monster of straining strings, so expertly, however, that the instrument reveals whole new aspects of, shall we say, indecency. A tortured sound, like the sound of a grossly overdriven amplifier (where have we heard *that* before!) but a sound that is unforgettable—if the player can rise to its agony.


Bartók

Others have, and have perhaps ruined their valuable fiddles or at least strangled a couple of strings, 'mid buckets of sheer sweat. Somehow, I sense that Mr. Banat is loth, like the swimmer who would rather not get his hair too wet. Perfectly good swimmer. I find myself urging him on—*more, louder, gutsier!!* But he doesn't. His hair stays dry.

In the slow movements, Mr. Banat rises to perfection, where beauty of tone and musical intelligence can have full sway. He is superb. In the highly dissonant Sonata for Violin and Piano, Lawrence Smith, out of Portland, Oregon, plays an accomplished piano, if also just a trace on the too-proper side. The violin-piano recording leaves the fiddle almost too much in the background, with the piano taking the lead. A fine sound but not an ideal balance (usually it goes the other way, however, too much violin). The Solo Sonata sets Gabriel Banat up for maximum impact, a gorgeous violin sound, big and full. There's plenty of "echo" in the resonant recording place; users of four-channel matrix equipment will find a great deal of it coming through those back channels.

Performances: B+ Sound: B+, B—

Gordon Crosse: Changes. Vyvyan, Shirley-Quirk, London Symphony Orch. and Chorus, Del Mar. **Argo ZRG 656,** stereo, $5.95.

A vast modern British oratorio here, and I hardly know what to make of it. Curious—it is both modern and, in many ways, very traditional. In Britain, the electronic avant garde is, I would guess, less prominent (though no less far out) than here, and music of a modern sort but in the traditional forms, for the standard "live" instruments and voices, is the thing when it comes to being up to date.

This opus is set to a batch of texts by such as Robert Herrick and William Blake, but scarcely a word of them is intelligible in the hubbub, and Argo does not give us the printed lines. It would help immensely, if we could read and listen simultaneously. Anybody who has listened to the big, modern choral-vocal works will spot antecedents and near-relatives galore for the musical sound. The huge, clangingly percussive orchestral bursts remind of Carl Orff out of Germany, with a good taste of Henze too—both those men skillful in the same sort of big-stage musical drama that we have here. But before them, one thinks of that old pro, Honegger, whose numerous dramatic works, whether cantatas, oratorios, or what-not, (mostly they just have names—"Judith," "Nicholas de Flue," "King David") set the frame for all of those which have followed. Honegger, it is more and more clear, was a real pacemaker, back in the twenties and thirties. Gordon Crosse may not even know Honegger's work; no matter. It is part of his own.

Isn't British music always very much itself, yet virtually always modeled on some form of Continental expression? Geographically inevitable. Like Norman architecture, and British Gothic. It still happens. In spite of the Continental influences that come to mind here—and one can go as far afield as Prokofiev, with his big dramatic cantatas ("Alexander Nevsky," and "Ivan, The Terrible")—Crosse's "Changes" is immediately British, even to its inevitable boy choir, the li'l angels singing as they always do, high above the vast concourse of mature performers. And, in its Britishness, the music is most immediately out of—guess who?—Benjamin Britten, of course, a larger, less concise idiom than Britten's, more fluent, more verbose, but borrowing many a nuance, as who wouldn't? Britten, too, has been a pacemaker in the field.

A glorious, big performance, enthusiastic and well rehearsed, with the fabled Vyvyan at her best in the soprano solo and John Shirley-Quirk the very model of an oratorio basso. The fi is great too, and all that is lacking is, as I say, the text. Just so we might know what it was that got such a whale of a big noise going.

Performance: A— Sound: B+

Scriabin: The Poem of Ecstasy; Prometheus, the Poem of Fire. Philadelphia Orch., Ormandy. **RCA LSC 3214,** stereo, $5.98.

I am *very* suspicious of this sudden enormous fad for the music of Scriabin, which this new disc hopefully exploits. Scriabin and these two works have all been around for a long time, and until day before yesterday, nobody was taking very much notice. Now, whoosh!—Scriabin is in orbit. Especially among the young, who are the least likely to be able to understand the immensely complex harmonic idiom of these works from the early 1900s. Why the sudden reincarnation?

Oh-so-simple. Not because of the *music,* friends, but because of the ecstasy. The mysterious, exalted *OM*-stuff, the wildly all-embracing, cosmos-busting, super galaxy-transcending karma that this man spouted forth in words, then turned into music! I don't think the current fad is musical at all. It's all about Scriabin the great (self-elevated) mystic. The music itself leaves *me* chilled. In fact, the stuff gives me the horrors; I can't stand its screaming, introverted, dogmatically repetitive harmonies, so sickly sweet they turn sour in minutes, so small-

minded (not large minded), that a true cosmos-inclined genius like Mahler, who had his own big ideas too, looms a thousand times larger . . .

Any how, RCA has more conventional ideas in its sales department. If you want to know what their intentions are, just gander this: " A Sensual Spectacular! Soaring, surging, shimmering music of naked exaltation!" And just to be sure, there's a pair of naked statues embracing on the cover. Even Scriabin would have been astonished.

