STEREO EQUIPMENT & RECORD REVIEWS

The Authoritative Magazine About High Fidelity

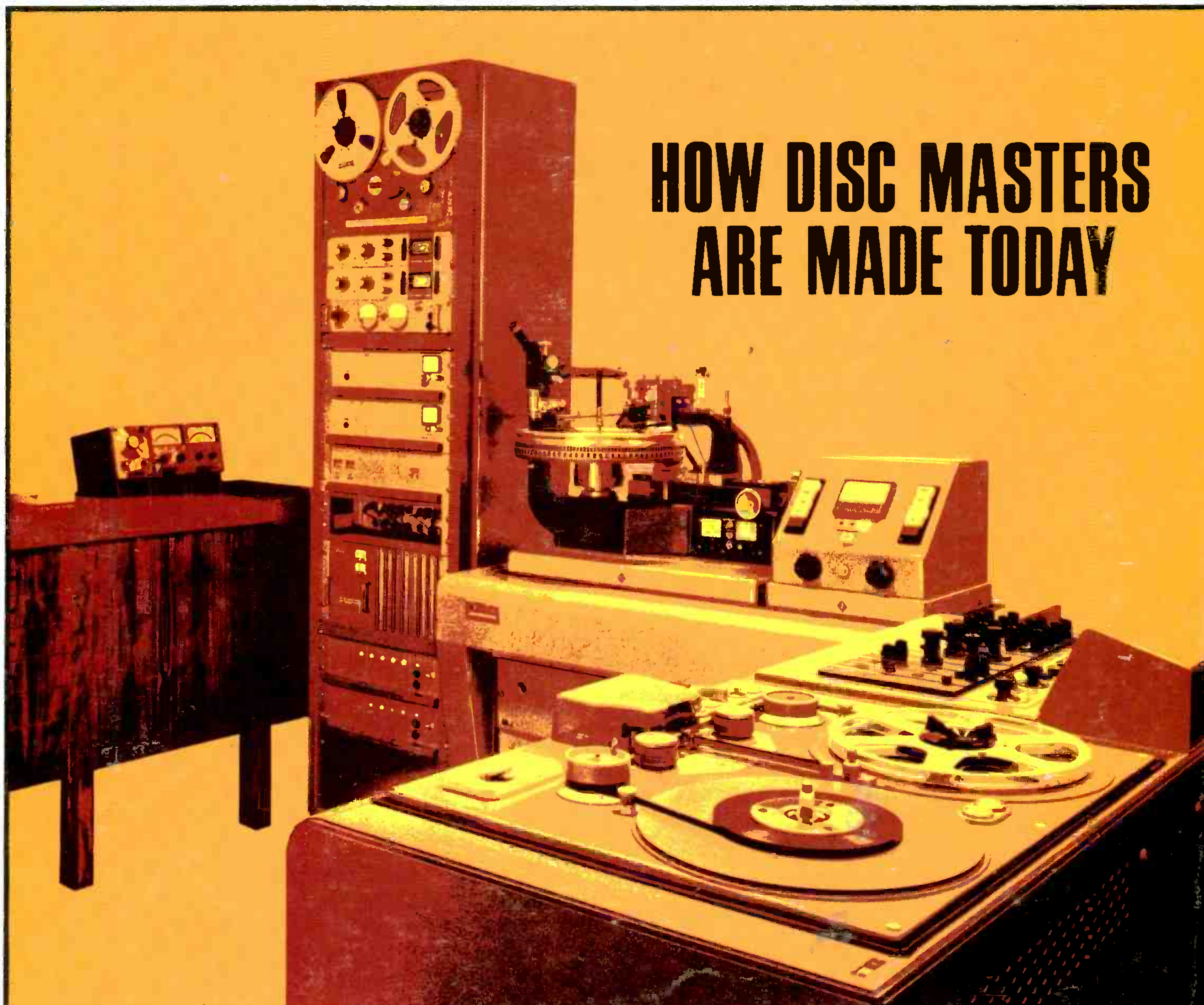
AUDIO

NOVEMBER 1969

60¢

■ SPEAKER SPECIFICATIONS ■ MOOG MUSIC "LIVE"

■ BUILD AN I-C TONE-CONTROL STAGE



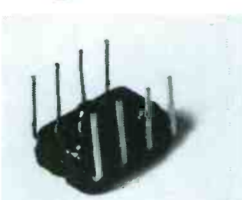
HOW DISC MASTERS ARE MADE TODAY

Inside Scott's new 382C AM/FM stereo receiver is a specially-developed digital computer circuit called "Perfectune," that takes the fiddling, guesswork, and wasted time out of tuning . . . gives you perfect sound, instantly, every time.

How does it work? The Perfectune integrated circuit scans the other tuner circuits and decides exactly when you have tuned for both lowest distortion *and* best reception. It then flicks on the Perfectune light .

Perfectune gives a far more exact reading than a meter, which may read at its highest point when the signal is masked by interference. The Scott 382C still has a meter . . . but it's a signal strength meter you use only to position your antenna for optimum signal . . . then you let Perfectune take over for perfect sound!

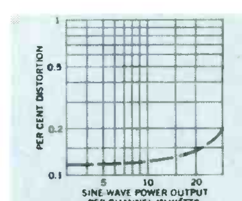
Perfectune is only one of the advanced Scott features that make the 382C your best AM/FM stereo receiver buy. The photos below show some of the other Scott exclusives incorporated in this superb unit.



Full complement of 7 Integrated Circuits . . . more than any competitive receiver.

"Wire-Wrap" . . . a permanent connection technique that eliminates solder joints.

New IC multiplex section that gives better stereo performance and reliability.



Full Complementary Output circuitry that gives virtually distortion-free listening at all levels.

Snap-in printed circuit modular construction for reliability and ease of service.

Specifications:
Power (± 1 dB) 110 Watts. IHF power specifications @ 0.8% distortion, both channels driven: Dynamic power @ 4 Ohms, 45 Watts per channel; Continuous power @ 4 Ohms, 33 Watts/channel, @ 8 Ohms 25 Watts/channel. Selectivity, 40 dB; Frequency response, ± 1 dB, 15-30,000 Hz; IHF power bandwidth, 15-25,000 Hz; Cross modulation rejection, 80 dB; Usable sensitivity, 1.9 μV; Stereo separation, 30 dB; Capture ratio, 2.5 dB. Prices and specifications subject to change without notice. Walnut-finish case optional.

Choose either the 382C AM/FM stereo receiver at $299.95 or its FM stereo counterpart, the 342C at $269.95.

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How to flip over the sound without flipping over the reel.

For years you've flipped over a little thing called a reel. You flipped because the tape would run out at inconvenient times like 30 seconds into the Minute Waltz, or three and a half movements of your favorite symphony.

Something had to be done about it.

Panasonic, the world's leading manufacturer of tape recorders, did something. That something is the Panasonic Symposium. It's a Solid-State 4-track stereo deck that's unflippable.

Unflippable because of continuous Automatic Reverse. You'll never flip over another reel again. And the turn around is so quick you'll hardly miss a beat.

And the beat is steady. That's because there's Dual Capstan drive on all three speeds. That way the Tijuana Brass won't sound like 76 Trombones and vice versa.

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Will the Symposium match your rig at home? Yes. It has 30-20,000 CPS response, and the signal-to-noise ratio is more than 52 db's plus a recording system that has an AC bias of 90 kc. For sound-*on*-sound or sound-*with*-sound that's plenty of fidelity.

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So why not go down to any dealer we permit to carry the Panasonic line. We think that once you hook up our Model RS-796, you can stop flipping over its reel and really start flipping over what you hear.

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Tape Deck, Model RS-796

November 1969 Vol. 53, No. 11

AUDIO

Successor to RADIO, Est. 1917

FEATURE ARTICLES

EQUIPMENT PROFILES

RECORD/TAPE REVIEWS

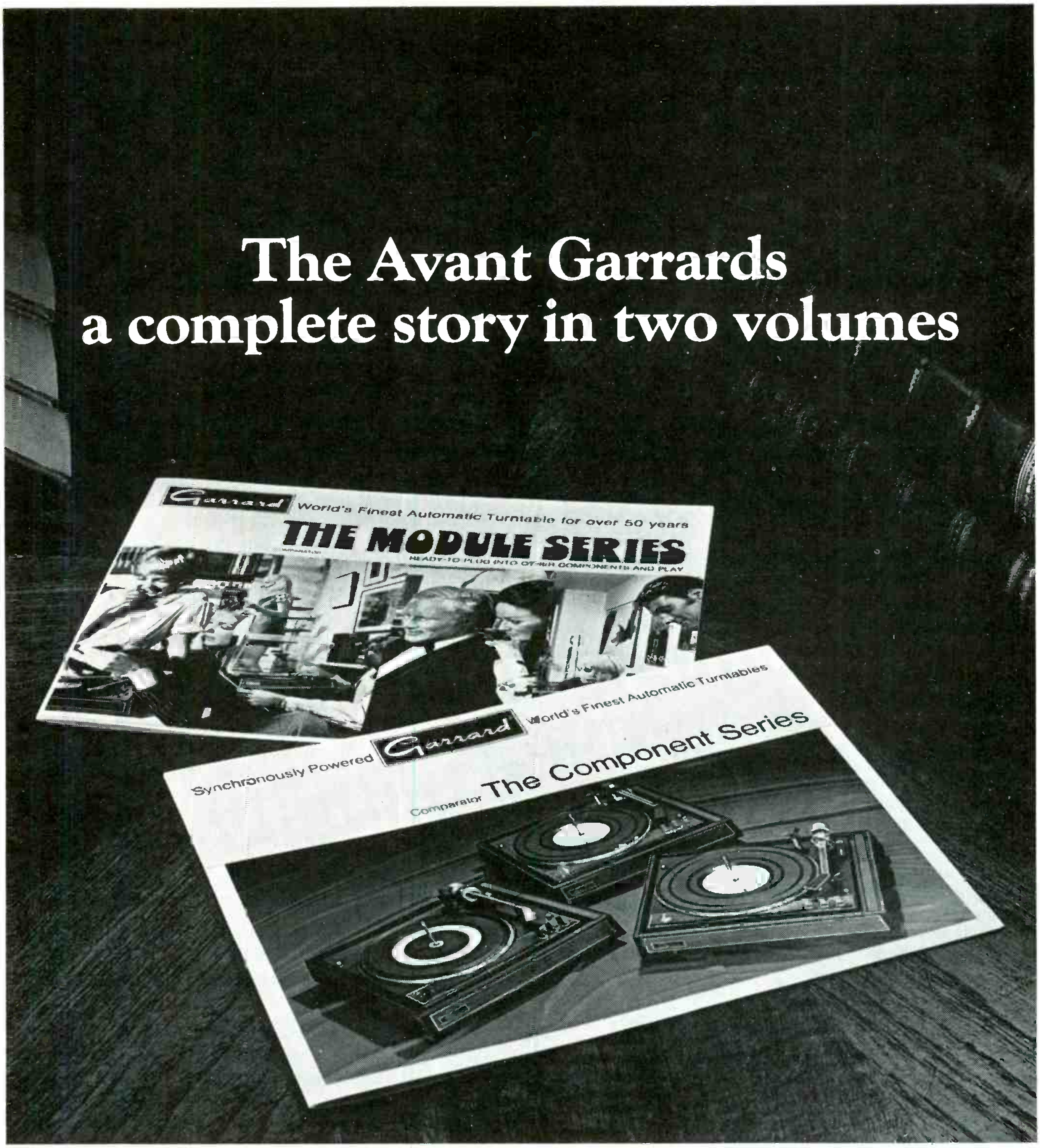
AUDIO IN GENERAL

AUDIO (title registered U.S. Pat. Off.) is published monthly by North American Publishing Co., I. J. Borowsky, President; Frank Nemeyer, C. G. McProud, and Roger Damio, Vice Presidents. Subscription rates—U.S. Possessions, Canada, and Mexico, $5.00 for one year; $9.00 for two years; all other countries, $8.00 per year. Printed in U.S.A. at Philadelphia, Pa. Second class postage paid at Phila., Pa.

REGIONAL SALES OFFICES: Jay L. Butler and Sanford L. Cahn, 41 East 42nd St., New York, N.Y. 10017; Telephone (212) 687-8923.
Louis Weber, 5201 N. Harlem Ave., Chicago, Ill. 60656; (312) 775-0755.
Jay Martin, 15010 Ventura Blvd., Sherman Oaks, Calif.; (213) 981-7852.

REPRESENTATIVES: United Kingdom: H. A. Mackenzie and Peter E. Holloway, 4a Bloomsbury Square, London W.C.1. Tel. HOL-3779.
Continental Europe: John Ashcraft, 12 Bear St., London W.C.2. England. Tel. WHitehall 0525. For Benelux & Germany: W. J. M. Sanders, Mgr., Herengracht 365, Amsterdam, Holland. Tel 24.09.08.
Japan: Matsushita Inc., 709 Kitano Arms, Hirakawa-Cho, Chiyoda-Ku, Tokyo.

AUDIO Editorial and Publishing Offices, 134 N. 13th St., Philadelphia, Pa. 19107
Postmaster: Send Form 3579 to the above address



Volume I. Packed with drama, this 24 page full-color Comparator Guide describes the eight distinctive new component turntables in the Avant Garrard line. Each new model is a chapter in itself. Featured is the outstanding Synchro-Lab Series including the magnificent SL95B at $129.50, the world's most advanced automatic transcription turntable.

Volume II. Stirring adventure in 12 pages. This full-color Comparator Guide gives you daring new insight into the world of modules. Garrard introduces four exciting units, complete with fine cartridge, base and dust cover, ready to plug in to other components and play. They range from the SLX-3 at $99.50 to the X-11 "Demi" at $39.50.

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COMING IN DECEMBER

Inside the Moog Synthesizer—Much has been written about the results of electronic music recorded on LP discs. Now, Robert Ehle writes about how electronic music is created through use of the Moog synthesizer at North Texas State University.

Layman's Guide to Loudspeaker Specifications, Part II—Victor Brociner continues his examination of technical specifications of speakers and speaker systems.

. . . and more.

PLUS:

Equipment Profiles (Marantz Model Twenty Stereo FM Tuner, Pioneer Model CS-66 speaker systems, and Dual Model 1219 automatic turntable, among others).

. . . and other regular departments

ABOUT THE COVER:

The state-of-the-art of disc mastering is exemplified by a recording studio photograph taken at Sterling Sound's cutting room in New York City. A rack containing the cutterhead drive system, limiters, and a Dolby audio noise reduction system are shown at left-center. In the middle of the photo can be seen a Neumann VMS-66 computer-controlled lathe, while in the foreground (right) is a Telefunken M-10a tape machine and control console. The preview delay loop can be observed between the reels on the tape transport. At the extreme left can be seen a Sony manual turntable and an assortment of test instruments.

Audioclinic

If you have a problem or question on audio, write to Mr. Joseph Giovanelli at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107.

JOSEPH GIOVANELLI

Cartridges & Phono Input Sensitivity

Q. I have an amplifier with a sensitivity of 3.3 mV at the magnetic phono input. Attached to the input I have a cartridge which delivers an output of 1.1 mV per cm per second at 1 kHz. I wish to buy a cartridge of higher output. However, manufacturers use different methods to denote sensitivity. For example, some state output figures based on a stylus velocity of 1 cm per second; others, at 3.5 cm/sec., 5.5 cm/sec., or 7 cm/sec. Therefore, it becomes difficult to compare output values. They all appear to use 1 kHz as a reference.

I have the following questions:

1. Is there a formula that can be used to convert output ratings to 1 cm/sec. or to some other standard?

2. Based on a measurement of 1 cm/sec. at 1 kHz, can you recommend what the optimum output of a cartridge should be to drive my amplifier to its maximum power output consistent with low noise and distortion so that the preamplifier is not overloaded?—Richard Garlatti, New Brunswick, N.J.

A. If you have a cartridge which delivers 1.1 mV at 1 cm/sec. stylus velocity, you will have more than ample output to drive your amplifier when using that cartridge.

If a disc is modulated at 7 cm/sec., that disc is cut at zero dB recording level. On loud passages you can expect at least this much level to be supplied by the disc. Very often levels will reach 10 dB above this nominal zero-level value.

In order to compare specifications of various cartridges you need to know the relationship between stylus velocity and the output voltage produced by the cartridge. This relationship is a direct proportion. If the stylus velocity doubles, the output voltage from the cartridge will also double. This assumes, however, that the entire electromechanical system—record, stylus, and cartridge—are linear. You have to expect some nonlinearity, but the amount will be rather small.

For example, in the case of your cartridge rated as having 1.1 mV output at 1 cm/sec. at 1 kHz, this cartridge will provide 7.7 mV output at 1 kHz when playing as disc recorded at 7 cm/sec., or normal recording level.

TV Sound

Q. Is TV sound, as transmitted by television stations, similar in frequency range to FM sound? If not, what is the frequency range?—Joseph Weiglein, Milwaukee, Wis.

A. Television audio is capable of producing a wide frequency range from 50 Hz to 15 kHz. TV sound is FM sound, but employing less carrier deviation.

However, much of the material produced for television is recorded on optical sound tracks. This places high-frequency limitations on the resultant sound because optical sound systems are usually designed to cut highs sharply above 6 kHz. Video tape recorders, on the other hand, are capable of good high-end response out to 15 kHz. This will be fine if you listen to a live or recorded locally generated show. Network shows will be restricted to 5 kHz unless you happen to be listening to the station from which the broadcast is originating. The bandwidth of the telephone-line circuits is responsible for this high-frequency loss from network feeds.

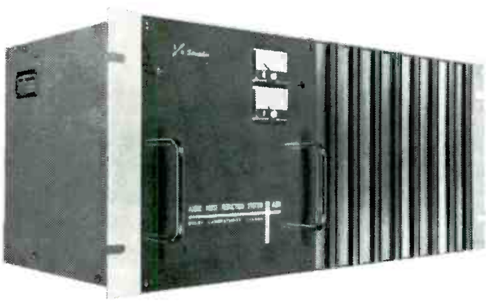
Microphone Switching

Q. I am going to build a mike mixer-preamplifier. I want to switch mikes in and out without any clicking noises. Can you give me a circuit which will accomplish this?—Harold Grovesteen, Hyde Park, N.Y.

A. Eliminating "clicks" when switching microphones in and out of "hot" circuits can definitely present problems, but it can be done. I would say that the job is practically impossible if the microphones to be switched are of the high-impedance type. However, no matter what kind of mikes are employed, the procedure is the same.

You must obtain a low-capacitance key whose contacts are of the make-before-break variety.

"Thanks to the Dolby System our new recordings of The Vaughan Williams symphonies are free of tape noise,"



The Dolby A301

says Roger Hall, Manager, Red Seal Artists and Repertoire RCA Records.

"The Vaughan Williams symphonies have great dynamic range and many pianissimo sections," says Mr. Hall, "Thus when we assigned Andre Previn and the London Symphony Orchestra to record all nine of these symphonies, we used the Dolby System to preserve this dynamic range and to ensure that the quiet sections of the works would be free of the degradation and distraction of tape hiss, print-through and cross-talk."

Music lovers everywhere appreciate the new realism of noise-free Dolby recordings. Over 100 companies in 19 countries are recording with the dependable Dolby System. On your next recording session why don't you use the Dolby System? Call or write . . .

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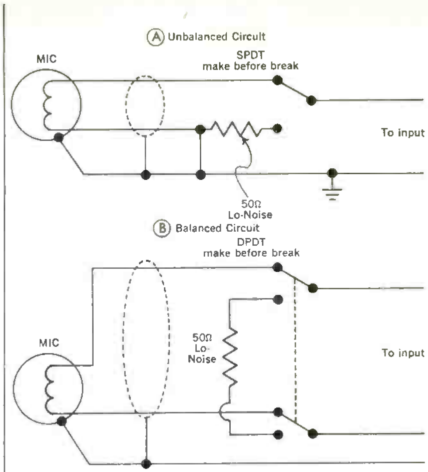


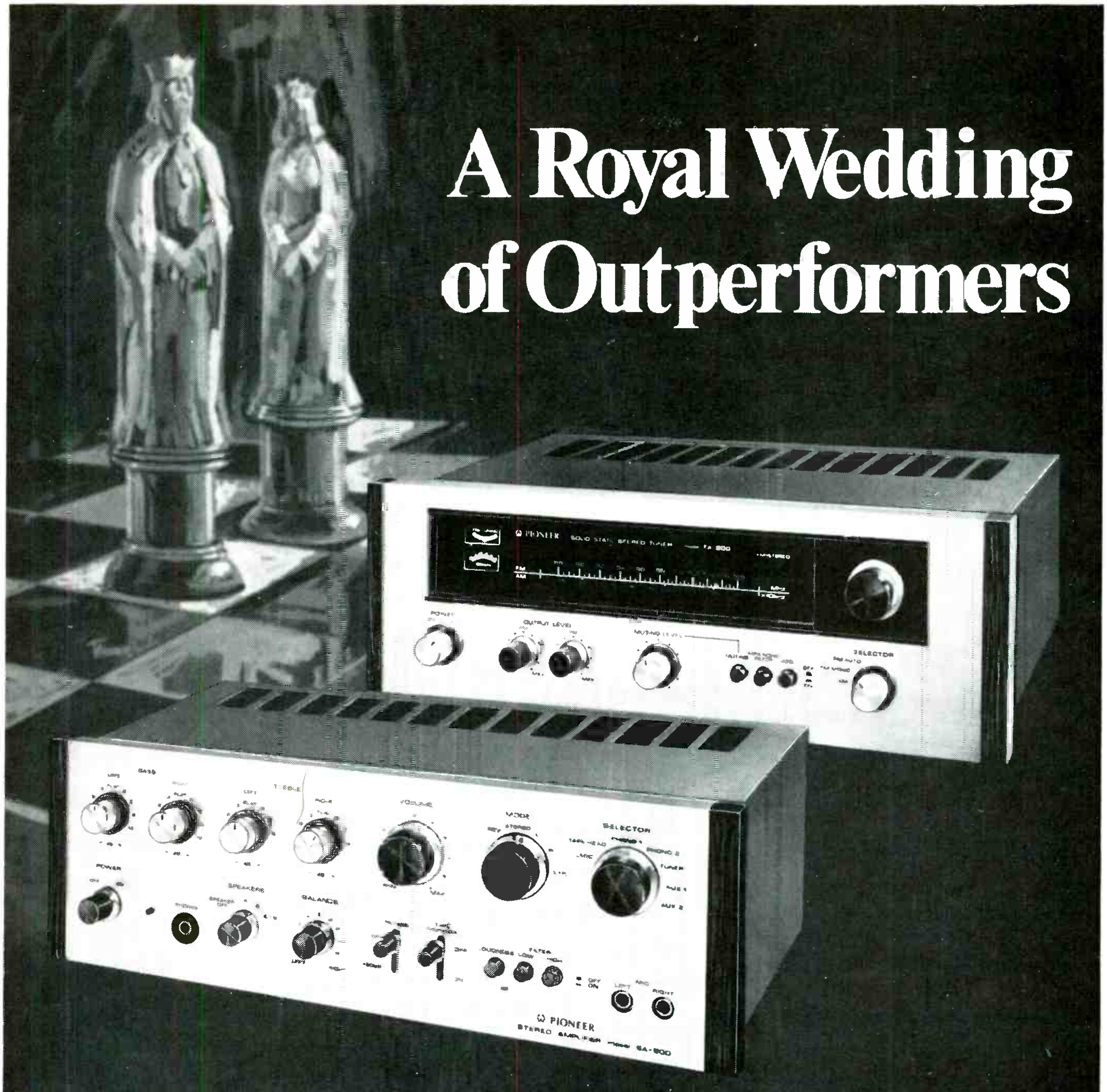
Unbalanced circuits are wired as in Fig. 1A. Balanced circuits are wired as in Fig. 1B. These two circuits assume that low-impedance microphones of 50 ohms are to be used. However, if the impedance of the mikes is of some other low value, the 50-ohm resistor shown must be changed to a value equal to the impedance of the microphone used.