Performances: B Sound: B+

Richard Strauss: Don Juan; Till Eulenspiegel's Merry Pranks. Royal Philharmonic, Henry Lewis. **London Phase 4 SPC 21054,** stereo, $5.98. **Rachmaninoff: Piano Concerto No. 2.** Ivan Davis; Royal Philharmonic, Henry Lewis. **London Phase 4 SPC 21057,** stereo, $5.98.

The more I enthuse over Phase 4, the more London sends us records. I don't know what's going on in the regular London line these days; I'm all wrapped up in this one. The sound is so "different" in these startling discs, not only in the fi but in the musical qualities of the mic pickup, that I am reminded of the original London ffrr impact when those sensational hi fi 78 rpm shellacs appeared here some 25 years ago. I donno what they do over there in Britain. I only know what my ears say.

Of course, all this would be in vain—for me—if the music itself were not interesting and interestingly served. That's the clincher. It is. Whether we are listening to Stokowski or, as on this pair of discs, Henry Lewis, Phase 4 fare is intelligently and challengingly presented in musical terms, and the somewhat radical recording technique, somehow, is carried through cooperatively with the music and the musicians themselves. This is the more remarkable in that most of Phase 4 is "warhorse" music, and thus easily subject to casual performance and a crass hi-fi treatment. It happens often enough! Yes, I'm aware that makers of a few other labels will be grieved at my words. Can't help it.

The two Strauss works have been recorded so many times that I could hardly bring myself to try them. But—lovely! Mr. Lewis knows his Strauss and so do his musicians. These are warm, natural, outgoing performances—shall I say civilized and friendly—and for my ears they seem remarkably free from tiredness or the all-too-common "it's a job; let's get it over with" at-

titude. Phase 4, taking over this music, spreads out the inexhaustibly interesting Strauss orchestrations as I have never heard them, with uncanny presence. Whole solo passages I did not know existed emerge from inside the music. Phrasings, accompaniments, decorative figures, even individual musical personalities behind the instruments, are brought forward. As another company puts it, *You are there.*

True, as always, Phase 4 sacrifices some ensemble blend for this special close-in look. I would not want to depend entirely on this recording for my conception of the music's sound. There are other ways to get it down. But that does not lessen the impact nor the interest.

As for Rachmaninoff, it is a splendid performance, no less, though the nature of the music leads to a quite different sonic impact. Again, there is a naturalness, a rightness and richness and honesty in the playing, along with perfect discipline in this superb orchestra. Ivan Davis, definitely of the young Romantic generation, is spectacularly good too, though by temperament very unlike the granite Rachmaninoff himself. He is not merely spectacular (though his technique is up to it) but musical and sincere. Indeed, the feeling grows that these musicians really mean what they say, even if the piece is not the greatest of masterworks. Believe me, in the last movement the excitement of performance is palpable, the exchange between piano and orchestra absolutely electrifying. This is the sort of music-making you always hoped to get from such as Toscanini! (But occasionally didn't.) I was in truth quite stunned, for mostly Rachmaninoff washes harmlessly past my ears with little noticeable effect.

Phase 4 in this case is principally concerned with a massive, well controlled piano sound, since the composer, like most composer-pianists, never lets his instrument stop. His orchestra (and cf. Chopin, Prokofiev, as well) is largely discreet accompaniment, plus an occasional transitional passage. Even so, the fi jumps out at you now and then, in a startling blast of brass or a bass drum that you can feel, and in the wide dynamic range (on quiet surfaces) which marks the contrast between loudest and softest. The solo piano, unlike many another recorded concerto, is thoroughly blended in with the sound of the orchestra. Good! (Columbia's Gary Graffman, for instance, seems to play in a semi-isolation chamber, apart from the orchestra.) My only (mild) reservation is that the deadness of overall sound, perhaps required for this mic technique, is not ideal for such music. Can't have everything.

In that connection, it's worth noting that via matrixed four-channel equipment there is unusually little difference-signal, or ambient sound, to feed to the rear channels, in spite of the sharp stereo separations of the recording. Just what this indicates in terms of phasing vectors I am not sure. It could mean a rather accurate control of mic relationships—or am I just in a mood to toss praise right and left?

Performances: A- Sound: A

Vladimir Vlasov: Concerto No. 1 for Cello. Henri Sauguet: Melodie Concertante. Rostropovich; Moscow Radio Orch., Rozhdestvensky, Sauguet. **Melodiya/Angel SR 40180,** stereo, $5.98.

Vladimir Vlasov's big, loud, noisily Romantic concerto turned my musical stomach, though the fabulous Rostropovich plays it with impeccable cellistic gusto. It is one of those hard, business-like pro jobs, written with all the sincerity of a high-powered Madison Avenue ad campaign and just as expertly. Great blasts of hideous dissonance to start, proving that we are modern as all-get-out; then straight into a comfortable B flat minor, à la Rachmaninoff. Everything gets in, even a batch of brassy 1920s nostalgia (currently popular in Russia), in the third movement, and plenty of lush cello melody in the second. But I found myself longing for somebody like, say, John Dowland. Or Mozart. Somebody with modesty and a yen for briefness.