Suppose that the microphone is being switched out of the circuit. Just before the contacts of position 1 are broken, contact 2 closes to the wiper of the switch, placing the resistor in the circuit. Very little difference in sound will result from this change. The difference is not great enough to cause a "click." As the switch is moved further toward position 2, the microphone contacts—position 1—open, leaving the amplifier loaded with the resistor.

The cause of the clicks is the sudden loading or unloading of the input circuit, and the circuits shown here are designed to prevent this. We have described how this works when the mike is switched out of the circuit. However, when the mike is switched back into the circuit, the process is reversed.

If the resistor were not present in this circuit, switching the microphone out of the circuit would result in the amplifier's becoming unterminated. This would bring about a sudden increase in "hiss" level.

Even with the resistor switched into the circuit, trouble will still occur if a break-before-make switch is used. During the switching process, there will be a time when neither the microphone nor the resistor is connected to the amplifier. For that brief instant the amplifier will be unterminated, and this will lead to a momentary increase in noise, probably heard as a click.



A Royal Wedding of Outperformers

Noblesse oblige. Royalty has its responsibilities. And this regal pair combines to produce the ultimate in stereo sound reproduction. Enough to say they are the finest units in the Pioneer collection of quality components.

SA-900 PRE/MAIN AMPLIFIER — Its IHF music power rating of 200 watts (at 4 ohms) is just part of its magnificence. The solid state preamplifier is designed to give exceptionally low noise level . . . better frequency response . . . decreased distortion . . . improved tonal quality. Unlike other units at this price, it offers stepped tone controls for the finest precision adjustments. The pre and main amplifiers can be used independently. Maximum flexibility with inputs for 2 phono, tape monitor, microphone; outputs for two sets of speakers. $259.95.

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What's New In Audio

Pan Pot

Gately Electronics' new four-channel PP-4 unit accepts up to four inputs and permits panning these sources anywhere in the stereo output signal. Automatic level compensation is incorporated so that the signal level appears constant regardless of stereo image location. The unit also has a stereo master gain control. Dimensions are 5¼″ H x 19″ W x 7½″ D. Noise is under −75 dBm; maximum output is +30 dBm without clipping. Input impedance is 10k ohms unbalanced bridging, and output impedance is 600/150 ohms balanced or unbalanced.

Check No. 105 on Reader Service Card

Auto Cassette Player

Sony/Superscope enters the auto cassette machine market with its new Model 20 stereo automobile cassette player. It features a push-in front-loading operation that permits one-hand insertion of cassettes. The cassette is automatically ejected when the end of the tape has been reached, whereupon power to the unit is shut off. The auto cassette machine also features fast-forward and rewind for program search, and tone and volume controls. Incorporating an 18-watt (IHF) dynamic music power output, the company states that the Model 20 is the most powerful auto tape unit available.

Power requirements are 12 volts (auto battery, positive or negative ground). Signal-to-noise ratio is 45 dB; wow and flutter, 0.28% 1⅞ ips; outputs, two extension speakers (impedance for each channel is 3.2 ohms). Dimensions are 2⅞″ H x 7-3/16″ W x 8¼″ D. Price is under $119.50, complete with car mounting bracket and hardware, head-cleaning device, and a coupon for purchase of a 3-pack of prerecorded Superscope cassette albums at a special introductory price of $8.85.

Check No. 106 on Reader Service Card

New Elac/Miracord Turntable

Benjamin Electronic Sound has introduced the Model 750 automatic turntable, at $139.50. It is said to be identical to the Miracord 50H ($159.50) except that the Model 750 has a special four-pole induction

motor instead of a Papst hysteresis synchronous motor, and has different trim. Thus, it retains pushbutton controls, a 12-in. one-piece die-cast turntable platter, and silicone-damped cueing.

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Audio Pot Pourri

- The 1970, 552-page Allied Radio catalog (No. 290) is available free on request.

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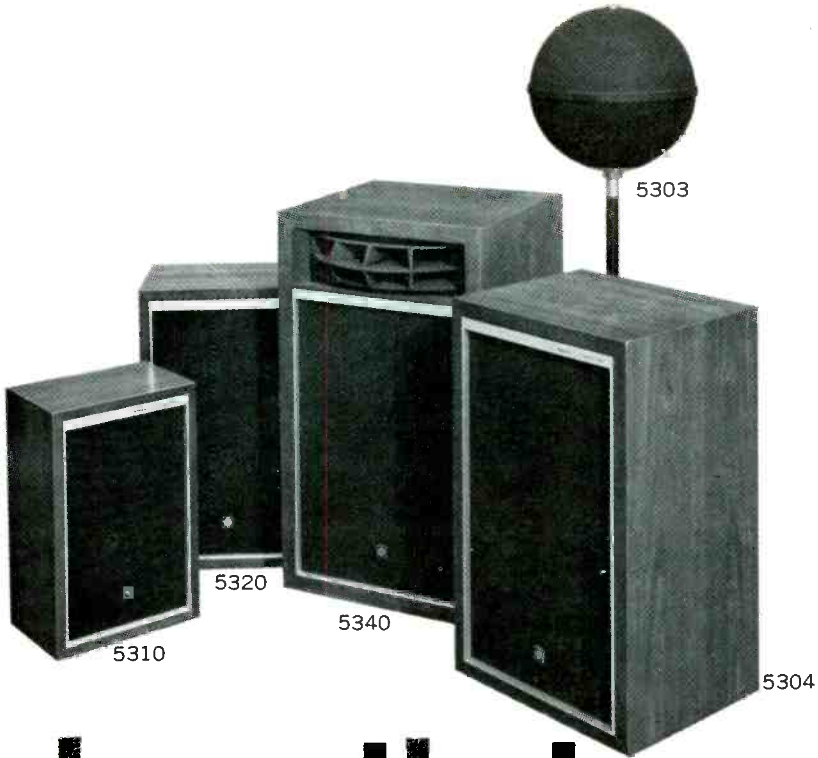
- Michigan Magnetics has added a shifting cassette head to its line that is said to provide bi-directional cassette recording and playback. The new tape-head system operates in a similar manner to the eight-track shifting technique.

Check No. 109 on Reader Service Card

- Formation of a new hi-fi firm, Hegeman Laboratories, Inc., specializing in top-quality hi-fi kits and factory-wired units, color VTR, and electronic musical instruments, was announced by A. Stewart Hegeman, Chief Technical Officer.

- Norelco Philips is reported to have a small, 26 lb. video tape recorder that uses ½″ chromium dioxide tape. It is said to be priced at $646.00. First shown at a European photo show, where it was *not* equipped to use the U.S. 525-line TV system, reports are that a U.S. model will be introduced.

- Morris L. Finneburgh, Sr., Board Chairman of the Ohio-based Finney Co. (manufacturer of FINCO antennas), has been elected to the "Electronic Hall of Fame," sponsored by the National Electronics Association (NEA). He is the first living industrialist elected, previous persons being Thomas A. Edison, Lee DeForest, John A. Fleming, Allen Dumont, Edwin Armstrong, Guglielmo Marconi, and John P. Graham.



Speakers that speak for themselves from JVC

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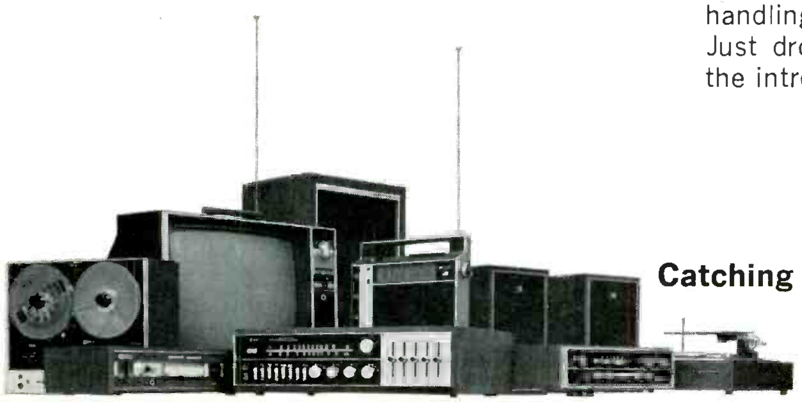
Check the other JVC systems, too. Models 5340 and 5304, powerful 4-way systems with multi-channel inputs. Handle 40 watts RMS and 80 watts peak. The 30 watt 5320 and 25 watt 5310 3-way book-shelf systems also deliver full range JVC-quality sound.

Get more information about JVC speakers and the name of the dealer handling JVC products in your area. Just drop us a line and we'll make the introduction.



Catching On Fast

JVC

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BEHIND THE SCENES

BERT WHYTE

A Professional Viewpoint: An interview with Larry Scully →

Larry, these days your Scully Recording Instrument Co. is mainly engaged in the manufacture of tape recorders, whereas for many years the principal production was of disc recording lathes. Am I correct?

SCULLY: That's right. My father started the business in 1918, after having worked at the Columbia Record Co. from 1905 to 1918. He was in the experimental laboratory. In those early days the record companies had to manufacture all the equipment used to produce a disc. They made their own lathes, made their own soundboxes and megaphones to pick up the sound in the studio, did their own plating, made their own presses . . . the whole works.

Even their own phonographs!

He worked mostly on the development of the disc recording lathe, and from that experience when he left Columbia in 1918 he started to make the lathe on his own, hoping to interest some independents to get into the record business. It took him about a year to build the first machine.

Was this the machine that worked on "gravity drive," and gave rise to the expression of "throwing the weights out of the window"?

SCULLY: Yes, it was a weight-driven machine. The lathe was usually put up on a pedestal at least 5 or 6 ft. high, so that there would be enough of a drop for the weights to drive the machine for the amount of time needed to cut the disc. If they wanted a longer time there was a hole in the floor to give the weights more room, or they raised the pedestal even higher. They had to use platforms to stand on in order to operate the machine.

I understand that although this all sounds relatively crude, this arrangement made the motor drive the turntable very smoothly.

SCULLY: Well, it was very good for the time. The motor was controlled by a governor which made it quite smooth. The entire lathe operated on a purely mechanical basis, of course.

What did they do about lead screws in those days?

SCULLY: They cut their own lead screws, and in those days the pitch was quite coarse, running perhaps 70 to 80 lines to the inch so they had very little trouble with overcutting.

I presume the coarse pitch was practically mandatory, since there were no really quiet sections on a disc and everyone had to bellow into a megaphone in order to drive the cutting stylus.

SCULLY: That's right. It took a lot of acoustic energy to move the diaphragm and the relatively heavy mass of the stylus against the resistance of the wax master.

After your father set up his company, who bought the first lathe?

SCULLY: Well, he didn't really start a company at that time. He bought the necessary machine tools and built the lathe at home. Then he went to New York and sold it to a group that became the Cameo Record Co. My father was a fairly good showman too. He would not bring the machine to New York to demonstrate its performance. Instead he would have them come up to his house, where he used the living room with fancy backdrops and special lighting to set off the machine, which if I may say was pretty impressive.

Sounds like he pre-dated some of our modern merchandising methods! And I quite agree about the appearance of the lathe. The first time I saw one with all the gleaming engine-turned finish, I was reminded of Bugatti racing car engines, or the instrument panel of a Duesenberg "J" model roadster. It was all very confidence-inspiring!

SCULLY: The look of the machine was important and had its advantages. In later years, when transcription recording came into being, some of the broadcasting outfits would keep the lathe in full view to impress their clients.

The "modern" version of the lathe came out about 1938, I believe.

SCULLY: Yes, and except for convenience features dictated by advancing technology and the advent of stereo, the present lathe has the same basic configuration.

What was the original method used for the reduction of rumble in the lathe?

SCULLY: In the initial units there was a motor and a gear-reduction system used to drive the turntable directly. You needed a thrust bearing in order to carry the weight of the turntable, and that meant you had to have either a ball thrust of a plain bearing. The plain thrust bearing produced a lot of friction because of the mass of the table, whereas the ball bearing tended to produce rumble, or worse still, a pattern on the record.

I've never heard of that. What kind of pattern?

SCULLY: A pattern produced by the vibrations. You could practically count the number of ball bearings by the pattern. The ball bearings used to be set in the ball races in felt in order to minimize this problem. Of course the requirements then were far less than they are now. In 1938 we went to the belt drive, primarily to get rid of the thrust bearing involved in a "straight-through" drive.

That was the multiple bearing system, if I recall. At that time, I believe you also had a massive flywheel at the bottom of the lathe, driven by a belt, with the flywheel and the turntable connected by a shaft with a flexible decoupling stage.

SCULLY: Yes, we have this filter drive assembly that cuts down the rumble and also was designed to keep out high-frequency flutter.

Larry, I have heard through the years that in order to take best advantage of all the precision built into the lathe and to keep rumble at the absolute minimum, it is preferable to mount the lathe on a concrete floor. Is this true?

SCULLY: It would be nice to always

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removes the "veil" from between the performer and the audience

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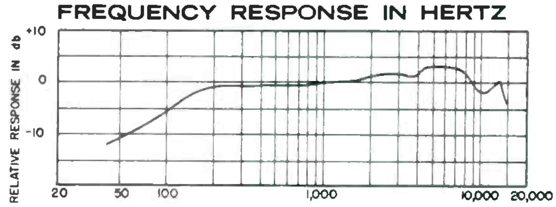
FREQUENCY RESPONSE IN HERTZ



SHURE 579 VOCAL SPHERE

low impedance omnidirectional dynamic microphone

Shure Brothers Inc., 222 Hartrey Ave., Evanston, Illinois 60204

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have it that way, but it has been my experience that with the type of solidly constructed floors they have in New York, for example, there isn't much of a problem.

What if the floor is the standard wood type?

SCULLY: Well, if it is wood, you can run into troubles.

With resonances, I presume?

SCULLY: Yes, although sometimes you can be lucky enough to be at a null point of the vibrations. Depending on the general construction of the building and the type of wood floor, some type of extra damping would be necessary to use the lathe in such a location.

Many record critics often speak of rumble in a recording, but I have always contended that a well-maintained lathe mounted in an optimum way has rumble so far below signal as to be inaudible, and what these critics are hearing is mold grain due to the electroplating process and subsequent grinding of the stamper in order to make it fit properly in the press.

SCULLY: I would say that is correct, although we must admit that, with the vertical component of the stereo disc, rumble suppression has been made more difficult and you have to keep on top of all the factors involved.

The lathes are still being made in spite of your emphasis on tape recorders these days. That is done in a separate plant, as a different division?

SCULLY: It is not actually a separate division, what we do is combine the lathe work with machine work necessary for the tape recorder.

Singer Jerry Vale in control room, with Scully 280 tape unit at right.

Lathes last a long time, and people generally don't order them by the dozen. I presume that between yourselves and the one other company in field the market is pretty circumscribed.

SCULLY: Yes, even when we had literally the world market to ourselves, it wasn't a tremendous business. The Japanese and the Italians, too, looked at the possibilities of the disc lathe business right after the war and concluded that it was too limited. Today we build the lathes strictly as a custom product.

This limited market was what prompted your move into the tape recorder field. That was about 1961?

SCULLY: That's right. We decided we had a good reservoir of machine tools, trained personnel, and experience which was certainly related in many ways to the manufacture of tape recorders.

In 1961 I presume your first products had to be machines for the full-track and half-track mono and two-track stereo on quarter-inch tape, and three-track stereo on half-inch tape?

SCULLY: No, our first tape machine product was a playback-only unit, the model 270. That unit was designed to be used with automated radio station equipment, which at that time was thought to be a "coming thing." We produced this unit between 1961 and 1963, and when the anticipated sales of the radio station equipment didn't materialize we went into production of our first quarter-inch two-track recorder. Shortly thereafter, the three-track machines were the big thing on the market, and then the four-track, half-inch tape unit was the mainstay of production for several years.

Then about three years ago, the eight-track machines came into being, and then the 16-track and the 24-track . . . and just where will it all end?

SCULLY: Well, from our experiences in the field, it would seem that the 16-track unit seems to be presently favored and is thought by many to have the most versatility.

The 16-track unit uses one-inch tape?

SCULLY: Yes, and we have made some 12-track one-inch recorders as well.

Let me ask what may be a dumb question. As you know, 24 tracks are being used, and these days the studios are in a peculiar bind with these rock-and-roll record producers who insist on all sorts of wild effects, and who are literally forcing many studios into multi-track situations. They feel that an eight-track studio is already "old hat." Wouldn't it be cheaper and technically feasible to sync together two 16-track machines and afford these producers thirty-two tracks?

SCULLY: It might be a distinct possibility since with that many tracks available you could use some of the tracks as control tracks.

Yes, the control tracks would help. And with all the tracks self sync, the effects possible would be almost limitless. Then, too, there shouldn't be much trouble in the eventual mix-down to two-track stereo.

SCULLY: Once the two machines were synced together, everything else would work quite normally.

If the two recorders could be synced together, I wonder if there would be a problem because of small but nonetheless differing degrees of tape stretch on the two recorders? Mylar does stretch, although these days they have that special "pre-stretched" Mylar tape.

SCULLY: I don't think that would be a factor and the degree of displacement between the two tapes would be minute. We make our big multi-track recorders for two-inch tape and all the two-inch machines we have on order at present are for 16 tracks. It doesn't mean that if someone wants to go to 24 tracks that his machine is obsolete; but he would have to get a new head assembly and the additional electronics. So there is a certain degree of flexibility possible before we may have to think about syncing two 16-track units together!

Most of the 4-track units are on half-inch tape, but I understand you have made some 4-track units using one-inch tape.

SCULLY: Yes, these were for the most part for the European market.

I suppose they wanted wider track widths to give them better signal-to-noise ratios. That isn't much of a problem any more with the advent of the Dolby System, I should imagine.

SCULLY: That's right. The Dolby System has helped in this respect. Nevertheless, I don't feel track width should be restricted if it can be avoided.

Is this because distortion is higher at the narrower track widths?

SCULLY: Only marginally so, but the kind of quality our clients seem to

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BEHIND THE SCENES

(Continued from page 12)

want is exemplified by their restricting their orders for two-inch recorders to 16 tracks.

Larry, to digress a moment, you know that the Studer Co. in Europe manufactures expensive professional tape recorders, but they also make a little "kid brother" recorder called the Revox which has made quite an impression in this country. Do you think you might ever make a consumer-type tape recorder?

SCULLY: We could design such a machine, and I think we could come up with some new ideas, but the cost would be prohibitive. I think for the forseeable future we will stay out of that market.

With your company's extensive background in machining, a "spin-off" from your lathe production, I assume you machine and manufacture most of your own parts for your tape recorders?

SCULLY: Yes. Only when the requirements for quantity cannot be met with our facilities here do we farm out machine work to appropriate firms.

Do you make your own tape heads?

SCULLY: No, use heads made by Nortronics and by IEM. We order them to a particular configuration and specify inductances and other electronic requirements to conform to our electronics.

You do not make your own motors, do you?

SCULLY: No, we do not. And getting the right kind and quality of motors is a continuing problem.

You mean motors with sufficient torque, cool-running, etc.?

SCULLY: Not that so much as motors that are quiet. This is largely a matter of ball-bearings.

Maybe you need some of those new bearings they say someday will be cast in outer space and which will be perfectly round.

SCULLY: Well, a lot of the bearings are pretty good, but we run into a variety of lubrication problems. You run into greases that are too stiff for your application. By and large, I think our company (and I think most other tape recorder manufacturers would bear this out) has to contend with occasionally noisy ball bearings in the motors and in other areas where they are used. Then there is also the problem of bearing damage in shipping. The rotor of the motor has mass, of course, and it's spring-loaded at the top end to seat it in the ball bearings at the bottom. If the shipping case is dropped so the inertia unseats the rotor shaft and then the spring bounces it back against the ball bearings, tiny "flats" are formed, and this means a noisy motor.

Your capstan motor is a hysteresis synchronous unit. Have you given any thought to what appears to be a coming trend, the servo controlled motor?

SCULLY: Oh yes, we are digging into that, and in fact have been investigating this type of motor for over a year. So far we haven't seen a very great improvement in performance—I'm talking about capstan motors not spooling motors—to warrant replacement. A good hysteresis motor will get you .04 to .06 NAB wow and flutter unweighted. A good d.c.-control-type motor will give you about .04, and it will be a little less "spiky" than the hysteresis motor.

How many poles do you use in your hysteresis motor?

SCULLY: We have six poles and twelve poles in our combination two-speed motor.

You hear these tales going around that the more poles the better the motor. I suppose after a point it's a question of diminishing returns.

SCULLY: It is a matter of construction, a mechanical problem. The outside-in motor can tolerate more poles and still not sacrifice too much of the iron by having too many slots in it.

The idea of the outside-in motor is that it gives you more rotating mass and presumably a smoother drive function?

SCULLY: Yes, that was my original thinking back in 1963, but I have found that the more mass you get the less damping you get. It makes the motor difficult to damp so today, we lean more towards less flywheel action on the capstan motors.

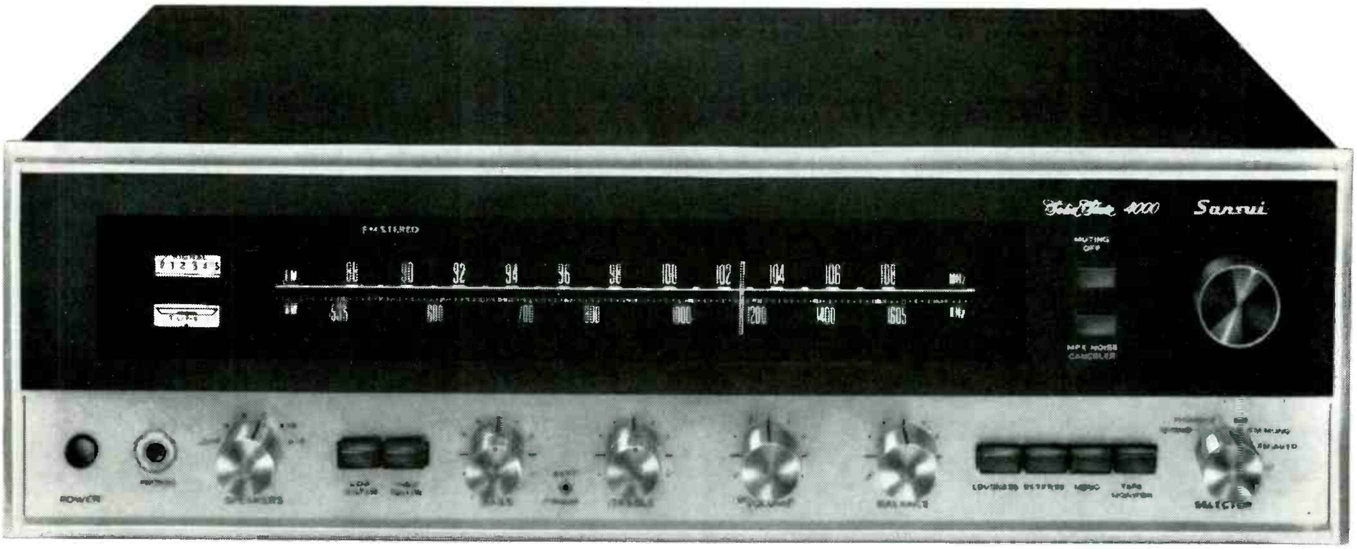
This is unusual! The old way was to supply mass through a big flywheel.

SCULLY: Well, it is good for high-frequency perturbations, but not for low-frequency upsets.

There appear to be many new ideas in

(Continued on page 16)

widedialed wonder . . .
and linear too



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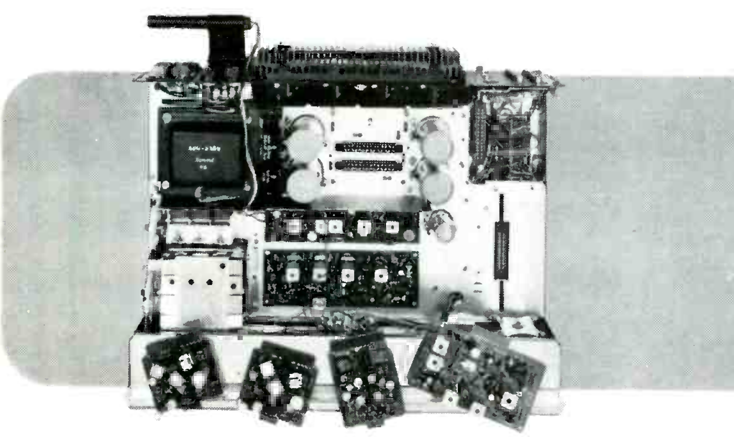

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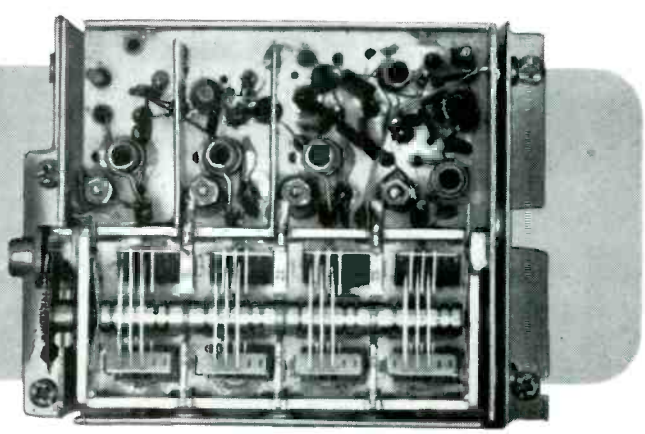

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BEHIND THE SCENES

(Continued from page 14)

tape-machine construction that run contrary to some of the old accepted practices. For example, a friend of mine builds a high-quality recorder in which he uses what would seem to be an amateur anachronism: a tiny nylon head pad, which he claims gives much better high-frequency response.

SCULLY: I think all of us would like to use a pad, but head wear gets involved. In the eight-track cartridges they have the little spring-loaded pads that hold the tape tight against the head. This is a big advantage in that particular application in maintaining high-frequency response.

In other words, even though the tape manufacturers have done a pretty good job in giving us smooth tape surfaces, there are, inevitably, little undulations and other discontinuities on the surface which the use of the pads helps overcome and gives the better high-end response. Too bad the wear factor is such a problem. Perhaps the use of ferrite heads would help in this respect. Have you used any of this type?

SCULLY: We use ferrite heads for our erase, but thus far not for record or playback heads.

Well, I have heard the ferrite heads are friable, being easily chipped or broken. But the head-wear aspect is terrific. And many of the crosstalk problems in tape duplicating, due to head grooving and subsequent skewing, have been overcome with these heads.

Getting back to the servo motor again, another thing I was told was, that in addition to the low wow and flutter, this motor has better torque than a hysteresis type.

SCULLY: It has more torque, but it is not much of an advantage in capstan drive. Ideally, if your spooling motors are set right, the capstan motor should not be doing much more than metering the tape as it goes through.

Is there any advantage of the servo motor over the hysteresis in terms of drift, the long-term stability from one end of the reel to the other?

SCULLY: No, it would be subject to the same conditions as the hysteresis unit because of the slippage problem at the end of the reel.

Would you ever consider building your own motor in order to get your ideal specifications? I think you did this once in the old disc-lathe days.

SCULLY: Yes, about 1934 I built a motor for the lathe, but the cost today precludes any such possibility, even if we had the time and the inclination.

I believe you make all your record and playback electronics here?

SCULLY: Yes, the control and ready availability makes this important.

Do you make the printed circuit modules as well?

SCULLY: No, that is subcontracted, and I should have expanded my previous statement in that about 20 per cent of our electronics is by intent made outside so that in the event of a fire or something that might happen here we would not be out of business because of lack of electronics.

Obviously you maintain a complete test facility for both electronic and mechanical components. In its final run-through and check does each machine have its bias adjusted for a particular kind of tape?

SCULLY: Yes, they are adjusted for Scotch low-noise 201. The user is, of course, free to adjust the bias to any other tape for particular characteristics.

One of the basic concepts of your design is the interchangeability of heads and tape guides and electronics. Thus, a quarter-inch two-track machine can be changed to a 4-track half-inch recorder, and so forth. I have always thought this would be a great thing to have on a high-quality amateur recorder, but I suppose that in mass production this would be very difficult.

SCULLY: I'm afraid so. The head block, for example, must be machined to fit into an equally machined place on the top plate. This calls for extreme care, and in this business this means it becomes expensive.

The electronics are all the same, except, I presume, for some special switching which may be on those used with the 8- and 16-track units. Interchangeability is much easier here?

SCULLY: Oh, yes. It is a simple matter of plugging and unplugging until you set up your desired configuration.

The electronics and the heads are all set up for self-sync. By switching, the record head becomes a playback head, and will play back the program while new material is being recorded along with it. This can go on for as long as you have tracks available. The "mix down" to two tracks can get very involved and pass through many generations and is a prime

(Continued on page 79)

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EDITOR'S REVIEW

Glimpses of the 1970s

■ Four-channel stereo, first reported by Edward Tatnall Canby in the September 1969 issue of AUDIO Magazine ("4 on Tape," page 27), is producing tremors within the industry. Four-channel equipment designs have gone beyond the prototype stage in some instances since Vanguard Records demonstrated its four-channel "Surround Stereo" system, which utilizes magnetic tape— Both Crown International and Telex, for example, have introduced four-channel tape machine models; H. H. Scott has a four-channel, 35-watts (rms)/channel integrated amplifier, the Model 499 "Quadrant."

Vanguard's demonstration was quickly followed by a four-channel broadcast (utilizing two stereo FM stations) at Tanglewood, Mass., with Acoustic Research, Inc. being one of the sponsors. AR thereupon set up a four-channel system in its Grand Central Station exhibit room for all to hear. Reports are that CBS is producing the demo tapes. New York City, too, has had four-channel broadcasts with the cooperation of multiple broadcast stations. Even more exciting, however, are prototype designs of equipment that will enable *one* FM broadcast station to transmit four-channel stereo through use of the SCA piggyback frequency. Adapters have already been designed to convert conventional stereo (two-channel) FM receivers to four-channel receivers. The FCC is now mulling this one over. And to top it all, *Time* Magazine reports that an enterprising inventor has created a four-channel system for LP discs!

Meanwhile, speaker manufacturers might have an opportunity to double sales again should the new concept be accepted.

The world of video, too, is being shaken up a bit by events. For example, RCA unveiled a laboratory model of a color TV tape player, called "SelectaVision," built around lasers and holography. According to RCA spokesmen, the unit will be designed to attach to any standard Color TV set, will play full-color programs recorded on tapes made of the same inexpensive plastic material used in supermarkets to wrap and display meats (which will cost only about 1/10th as much as conventional-type films), and is expected to be ready for home use in the early 1970s. Target price for the "SelectaVision" players is under $400, while target price for a half-hour prerecorded cartridge videotape is about $10. Interestingly, the tapes are said to be dust-proof, scratch-proof, and can be moved at any speed to achieve slow-motion effects or even be stopped completely for viewing a single frame.

The CBS "Electronic Video Recording" system introduced much earlier seems destined to run smack into the new RCA system. Its price is substantially higher ($800 for the player, for example). But EVR is moving fast. A Canadian company who has marketing and distributing rights for CBS' EVR film process has acquired world-wide EVR rights to the Hal Roach Film Library, for example, which includes some 500 comedies (Laurel & Hardy, Harry Langdon, et al).

With the above video systems using cartridges, and with the tremendous consumer acceptance of cartridge (and cassette) audio tapes, could cartridges for conventional video tape recorders be far behind?

The Japan Broadcasting Corp. has begun some experimental broadcasts of two sound channels for television, we learned. Westinghouse had developed a "stereo-sound TV" (experimentally) some years ago, of course. But advocates of stereo FM sound for TV are gaining strength.

If the past Institute of Electrical and Electronic Engineers (IEEE) Chicago Spring Conference was any indication of things to come in home entertainment electronics, expect to see more and more digital tuning through pushbutton and thumbwheel controls.

Further, we expect active equalizers to make considerable headway in 1970, both for enhancing speaker performance and to modify sound output to meet the need of a particular environment.

A. P. S.

PHOTOGRAPH BY FRANZ EDSON

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Tape Guide

HERMAN BURSTEIN

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

From time to time readers ask why there are surprisingly large price differences among tape machines with similar performance specifications and similar surface appearance. To the layman, and particularly to the novice, there is a substantial tendency for two machines of the same dimensions, one glittering with knobs and costing $150, and the second, glittering with about the same number of knobs but differently arrayed, and costing $300, to look much alike. The general answer is that differences in price tend to be due to differences in how well a machine performs and in how long a machine continues to perform well.

Play Records through a Recorder

*Q. I intend to use my stereo record player with other stereo equipment. If I should purchase a *** tape recorder, what would be a good way to hook it up? Also, can I use this tape recorder as an amplifier? If I cannot, can I purchase an amplifier to be used with the turntable and tape recorder? Please advise as to the speaker system.*—G. F. Ingram, address withheld.

A. The tape machine to which you refer has a power amplifier, so that you can hook up an external speaker to it, if you wish. If your record player has a ceramic cartridge, rather than a magnetic one, you can probably find some way of operating your record player through the tape machine. But if the record player has a magnetic pickup, I doubt that you can feed the pickup signal directly into the tape machine. However, some relatively inexpensive phono preamps are available from the audio stores and catalog houses; these can preamplify and equalize the signal from your magnetic preamp, so that the resulting signal can be satisfactorily fed into the tape machine's high-level input.

Stereo Mixer

Q. I have been searching for plans for a high-quality solid-state microphone mixer (stereo). Could you make suggestions for such a mixer or guide me to a source of plans for such a mixer?—John Richardson, Pauls Valley, Okla.

A. You may find parts or all of what you are seeking in: (1) William G. Dilley, "A Condenser-Microphone Mixer," AUDIO, October 1962; (2) Peter A. Satrk, "Transistorized Stereo Microphone Mixer," AUDIO, October 1963; (3) William A. Rheinfelder, "High-Quality Phono Preamp with FET's," AUDIO, November 1966.

Cross-Field Heads

Q. I am interested in finding a tape recorder that is capable of recording the whole audio spectrum from 20 to 20,000 Hz with good fidelity. I notice that many preamps and power amps are capable of this wide-range response. Thus I have come to the conclusion that the tape head is the part of the tape recorder that limits frequency response and uniformity of response. Is this conclusion correct? If so, what type of head is best for wide-range frequency response? I have heard about cross-field heads and have noticed that they are held to be capable of wider response, but do they also exhibit uniformity of response? Also, do they affect fidelity in any other way? Can I obtain information about cross-field heads?—Jim Rasmussen, Cicero, Ill.

A. The limitation on frequency response, particularly treble response, is basically tape speed. The art of making tape heads has reached the point where at speeds of 3.75 ips and higher the heads present very little problem. An important factor in treble loss is bias current applied to the tape (bias is employed to minimize distortion and maximize the amount of signal recorded on the tape). Bias loss varies inversely with wavelength; thus, the slower the tape speed, the shorter is the recorded wavelength at a given frequncy, and the greater is the loss at that frequency. In most machines, bias current is applied to the tape via the record head. Using the cross-field principle, however, bias current is applied via a separate head. Usually this head is placed opposite the record head, so that the bias head contacts the base of the tape rather than the oxide (as do the record, play, and erase heads). The cross-field principle was developed by the Illinois Institute of Technology, Chicago, Illinois. More information may be obtained from the January 1969 issue of AUDIO.

Red and Black Oxides

Q. I have some questions pertaining to magnetic tape: (1) Why is practically all pre-recorded tape red oxide? (2) Why is black-oxide tape used so much in blank white box and bargain-tape sales outlets? (3) Is black oxide any more severe on tape recorder parts than red oxide? Let us assume both are a good-quality product. (4) Is there any major difference in print-through, output, or frequency response when both red- and black-oxide tapes are quality tapes? (5) Is there any specific reason why black-oxide tapes are often lower priced?—Glen Blair, Idaho Falls, Idaho.

A. (1) I would guess because the oxide formulation in question best meets audio needs. (2) This may be because the tape was originally made for other than top-quality audio purposes, or because the formulation is a cheaper one. (3) I don't know. The important thing is the amount of lubricant in the tape and the smoothness of the oxide formulation so that there is minimum friction between head and tape. (4) There may be. So-called high-output tapes, which achieve this higher output partly through a different oxide formulation, tend to have higher print-through. Different oxides also have different frequency-response characteristics. To the extent that differences in color correspond to differences in oxide formulation, differences in color correspond to differences in output, frequency response, and print-through. (5) This question really relates to question 2.

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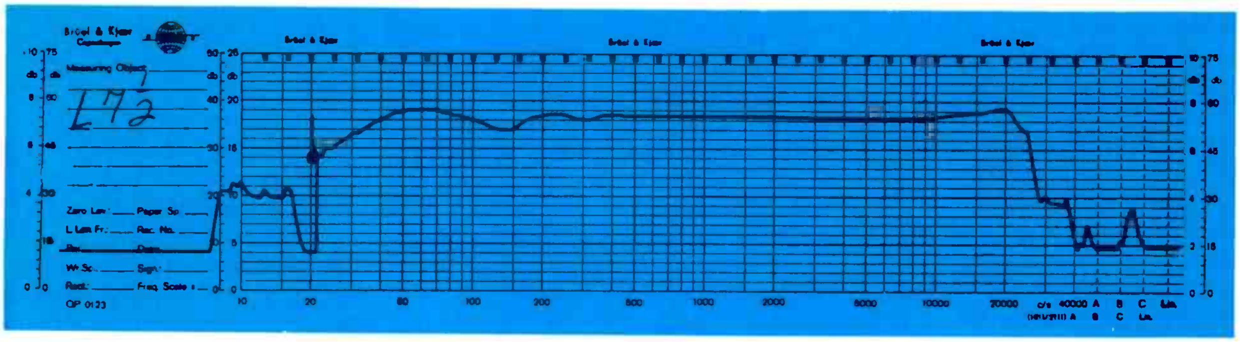

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Layman's Guide to LOUDSPEAKER SPECIFICATIONS

Part One

VICTOR BROCINER*

INTERPRETATION OF SPEAKER SPECIFICATIONS probably presents more of a problem to the layman than understanding the specifications of any other component of a sound reproducing system. This is partly because of the complicated nature (despite a speaker's simple appearance) of its functioning. Tuners, amplifiers, and tape units have both inputs and outputs that are electrical. Phonograph pickups convert a mechanical input to an electrical output. But speakers accomplish a double transformation: electrical to mechanical to acoustics. Also, the acoustic output does not appear at a convenient pair of terminals where it can be measured, but is diffused, usually nonuniformly, through space. The sound field produced is markedly altered by the listening room itself, so measurement is not easy. Mainly because of this, no complete, generally accepted standards exist. There is a natural tendency for manufacturers to present data in a manner that is most favorable to their product based on measurements made, at least partly, to their own standards.

Speaker systems present great variety in concept and design. Their description is necessarily made in somewhat technical terms, many of which may be unfamiliar to the layman both as to definition and significance.

The purpose of this article is to define the technical terms used, in an understandable manner; to provide some information about what they mean in terms of speaker performance; and to acquaint the reader with speaker specifications so that he will be able to evaluate them and to ask pertinent questions when more complete information is required.

The terms referred to include not only performance specifications such as frequency response and power-handling capability, but also descriptive terms such as air suspension, loading, flux density, and the like. The definitions do more than explain what the speaker manufacturer is talking about; they include a brief treatment of the effect each item has on speaker performance; in fact, they even help to explain how a speaker works.

Vice President Planning, H. H. Scott Inc., Maynard, Mass.

Definitions and Explanations

Let's begin with a definition of the subject of our discussion. A *speaker system* is an assembly consisting of one or more speaker units in an appropriate enclosure. The enclosure itself may constitute a horn, loading the woofer. The remaining terms are listed in alphabetical order. This means that a given definition may use words not defined until later.

Acoustic Lens—A device that is used to widen the dispersion of the higher frequencies which otherwise tend to form a narrow beam of sound. Acoustic lenses can take the form of parallel, bent plates, closely-spaced arrays of bars, rods, or other solid objects, or multiple holes or slots in plates.

Acoustic Suspension (also called "air suspension")—The speaker cone has a highly compliant suspension; it moves very freely, so its motion is determined more by the spring-like action of the air in the box behind it than by the mechanical action of the suspension itself. An air spring is much more linear than mechanical deformation of the suspension, reducing distortion in the bass range, where the cone goes through large excursions.

Annulus—See "Surround."

Baffle—In free air, there is cancellation between the sound wave produced by the front of the speaker cone and that produced by the rear. When the cone moves forward, it compresses the air in front of it, which flows around the edge of the speaker and tends to annul the partial vacuum created at the rear of the cone. This effect also occurs, of course, with reverse motion of the cone. It is appreciable only at low frequencies. A flat baffle must be quite large to be effective at low frequencies. At 30 Hz it would have to be about 19 feet in diameter! Since this is not very practical, especially for bookshelf speakers, flat baffles are no longer used. One exception is a speaker mounted in a wall, with its rear radiating into an adjacent room. However, the term is still sometimes applied to any device used to separate the front and back waves, such as a closed box. See "Infinite baffle."

The reader may wonder why cancellation takes place only at low frequencies. A really good explanation is not simple and (like the large baffle) would not fit into this series of definitions. But a rather good analogy is the motion of a paddle in still water. For a slow back-and-forth motion, the water flows around the paddle. A fast motion produces waves that spread out from the center of disturbance.

Basket—See "Frame."

Bass Reflex—When a speaker is mounted in a closed box with an auxiliary opening, or port, whose size is suitably related to the volume of the box, the rear wave emerges *in phase* with the front wave and reinforces it over an appreciable part of the low-frequency range. The mass of the air in and near the port and the stiffness (or compliance, or springiness) of the air in the box form a resonant system which produces a phase reversal. The action can be explained by means of a mechanical analogy. Consider a heavy pendulum, whose weight is the analog of the mass of air in the port. Attach a rubber band to the pendulum. The rubber band's compliance corresponds to that of the air in the box. Hold the other end of the rubber band in your hand and move it forward and back very slowly. The pendulum will swing in step with the motion of your hand. Now gradually increase the speed of motion. At one critical speed (frequency) the pendulum will swing forward when your hand moves backward, and vice-versa. This means that its phase has been reversed, as is the phase of the back wave in the bass reflex cabinet. For this reason it is also referred to as a "phase inverter" system. Other terms used are "ported cabinet." See "ducted port."

Coaxial Speaker—A speaker with a tweeter mounted on the axis of a woofer and inside its cone. A horn driver unit may be placed within or behind the magnetic structure of the woofer, with the horn throat passing through the center pole of the magnet assembly.

A woofer, mid-range speaker, and tweeter may be mounted coaxially, forming a three-way coaxial speaker. Sometimes the mid-range is covered by an auxiliary cone, attached to the woofer voice coil and having an unsupported or free edge. Opinions differ whether this should be called a three-way speaker. The transition from bass to mid-range is effected mechanicallf and the change to high frequencies electrically, unlike a "pure" three-way system where three distinct electro-mechanical assemblies are used. But it operates in three modes.

Sometimes the units of a coaxial system are not really coaxial but slightly displaced from each other laterally. This can improve the smoothness of the frequency-response curve in the region of the crossover frequency between speakers.

Coaxial speakers are made because they are more convenient to handle by the user who installs them in a cabinet himself; they save space, because the relative positions of the speakers are fixed by the designer to provide smoothest response, and for another reason as well: in a two- or three-way speaker system, the path lengths from the individual speakers to the listener are somewhat different, resulting in different arrival times for the components of a transient. The coaxial construction minimizes the differences in path lengths. Not everybody agrees that this is important, but for those who do there are coaxial speakers.

Compliance—The ease with which a material "gives" when a force is applied. In a speaker, compliance is the distance of cone movement divided by the strength of the applied force. A speaker suspension must have compliance to enable the cone to move, and the compliance must remain as nearly constant as possible over the large excursions that take place in the bass region. Another way to put it is that the motion is linear, that is, proportional to the applied force. This enables the speaker to reproduce low frequencies without distortion. People often say "high-compliance cone" when they are actually referring to the cone *suspension* (the surround and spider).

"High-compliance" speakers are linear over a large excursion range. It is generally thought that this results in a low resonant frequency. This is not necessarily so if the cone and voice coil are very light. In this case efficiency is good in the middle register but bass is not well reproduced. For good bass reproduction the moving system must be heavy and not too strongly damped, either mechanically or electrically.

Cone—The reciprocating diaphragm or sound radiator of a direct-radiator speaker, usually conical in shape. Straight-sided cones are most often used in woofers because they offer maximum rigidity. Curved cones break into concentric modes of vibration at higher frequencies, so that the outer sections become "decoupled" and tend to remain stationary as the frequency is increased. The effective cone size is decreased at high frequencies which reduces the moving mass and holds up the response which would otherwise fall off in the treble range. The smaller effective cone size also produces a wider dispersion and prevents the "beaming" effect of a rigid piston.

Cones are usually made of felted paper, which provides a desirable combination of strength, light weight, and good mechanical damping. The material is "dead"; it does not ring like a bell when struck, and consequently produces far fewer spurious responses than would a "live" material. Cones have also been made of foamed polystyrene and polyurethane because of their high stiffness-to-mass ratio. In general, their internal damping has turned out to be less than anticipated. However, foam cones are being successfully used in some designs, sometimes coated with aluminum foil. Polymerized plastic cloth is also used.

Cone Bead—a thickened section, usually circumferential, used to stiffen a cone.

Cone Break-Up—At low frequencies, a cone moves as a unit, like a piston. As the frequency increases, flexibility and mass of the cone change the nature of its motion. The apex follows the motion of the voice coil, but the remainder of the cone does not. At some frequencies, parts of the cone may actually move backward when the coil moves forward. The irregular manner in which different parts of the cone move is called "break-up."

Cone break-up causes irregularities in the frequency-response distribution pattern of a speaker. Break-up can be designed into a speaker to provide extended high-frequency response and improved dispersion. A rigid piston becomes more and more directional as the frequency increases, and its response drop off as well. If the outer zones of a cone can be made to move less than the inner ones at high frequencies, the cone acts like a smaller, lighter cone with more high-frequency response and wider distribution. Cone design and fabrication are the most critical of any of the aspects of speaker design and manufacturing, and more of an art than a science. The term "cone break-up" is generally used to refer to the *undersirable* modes of operation.

Cone Corrugation—A circumferential U-shaped bend in a cone that acts against unsymmetrical deformation of the cone. Since it is compliant in a radial direction it is used to divide the cone's motion into circular zones at the higher frequencies. A number of corrugations can be designed progressively to decouple the outer sections of a cone as the frequency increases, producing better treble response and improved angular distribution. Multiple corrugations at the outer edge of a cone are often used as a compliant edge suspension that supports the cone while permitting axial movement. See "Surround."

Cone Stiffness—Stiffness is the opposite of compliance. Cones made of stiff materials are strong but tend to break up into undesirable modes of vibration. Often incorrectly used to refer to the stiffness of the *suspension*. (The surround and spider.) Stiff cones deform only slightly when pressure is applied.