Henri Sauguet's music is hardly a model of briefness. His "Melodie" meanders for an unconscionably long time and, considering that the composer is conducting (he's 70), it sounds very old fashioned. At first. But Sauguet has what Vlasov hasn't: sincerity and honesty. In the 1960s, Sauguet, whose heyday was in the naughty twenties in France, wrote in a half-impressionist style which could date perhaps from 1905. And yet, interestingly, there is an overlay of dissonance that is both meaningful and, no doubt, a last reminiscence of flaming youth. His basic melodic idea, too, is strong, sinewy, and good for sober development. The longer you listen, the more modern this music sounds. After awhile, you'll begin to hear a gentler Alban Berg, a sweetened Bartók. The man is not great, but he is real and so is his music—if you have the patience to stick out its length.

Performances: A Sound: B

Canby's Capsules

CLASSICS REVISITED

Werner (trans. Haydn): Three Fugues for String Quartet. Boccherini: Quartet. in D, Op. 40/3. Sinnhoffer String Quartet. **Orion ORS 7035,** stereo, $5.98.

An odd pairing—A Haydn transcription of music by his (Bach-period) Esterhazy predecessor, and a Quartet by the Haydn-like Boccherini. Easy to hear why H. turned back to Werner: the older man's harmonies were daring for the early 18th C., if somewhat uncouth, his fugues already sounding "learned" in the later manner of Mozart and Beethoven. A minor figure but interesting. Boccherini's graceful Haydn-like music makes a pleasing contrast.

Beethoven: Mass in C. Ameling, Baker, Altmeyer, Rintzler, New Philharmonia Chor. & Orch., Giulini. **Angel S 36775,** stereo, $5.98.

This has much bigger dimensions than the recently reviewed Telefunken recording (Oct.), larger in the sound, slower, more impressive. With due respect for Giulini and excellent performers, I don't like it. Too big, too Mendelssohnian for its content, out of style for the period of this work. The real Beethoven comes through better via Telefunken.

Purcell: Consort Music for Strings and Harpsichord. Gustav Leonhardt, Leonhardt Consort. **Telefunken SAWT 9506,** stereo, $5.98.

A good survey of the later Purcell, bordering between "chamber" music and orchestral. Two sets of recordings intermixed, for small string group and for solo harpsichord, nicely played if with some (Dutch) misapprehensions of tempo. The strings again show that peculiar buzzy distortion noted on other Telefunkens. Groove shape? Elliptic stylus mismatch? But why only on this label?

Bach: Art of the Fugue. Lionel Rogg, Organ of St. Peter's Cathedral, Geneva. **Angel SB3766,** two discs, stereo, $11.96.

The monumental final Bach opus, unfinished, written merely as a paper abstraction, here adapts to organ format with immense success—one of the best versions to date. The young Swiss organist avoids all pitfalls; he plays massively but with lightness, excellent Bach-period registrations and plenty of color, with a fine grasp of the unfolding architecture on the large scale. He even brashly completes the final fugue—I dare you to spot where Bach ends and Rogg begins!

Debussy: La Mer. Ravel: Daphnis et Chloe Suite No. 2. London Symphony Orch., Stokowsky. **London Ph. 4 SPC 21059,** stereo, $5.98.

The spectacular Stokowsky Phase 4 series continues—lively, knowledgeable readings of basic classics, vividly communicative if often inaccurate in detail and occasionally eccentric, the far-out Phase 4 mic pickup generally revealing of new instrumental detail, super-impressive in the fi.

Historic Organs of England. E. Power Biggs. **Columbia M 30445,** stereo, $5.98.

Off he goes again—another whirlwind sonic tour of the local organry, out of the past. After so many brilliant Continental instruments, the modest British items (often without pedals) seem a bit sedate and colorless and there aren't many available. (Oliver Cromwell, and the Victorians, did 'em in by the dozen.) As usual, Biggs plays appropriate local British music, from the 1400s on. He keeps things moving.

ODDITIES

Ezra Pound reading his Translations of the Confucian Odes. Spoken Arts SA 1098, mono, $6.50.

A moving recording, this one. The ancient Pound, now 85, reads (in Italy) in a feeble gravel voice his 1950s translations of 2500-year-old Chinese. Gravel or no, he grows on you as you listen carefully. The famed mind is still there, the words are clear and spoken with authority and sense; the command of ideas and of English, superbly evident. Best heard with text in hand (not provided), but you can get the sense easily even without.

The Sound of Folk Music—The Original Trapp Family Choir. RCA Camden CAL 904 (e), sim. stereo, $2.98.

Picked this up at a rummage sale—it may still be available in some places. The original Trapps were a far cry from the celebrated and banal "Sound of Music." Here they are, singing "classical" settings of mostly Germanic tunes, with their lovely ensemble and perfect taste. From old 78 rpm albums, long before the famed musical show.

Authentic Music of the American Indian. Everest 3450/3, sim. stereo, $14.94.

Exasperating Everest! Not a word as to where or how or when or by whom; but this is obviously an authentic collection and a valuable reissue, whatever its hidden source. The recordings are 78 rpm electrics by the sound, dull but clear, with good bass for the drums. Lots of authentic shoutings and garglings and war whoops in that peculiar Indian fast vibrato, like a bass singer recorded at 33 and played back at a tenor 45! Generalized notes, no details. Six sides is a lot—so much the better for specialists.