Crossover Network—(Dividing Network)—In multi-speaker systems the incoming signal to each speaker must be restricted to the frequency range for which that speaker is used. This is done by means of an electric filter. In inexpensive systems this may be a single element—a capacitor—in series with the tweeter. More elaborate systems use both inductors and capacitors. These are called LC filters. In these, the signal fed to the woofer is cut off *above* a certain frequency in addition to cutting off the signal to the tweeter *below* its working range.

The *Crossover Frequency* is the transition point from one speaker to the other. Two-way systems have one crossover frequency, three-way systems have two, and so on. Dividing networks do not cut off abruptly but have slopes to their frequency characteristics. Accordingly, they may have 6 dB-per-octave, 12 dB-per-octave or even higher slopes. The sharper slopes require more L and C elements. For the reasons for choosing particular frequencies and slopes, see the discussion under 2-way and 3-way systems.

Damping—The cone/voice-coil assembly has inertia, and is held in place by a springy suspension. Because of inertia a cone tends to keep moving after the applied force has been removed. The springy mounting results in a tendency to oscillate. At the (so-called) resonant frequency of a cone, at the lower end of the reproduced frequency range, the effect is quite large. See "Hangover." The duration of the oscillation is determined by the "Q" of the speaker, as in an electrical tuned circuit.

Appreciably above the resonant frequency, the inertia determines the behavior of the speaker: the velocity of the cone decreases as the frequency increases. But the ability of the cone to transform the energy of its motion into sound increases with frequency, making up for the reduced velocity, so that the frequency response is uniform.

At resonance, there is likely to be a peak in response. The height of the peak is greater the higher the Q, which can be controlled by adding a resistive element to the motion. This reduces the peak; its effect is called damping.

If the amount of damping is too much, the motion at resonance is restricted too greatly. With too little, it would still be excessive. *Critical damping* results in a condition for which the moving element does not overshoot its rest position after being deflected. Response is down 6 dB at resonance. Less-than-critical damping results in increased response at resonance; a slight amount (one-half of critical, to be exact) produces flat response. Increased damping beyond critical produces a fall-off in bass response. So, while damping is desirable and in fact necessary, there can be too much of a good thing.

Damping can be mechanical, acoustical, or electrical. An example of mechanical damping is friction. Acoustical damping utilizes resistance to air flow, as by covering the back of the speaker by a perforated material. Electrical damping is caused by the "back e.m.f." (a voltage opposing the signal voltage when the voice coil moves through the magnetic field in the gap). This reduces the flow of current and the resulting motion. Electrical damping is improved by using high flux density in the gap. It is operative only when the speaker is connected to an operating amplifier. Amplifier damping factors greater than 5 to 10 have no significant effect.

Diameter—The specified diameter of a speaker is the outside diameter of the speaker frame; the *cone* diameter is less—considerably so if a wide surround is used to provide high compliance. We will not discuss the rare cases where frames are made oversize to increase the nominal diameter.

Diaphragm—The moving, sound-radiating element of a loudspeaker. See "Cone." This terms also applies to elements such as the dome-shaped radiators of some tweeters and midrange units, the variously-shaped moving elements of horn-loaded speakers, and the driven elements of electrostatic speakers.

Diffraction Horn—See "Horn."

Direct Radiator—A speaker whose cone or diaphragm radiates sound directly into the air. The word "directly" includes cases where the air in front of the speaker may be partially confined by a partition with openings, forming a front air chamber, or by obstacles such as an acoustic lens. A direct-radiator speaker facing into an expanding passage coupling it to the air becomes a *horn speaker* (see definition). A direct-radiator speaker *system* is simply one or more speakers mounted in an enclosure. The speaker itself is called a direct radiator if it is designed for use in a direct-radiator system.

Direct-radiator speaker systems are relatively simple, can be made quite compact and have low efficiency. The latter is not necessarily bad.

Distributed Port—In a bass-reflex cabinet, a port consisting of a series of small holes. The air friction in the holes increases the acoustic resistance of the port which may be desirable in some cases.

Dividing Network—See "Crossover Network."

Doublet (Dipole)—A speaker without a baffle radiates sound into the air from both sides of its diaphragm. This is called an acoustic doublet. Its frequency response and power capability fall off rapidly as the frequency decreases. It can provide reasonable bass response if made large enough, as in some electrostatic speakers. At low frequencies, its distribution pattern concentrates sound along the speaker's axis, with a minimum in the plane of the cone edge. The distribution is made more uniform by reflections from the room walls.

Doubling—The creation of large amounts of second-harmonic distortion by non-linearity; an effect that occurs in the bass range. This component, of double the fundamental frequency, can actually be much greater than the fundamental itself, producing a false illusion of bass response. Driving a speaker hard at low frequencies causes mostly third-harmonic distortion, or *tripling*. Its effect is similar to doubling. These types of distortion can be avoided by designing a speaker for *linearity*. See reference.

(continued on page 89)

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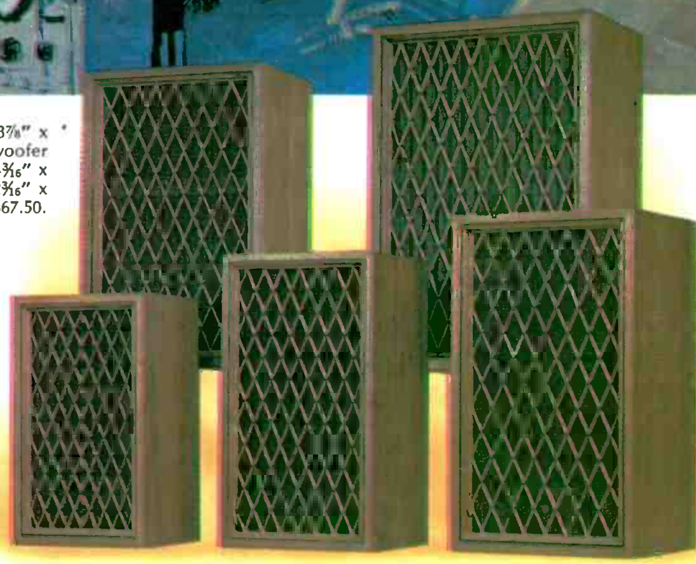

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How Disc-Masters Are Made Today

R. LEE HULKO*

Record mastering is both science and art. The production of quality record masters is dependent upon numerous factors, and is a precise co-ordination of man and machine.

Mastering is the step between recording and manufacturing. The master lacquer disc is electroplated after it is cut, and the metal part which is then separated from the lacquer contains ridges instead of grooves. This metal plate is used as a die on the press which stamps out the vinyl plastic records.

Without even considering the sound aspect, we are dealing with a precision mechanical operation. The size of a record groove is often two one-thousandths of an inch across, less than the thickness of a human hair, and its length on one LP can be almost a mile. With its wiggles up and down it must never get smaller than two mils, and from side to side it must never cross into the groove beside it. The master lacquer, or acetate as it is often called, must be perfect. The spacing and dimensions must adhere to rigid specifications to ensure that the record will play on all types of equipment, and the master should not present any problems in subsequent operations of plating and pressing.

*President, Sterling Sound, Inc., New York, N.Y.

The Cutting Lathe

State-of-the-art technology provides the mastering studio with high-quality tape-to-disc transfer equipment with a high degree of automation and reliability. The lathe, in its simplest form, is a machine which revolves the blank disc and slowly moves the cutter-head and stylus across the disc surface. The rate at which the stylus moves across the disc is referred to as the pitch and it is measured in lines per inch. When grooves are unmodulated they can be very close together, cut at fine pitch, but as modulation increases, the pitch must be increased to leave room for the "wiggles" of the groove. This is called variable-pitch cutting and the rate varies on a normal LP from about 400 lines per inch to perhaps 150 lines per inch. Fixed-pitch lathes are still used but their pitch must be set coarse enough to allow for the highest modulation, which wastes considerable space on quiet passages.

In stereo cutting, the stylus is modulated in a vertical plane as well as laterally so that some form of groove-width control is required in order to maintain a minimum groove size, usually 2 mils. Because of the "V" shape of the groove, width control is accomplished by deepening the groove, an action called depth control. During quiet or lateral passages the depth is decreased to conserve space, and as vertical modulation increases, the basic groove depth is increased. As depth is increased, basic pitch must also be increased proportionately to make room for the wider groove. This pitch-and-depth control must take place just before actual modulation so an advance head is needed on the tape machine to feed preview information to the lathe.

The Neumann VMS 66, a modern, sophisticated lathe, uses a computer to control pitch and depth in a way that wastes no space. The computer contains sixteen memory cells which store modulation and preview information separately. The memories are alternately charged and discharged every quarter revolution of the turntable and the control signals are stored for half a revolution. By utilizing the right and left signals separately, space is provided only for the groove wall that needs it.

When cutting at fine pitch, additional control is required to prevent "wall echo." It is particularly noticeable at the beginning and end of unmodulated passages in the

Voltage supply in your city can vary as much as 10%. And even a 2% variation causes a significant tape speed change in tape decks with induction motors and a difference in reproduced sound that is intolerable.

The Concord Mark II stereo tape deck completely ignores fluctuations in line voltage. It is driven by a hysteresis synchronous motor which locks onto the 60 cycle power line frequency and maintains constant speed (within 0.5%) regardless of voltage variation from 75 to 130 volts. So if you're about to buy a tape deck that doesn't have a hysteresis synchronous drive motor, you're liable to negate any other fine feature it might have.

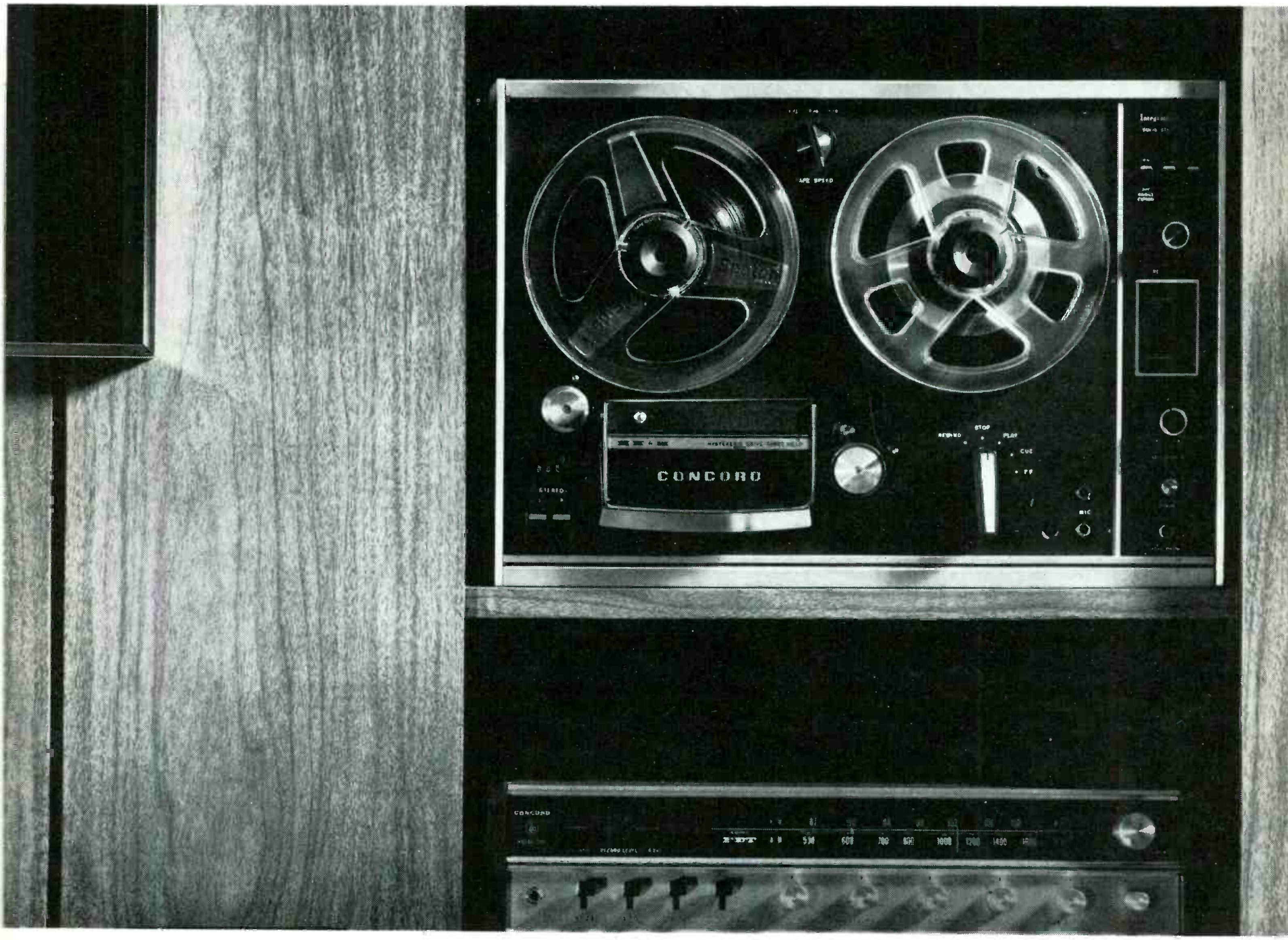
Don't get the idea the hysteresis motor is all the Concord Mark II has to offer. It also has just about every other professional feature. Three high-quality heads: ferrite erase head; wide gap Hi-Mu laminated recording head for optimum recorded signal and signal-to-noise ratio, narrow gap Hi-Mu laminated playback head for optimum reproduced frequency response. No compromise combination heads. The three heads and four preamplifiers also make possible tape monitoring while recording.

The tape transport mechanism assures a fast startup—you don't miss a note. Supply and takeup tape tension arms eliminate startup burble. A special flutter filter eliminates flutter due to tape scrape or cogging action. A cue control provides instantaneous stop and start operation. Other important conveniences: the flip-up head cover permits you to see the head gap position markings for professional editing; 3 speeds; automatic sound-on-sound with adjustable level controls; variable echo control for reverb recording; calibrated VU meters with individual record indicator lights; stereo headphone jack; electronically controlled dynamic muting for automatic suppression of tape hiss without affecting high frequency response. All this, for under $230.

The hysteresis drive Concord Mark III has all of the features of the Mark II plus pressure-sintered ferrite heads for extended frequency response and virtually no head wear. It sells for under $260.

The hysteresis drive Mark IV, the top-of-the-line Concord deck offers all of the performance and conveniences of the Mark II and III including wide gap record, narrow gap playback heads, tape source monitoring, sound-on-sound, echo recording. Plus, a dual capstan tape transport mechanism with electronic automatic reverse, no metal foil or signal required on the tape. Superior recording performance plus the convenience of automatic reverse and continuous play. A superb instrument with the finest performance money can buy, and it's under $330. Audition the new Concord Mark series, the tape decks with the hysteresis synchronous drive motor. For "all the facts" brochure, write: Concord Electronics Corp., 1935 Armacost Ave., Los Angeles, Calif. 90025. (Subsidiary, Ehrenreich Photo-Optical Industries, Inc.)

For copy of Concord Mark III Instruction book, mail 25¢ in coin



NEITHER AIR CONDITIONERS, TV SETS, WASHERS NOR ANY OTHER ELECTRICAL APPLIANCE CAN KEEP THE HYSTERESIS-DRIVE CONCORD MARK II FROM ITS PRECISELY APPOINTED SPEED.

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record and sounds like tape print-through. Wall echo usually gets worse during plating and pressing so steps must be taken during mastering to prevent it. This is accomplished by a manual or automatic device which further increases the pitch at the beginning and end of these quiet passages.

The lathe is equipped with timing and switching devices which control lead-in, spiraling, and lead-out. These functions can also be programmed by the use of a photoelectric sensing device on the tape machine which will trigger spiraling and lead-out functions of the lathe when it senses a leader in the tape.

All professional lathes utilize a vacuum to remove the "chip," the thread cut out of the groove, and to hold the blank flat and firm on the turntable. A suitable device for the purpose is a suction unit of the type used to operate a player piano. It is small and almost silent. A Variac in the motor circuit is used to adjust the air flow.

The tape machine must be equipped with an extra playback head and a means of varying the distance between the heads in order to keep the preview time the same regardless of the tape or disc speed. The best machine for this purpose is the Telefunken M-10a which has a special head assembly which allows the preview distance to be varied from 6.4 to 16.5 inches.

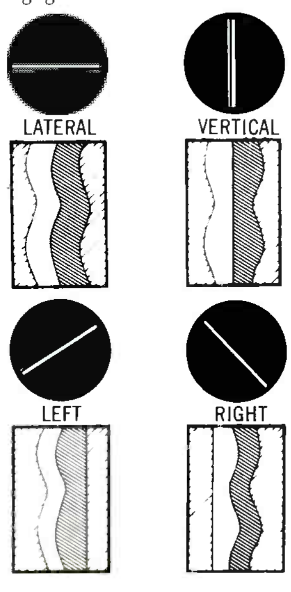
State-of-the-art cutterheads use large amounts of regenerative feedback to achieve a frequency-response characteristic that is virtually flat and with very low distortion. Separation can be better than 35 dB throughout the audio range. To help in dissipating the heat produced by currents in excess of 1.5 amps in each of the cutterhead drive coils, a small amount of helium is fed into the cutterhead at all times. The helium provides a better path than air for the heat to travel from the coils to the magnet structure where it is dissipated. The Neumann system provides a special protection circuit which monitors the temperature of the drive coils and disconnects the cutterhead when a dangerous temperature is reached.

In the channel between the tape machine and the cutter amplifiers are various equalizers, limiters, compressors, and control devices. It is important to remember that any signal processing in the cutting channel must also be done in the preview channel in order to maintain accurate pitch-and-depth control.

Monitoring facilites are important. In addition to a good listening system and standard VU meters, a peak indicator is extremely useful. A light-beam peak-indicating meter shows cutter action more accurately since it reacts to peaks that escape the VU meter. Also, the peak meter has a scale calibrated from +5 to −50 compared to +3 to −20 on the VU meter.

For monitoring phase, two devices are useful. The first is a compatibility meter, which has a scale with zero center. A "0" indication shows no phase relationship between right and left (total separation). Full scale on the + side indicates a completely in-phase signal (mono, lateral, center channel). Full scale on the − side indicates an anti-phase signal—vertical component. Desired readings are in the + direction, indicating a greater degree of lateral stylus motion than vertical. The other device is an X/Y oscilloscope with a matrix network at its inputs or the CRT rotated 45° so that a mono signal produces a horizontal sweep and an anti-phase signal produces a vertical sweep. Left and right form the arms of an X. The display shows lateral/vertical ratio, channel balance, and level. It is also very useful when cutting mono with a stereo system, as small variations from the lateral mode are easily seen. With an equalizer to produce the RIAA cutting curve, the display will show actual stylus motion.

Fig. 1. Oscilloscope display with corresponding groove shown below them.



Since most of the mechanical operations are performed by the machine itself, the cutting engineer is free to concentrate on fine detail and esthetics. In an ideal situation the mastering studio must make a one-to-one transfer from tape to disc. Sometimes adjustments are required and are made at the request of the producer or at the discretion of the mastering engineer. In custom mastering it is important for the producer and the engineer to work together and to understand each other.

When cutting records, one is always faced with the problem of level vs. playing time. The louder the record, the greater the groove excursions, the coarser the pitch must be, so the less time can be recorded on the disc. The most common request is for "more level and more bass." The mastering engineer must please his client with more level and bass but at the same time make a record that doesn't skip or distort, and which conforms to space limitations on the disc. The engineer must use his skills to manipulate and optimize several interdependent variables, such as pitch, depth, level, and bass-and-treble equalization, and have modulation end at the preferred 5.5-in. inside diameter. RIAA specifications allow modulated grooves to a diameter of 4.75 in. and it is often necessary to use the entire allowed space, but due to tracing problems in playback high frequencies fall off seriously and distortion increases significantly past the 5.5-in. mark.

The common level standard or "0" reference level is 7 cm/sec lateral at 1000 Hz. Usual peaks for LP's are 2 or 3-dB above this reference level, and for 45's the average level is +4- or +6-dB peaks. Many records have peaks higher than this and many have much lower average levels. The final level selected is a consideration of length, treble, bass, vertical content, and established levels on a particular label. A limiter is often used to control flash peaks that might make the record mis-track.

Greatest tracking problems are caused by heavy bass, particularly side-channel bass. Corrective measures are equalizing, vertical limiting, or the use of a vertical roll-off network. This last method has the effect of moving bass frequencies to the center. The shift is usually not noticeable since low frequencies are non-directional in most listening situations. High-level 45's should be cut with such a device to assist in tracking on inexpensive players, and the cutting room should be equipped with one of these machines for performing tracking tests.

At the other end of the spectrum, some problems are created by excessive treble. Because of the RIAA pre-emphasis curve used in disc recording, there is always a danger of amplifier overload and high cutterhead currents which can cause cutterhead damage. Very high frequencies at high level often produce groove modulations too small to be traced by the playback stylus and end up only as a source of noise in the pressing. High-frequency problems are corrected by equalizing or treble limiting, or by half-speed cutting. When using this last technique the tape and disc run at half speed, thus cutting all frequencies in half. No response is required above 10 kHz but the system must operate at very low frequencies and corrective equalization must be employed to restore the proper tape and disc curves.

The best solution to most of these problems is to reduce the overall level. Often 1 dB can make a significant difference. Corrective techniques, when properly employed, usually do not result in any aural degradation and in fact will probably enhance the sound.

When tapes of unknown quality come in for mastering it is a good idea at least to spot check them for azimuth, level, equalization, and timing. It is not at all uncommon to be changing equalization, limiting, levels, and even phase between bands on an LP. Careful notes should be made for each master for future reference. If problem areas are encountered it is often helpful to make test cuts for examination and playback. Completed masters should not be played and it is a good idea to cut part of the first band in the test area for playback checking.

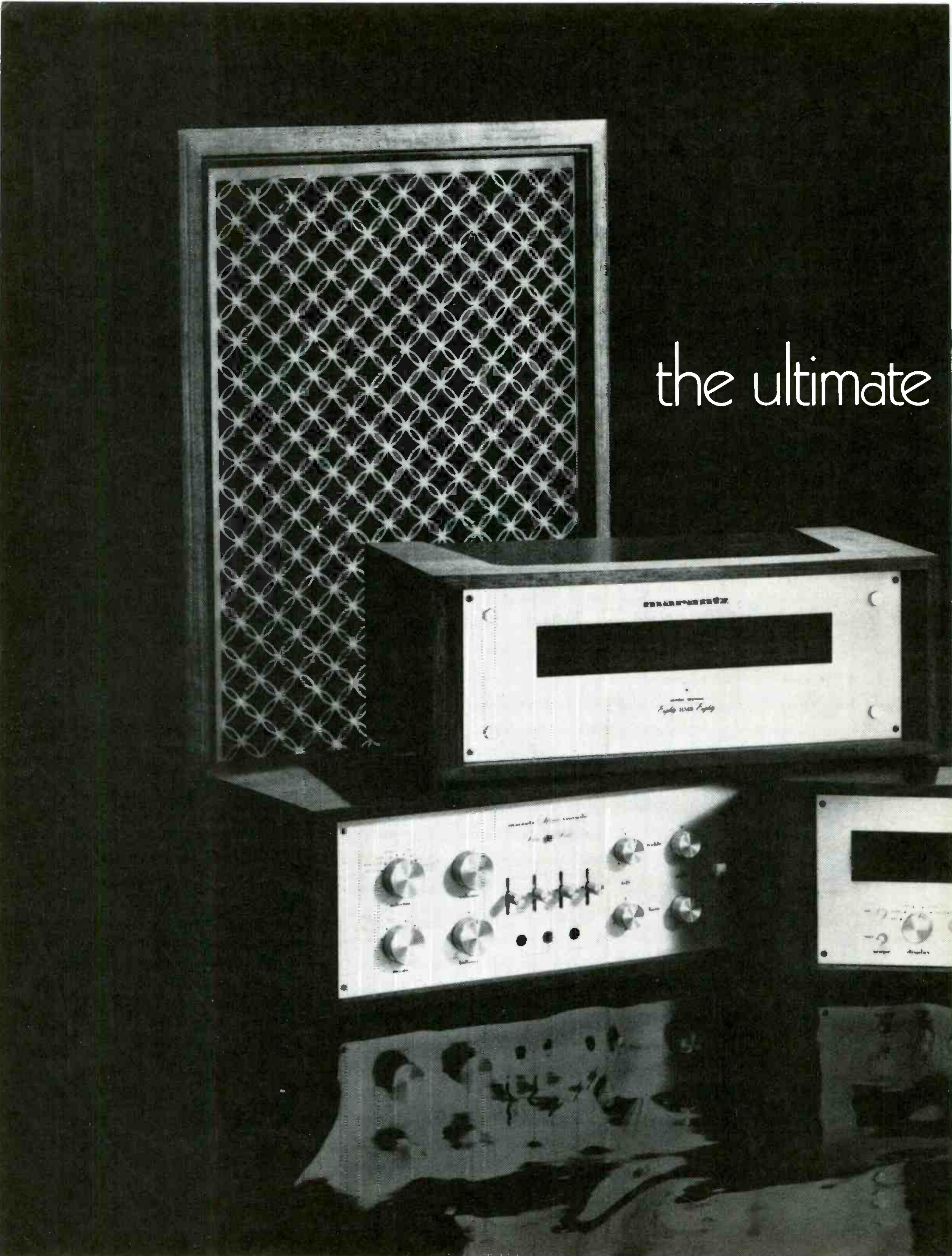
The microscope is an invaluable tool in the cutting room. The most useful is about 200× and has a light-projecting lens which surrounds the viewing lens. With the microscope absolutely perpendicular to the disc surface and a strong lighting unit it is possible to look right down into the groove. The land—the area between the grooves —appears black, and each groove appears as three bright lines, indicating the groove bottom and the groove/land intersections. Modulation on the groove walls appears white and black. A reticle in the microscope, calibrated in mils (thousands of an inch) allows the groove to be measured. Minimum groove width should be about 2 mils so that playback stylus is always riding on the walls of the groove. Examination of the groove will show the condition of the cutting stylus, and the effectiveness of stylus heating and chip removal. Problems such as overcutting, excessive treble or bass, or excessive modulation will seen easily. The groove should be bright and shiny and should have no rough or torn parts.

The blank disc used for cutting is made from a flat aluminum plate with a thin coating of cellulose nitrate applied to its surface. The blank should be inspected visually before it is used to make sure that there are no bumps, bubbles, or other flaws. The evenness of the surface can be checked by watching the reflection of a straight edge in the acetate. The blank size for 12-in. records is 14-in., and for 7-in. records a blank with a diameter of 10, 12, or 14 in. is used, depending on the requirements of the plating plant. The extra space is necessary for cutting test grooves and for handling.

The stylus should never be allowed to cut into the aluminum base of the acetate. Since the synthetic sapphire stylus is made from an aluminum oxide crystal, the stylus has an affinity for aluminum and it is practically impossible to remove the metal from the stylus. If the stylus should hit the aluminum it is safer and faster to discard the stylus than to attempt its salvage. The stylus should not be touched with the fingers and should be handled by its heater wires or with non magnetic tweezers. The stylus should be replaced for a variety of faults: when the cut is no longer shiny and smooth, when the tip radius exceeds 0.25 mils (bottom line 0.5 mils), when it becomes chipped, when the noise level is too great or when high-frequency response falls off. The cutting edges will start showing signs of wear after 10 hours of cutting and the tip radius will be too large after about 20 hours.

The stylus is heated to reduce noise level, to improve high-frequency response, and to prolong stylus life. The styli are supplied with several turns of nichrome wire wound around the shank and held by ceramic cement. Silver plating on the leads prevents them from heating and avoids the danger of burning the chip if it should become fouled. The degree of heat is adjusted with a rheostat and heater current is indicated on a meter. Heat is adjusted to the value that will produce the lowest hiss level in an unmodulated groove. It is best to check the noise level at outside and inside diameters and use an average setting. Since more heat is required at smaller diameters due to slower groove speed, it is sometimes helpful, in critical work, to increase heat slightly towards the center of the record. With the microscope described previously it is possible to adjust the heat visually. While watching an unmodulated groove it can be seen that too little heat produces a groove wall with a gray appearance, while too much heat will produce score lines along the wall. The heat setting should be checked with each new stylus or new batch

(continued on page 79)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If you can afford the ultimate system, this is it. Marantz.

To own Marantz is to own the best. In this case, $2023.00 of it. But in this unique system you'd have the finest FM stereo tuner, preamplifier, power amplifier, and speakers in the world. With the most natural, true-to-life sound.

The **Model 20 Solid-State FM Stereo Tuner** lets you experience the sight of sound—the incoming FM signal is displayed on a built-in oscilloscope. It's the only tuner in the world with this feature, which shows you how your signal improves with the best position of your antenna, shows you whether the FM station is broadcasting in true stereo, and lets you see if the signal is out of phase. It also visually monitors stereo separation and lets you check your other equipment, too. Of course, it has all of the other superior Marantz features and specifications also—that's why it's the world's most precise tuner. $495.00.

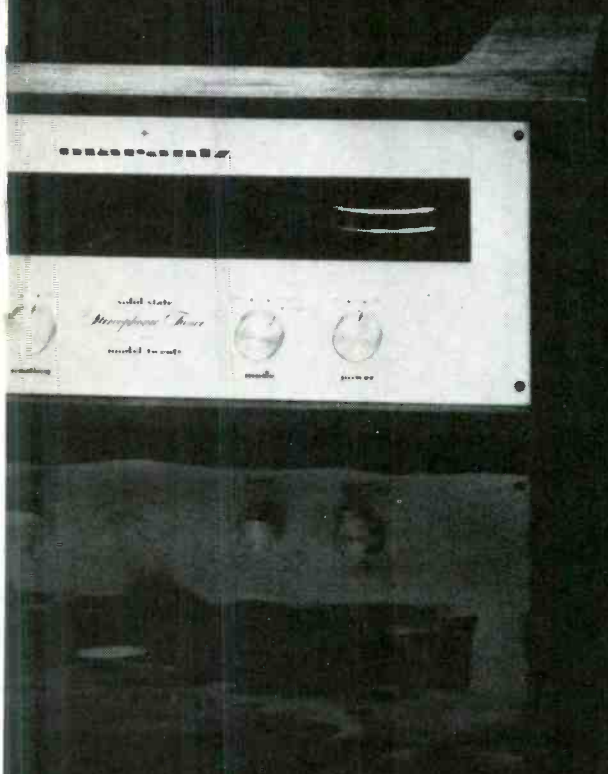
With the **Model 7T Solid-State Stereo Preamplifier** you can run the whole show with an extensive array of controls. This unique preamp has an input stage so well designed that it can't be overloaded. Consider, too, distortion so low it can't be measured on conventional test equipment. And—there are many other reasons why the Model 7T costs $395.00.

The **Marantz Model 16 Stereo Power Amplifier** muscles up 160 watts' continuous-power RMS. That's 80 watts' continuous power, at any frequency, from each channel. (If Marantz used the unscientific conventional IHF method, the Marantz Model 16 80-80 RMS power amplifier could be rated as high as 320 watts per channel.) Integrated circuitry ensures absolute reliability and stability, and Marantz' patent-pending Variable-Overlap Drive eliminates any possibility of transistor or speaker blow-out. No wonder it costs $395.00.

Now, to complete the ultimate stereo system. Martial your awesome audio forces through a pair of **Marantz Imperial II Speaker Systems** that have no artificial coloring added. Just clean, natural, full-frequency sound. Each speaker features Marantz-exclusive Quadlinear woofers for bass without boom. Two dome-type midrange speakers and two tweeters provide natural unpeaked midrange and exceptionally silky undistorted highs. Everything elegantly enclosed in decorator cabinetry. The pair: $738.00.

If our Marantz Ultimate System is too much for your budget, don't despair. You can get unmatched Marantz-quality component systems in all price ranges—as low as $199 for a complete stereo receiver. Whichever components may serve your individual purposes best, an instrument bearing the Marantz name represents the ultimate in its price range. To prove that this is more than just an advertising claim, Marantz backs all its products with the same three-year warranty on parts and labor — five-year warranty on speaker components.

Sound out all the facts for yourself at your franchised Marantz dealer's. He'll be happy to demonstrate. Then let your ears make up your mind.



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Build an INTEGRATED-CIRCUIT TONE-CONTROL STAGE

DICK CRAWFORD

INTEGRATED CIRCUITS are fast becoming an electronic way of life. But there are certain requirements that integrated circuits should fill before they can be adopted in the best of hi-fi equipment:

1. Low distortion.
2. Low noise.
3. Adequate output level.
4. Output short-circuit protection.
5. Input overdrive protection.

Long and sometimes sad experience in the misuse of audio equipment leads me to the last two requirements.

How do recent linear integrated circuits measure up to these criteria? Very well indeed, for low-level and preamplifier applications. The author has had the opportunity to use quite a few linear integrated circuits, and the experience has prompted the design of this tone-control circuit

The Baxendall or feedback type of tone control circuit was chosen. Since it is a feedback type of circuit it achieves the tone-control action by varying the amount of negative feedback at different frequencies. This generally results in lower distortion

Fig. 1—Schematic of IC tone-control circuit. For stereo use, two identical units are required. The numbers in circles indicate pin numbers. Both 100-k pots are linear.

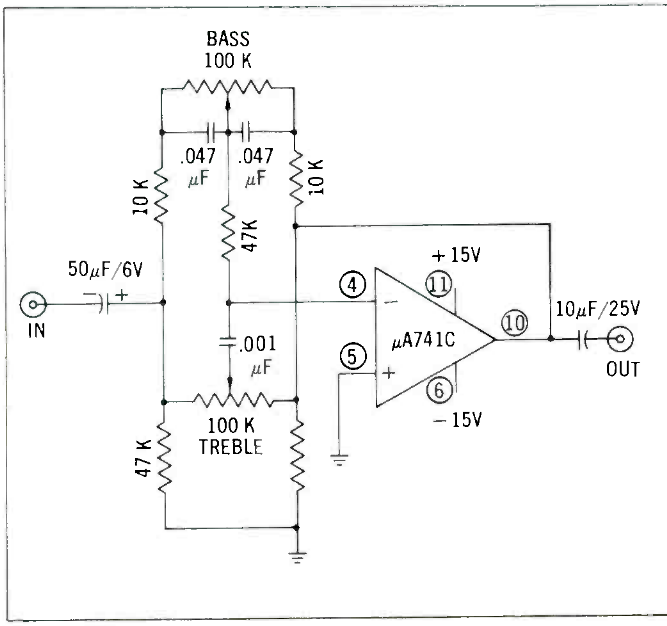
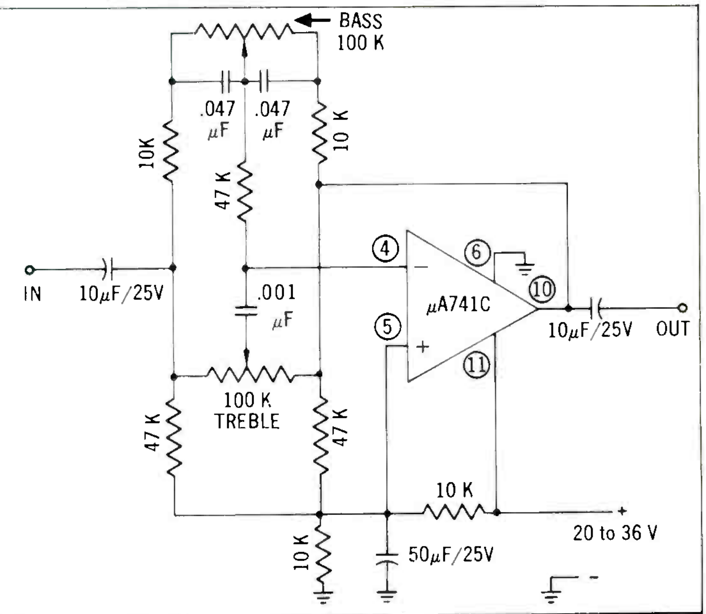


Fig. 2—Schematic of the tone control rearranged to work with a single positive supply voltage. This requires two additional resistors and one extra capacitor, but eliminates need for the negative supply.



Some people say Ampex recorders are heavy.

They're right.

We build them that way. We have to because of our *deep-gap* heads. Our heads deliver a higher frequency response much, much longer than the others.* So we have to make *machines* that work accurately for just as long as our heads. Machines that move the tape across the heads at an exact azimuth angle for years. And keep the tape moving at an exact speed. And, to do all that, we have to build our machines *heavier*.

To keep the tape moving at an exact angle across the heads, we have to keep the heads absolutely rigid. If they move even a fraction, the angle is destroyed and you lose maximum frequency response. To keep this exact angle, we have to *die-cast* our base plate and head bridge. We can't make them out of cut metal or plastic. Die-casting gives us a rigid framework to mount the *deep-gap* heads on—so they'll stay rigid for years.

To keep the tape moving at an exact speed longer we begin with the hysteresis synchronous motor. We die-cast the flywheel/fan to make it heavier and more perfectly balanced.

Then, we install a dual capstan drive system to insure perfectly smooth head-to-tape contact. It means we use *two* hard steel capstans—one in front of the heads and the other behind—rather than just one. Some people call this a "gimmick." But it's not. Because, our dual capstan drive eliminates the need for pressure pads. Pressure pads not only wear out your heads, but they wear on tapes too!

Then we match the dual capstan drive system with die-cast dynamically-balanced flywheels. It all works to reduce wow and flutter even more—and it works much *longer*.

All in all, we die-cast over 1/3 of each Ampex unit's weight to make sure critical parts stay precisely aligned. Sure, it adds weight. But with *heads* so good, you need whole *machines* just as good. That's one reason Ampex is the *heavyweight* in the industry.

A case in point: the new Ampex 755A Stereo Deck. Handle it and hear it. We think it's the best buy on the market. You get Sound-on-Sound, Sound-with-Sound, Echo Effect, Monitor, Pause Control, 3 Deep-Gap Heads, Rigid Block Head Suspension, Dual Capstan Drive, and honest performance specs. Suggested list price $249.95 (base included).

Write Ampex Corporation, Consumer Equipment Division, Dept. SQ9, 2201 Lunt Ave., Elk Grove Village, Ill. 60007, for full-color spec sheet on the 755A and a brochure on the entire Ampex line.

AMPEX

**While warranted for three years, Ampex heads have been known to last well over twelve years, based on an average of two hours use per night, every night. See "A Message from the Heads of Ampex," in March, 1969 audio magazines.*

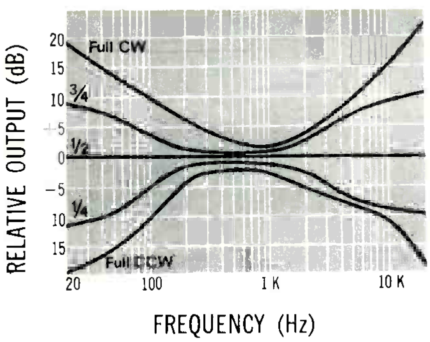


Fig. 3—Frequency-response curves for the tone-control circuit of Fig. 1.

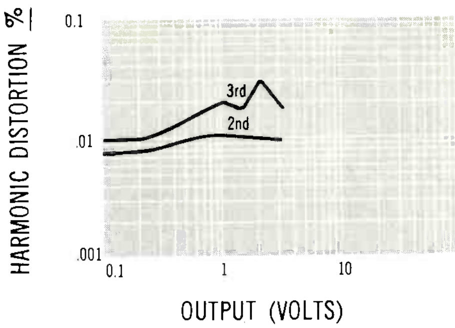


Fig. 4—Measured harmonic distortion of the IC tone control.

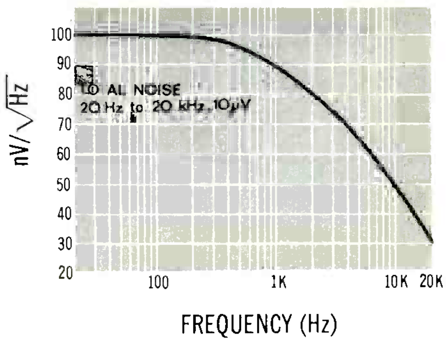


Fig. 5—Noise output. Total noise of the circuit from 20 Hz to 20 kHz is 10 μV.

than the more conventional tone control, where control is achieved by varying the loss at different frequencies. Secondly, it uses linear potentiometers, which implies better tracking between the two channels of a stereo amplifier insofar as the tone controls are concerned. Conventional tone controls use audio or logarithmic potentiometers, which, due to the way they are made, typically do not track as well as linear potentiometers.

A disadvantage of the Baxendall circuit is its relatively low input impedance. Another disadvantage is its nominally low gain, namely one. A third disadvantage of the typical circuit is that it requires a center tapped potentiometer, but this drawback has been eliminated in this design (see Fig. 1).

The performance is very good. From Fig. 3 we note that nearly 20 dB of control are available at 20 Hz and 20 kHz. Control is proportional to rotation. The response is within plus or minus one dB from 20 Hz to 20 kHz when the controls are set in midposition.

Distortion is exceptionally low, never rising to more than .025 per cent for any output level up to 5 volts rms at 1 kHz (Fig. 3). Actually the circuit will put out more than that; I just didn't test it any higher.

The circuit as shown in Fig. 1 operates from positive and negative supply voltages, as is typical with operational amplifiers (op amps). In this mode its output will have less than one volt d.c. offset. Figure 2 shows an alternative arrangement for connections involving a single 20-to 36-volt supply. In this latter configuration the circuit must be a.c. coupled, as shown.

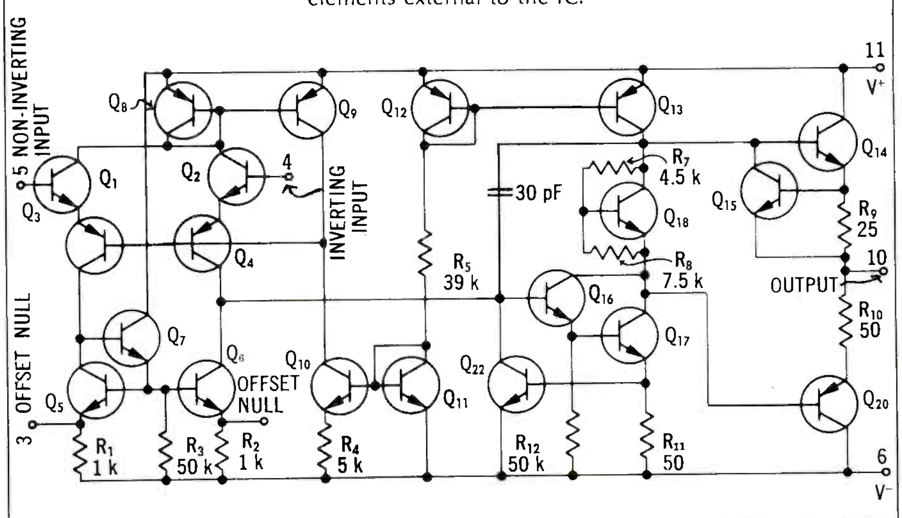
Figure 5 shows the noise characteristics of the tone control. This includes the impedance effects of the tone-control network, the noise characterisics of the integrated circuit itself, and a 600-ohm source impedance. As can be seen the noise is relatively constant at 100 nanovolts per square root Hertz up to about 1 kHz, where it begins dropping. This is probably due to the current noise of the IC and the impedance variation of the tone control with frequency. At any rate, the noise including hum is very low, being only 10 microvolts from 20 Hz to 20 kHz. If the signal is 1 volt rms, then the signal-to-noise ratio is 100 dB.

This unit could be built in a box as an adjunct to a present amplifier, but it is really intended as part of the control circuitry of a stereo amplifier or preamplifier.

The particular integrated circuit chosen is the Fairchild μA741C, of which the author is fond, but I presume that others could be used. The National LM 307, Motorola 1539G, RCA CA-3029, and Signetics N-5709 are suggestions. Not all of these have internal frequency compensation, so you had best refer to the data sheets of those devices for recommended unity-gain compensation networks before plugging them in. The Fairchild distributors (try your phone book) are my source for the μA741C's. Amelco and Texas Instruments are also reputedly making the μA741C. The circuit diagram of the μA741C or as close to it as a user is apt to get, is shown in Fig. 6. A veritable forest of transistors, all on a silicon chip less than 1/16 in. square.

A perfect amplifier has been described as a straight wire with gain. his tone-control circuit has no mid-frequency gain, little noise, and almost no distortion. Perhaps it could be called a flexible wire. Æ

Fig. 6—Schematic of the IC itself. Different models may require compensation circuit elements external to the IC.

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ACOUSTICAL MATCHING of SOUND SYSTEMS & AUDITORIUMS

DAVID L. KLEPPER*

THE SOUND-REINFORCEMENT system is one of a number of electroacoustic systems that is required in the design of a performing arts hall. Any electronic reinforcement system is intimately involved in the overall acoustical design of the hall. However, all systems of any type must be matched to the hall acoustically as well as matched to the program. Planning any sound system requires consideration of what it is supposed to do both acoustically and in terms of communication.

Need and Purpose. There is no stock solution for every auditorium. Not all spaces require reinforcement systems. We were recently asked why we did not include a sound reinforcement system in our estimates for a certain 300-seat theater. The reason was there was apparently no particular need for a sound reinforcement system for that theater. Such theaters as the Tyrone Guthrie in Minneapolis and the new Alley Theater in Houston, Texas, with approximately 800 seats, do not have any need for a sound reinforcement system; they are used by resident theater companies and the acoustics are so designed that electronic reinforcement is unnecessary. Let us consider a number of different performing-arts facilities to determine whether sound systems are required and for what possible uses.

(1) A small outdoor-music facility, perhaps seating 1000 people with a well-designed acoustical bandshell. We might say no electronic amplification is required for this particular facility if used just for orchestra and band music.

(2) A large outdoor music facility, perhaps located in a park in the middle of a city with attendant traffic and aircraft noises. Sound reinforcement would be required for practically all activities in this facility.

(3) A typical concert hall of perhaps 1500-3000 seats. Sound reinforcement is not provided for orchestral music; perhaps not even for a soloist. It is provided for a narrator speaking with the orchestra and for announcements. Occasionally it is provided for amplification of very weak instruments when requested by the music director. Harpsichord amplification is an example, although harpsichords are available that can carry the 1500 to 3000 seat hall. In any case, the sound reinforcement system should be planned around these specific uses.

(4) A multi-purpose performing-arts center, a theater-concert hall-auditorium. This is the most typical college, university and municipal performing-arts facility. Speeches and narration with an orchestra will require amplification in this hall. It has become conventional to provide sound reinforcement for musical comedy because musical comedy pit orchestra sound is scored to be loud and brassy and listeners expect singers to be amplified so as to be heard against the sound of the loud pit orchestra. Most opera composers are quite careful to score orchestral music so as not to compete with singers on the stage, so opera usually does not require electronic amplification.

(5) A typical summer festival concert hall. In most cases, all the amplification is provided inside that would be provided in a conventional concert hall (not for the orchestra itself). Amplification would usually be provided for all activities *including orchestral sound* for the *outdoors.* All these considerations have to go into the program for the sound reinforcement system.