Wake Up America, Including the Battle Hymn of Lt. Calley. "C" Company, with Terry Nelson. **Plantation PLP 15,** $4.98.

Nashville-based, mildly peppy patriotism, updated to include Lt. C. and Vietnam; Terry Nelson speaks and sings to a vaguely country music backing, that mixes in old familiar tunes. Not really worth getting hot and bothered about—pro or con. I'd call it a batch of conventional platitudes.

(Continued from page 34)

I would like to have this article regarded as a description of what I believe to be a meritorious principle in loudspeaker design and as a statement of work in progress. My intent here is not to present a finished design; more work must be done. I would like to build dividing networks having better transient and phase characteristics and find better treble units. (The PM 7 range is up to 22,000 Hz, but the undamped edges of the whizzer cones produce dissonances at times: JBL LE-8T units probably would have been more suitable.) Also, both harmonic and modulation distortion measurements should be taken, as well as frequency response data, but I do not have the facilities to do this properly I hope that I may soon have the opportunity to work on this design with some interested loudspeaker manufacturer.

I believe that the industry will have to develop measuring techniques and the appropriate instrumentation which will provide a valid correlation with listening tests. At present there is far too much reliance on subjective evaluation.

It is a bit unfair for a reviewer to say of speaker testing, "It is folly to expect that the average layman could interpret such a mass of data correctly." This may be true but many engineers cannot interpret data correctly. The data should be available nontheless, just as it is in the case of amplifiers, tuners, and phono cartridges. If all loudspeaker data were presented in terms of measurements taken in an anechoic chamber with standardized parameters, the intelligent laymen would soon learn how the acoustic properties of such a chamber differed from those of his listening room and make the necessary allowances. Also, the day should be long since past when an equipment reviewer can put the "high fidelity" label on speaker systems that generate 20% harmonic distortion at 30 Hz with a one watt input!

We simply must have more of the effort exerted by Harwood, Klipsch[9], Kaminsky[10], Schaumberger[11], and others to take the witchcraft out of speaker design and put speaker evaluation on an objective basis. Æ

As the author says, he is not presenting a finished design, but experimenters will find the ideas offer an interesting field for investigation. For instance, 8- or 10-in. speakers can be tried. Input to the rear mid-range and treble units can be modified to change the ratio of direct-to-reflected sound for an optimum dispersion with a good stereo image. Note that the bass speaker cones should be quite rigid—especially if a small enclosure is used. The speakers used the G.E.C. "Periphonic" system had metal cones with a very flexible surround.—Ed.

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12. Tillett, "Motional Feedback," in *HI-FI Yearbook,* 1965/6, p. 73.

(Continued from page 14)
T. In use, the spare power amplifier output found on most pre-amps is connected to the input of the Delta T. The Delta T can be supplied with as many as five output modules, each of which is capable of the full 320 ms range of delay. The delay is simply set with either or both of two rotary switches, one for coarse adjustment in 40 ms steps, the other a fine adjustment in steps of 5 ms. In four-channel stereo simulation, the coarse switch is rarely used. On each module is a rocker switch which enables you to switch between the direct information of the front channels (delay off) and the delayed sound in the rear channels (delay on). I should have mentioned that the stereo output of the pre-amp is fed into a Y connector and thence into the single input of the Delta T. This of course is monophonic, but you feed this into two of the output modules, which in turn feed into the rear channel amplifiers and speakers. This mono input and double (not stereo) output is common to most of the delay devices I have described. Since you are dealing with non-coherent sound that is almost totally non-localizable, this mono rear channel sound is not a problem. The dynamic range of the Delta T is over 60 dB, more than enough to handle almost any kind of program material. I found that in my living room, delays between 10 and 30 ms were the most effective. In fact, with the Delta T it was easy to detect the 33 ms limit of sound fusion in the brain, by simply switching in an exaggerated delay of 50 or more ms, raising the level of the rear channels and playing music with plenty of repetitive transients. The resounding "slapback" under these conditions was an eloquent witness for the validity of the fusion thesis. It was quite astonishing to select a nice two-channel stereo recording, run it through the Delta T with about 20-25 ms delay, and have the whole room open up with a spaciousness and heightened sense of "participation" and reality that was hard to believe. Switch off the delay and the effect is dramatic . . . the whole sonic perspective seems intolerably cramped and circumscribed. Believe me, it is one helluva effect, but at $4000.00, this can hardly be described as home type equipment. The Delta T is of course a tool for the modern recording studio. For example, take a group of six string players, mike them through the Delta T with an appropriate amount of delay, and all of a sudden the six violins sound like 12 violins. In the wild special effects that rock producers want these days, a highly exaggerated delay is deliberately used with certain instruments. The Delta T also has obvious uses in the public address field. In closing I should also mention that the Delta T would be a highly precise and controllable delay device to replace the 80 inches per second tape delay used in the Eargle process four-channel tapes.

There would seem to be little doubt that a good delay unit can add an impressive quotient of realism in the home listening situation. Now if only someone can come up with a reasonably priced unit. . . .