(6) A gymnasium/auditorium/coliseum that is also used for performing arts. Generally, amplification is provided for all activities.

Acoustics-Sound System "Match"

One of the first things to consider in the acoustical match between the sound system and the auditorium is the type of system that should be used. There are two basic kinds of sound-reinforcement systems. One is a distributed-loudspeaker system. There are many kinds of these, including some with a loudspeaker for each seat built into the seat back. The most typical installation is a ceiling-mounted distributed-loudspeaker system.

The second basic kind of system is the central system which places the loudspeaker in reasonable proximity to the stage or the front of the hall in an attempt to provide directional realism for the amplified sound.

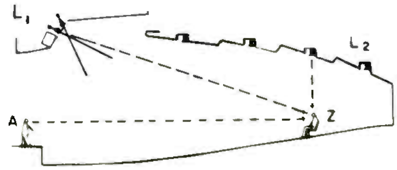


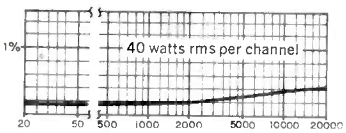
Fig. 1—Hall with both a distributed loudspeaker system and a central system.

Figure 1 shows a hall with both types of systems. Reasons for the superiority of the central loudspeaker systems over the distributed-loudspeaker system are fairly well illustrated in this example. Remembering that sound travels at about 1130 feet per second, the listener over at "Z" would hear sound in the nearby distributed loudspeaker well in advance of sound from the stage. This would have two bad effects (1) he'd localize sound as coming from the loudspeaker rather than from the stage, and (2), the live sound from the stage would be delayed sound with respect to the

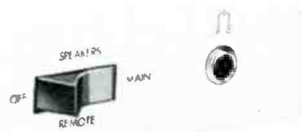
* Senior Consultant, Bolt Beranek and Newman, New York, N.Y.

THE HEART OF YOUR DYNACO RECEIVER SYSTEM

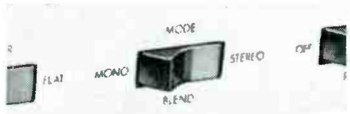
SCA-80 amplifier



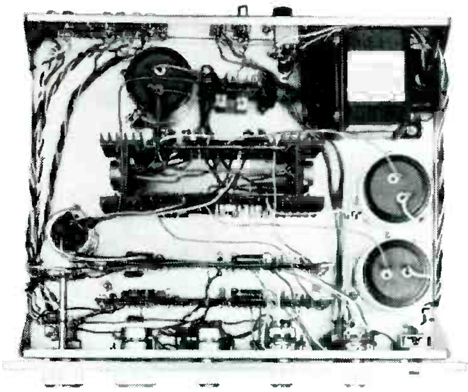
The SCA-80 delivers 40 watts per channel rms continuous power from 20-20,000 Hz at 8 ohms. Plenty of power for driving 4 ohm speakers too.



Front panel low-impedance headphone jack is always live. Rocker switch permits you to choose between main and remote speakers too, or turn speakers off.



Center channel speaker can be driven without an auxiliary amplifier with mode switch in BLEND, which also reduces unrealistic stereo separation when using headphones.



Open, uncluttered layout facilitates kit construction. Four etched circuit boards are factory assembled and tested.

The Dynaco FM-3 tuner ($99.95) is completely compatible with the SCA-80. The SCA-80/FM-3 system delivers up to three times more continuous power across the audio band than other one-piece receivers in the same price range.

ALL THIS FOR ONLY $169.95*

*$249.95 factory-assembled.

See at your dealer or write for information.

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nearby loudspeaker sound and would actually be heard as an echo unless some kind of tape loop or acoustical delay device was used to delay the sound to the nearby loudspeaker.

In designing sound reinforcement systems, it is preferable, whenever possible, to use a central loudspeaker system located over the proscenium. The design goal is that the live and amplified sound should arrive at the listener's ear at approximately the same time so that they reinforce each other, much as sound reflected off sound-reflecting panels or a hard, reflecting ceiling reinforces direct sound from the actor's or singer's voice. Distributed loudspeakers should be used locally in performing-arts halls to solve deep underbalcony problems or an unfavorable throw ratio (nearest-to-farthest seat) problems. Usually, deep underbalconies should be avoided for important room-acoustical reasons aside from the sound system. However, when line-of-sight on the central loudspeaker is lost, the central loudspeaker systems must be supplemented with local time-delay loudspeakers. An unfavorable throw-ratio would occur if the distance to the farthest listener is ten times the distance to the nearest listener. It is a difficult engineering job to design a central loudspeaker cluster that will provide both adequate levels at the farthest seat without unduly high levels at the nearest seat. One possible solution is the use of distributed loudspeaker over the farthest seating area, again delayed so that amplified and live sound coincide. We are becoming cleverer at designing central loudspeaker systems so that their directional characteristics can be coordinated with the room design to provide fairly even coverage even under throw-ratio conditions that several years ago would have been considered unfavorable for a central loudspeaker system. The central loudspeaker system is the general solution to reinforcement for performing activities.

Figure 2 illustrates the typical central loudspeaker system combined with directional footlight microphones that are intended to pick up action on the stage. The directional characteristics of the microphones have to be chosen carefully so that there is no undue variation in level as the actors proceed from one microphone to another.

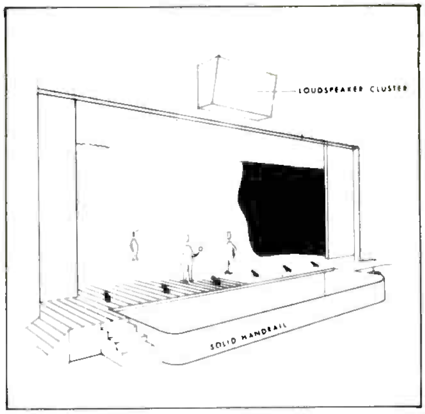


Fig. 2—Typical central loudspeaker system with directional footlight microphones.

The directional characteristics of the microphones and the loudspeaker systems have to ensure that there is little danger of feedback. At the same time the loudspeakers and microphones must be chosen for smooth frequency response, both to avoid feedback and for naturalness of reinforcement. This basic system generally in use today has one bad effect in that the microphone is quite a distance from the speaker, actor, or singer. This means it will pick up some reverberant sound which reduces clarity as compared with a microphone close to the persons speaking or singing. One possible solution is the use of wireless microphones. These raise other problems including interference and the coordination between microphoning and costuming.

The directional characteristics of the microphone are arranged to discriminate against orchestral sound because in musical comedy reinforcement the orchestra is always more than loud enough. The singers' voices should be brought over the orchestra. Sometimes producers or conductors may demand microphoning the orchestra.

If the hall has an electronic reverberation system and if we want to add reverberation to an orchestra during particular times, microphones are used for the pit orchestra. This requires a lot of rehearsal and a considerable skill on the part of the sound system operator. However, when requested by people to provide amplification for the pit orchestra, it is preferable to put microphones in the pit—maybe connect them, perhaps demonstrate them, but *not* use them during the show because the main purpose of the system is to provide a satisfactory balance between the singers and the orchestra and it is always the singer that requires amplification.

The architectural integration of these elements is, of course, of supreme importance. Visual masking can help eliminate an audience's awareness of amplification per se. If permanent footlights are installed in a theater then perhaps the microphones can be mounted in the footlight troughs. Whether or not the footlights are used for a particular show, if amplification or reinforcement is provided, the footlight troughs are raised and the microphones are hidden from the audience. Loudspeaker integration is both an architectural and room-acoustics design problem. Often a sound transparent loudspeaker grille is indicated at just where the most important sound-reflecting element of the ceiling or sound-reflecting panel should be located. This creates an acoustical design problem regarding which should be compromised—the loudspeaker system, perhaps by being displaced to a less favorable location—or the room acoustics of the hall.

Figure 3 shows the new Fisher Theater in Detroit with emphasis on the loudspeaker system. It was especially lit up for the photograph. When the lights are off it just appears as a part of the proscenium, and nobody is particularly aware of the loudspeaker system. I have had people ask me, "Where's the amplification system?"

In addition to this central loudspeaker cluster which is the main sound reinforcement-system for the theater, there are supplementary stereo loudspeakers for special effects and for broad source amplification located behind perforated metal on the walls of either side of the proscenium. The close-up of the low-frequency horn

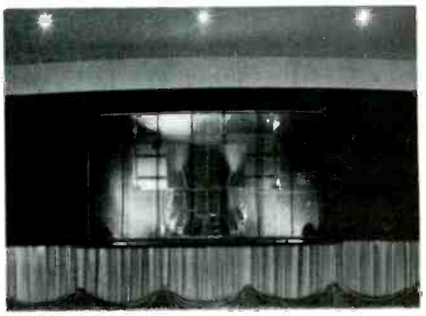


Fig. 3—Loudspeaker system appears as part of the proscenium when lights are off.

The world's fastest bookshelf speaker.

That's not a joke. The new **Rectilinear X** is at least four times faster off the line than its closest competition. And you're not reading a drag-racing magazine.

But let's begin at the beginning.

A few months ago, we announced the **Rectilinear X** (that's a ten, not an ex) as the world's first high-fidelity loudspeaker. We explained that it was the first speaker system to pass a signal more or less unaltered, in the same sense as a minimally acceptable amplifier. (We didn't say, as a few people seemed to interpret us, that our new $199 bookshelf speaker made all costlier systems obsolete. There will probably always be a need for larger, more expensive speakers for reasons of power, efficiency, versatility, special acoustical problems, etc. But not accuracy.)

What we want to point out in this ad is the specific reason for the superior accuracy of the **Rectilinear X** as a listening device.

Not the frequency response, although it happens to be beautifully flat and smooth. Nor the absence of harmonic distortion, although the 10-inch woofer with its one-inch linear travel won't distort a 50 Hz signal at 10 watts any more than a medium-priced stereo receiver. Nor even the transient response, although the exceptionally low-mass tweeter follows steep wave fronts with great alacrity.

No. The truth is that all of today's top speakers have reasonably smooth frequency response, low harmonic distortion and good transient response. And it would be utterly impossible to predict their individual sound quality or their relative ranking from these data alone.

However, as we have discovered, there *is* a measurable quantity that corresponds very closely to audible differences in speaker performance. *Time delay distortion*.

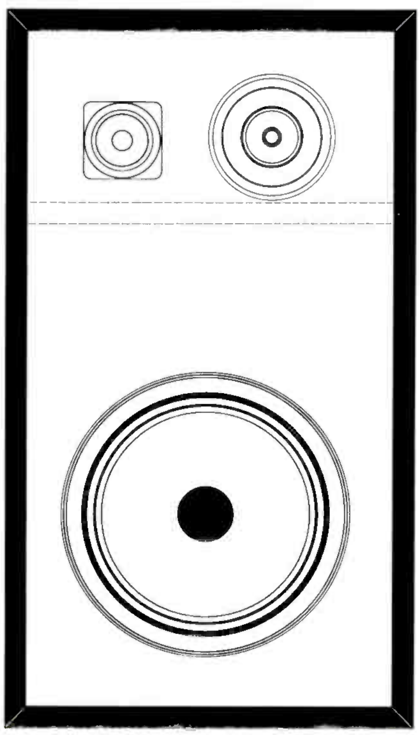
In our introductory advertising, we referred to this much-neglected criterion by the more specialized mathematical term of envelope delay distortion, a concept with many ramifications in network theory. A sophisticated explanation would require a very involved discussion of loudspeaker phase response as distinct from amplitude response, but the basic idea is quite simple.

Sound waves travel through air at the rate of approximately 1135 feet per second (at room temperature). Therefore, if you're sitting let us say 11⅓ feet from a speaker, you'd expect a signal to reach your ear one one-hundredth of a second (10 milliseconds) after the amplifier feeds it to the speaker terminals.

Not so. It will reach your ear more slowly.

It seems that speakers don't speak the instant they receive a command from the amplifier. Between the entry of the electrical signal and the exit of sound, there's a time delay. Not just a slowdown of the rate at which pressure amplitude builds up (i. e., transient response), but an actual moment of silence. Dead silence.

What's more, the length of this moment is frequency dependent. Generally speaking, lower frequencies are delayed longer than higher frequencies. Which means that the low and high frequency components of a signal that enter a speaker at the same instant don't arrive at your ear at the same instant. There's a smearing effect. This accounts, in part, for the gutsy, canned sound of some popular speakers, which many people like although its bears no resemblance to live music.



Now, time delay distortion is least audible at low frequencies and becomes more and more obvious going up into the midrange. Woofers, with their massive moving parts and complex networks, are the worst offenders, so it becomes important to keep them out of the midrange. The only speaker system that goes all the way in this respect is the **Rectilinear X.**

Although the specially designed 10-inch woofer has remarkably little time delay to begin with, it's crossed over at 100 Hz to a 5-inch midrange driver with phenomenally low time delay distortion. Thus the entire midfrequency band has the benefit of minimum time delay. And you can hear it.

At 500 Hz, for example, the **Rectilinear X** has a time delay of less than 0.2 millisecond. By comparison, the top-of-the-line model of the most famous name in bookshelf speakers has a delay of approximately 0.8 millisecond at the same frequency, mainly because most of the output is still coming from the woofer. The **Rectilinear X** is literally faster off the start line.

Since no other speaker system cuts off the woofer at 100 Hz, and no moving-coil speaker is faster in the lower midrange than our 5-inch driver, the **Rectilinear X** is the world's speed king

At which point we can't resist borrowing a phrase from the underground. "Speed kills." Our competition.

(For further information, see your audio dealer or write directly to Rectilinear Research Corporation, 30 Main Street, Brooklyn, N. Y. 11201.)

Rectilinear X

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IT'SONY

$200.

Sony has placed its name on an under $200 FM stereo/FM-AM receiver — the Sony STR-6040. We broke the $200 price barrier without putting the slightest dent in quality. We did it by eliminating the unessentials, designing an amplifier with less than a super power rating and by drawing upon advanced radar and microwave technology in the tuner design.

The amplifier delivers 30 watts RMS continuous power into 8 ohms, both channels operating — more than enough to drive even relatively inefficient "bookshelf"-size speaker systems to room-filling volume, without distortion.

The tuner employs a completely passive front end. There is no amplification of the incoming signal frequency. This eliminates two common problems: internally generated background hiss and overloading of weak stations by strong ones (spurious-response rejection is 100 dB down).

The Sony 6040 comes through with flying colors in all areas essential to superior receiver performance. Sensitivity, stereo separation, capture ratio and noise suppression characteristics are excellent. Solid-state i.f. filters are used. With their help alternate channel selectivity reaches a full 70 dB. What's more, they never require realignment.

While we streamlined the 6040, we did provide a number of important operating conveniences: switches for easy selection between the most common program sources, radio or records and for instant comparison between original and recorded program material; automatic stereo/mono circuitry; a headphone jack and an auxiliary input on the front panel; and precise tuning meter.

The Sony name, Sony quality and an un-Sony-like under-$200 price tag. That's the Sony 6040, and that's beautiful music.

Sony Corporation of America, 47-47 Van Dam St., Long Island City, N.Y. 11101. SONY®

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and the high-frequency horns behind this sound transparent grille can give you some idea of the design work involved in integrating a satisfactory central loudspeaker system with the proper directional characteristics into a particular architectural environment.

Historically, sound systems have been considered necessary to make sound louder for an audience. However, often the emphasis should be on greater clarity than with live sound alone. To speak and be understood clearly is difficult in a large hall with the two-second reverberation time that would be ideal for orchestral or romantic music. We want the sound system to increase the ratio of *early* to *reverberant* sound energy to override the reverberant sound and ensure high speech clarity. Such systems are commonly required for reverberant churches, where it is not necessary to increase the loudness but where clarity must be increased.

The opposite types of systems are the electronic reverberation systems. In a hall designed with a relatively low cubic volume, organ music, choral music, and perhaps orchestra/romantic music should be heard with a lot of reverberation, and the sound system should provide sound from many different directions with many different time delays causing the hall to sound more reverberant. Again, loudness is the secondary consideration.

In systems that include electronic reverberation, the problem is just how reverberation is going to be provided. The best approach is usually to provide a reverberation room which generally requires about 20,000 cubic feet and should be well isolated from the hall itself and from extraneous noise sources. The basic elements of a reverberation system include: the pickup microphones which can be those for the usual reinforcement system; amplification and playback loudspeakers in the reverberation room; one or more pickup microphones in the reverberation room; some kind of a delay device —possibly a tape loop—to ensure that the reverberant sound doesn't get to the audience before the direct or reinforcement sound; amplification; and then playback loudspeakers in the hall.

We have discussed reinforcement in proscenium halls. Thrust-stage and arena-theater reinforcement systems are becoming more prevalent. The basic problem in such systems is not to increase the loudness of an actor. Even in a 1000-seat arena stage, an actor can be heard adequately. One recognizes that he is saying something throughout the theater; the problem comes in understanding what he is saying. The human speaking mechanism involves a mouth in the front of the face only and in an arena-stage theater it is obvious that half the people are going to be behind the actor.

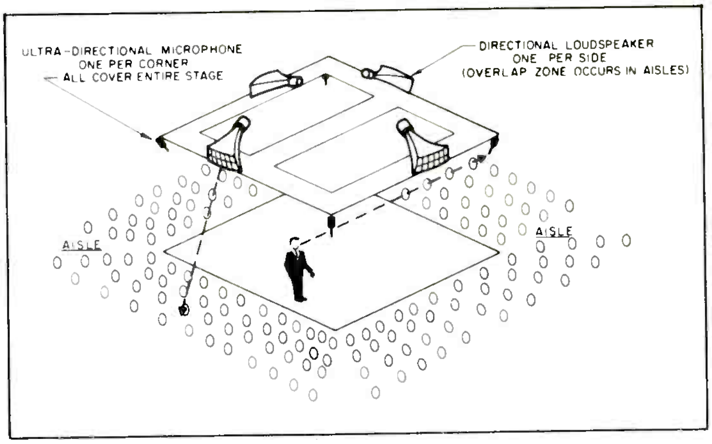

Fig. 4—Microphones and loudspeakers in a theatre-in-the-round.

Larger spaces provide some unique problems. The reduction in high-frequency energy when an actor has his back to the listener is about 10 dB (at about 3000 to 4000 Hz) and intelligibility will be marginal. Remember that consonants, s's, f's, t's, and m's are mostly high-frequency energy. So amplication is provided with directional loudspeakers on the four sides, each system covering the seating area on that side, with the overlap zones (where intelligibility and quality are minimum) occurring on the aisles, and using ultra-directional microphones below the grid corners, one in each corner and each one covering the stage, so that no matter which way the actor turns he is facing a microphone. One system of this type has been in use for seven years in one theater where there is no particular awareness on the part of the audience that reinforcement is being used. That system limits the amplification to the high-frequency range, which suffers when the listener is behind the actor's back and the overall loudness is not changed. Instead, when the actor turns away from a listener the high frequencies drop about 3 or 4 dB, not 10 dB; and there remains enough high-frequency energy to provide intelligibility, but not so much that the system is obvious in use. This particular system is adjusted by the contrator every several months; the gain is set and it is simply turned on for each show. Thrust stages can use variations on this arena-stage system, but as the 360-deg. angle of the arena stage is narrowed to 180 deg. or less, the necessity for sound reinforcement becomes less because less of the audience is behind the actor's back for a smaller proportion of the time.

Although the arena-stage system does not require an operator, most sound systems do. Most of them require intelligent operation and it is important that operator hears the sound he controls. This usually means some kind of booth at the rear of the hall that is acoustically open to the hall itself. The operator can look and hear through a sound transparent mesh; he cannot hear through glass. Sometimes windows are required so that the sound-system operator can close himself acoustically from the hall to cue material. But most of the time the reinforcement operator should hear the sound just as the audience does.

In systems providing electronic reverberation, the operator must be brought from the rear of the hall, which is not a typical hall location, out into the house itself, so that he can be surrounded with reverberant sound just as the typical member of the audience is. Such a control location usually involves some kind of architectural design problem which can be solved by building a platform or a pit. Monitor loudspeakers are not the solution because they give the operator a picture of what the sound reinforcement system is doing alone and not a mixture of sound reinforcement and the live sound of the hall.

Controls for the operator are designed to be as human engineered as

(Continued on page 79)

An Outperformer for the Tape Deck Set!

Tape recording has reached a new level of excellence with the new Pioneer T-600. These remarkable innovations tell the story. The ingenious auto-reverse unit offers the fastest automatic and pushbutton reverse playback and recording — less than a second. No more turning tape over . . . no more annoying recording interruptions. The dramatically different swing-in, swing-out pinch roller assures optimum tape pressure at all times — just right for flawless reproduction. Reel loading has been relegated to a one hand operation, significantly reducing mounting and threading time and the possibility of torn or damaged tapes. Other features include: solid state circuitry; 4 heads; 4-track stereo & monaural Record/Playback; 2 VU meters; hysteresis synchronous motor; center capstan drive; headphone jack; automatic tape braking; pushbutton 4-digit counter; vertical or horizontal operation. Naturally, the quality is incomparable. It's a Pioneer Outperformer. Ask your Pioneer dealer for a demonstration. Only $299.95 incl. dust cover.

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Tape Transport Maintenance

Part III: Drive Systems

H. W. HELLYER

Design philosophy dictates which sort of tape drive shall be used—direct motor, belt, or idler. Each has certain advantages and some drawbacks. For speed exactitude, and precise control, directly driven capstan and reel carriers will be chosen; the obvious drawback is its high cost.

The choice between belts and idlers is not so simple. Quite often we find the maker has compromised, using both types of drive in the same machine, performing different functions.

Belts, or bands, may be rubber, composition or fabricised rubber, and can be round, triangular, or rectangular in cross-section. The most important criterion is evenness of cross-section, with elasticity following a close second.

Round-section belts will more often be used with a large-diameter motor pulley. It is more difficult to maintain constant diameter of a round belt, and under tension the belt 'flattens' at contact points, so angle-section belts are used with smaller-diameter motor pulleys having shaped flanges in which the belt rides snugly. The other alternative is a flat belt on a wide running surface, and fabricised flat belts which accept variations of tension for function change (play/fast wind/reverse) are favored by some designers. Where flat belts are used, the general tendency is to employ a slipping-belt drive for take-up rather than a slipping-clutch or gravity take-up, and vertically mounted machines may therefore have tensioned flat belts.

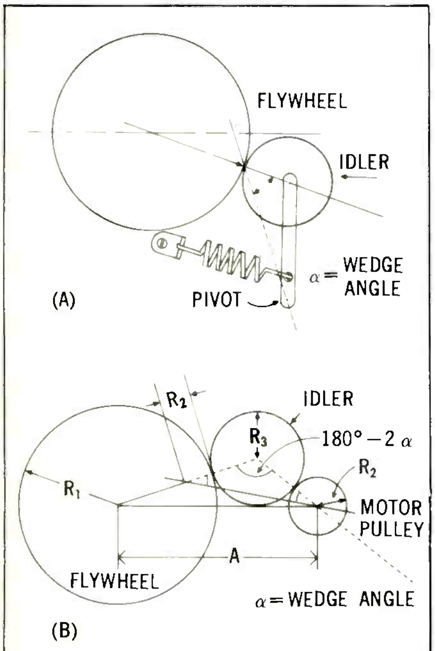

Fig. 1—(A) Wedge angle is important for correct transmission of torque. (B) Distances and wedge angles can be calculated when diameters of motor pulley and flywheel are known.

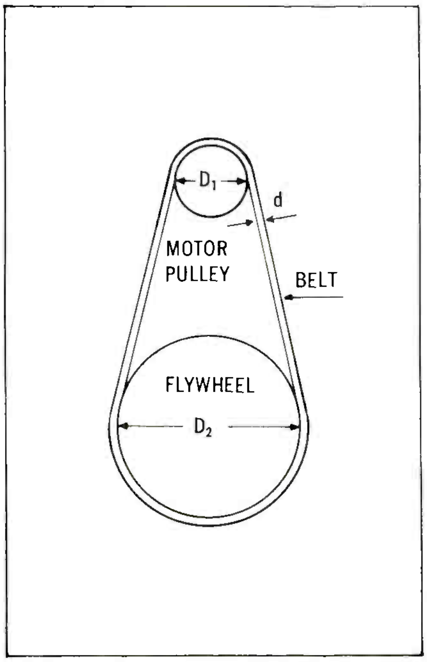

Fig. 2—Speed of a flywheel is not in inverse ratio to the diameters of motor pulley and flywheel, but has to take into account the thickness of the belt.

Idlers, jockey pulleys, puck wheels, or intermediate wheels, called variously (though not strictly correctly) by all these names, are used to couple the drive from the motor to the flywheel and to the reel carriers. Many different systems are employed, each with its own peculiarity.

Most idlers are rubber-tired, and the type of rubber used has to be chosen carefully. As well as having good elastic properties, it must have a good coefficient of friction, the minimum of self-heating, and high abrasion resistance—properties which do not always go hand-in-hand. Because maximum tension must be achieved to reduce slip, pressure on the idler will be high. This tends to stress bearings, and makes the initial contact of idler and drive (or driven) surface vulnerable to irregular forces. For optimum transmission of drive power, systems are designed to be self-adjusting, the idler being held in contact with the driving surface by spring pressure.

Idler wheels lend themselves to designs which need reversal of driving direction, such as for the rewind operation, and to speed changes which can be effected by a stepped driving pulley. They are useful when the spacing between drive wheel and driven surface has to be varied, or is large.

Because the friction wheel is spring-loaded to make contact, some retardation is inevitable, and this has to be allowed for in design. The wedge angle for optimum conditions has been determined empirically to lie between 35 and 40 deg. for optimum drive with least slip. Figure 1 (A) shows a simple spring-loaded drive wheel, and in Figure 1 (B) we can see the design principles for an intermediate wheel. The wedge angle of 35 deg. is determined by experience, and wheel diameters should have specific relationships.

The diameter of an idler wheel should, in theory, make no difference to the speed of the driven surface. This is dependent on the ratio of the motor to flywheel diameters, in the case of direct drive. Interposing an idler reverses the direction of rotation, but should have no effect on the speed. In practice, small changes in

The world's first faultless headphones.

Audiophiles have always been aware that, at least theoretically, headphones are the ideal way to listen to reproduced music, particularly stereo.

We said theoretically. Because, in actual use, headphones have thus far been hampered by a number of practical disadvantages.

Fisher engineers have never believed that these disadvantages are insurmountable. But it took them until now to solve all the problems to their satisfaction.

The result is a pair of headphones called the Fisher HP-100 which can truly be considered the first commercially available model with all plusses and no minuses. Listening to them, or rather with them, is a new and different experience. The theoretical potential of headphones has finally been realized.

The comfort factor.

One of the main objections to conventional headphones is that they are uncomfortable. After wearing them for half an hour, the listener wants to go back to loudspeakers.

Excessive weight and unpleasant clamping of the head are only the lesser reason, although most headphones are certainly much too heavy and confining. More important is the uncanny isolation of the listener from the audible world around him, as though his head were encapsulated. This, of course, is due to the more or less airtight "cup" that fits over the entire ear, to provide close coupling of the acoustic cavity of the phone to the eardrum. Otherwise, with conventional headphones, there would be a serious loss of bass.

The Fisher HP-100 solves this problem in a highly imaginative way. The phones are not only extremely light but are also allowed to rest lightly against the ear on large, flat foam-rubber cushions, leaving the perimeter of the ear unconfined. The diaphragm of the driver is completely covered by the foam rubber and acoustically "sees" the thousands of tiny air bubbles in it, instead of a single cavity. This, combined with special acoustic delay slots in the back of the driver, maintains proper bass loading without the conventional airtight seal and its attendant discomforts.

As a result, wearing the HP-100 is as pleasant physically as listening to loudspeakers. In fact, to some people the sound does not appear to originate in the phones but seems to come from a certain distance, as in loudspeaker listening, but with a much more pronounced stereo effect.

No more boominess.

Eliminating the single air cavity of conventional headphones also gets rid of another common fault: boomy bass. The low-frequency response of the Fisher HP-100 is amazingly smooth and is essentially flat down to 19 cycles, which is just about the low-end cutoff of the human ear.

As a matter of fact, the overall frequency response of the HP-100 is essentially uniform from 19 to 22,000 Hz, an unprecedented achievement due in part to the sophisticated driver design, which borrows from advanced microphone technology. It is, in effect, a reversed dynamic microphone with the coil driving the lightweight diaphragm, instead of vice versa.

Which brings us to another unique advantage of the HP-100.

Smooth treble response.

Nearly all headphones exhibit a certain roughness in their high-frequency response curve. Not the HP-100. The light microphone-type diaphragm provides completely smooth treble and superb transient response, so that the sound has the airy immediacy known only to owners of exceptionally fine tweeters.

Needless to say, distortion is nonexistent at normal listening levels. The impedance of the HP-100 is compatible with all types of amplifiers and receivers. Power input for average listening levels is 2 milliwatts.

The phones are supplied with a fully adjustable vinyl-covered headband, velvet-soft, non-stick foam pads that are removable (and therefore washable!), and 8 feet of cable.

After reading all this, you will be prepared for an important listening experience when you first try the Fisher HP-100.

But you are not yet prepared for the price. Only $34.95. Which may be, for the makers of the world's first faultless headphones, the greatest achievement of all.

The Fisher® HP-100

Mail this coupon for your free copy of The Fisher Handbook, 1970 edition. This 72-page full-color reference guide to hi-fi and stereo also includes detailed information on all Fisher components.

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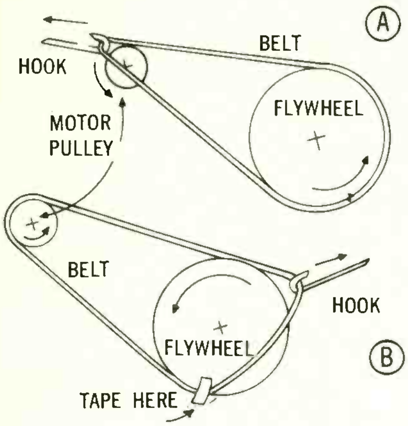
Fig. 3—(A) A simpler method of loading a new belt where surfaces are accessible. The hook is used to maintain tension. (B) Where other parts of the mechanism overlay the pulleys, a better method is to put the belt over the smaller diameter, secure at the rotational entry point, and use the hook to feed the belt over the larger diameter while turning gently.



diameter upset the tensioning, the wedge angle, and the calculated amount of slippage and can cause a slowing down or irregularity.

Belt Faults

Many of the factors governing regular running with idler-wheel drive also apply to belt-drive systems. Small variations in belt thickness can have a large effect on tape speed. The thickness of flat belts is more easily controlled than the diameter of round ones. Importance of exact belt diameter or thickness is illustrated with reference to Fig. 2.

If the motor pulley were geared to the driven pulley, the speed reduction at the capstan would be in inverse proportion to the diameters, i.e. $n_1/n_2 = D_2 D_1$. Taking a practical example, a belt-driven flywheel 95.5 mm in diameter is required to rotate at 300 r.p.m. The available motor rotates at 2900 r.p.m. If a thickness of belt is 1 mm this must be added to each diameter in the above equation, giving

$$\frac{n_1}{n_2} = \frac{D_2+d}{D_1+d}$$

thus

$$D_1 = \frac{n_2(D_2+d)}{n_1}$$

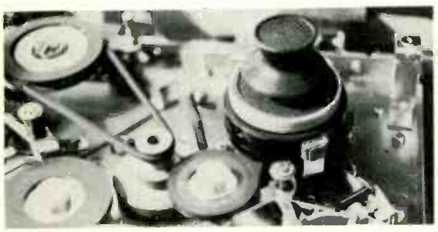
$$= \frac{300\times96.5}{2900} - 1$$

$$= 9\text{mm}.$$

So the effective drive at the motor has a diameter of 10mm.

Suppose there is a variation of 10 per cent in belt thickness over its length. The resulting speed variation will be 0.1 × 100/10 or 1 per cent. The running frequency of the belt is only a few cycles and speed variations of such a low frequency can hardly be equalized by the centrifugal mass, so wow will be heard from pitch variations.

A



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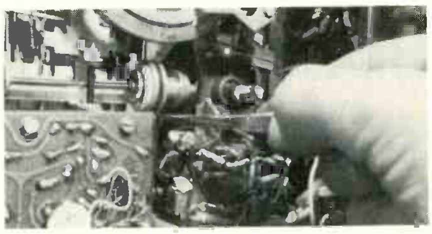

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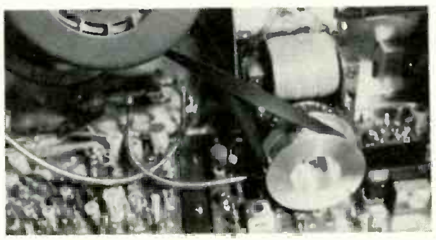

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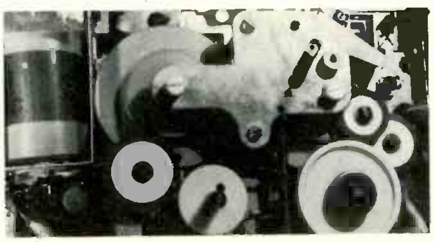

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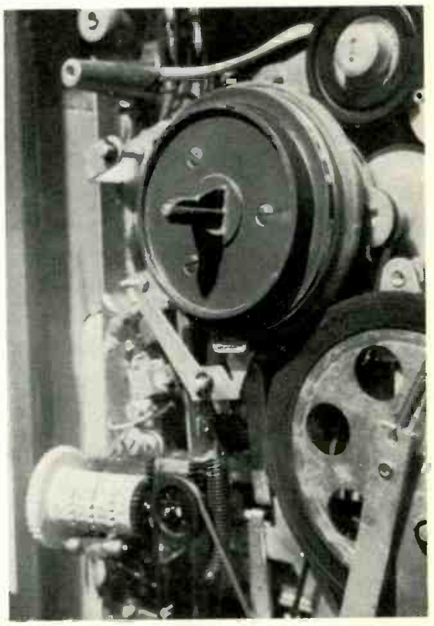

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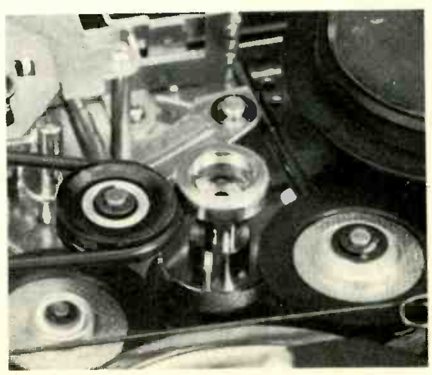

(A) Combination belt-and-pulley drive is used on many machines, as in this example—Sony TC-250.

(B) Small drive belts such as this one in the Uher 4000-L can be handled with a pair of tweezers, but extreme care is needed, and sharp edges of tools should be protected with adhesive tape.

(C) Flat wide belts may suffer from impregnation; small particles of metal from pulleys become embedded, imparting a surface polish. This example is a Sony CV-2000 video tape recorder.

(D) This assembly from a West German pocket portable uses a number of plastic pulleys with thin rubber tires. Check for binding bearings and out-of-line spindles.

(E) Japanese Standard portable has edge-drive from motor to flywheel and rim-drive from flywheel to take-up.

(F) Examples of the wide, thin take-up idler on a loose bracket which is liable to misalignment, and the smaller soft-tired auxiliary wheel at right. Philips 3548.

(G) Ramped idler for speed change.

Benjamin proudly announces the world's second best automatic turntable.

Small wonder that the Miracord 50H is the world's most coveted automatic turntable. The top, top authorities have awarded it top rating. And who doesn't want the very best?

The Miracord 750 is virtually identical to the 50H except that it employs a dynamically-balanced, 4-pole induction motor instead of a Papst hysteresis synchronous motor. It also costs $20 less—$139.50.

The new 750 still offers all of these wonderful Miracord features: the exclusive Miracord push-buttons; the slotted lead screw for precise stylus overhang adjustment; piston-damped cueing; effective anti-skate; the 6 pound cast aluminum turntable; and a dynamically-balanced arm that tracks to 1/2 gram.

Enjoy the world's second best automatic turntable and save $20 over the cost of the world's best. The Miracord 750 is only $139.50 at your high-fidelity dealer.

Benjamin Electronic Sound Corp., Farmingdale, N.Y. 11735. A division of Instrument Systems Corp. Available in Canada.

ELAC/MIRACORD 750

another quality product from BENJAMIN.

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If a flat belt is used, closer limits can be gained, and by hardening, then grinding the flat surfaces, deviations of less than 0.5 per cent can be achieved. From the foregoing it also appears that the larger the diameter of the motor pulley the less the effect of these deviations will be, but this has practical limits. This would require a slow-running motor, or a centrifugal mass (flywheel) of large diameter, or the addition of an intermediate drive wheel. We are back where we began.

Speed changing with belt drive can present special problems. The usual method is to feed the belt from one diameter to another on a common motor pulley. A fork drive may be used, or a tongue on the pulley.

One advantage of belt drive on simpler machines is the ability to filter out minor variations inherent in the system. Motor hum vibrations at 60 Hz can be reduced considerably by using a belt of sufficient elasticity to form an absorption circuit. This is very useful when a motor with an outer rotating cage (small diameter pulley) is employed in conjuction with a flywheel. The small diameter is dictated by the high rotational speed. Flywheel rotation should be as high as is practicable, and the short-term speed variations can be formidable unless belt elasticity is carefully chosen to filter them out. It follows that any hardening of the belt or loss of elasticity due to temperature and humidity changes will also affect drive regularity.

Neglect is the prime culprit—as has already been emphasized in this series of articles. Belts that are left in one position tend to harden and form to a shape, with flattened portions at the contact sections. The cure is a regular use of the machine, but if the condition has already set in, some remedy may be possible by heating and running the belt.

Best method of rejuvenating a formed rubber belt is to let it stand for a while in hot water, dry it, powder with French chalk or talcum, clean off surplus talcum to prevent it mixing with lubricants, and "run the belt in" for a reasonable period.

Mention of lubricants brings us to the prime enemy of belts—and indeed of any rubber or composition drive surfaces, including idler-wheel tires. This is oil or grease. Over-enthusiastic lubrication has caused more erratic tape drive than any other single fault. Oil tends to spin off rotating bearings in a fine film; grease can have a capillary action when heated, creeping up to idler surfaces. Always oil sparingly, and wipe any surplus from spindles before fitting belts or idler wheels. Diluted alcohol is the best cleaning agent, but even this has to be used with care on some composition materials, which can soften by its solvent action.

Refitting drive belts can face us with some problems. One or two tricks of the trade can make the job easier. The first thing to remember is sequence.

Unless you know the machine so well that dismantling deck parts becomes habitual, keep a note of the order in which parts are removed. Lay the parts in a logical sequence, ready for re-assembly.

Make drawings where necessary, and always include some sort of datum: 'deck front', 'head-plate', 'motor mounting', and so on. If it helps, number the operations on your guide drawing. For some of us, one map is worth a wealth of words.

When fitting a belt over two drive surfaces, with the belt under tension, some difficulty may be encountered in getting the belt to sit snugly on the larger diameter surface. Best method of attacking this problem is to loop the belt over the small surface, hold in place by stretching slightly, then feed it around the larger diameter slowly, turning in the direction it wants to go.

It is wise, when rotating flywheels or motors, to move these in their 'natural' direction of rotation.

Where a narrow flange is used, and the new belt is reluctant to stay in place, even with the tension and rotation method of fitting, one or two pieces of adhesive tape pressed lightly over the belt at the entry point will give a starter. After this, the wheel can be rotated and an outward tension maintained as it is fed into place. One useful aid for this job is that family heirloom, the button-hook.

If you can't find a button-hook, which is hardly likely today, fashion a stiff piece of wire into a nearly-closed loop and hook it over the belt. Use this, as in Fig. 3, to hold the belt away from the entry point of the flywheel, just enough to maintain tension while the wheel is rotated.

Although the use of pliers on rubber or composition belts is to be deprecated, it is occasionally necessary to employ a pair of tweezers to lift an otherwise inaccessible belt. Use the type with a flat blade and trust the clamping action to do the work. If this is not sufficient, you'll simply have to resort to the hook. But always avoid anything sharp. Protect the blade tips with a collar of rubber sleeving, or even a layer of cellophane tape.

After using any sort of adhesive tape on or near a belt, clean both the belt and any surface it contacts with alcohol. Before switching on, rotate the assembly by hand, ensuring that the movement of the motor pulley produces the correct result. After a tedious job of assembly, nothing is more annoying than a spilled belt.

Where flat belts run over tensioning pulleys, it is essential that these shall have their spindles at right angles to the belt run. Fitting tensioned belts is often easier when the tension is partly applied, so it helps to remove the strong spring and fit an auxiliary spring to give temporary weak pressure where needed—or, *in extremis*, to wedge the pulley bracket in place.

Belts that rely on forks or tongues to reposition them for speed changing should not be shifted unless they are turning. The prime cause of belt spill with some machines is speed changing when at rest.

Conversely, idler wheels that are ramped to step on different pulley diameters for speed changing should only be moved axially when in the neutral position. There are exceptions, but these are usually soft-tired idlers with lightly-sprung guide brackets. In these cases, attention to the spring pressure is needed: some slippage may be required, over-drive can be as bad as under-tensioning.

Prime cause of poor pulley drive is a binding bearing caused by an influx of dirt or a hardening of lubrication. Dismantle, taking care to note washer sequence, and clean thoroughly. Again, resort to the thumbnail sketch

(Continued on page 91)

HOW TO CORRECT TURNTABLE "BOUNCE"

DONALD R. HICKE

PLAGUED BY TURNTABLE BOUNCE? Does your cartridge skip a groove, or repeat one, every time someone walks past your record changer? Here's an easy way to return the spring to your step, by adding four of them to your changer.

The main reason a turntable bounces when someone walks near the cabinet is that the built-in suspension is too stiff. It was designed to prevent motor or loudspeaker vibrations, which are relatively high in frequency, from reaching the cartridge. However, it offers little or no protection against low-frequency seismic disturbances, such as those caused by footsteps.

We tried all the usual remedies to stop the bouncing of our changer, including foam-rubber and horsehair pads, but none of them worked. The solution was to suspend the changer inside the cabinet with four soft springs, as shown in the photograph. The ones we used measure 5 inches long and $\frac{7}{16}$-inch diameter unloaded, and stretch about 2 inches under load.

To select your springs, put your record changer, along with three or four records and whatever mounting hardware you plan to use, on a set of scales—baby scales work fine—and weigh them. Then divide the result by four and head for your local hardware store. Check the springs you intend to purchase by actually measuring how far each one stretches when loaded. You should be able to borrow some accurate weights and a ruler at the store.

For example, if your changer and accompanying hardware weighed 16 pounds, load the spring with four pounds and check that it stretches about $\frac{1}{3}$ its length. This will ensure a very low resonant frequency for the system.

Now take your springs home and fasten them to a plywood platform on which the changer will rest, as shown in the photo. Level the turntable by adjusting the position of the changer on the platform.

This technique will work for any record changer which is mounted inside a cabinet, whether the cabinet opens on top or in front. For changers sitting out in the open, use your imagination to find a suitable frame to support the springs. In either case, the results are well worth the effort. Æ

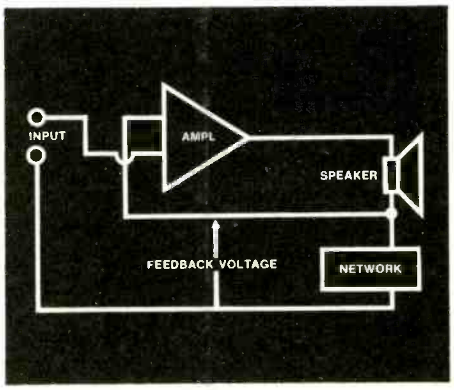
Electronic Suspension makes LWE the most technically advanced speaker in history of sound reproduction.

What is Electronic Suspension?

LWE researchers have taken the principle of inverse (negative) feedback—used so effectively in amplifiers—and adapted it to use in LWE speakers.

This revolutionary breakthrough in technology has been recognized by issuance of U.S. Patent No. 3,449,518, dated June 10, 1969.

LWE Electronic Suspension speakers can be used with any good amplifier (min. 20 dB of feedback).



The above circuit illustration shows how feedback voltage is derived when the LWE is connected to amplifier. A voltage is developed and fed back to the same point in the amplifier that the negative voltage feedback enters.

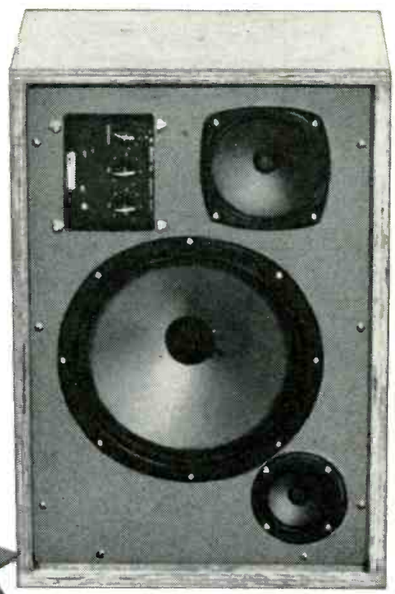
How does Electronic Suspension work?

LWE speakers utilize an electronic network to generate their own error voltages when the speaker does not follow the amplifier out-put. Inverse feedback is utilized to control the speaker cone electronically at all times, rather than allowing a resonant mechanical or acoustic mass-spring system to discolor response at low frequencies. Such "discoloration" occurs in most conventional designs such as folded horn, acoustic suspension, tuned port, drone cone, and bass reflex speakers.

How does Electronic Suspension improve speaker reproduction?

- Provides the best transient response ever achieved in a Hi-Fi speaker.
- Eliminates speaker resonance and its bad effects (resonant peaks, boomy bass and muffled percussion).
- Extends low frequency response, ranging from 20-20,000 Hz* in the LWE II to 29-15,000 Hz* in the LWE VI.
- Makes possible Room Gain Control to compensate for room acoustics and size.
- Delivers infinitely better musical instrument definition and clarity.
- Reduces distortion almost completely . . . especially at high volume levels.
- Increases speaker efficiency 5-10% over passive means of speaker equalization
- Allows freedom in speaker placement due to compact size (fits on floor or shelf—horizontal or vertical positioning).
- Adapts to any good quality amplifier or receiver, solid state or vacuum tube. (min. 20dB)

*Flat response range.



PASSIVE CROSSOVER NETWORKS FOR BI-AMPLIFIER SYSTEMS

Attributes of passive speaker crossover networks vs. electronic crossovers

BLAINE B. KUIST

ELECTRONIC CROSSOVERS are getting the spot-light in a resurgence of interest in bi- and tri-amplification (high, intermediate, and low frequencies split ahead of the power amplifiers).

A lot of hi-fi buffs might be interested in an alternative that is simpler to build (2 hours), not too costly ($50 for two channels with one crossover point), high in reliability with few components and top performance.

The alternative is the old workhorse—passive L-C filter networks.

An article about Electronic Crossovers[1], intrigued me with the potential of improved sound with bi-amplification. My hi-fi fever set in last spring after looking for a starter outfit with my teenage son. Casual looking and listening led to growing interest.