Early in November, the New York hi-fi press corps was present at a joint conference held by RCA Records, JVC, and Panasonic, which was billed as a "progress report on the four-channel discrete disc." It was known that RCA was investigating the JVC discrete disc, but the entry of Panasonic into the act was a surprise. We had the usual speeches from management and engineering, containing the usual ambiguities. And we had a demonstration of the discrete disc with a new Hugo Montenegro recording, which according to Hugo in person, was especially arranged and recorded for the four-channel medium. We also had a clever example of how discrete the JVC disc is by the expediency of four people speaking at the same time . . . in German from one loudspeaker, Italian from

another, Japanese from the third loudspeaker, and in English from the fourth unit! Now in the words of a famous politican . . . I want to make myself perfectly clear. The domonstration that I heard was very impressive. The sound was very clean, the discrete-ness of the stereo beyond question . . . in all aspects a rousing success! Alas, there are certain problems with this concept, which may not be resolved for some time to come. The JVC disc has been described in these pages before. You know that it works on a sort of modified multiplex principle, that the carrier requires a phono cartridge with response to 45-50 kHz, that a demodulater is required. Now here are some of the statements that were made at the conference. "The life of a discrete disc in laboratory testing when played on stereo home instrument-type equipment already is equivalent to that of stereo records played on the same equipment." "Partial mixed-system playback compatibility has been achieved. Discrete discs, played first in stereo equipment and then on four-channel equipment, have a playback life which has greatly increased within the past four months." "The playing time for a discrete disc now equals the playing time of stereo records *at the time of stereo's introduction* without sacrifice of the basic signal-to-noise ratio of record systems." I have underlined the kicker in that last sentence . . . which means that playing time is roughly 20 to 22 minutes. Indeed, the demo record given to me has perhaps 2¾ inches of recording on a side. As to the first statement about discrete disc life played back on four-channel equipment, although there are no statistics available, with present record playback technology, I'd be inclined to accept this as fact value. The mixed system playback is quite another matter. The crux of things is quite simply whether the high frequency carrier will be wiped off the discrete disc in a comparatively short time. We were told the life of the disc in this circumstance had been increased by a factor of two. But they never gave us the base figure! In answer to a question from the floor regarding the life expectancy of the carrier, it was stated that the JVC discrete disc would not be released to the public until the record could be played on the normal stereo equipment in the hands of the consumer, without degradation. When asked how soon this would be forthcoming, the answer was rather vague. However, it must be noted that JVC and Panasonic must evidently believe that introduction of the discrete disc is not far off, because between them they had six exhibit rooms crammed with handsome, well-designed working prototypes of all sorts of four-channel equipment. There were straight demodulators, demodulators with a stereo amplifier for the rear channels, preamps with demodulator, integrated amps with demodulator, four-channel stereo receivers with the demodulator, even four-channel compact systems, and of course the vital phono cartridges. One by Panasonic is a semi-conductor piezo-electric type. The JVC cartridge is magnetic.

As noted, the sound was very good indeed, the glittering array of equipment most impressive . . . the sad part of the whole thing, apart from the problems reviewed, is that the JVC discrete disc cannot be broadcast. At least not in the foreseeable future. The Dorren system would make it possible, but the FCC would have to do a radical about-face to embrace this idea. No matter what the people at the conference pooh-poohed about this, the inability to broadcast the JVC disc is a severe limitation. Perhaps the JVC discrete disc can stand on its own as a sort of audiophile special. It certainly has the best sound and it would be kind of a shame to lose one of the few chances we'll have to get a discrete four-channel stereo disc. Æ

Weingarten Looks At

Sherwood L. Weingarten

Multi-Disc Albums

AH, THE MERCHANTS of America, how well they play the game. Market something, anything, with a zinger of an ad campaign, promotion galore, and watch it soar, watch the cash registers ring. And keep watching until the sales begin to slow. Then change it a bit, maybe even improve it a little, and start all over again.

In the record industry, it started with the dust-catching, scratchy-sounding, highly-breakable 78 rpm disc. A long time later entered the 45, singles with better everything. Then, *viola,* came the LP, replete with the usual dozen cuts (at least nine of which the listener couldn't care less about). Extended-play offerings, the EPs, were next, comparatively short-lived because of too-high pricing and too-little quality. Then it was quiet for a while, but only until tapes began making rather deep inroads into disc sales; *voila, voila,* the double and triple LP packages started helping the inflationary spiral climb skyward.

When the **WOODSTOCK** triple-header busted chart records, apparently, manufacturers took a hard look and decided the multiple packaging concept was here to stay—even if there wasn't enough quality to fill two or three records, and even if a single performer or group couldn't hold an audience that long. And when **JESUS CHRIST SUPERSTAR** shook the industry with its double-album sales, any doubts disappeared.

The deluge began—and the manure that was piled thick and high onto pop recordings was difficult to believe, virtually impossible to listen to.

Now, not so long after the initial outpouring, the garbage continues to be produced. But the meaningful material, the better quality stuff, is beginning to surface—far enough, at least, so it can be differentiated from the rest.

Three recent examples of superb wheatseeds among the acres of chaff are **FIDDLER ON THE ROOF** (United Artists, UAS 10900), **THE 5TH DIMENSION LIVE** (Bell, 9000), and Joan Baez' **BLESSED ARE . . .** (Vanguard, VSD-6570/1). Each two-disc set is a masterpiece in its own way, in its own genre.

The first, an original movie soundtrack recording, improves on the long-run Broadway smash by utilizing the talents of concert violinist Isaac Stern, both as the mythical title fiddler and as a tour de force soloist in front of the studio orchestra conducted by John Williams.

And for those who were afraid that Topel, the Isreali star who assumes the lead role of Tevye, could not compete with Zero Mostel's live performance, it should be noted that the fears are groundless. The richness, the warmth, the humor—all are provided, sung and spoken to perfection.

And Molly Picon buffs certainly will not be surprised that she too captures exquisitely the flavor of the ethnic musical.

There's little need to repeat what it's all about, what with some 30 million persons having seen and heard the show in 25 countries since the original Broadway version opened in September, 1964. But just in case a reader or two was not among that mass of humanity, the story line—based on tales by Sholom Aleichem—deals with Tevye, his five daughters, and their life in Russia before the Revolution. The Jewish family's trials, and the community's plight, form the basis of the drama, the laughter, and the sentimentality that endeared the show to people of all walks of life, all faiths.

Highlights of the recording are difficult to select, for it flows not unlike a lazy but bubbling river, one segment into the next. The hits, of course, are "Tradition," "Matchmaker," "If I Were a Rich Man," "Sabbath Prayer," "To Life (L'Chaim)," "Sunrise, Sunset," and "Anatevka." But there are many more, not the least of which is the sterling, sparkling rendition of the title tune by Stern.

The 5th Dimension package, as different from the soundtrack as anything could be, includes three verbal introductions and 11 musical cuts, and of the latter three are medleys of the quintet's past chartbusters. It easily could be considered a "best of" album, for all the soul-pop winners are there.

The "Love Medley," for example, features Bacharach-David's "What the World Needs Now," Lennon-McCartney's "All You Need Is Love," and Jimmy Webb's "Have You Tried Love?" And the "Laura Nyro Medley" showcases the singer-songwriter's golden oldies recorded by the group, "Stoney End," "Stoned Soul Picnic," "Sweet Blindness," "Wedding Bell Blues," and "Save the Country." Webb comes in for a tribute of his own when the three-male, two-female ensemble gives out with "Up, Up, and Away," the one that got them up and started in the big time; "Paper Cup," "This is Your Life," "The Girl's Song," "The Worst That Could Happen," and "MacArthur Park."

If, however, you prefer single songs, try "Never My Love," the current hit that spotlights a solo by Marilyn McCoo, or Bobbie Gentry's "Ode to Billy Joe," a 7:45 entry that has each member of the group assuming a character in the once downbeat ballad now turned into a novel success.

Other highlights include Miss Nyro's "Eli's Coming," with a vocal solo by Ron Townson; Sly Sylvester's "I Want to Take You Higher," another chartbuster, and the big-big-biggie, "Aquarius/Let The Sunshine In."

Not incidentally, the audience applause rarely intrudes on the zesty musical extravaganza.

As a post script of sorts, if you desire a one-LP package by the same group, pick up the new 11-tune release, **REFLECTIONS** (Bell, 6065). Included are "Let It Be Me," "Sunshine of Your Love," "Poor Side of Town," "Ticket to Ride," "Blowin' Away," "Workin' on a Groovy Thing," "Carpet Man," and "Those Were the Days." Kind of a junior-sized "best-of" all by itself, released, oddly, at the same time as the double.

The Joan Baez package, oriented for those who appreciate humanity, religious notions, and the working class, provides 20 tunes (nine of which the folksinger wrote herself)—plus two on a 7-in., 33 rpm disc that's included in the album.

The thrush's voice continues to be angelic, her pathos-filled appeals to man's better side never ending. The dust jacket of the small disc, for instance, contains a dedication "to the farm workers of the world, may they soon cease to be victims."

Best items on the LP, which was

recorded in Nashville and sticks mostly to a country-folk flavor (with some choral backgrounds tossed in now and then to contrast with Miss Baez' solo voice and guitar picking), are not the singer's own works, unfortunately. The Baez compositions, in fact, are often too personal and can make a listener slightly uncomfortable, almost as if he's become a peeping tom, one that looks too deep and touches nerve endings.

One "must melody" is "Heaven Help Us All," a hit single and huge concert favorite for the protest-singer. Crammed with a love for life and a pop-gospel aura, its lyrics perhaps sum up Miss Baez' compassion:

"Heaven help the child who never had a home,
"Heaven help the girl who walks the street alone,
"Heaven help the roses if the bombs begin to fall,
"Heaven help us all . . .
"Heaven help the boy who can't reach twenty-one,
"Heaven help the man who gave that boy a gun,
"Heaven help the man who kicks the man who has to crawl,
"Heaven help us all . . . "

Interestingly, she alters a line or two (apparently for more impact) from the text printed inside the dust jacket, something she does occasionally on other tracks. A liner note explains it this way: "The differences between the words on the record and the words in the text are either intentional or otherwise."

Other songs the listener should not miss are Kris Kristofferson's "Help Me Make It Through the Night," Lennon-McCartney's "Let It Be," Mick Jagger-Keith Richards' "The Salt of the Earth," the bluesy "Lincoln Freed Me Today (The Slave)," "Put Your Hand in the Hand," and her latest hit single, "The Night They Drove Old Dixie Down."

The small disc also shouldn't be overlooked, with "Maria Dolores" (sung in Spanish) and Woody Guthrie's "Plane Wreck at Los Gatos (Deportee)."

Of her own works, most poignant are "Gabriel and Me," a lullaby she wrote to sing to her son; "Fifteen Months," an autobiographical lament about the time spent waiting for her husband, David Harris, while he served time in prison for protesting the draft; "Last, Lonely, and Wretched," the title tune.

All together, it's something to make you think—and something to sweeten your life, if your conscience is clear.

* * *

John KaSandra, who specializes in soft soul with meaning for all races despite the fact he musically talks directly to Blacks, has an exceptional nine-cut disc available, BEAUTIFUL NEW WORLD (Respect, TAS-2603). Best tune on the album, distributed by Stax, is "Don't Cloud Up My Sky," a pleasant yet poignant plea for humanity and the love of it as a whole. But the most touching piece is "The Nanny," a narrated ballad about a woman who plans to take care of her own grandchildren after years of caring for others' offspring; if you're in the right mood, it can draw tears.

Other tracks that are outstanding are "Love Is Not The Answer," the theme of which is that each person has the right to his opinions and beliefs as long as he couples them with respect for the ideas of others, and "Wings On Our Minds," almost a KaSandra sermon to Blacks indicating that now that the physical shackles have been removed progress depends on a positive mental attitude. AE

Jazz & Blues

Martha Sanders Gilmore

Leroy Carr: Blues Before Sunrise
Musicians: Leroy Carr, piano and vocals; Scrapper Blackwell, guitar, and Josh White, guitar.
Songs: Midnight Hour Blues, Mean Mistreater Mama, Hurry Down Sunshine, Corn Likker Blues, Shady Lane Blues, Blues Before Sunrise, Take A Walk Around the Corner, and nine more.
Columbia C 30496, $4.98.

As Columbia Records states on the album, this reissue is a "collector's item" indeed, culled from old Vocalion acetates. The 16 sides are a kind of autobiographical summation and sketch of smilin' Leroy Carr's very brief and tragic life. Only one month after his thirtieth birthday, Carr died of drink following one of his usual all night parties.

There is nothing but the blues here, stanza after stanza of references to Carr's own stomping ground comprised of barrelhousing women, infidelity, corn likker, and the inevitable hangovers symptomatic thereof.

Carr came out of Nashville, Tennessee, singing and playing through his 30 hard years—1905-1935—in such cities as Indianapolis, where he was influenced by the barrelhouse pianists of the Black West Side, and in joints from New York to Louisville.

The party pianist draws his colorful experiences with bold, basic, blues lines, sounding older than his years. At his side is guitarist Scrapper Blackwell whose contribution to Carr's realm of musical sound is indispensable. Blackwell, on his portable version of strings, heightens Carr's barrelhouse piano with a boogie bent, underscoring the piano's fuller resonance with a bull's eye, finger-pickin'-good approach, replete with flatted fifths. The honky-tonk guitar work of Scrapper Blackwell is a joy to hear and cannot be overestimated. The team appear as well suited as Siamese twins!

We are treated to young Josh White on three tracts in which the total effect has the dimensions of an entire band. White can be heard on "Big Four Blues," "Shining Pistol," and "It's Too Short," the latter taken at a fast pace and is not without humour.

These blues stem from the two-year period from 1932-1934 and are sincere, salted-in-the-shell comments on Carr's sordid, unwholesome existence bouncing around from joint to joint, under the influence (one suspects) and under the aegis of his own personal art of urban blues.

These were the days of the railroads and we hear the train whistle quite distinctly in "Big Four Blues" in which the clang, clang of the train is duplicated by the two guitars to a boogie beat. Carr is lilting and rocks to and fro in "Southbound Blues," singing "I mean I'm gonna ride that Dixie Flyer" to the tune on Blackwell's twangey guitar. Blackwell has a keen ear for the nuances of punctuation, pockmarking and clarifying Carr's keyboard statements by executing deft and deliberate notations on an instrument that differs in timbre and temperament from the piano.

One gets the feeling that Carr's piano is secondary to his voice and is used to further elaborate his feelings and inclination to tell it like it is. His piano style incorporates the suspended notes and rolls of the old silent-movie house pianos but his sound does not come through clearly here, frequently lurking behind the curtain. However, the higher, more penetrating notes of the guitar have no trouble breaking the sound barrier and listeners may be grateful for their rather pointilistic insistency.

Some of the outstanding cuts, many of them familiar, are "Midnight Hour Blues," a segueing "Hurry Down Sunshine" which is fairly well developed and wherein Carr cuts some fine jazz licks; "Blues Before Sunrise," a melodic, lyrical tune reminiscent of the work of Robert Pete Williams, and the circularly rhythmic "Take A Walk Around the Corner," full of guns and pistols and achieving a corral of sound which encircles the integrated effort. A masterpiece!

This music deserves close attention and, as background music, fails in that it might sound repetitious. But, sit thee down, listen, and you shall discover infinite variety and charm as in "I Believe I'll Make A Change," featuring Blackwell's excellent guitar.

Composer Carr's voice embraces a wide range and displays a fine technical facility, particularly in spots where he successfully seeks those high notes and has no trouble holding them, drawing out his words to further emphasize his phrases.

Columbia has considerately spared us the dreaded rechanneling for stereo and its accompanying machinations. All things considered, it has not only produced an LP of exceptionally good sound reproduction but has preserved the authenticity. The sound is expectably uneven, however, and varies from cut to cut—some blues were recorded in New York, others in St. Louis. The piano is not lucidly crisp and separate but we're glad it wasn't doctored up.

This is an inimitable collection for both the blues aficionado and music lover at large. There is never a dull moment and Carr's down-home piano and vocal work is pure, genuine, and raw. Here is a collector's item and blues classic. Get this one!

Performance: A Sound: B-

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Advertising Index

(Continued from page 10)

cert-hall acoustical characteristics are played back through speakers which duplicate the acoustic response of the concert hall, the response curve is compounded. A slope of 5 db at the high end therefore becomes a slope of 10 db, creating an unnaturally dead high-end.

The only reasonable and logical conclusion is that the speakers used in a stereo system should be capable of as nearly flat response as possible. If the speakers themselves are not capable of flat response, use should be made of tone controls or narrow-band equalizer controls to make the net system response as flat as possible. If an imposed effect is called for, concert-hall or otherwise, the controls can be readjusted.

Philip E. Bond
Teaneck, N.J.

Mr. Allison will have an opportunity to reply in the next issue. In the meantime, I would certainly challenge the assertation that the engineer mixes for the most realistic sound. Not necessarily! He may mix to produce that which, in his opinion, gives the most realistic sound under domestic conditions. Or he may aim for an exaggerated stereo effect, or he may try to achieve an exciting but unrealistic *sound. It all depends. . . .*—Ed.

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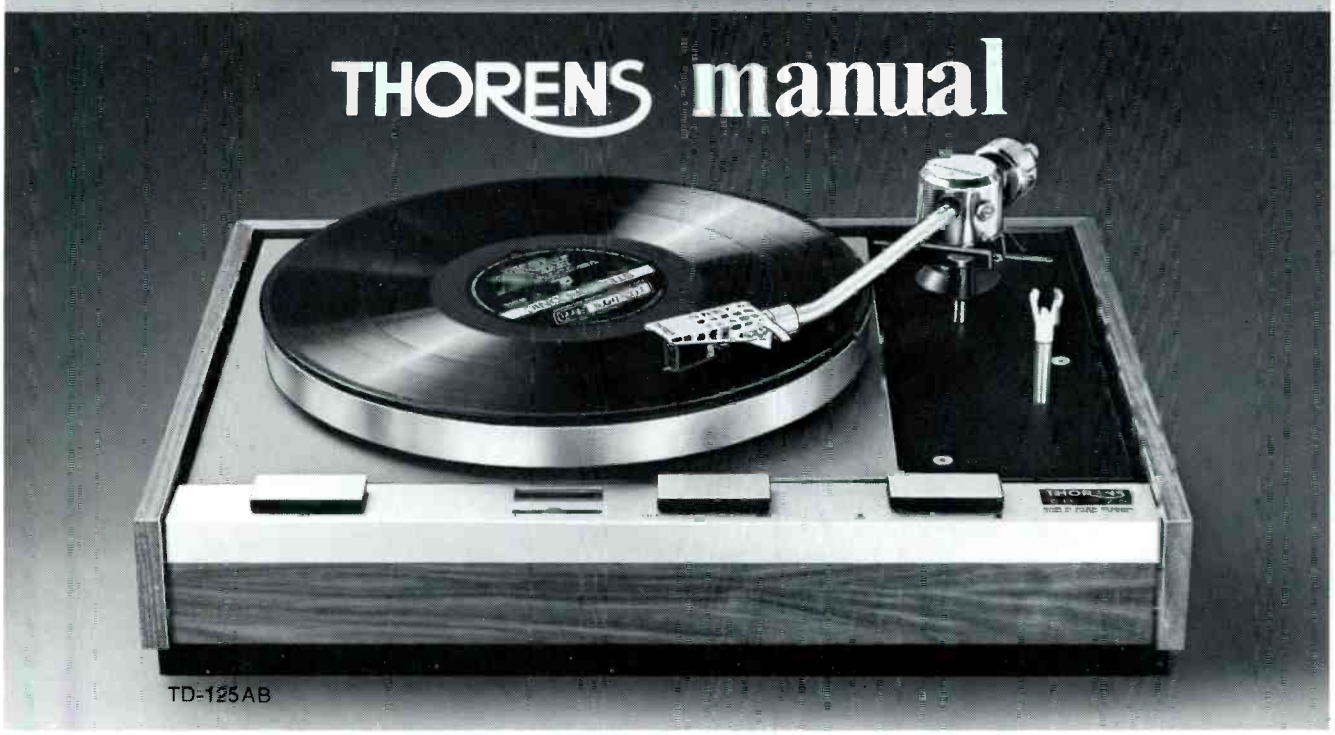

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