I wondered why a treble speaker like the Altec-Lansing 802-D driver and 511-B horn couldn't be teamed with a good 15-in. speaker, thus covering the whole audio range with just one crossover. By now I had eagerly waded through some of the good handbooks for hi-fi hobbyists, such as "Speaker Enclosures," by A. Badmaieff & Don Davis,[2] and "Hi-Fi Projects for Hobbyists, by Leonard Feldman.[3]

From current literature from manufacturers like Sony, Bozak, C/M Labs, and Pioneer, a tailored design (for a selected crossover frequency and cutoff slope) of an electronic crossover appeared to be a tough project for a beginner to tackle.

1 C. G. McProud, "How to Build a 3-Channel Electronic Crossover, AUDIO, February 1968, p. 19.

Fortunately, I talked to a professional audio engineer about my interests. His reaction was, "Why not use high- and low-pass filters?"

The key idea was to feed the filters from the pre-amplifier, matching the 600-ohm output impedance of the pre-amplifier with a 600-ohm input impedance of the filter. The 600-ohm output impedance of the filter was also matched and terminated by a 600-ohm resistor (in parallel with the 100-k ohm input impedance of the power amplifier). Thus the filter was matched at the input and output with 600-ohm constant impedances.

Settling on Filters

This sounded simple enough—until I tried to find the filters. A search of electronic catalogs, stores, and magazines indicated filters were readily available with 18 dB/octave cutoff slope of the constant-*k* type but would have to be special-ordered for the 12-dB slope which was desired. Perhaps these are available from some professional audio equipment suppliers but my hurried searches failed to turn them up.

So it was back to the "do-it-yourself" method which didn't disappoint me, really. AUDIO's articles on "Professional Audio Controls"[4] had had a refrence to Howard Tremaine's comprehensive handbook on *Passive Audio Network Design*.[5] This had the practicalities of filter design and construction spelled out.

3 Alexis Badmaieff and Don Davis, "*Speaker Enclosures*," Sams, 1st Ed., 3rd ptg., 1967.
4 Leonard Feldman, "*Hi-Fi Projects for Hobbyists*," Sams, 1st Ed., 3rd ptg., Nov. 1966.
5 A. C. Davis & Don Davis, "Professional Audio Controls," AUDIO, Feb., Mar., May, 1967.
6 Howard M. Tremaine, "*Passive Audio Network Design*, Sams, 1st ptg., Feb. 1969.

Again with simplicity in mind, I focused on parallel high- and low-pass L-C filters involving the familiar networks of conventional speaker crossovers except being designed for 600 ohms instead of the usual 4-, 8-, or 16-ohm speaker voice-voil circuits.

The filter networks selected and built are described as follows:

Parallel, *m*-derived
$m = 0.6$ for constant impedance over 85 per cent of transmission band
Impedance in and out: 600 Ohms
Crossover frequency: 500 Hz
Attenuation at crossover: 3 dB
Slope of attenuation: 12 dB/octave

The component values are derived from these formulas:

$$L_1 = (1 + m)\frac{R_o}{2\pi f_c}\text{ Henry}$$

$$L_2 = \frac{R_o}{2\pi f_c}\text{ Henry}$$

$$C_2 = \left(\frac{1}{1 + m}\right)\frac{1}{2\pi f_c R_o}\text{ Farad}$$

$$C_3 = \frac{1}{2\pi f_c R_o}\text{ Farad}$$

Where R_o = filter characteristic impedance
f_c = crossover frequency

In rounding up material to build the filters, we found the capacitors were readily available but the inductances were another matter. With values of 191 and 305 mH needed, air-core coils were out of the question because of large size and hence large resistance. Little usable information seems to be available for constructing iron-core inductors so it was back to the catalogs. Coils with desired characteristics were rarely listed and hard to find.

Unfair to competition!

Introducing Sony/Superscope's new Auto-Reverse Model 780. Here is the most sophisticated tape deck ever built, with every capability, every performance aspect, the most serious music-lover and hobbyist could possibly want. No other tape recorder on the market even comes close to the 780.

ESP Auto-Reverse with Tape/Source Monitoring in Both Directions. The unique Sony/Superscope 780 records, plays back, and permits tape/source monitoring in both directions. Reverse mode switch selects one-time or continuous reverse. Unique design permits recording and tape/source monitoring in both directions.

6-Head Function with Sony Exclusive Roto-Bilateral Head Assembly. This unique three-head assembly is actually equivalent to 6 separate heads and provides complete recording features of tape/source monitoring, sound-on-sound, and echo in both directions of tape travel.

Closed-Loop, Three-Head Tape-Drive System. Two interlocked capstans provide perfect tape tension and tape-to-head contact in both directions. The three-speed Servo-Controlled drive motor maintains precise tape speed regardless of variations in AC power.

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Electronic Sensory Search. Another Sony exclusive—put on your favorite prerecorded tape and press the ESS button. The Model TC-780 switches to fast-forward, precisely locates the beginning of the recorded material, stops, and shifts to playback mode. All automatically. No long leader-tape delay.

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Sony/ Superscope Model 780. $695, with walnut base and vinyl dust cover. If you prefer a custom-console installation, the transport and electronics sections of this unit can be separated and individually mounted. For your free copy of our latest color catalog, please write Mr. Phillips, Sony/Superscope, 8142 Vineland Ave., Sun Valley, Calif. 91352.

SONY SUPERSCOPE The Tapeway to Stereo

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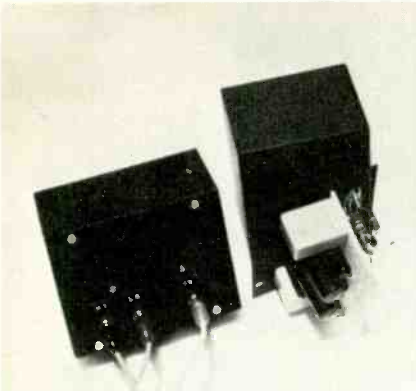


Fig. 1—The passive networks are assembled in metal boxes, and connected ahead of the power amplifiers—one for the highs, and one for the lows.

However, the United Transformer Company catalogs listed coils that covered the audio-frequency range with Q's of the order of 10 to 30 at the 500-Hz crossover point.

For the first pair of coils, the HVC Variductors were tried because they were adjustable and available at a nearby electronic store. The coils were finally set reasonably close to the desired values but they were sensitive to set, although once set, they held their settings and worked well.

For the second pair of coils, the MQA fixed inductances were chosen. These high "Q" toroids with inductances of 200 and 300 mH ± 1 per cent, the numbers closest to those desired without a special order. This compromise on inductance from the desired 191 and 305 mH was not significant.

A description of the coils used follows:

		mH	*d.c. mA*	*Resistance*
Filter A	HVC-4 Variductors	30-300	30	8.6 ohms
	HVC-5 Variductors	70-700	20	22
Filter B	MQA-8 Hi-Q Toroids	200	50	16
	MQA-9 Hi-Q Toroids	300	40	25

Typical "Q" curves for the metal-core coils rise to a peak then fall off after the saturation point of metal cores is reached. The peak Q (about 160) for the MQA coils occurs at about 5 kHz. At the crossover of 500 Hz the Q is about 40. At 20 kHz, Q is about 25 and at 20 Hz it is in the range of only 1 to 2.

The HVC coils being adjustable, the peak Q falls somewhere in the lower half of the audio range depending on the setting. At 500 Hz the Q is in the range from 5-15.

Although the MQA coil had in general the higher Q characteristics, there was no audible difference in performance.

Filters Assembled

With the coils in hand, the remaining parts were reaily available and the assembly went fast. All the parts were mounted on a plastic board fastened to the cover of a 4" x 5" x 3" steel box. Steel was used for shielding although this was found later to be unessential.

The assembled filters are shown in the Fig. 1 with the back of the cover and the board exposed to show wiring and components for one low- and high-pass filter combination.

Response vs. frequency curves were run with an audio generator and a VTVM with the results shown in Fig. 3. The 520-Hz crossover point was close enough to the 500-Hz goal.

The crossover point was down 3.5 dB from the bass plateau and

Fig. 2—Schematic of the passive filter networks used with the bi-amplification system described by the author. Two networks are required for stereo.

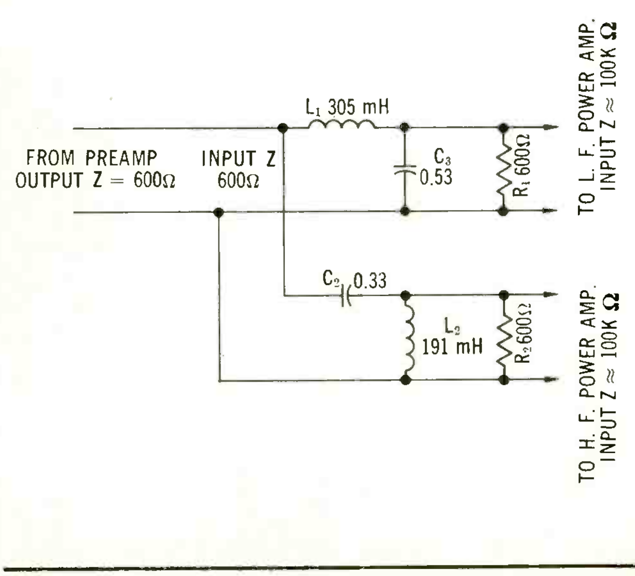
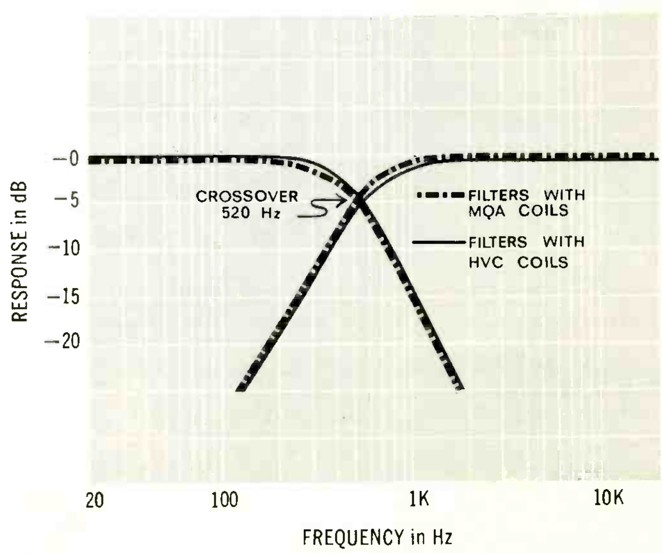


Fig. 3—Frequency-response curves for the author's passive networks.



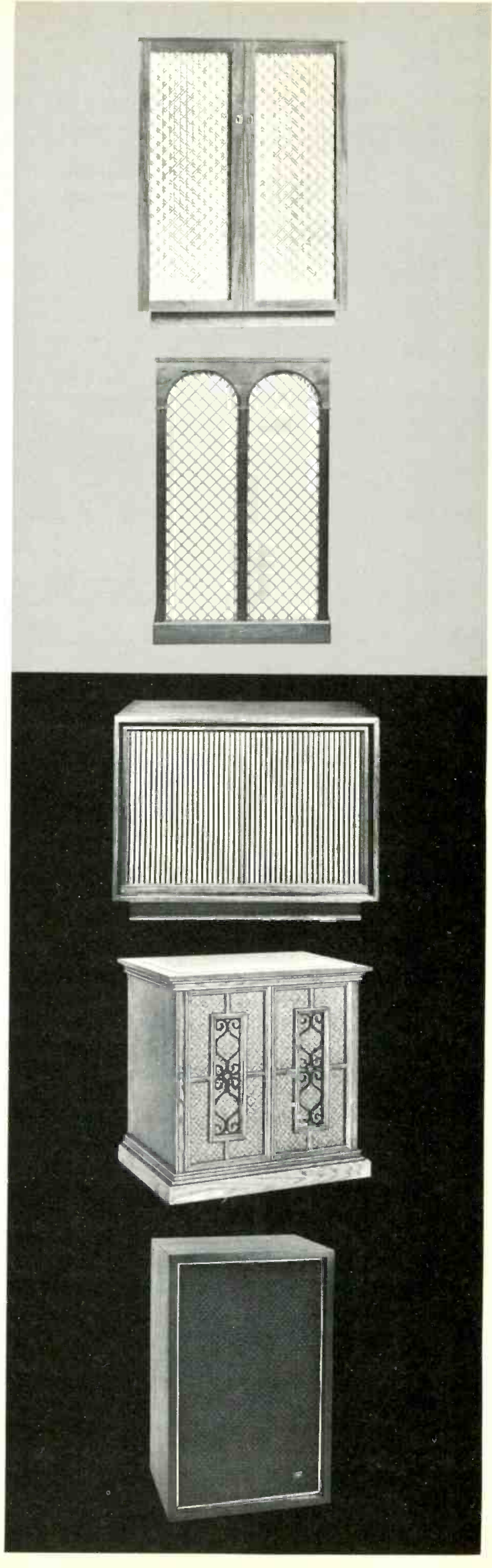


TABLE I
COMPARISON OF CROSSOVER ALTERNATIVES

	PASSIVE Ahead of Amplifiers	ELECTRONIC Ahead of Amplifiers	CONVENTIONAL After Amplifiers
Bass speaker: damping and transient response	Permits performance to full damping ability of amps.	same as passive	Reduces woofer response by resistance and reactive impedance between ampl. and speakers.
Amplifier performance	IM distortion minimized by high and low freqencies going through separate amplifiers. Greater dynamic range due to separate amplifiers.	same as passive	IM distortion due to hi and low going thrrough same amplifier. Dynamic range limited because power peaks for hi and low are additive.
Speaker distortion	Minimized None due to crossover frequency shifting.	same as passive	Distortion added. Crossover frequency and phasing of hi and lows shift with actual impedance of speaker causing unwanted frequencies going into wrong spakers and dulling of stereo image.
Crossover network distortion	<0.1% THD	<0.1% THD Coml. units 0.1 to 0.5%	Can be <0.1% THD with top quality components.
Reliability	Good—few components.	Has several fold more components with more chance for problems.	Good—few components.
Costs	Crossover: parts $50 for 2 Ampl: Requires amplifier for each speaker.	Crossover: parts $50 for 2, ready-built $100-$200 for 2. Ampl: Requires amplifier for each speaker.	Crossover: lowest cost Ampl: only 1 stereo required.
Time to build by amateur	2 hrs. for 2	20-40 hours. for 2	2 hrs. if coils ready built; add time if coils to be wound.
Insertion loss (—) or gain (+)	— 3.5 dB	0 to +3 dB typical Some types, —6 dB	Depends on quality (hi Q) of particular coils used. —0.1 to —2 dB typical.

4.0 from the treble, vs. the goal of 3.0. Theoretically, the total sound pressure level should then suffer a bit of a drop in the crossover region. Practically, this slight dip could not be measured in the total output from the speakers (audio generator input and microphone pickup) and certainly could not be detected by ear. The insertion loss was 3.6 to 3.2 dB (20 Hz and 20 kHz respectively).

As the text books state, distortion for the passive filter network should be practically nil. This was checked through the courtesy of a manufacturer's amplifier clinic and proved to be so. The filters were used between a Dynakit PAT-4 preamplifier and two Dynakit 120 amplifiers. The THD was measured at 2 volts output, which would fully load the amplifiers when feeding 16-ohm speakers. No difference could be read in the THD with and without the filters in the output.

In my setup, the amplifiers were fed into the Altec-Lansing treble horns mentioned earlier and Klipschhorn bass corner horns. The defenders of the conventional crossover have pointed out that the electronic crossover (or filter) ahead of the amplifiers adds little or nothing to the damping of the bass speaker which is horn loaded like the Klipsch. Theoretically, this might be right. I have not had the opportunity yet to check this by A-B tests of conventional crossovers vs. filters with the horn-loaded speakers. Probably the differences are less prominent than with direct-radiating speakers. All I can say at this point is that the sound from the horns with the filters ahead of the amplifiers is superb.

If you have been following the interesting articles and letters to the editor in AUDIO Magazine for the last year and a half on this subject, you are pretty well posted on the pros and cons of electronic crossovers vs. conventional crossovers after the amplifiers.

This article presents another alternative, the passive filter networks *ahead* of the amplifiers. Comparing filters with electronic crossovers, it appears that there is a lot to be said for the filters, especially for the audiophile who wants to build the device himself with minimum time and cost. Advantages and disadvantages of the three alternatives are listed in Table I.

The debates continue on whether the sound is significantly better (and worth the cost) with the crossover ahead of the amplifiers. To anyone who has listened to an A-B test with direct radiating speakers, there is no doubt about the result being audibly better with crossovers ahead of the amplifiers. And for the audio buff who is determined to get the best in sound, an easy, economical, and reliable way to it is with the passive filters. Æ

ABZs of Stereo FM

LEONARD FELDMAN

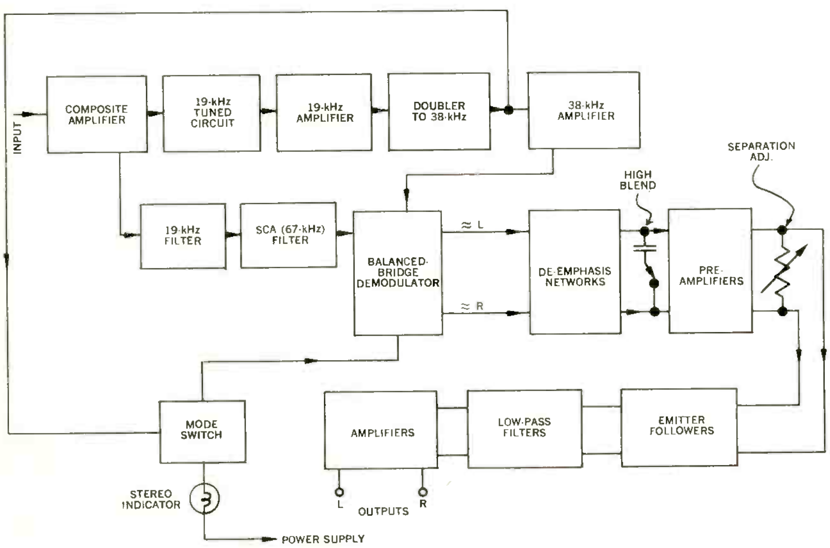
A Modern Switching-Circuit Decoder

HAVING previously considered the way in which a so-called "Time Division" or "switching" stereo-multiplex decoder works, it would be well to examine in detail a latter-day circuit embodying these principles. Starting with the basic concepts described last month, many manufacturers have embellished their circuits to such an extent it is often difficult to "pick out" the elements of the decoding process. Usually, the refinements are present for two very good reasons—first, to improve performance specifications, such as separation at all frequencies, adequate residual 38- and 19-kHz rejection following demodulation and so on, and secondly, to incorporate such convenience features as automatic switching of mode (from monophonic to stereo FM), stereo indicator lights, and the like.

A straightforward and clean design is to be found in the MPX decoder section of the Sony STR-6120 Receiver and, with the kind permission of that company, we shall use elements of that design to describe the "decoding" process in terms of an actual, currently marketed, design. Since this particular receiver is in a fairly high-priced category, its designers incorporated just about every feature that can be found in modern stereo FM circuitry, and it will therefore serve well for these illustrative purposes.

A block diagram of the circuit is shown in Fig. 1. The input signal, taken from the output of the ratio detector and without any de-emphasis applied, is first amplified by a composite amplifier stage. Outputs are taken from both the collector and the emitter of this transistor amplifier. The collector is followed by a tuned circuit, adjusted to resonate at 19 kHz (the pilot-signal frequency) which, together with a transformer tuned to the same frequency, eliminates everything in the composite signal but the desired 19 kHz and couples this signal to a 19-kHz amplifier. The 19-kHz signal developed at the collector of this stage is transformer coupled to a full-wave rectifier consisting of a pair of diodes. This portion of the circuit is shown schematically in Fig. 2. Since the pulses produced by the pair of rectifiers are not filtered, two such pulses are produced for each cycle of 19 kHz, as shown in the figure.

Fig. 1—Block diagram of the Sony STR-6120 stereo FM decoder circuit.



It is these non-sinusoidal, but fairly large-amplitude pulses which are used to trigger the mono-stereo mode switch shown at the lower left of the block diagram of Fig. 1, and about which we shall have more to say later. The collector circuit of the next stage (38-kHz amplifier) is tuned to 38 kHz by means of a resonant tank circuit. The resulting sinusoidal 38-kHz signal is transformer coupled to a bridge-type demodulator circuit, which differs from the simple, two-diode demodulator previously analyzed, as shown in Fig. 3.

Referring back to the composite amplifier of Fig. 1, the signal derived from the emitter of that stage contains all the frequencies of the composite signal—i.e. main-channel frequencies from 50 Hz to 15,000 Hz, the 19-kHz pilot signal, stereo sideband signals in the range from 23 to 53 kHz and, if SCA (Background Music Subscriber Service) is transmitted, the frequency-modulated 67-kHz subcarrier as well. The entire composite signal is first passed through a 19-kHz band-elimination filter, to remove that component, and then through a 67-kHz filter to eliminate frequencies associated with any possible SCA transmission. The resultant composite signal is applied to the center tap of the secondary winding of the demodulator transformer shown in Fig. 3. By employing four diodes in a balanced-bridge arrangement, the system cancels most of the residual 38-kHz products which would otherwise be present in the simpler two-diode arrangement. Alternate conduction of upper and lower diodes (as alternate polarities of 38 kHz are applied to each end of the secondary winding) results in the detection, or sampling, of the L and R signals at their respective output lines. Note that in the block diagram of Fig. 1 we have labelled these outputs as ≈L and ≈R, the wiggly symbol being a mathematical term meaning "approximately"—that is, approximately L only and approximately R only.

For many reasons, beginning way back in the i.f. system or at the output of the main channel ratio-detector, the "mix" between main-channel program content and sub-channel sidebands may have become unbalanced in both amplitude and phase. Unless this "mix" is in precisely the correct proportions, there

Fig. 2—Full-wave rectifier followed by tuned amplifier "doubles" the 19-kHz pilot signal to 38 kHz.

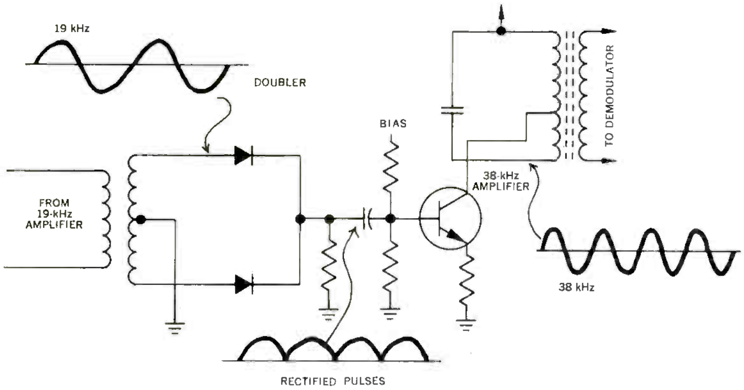
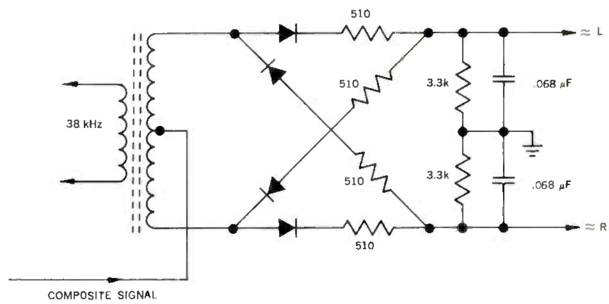


Fig. 3—Balanced-bridge demodulator circuit used to recover L and R signals.



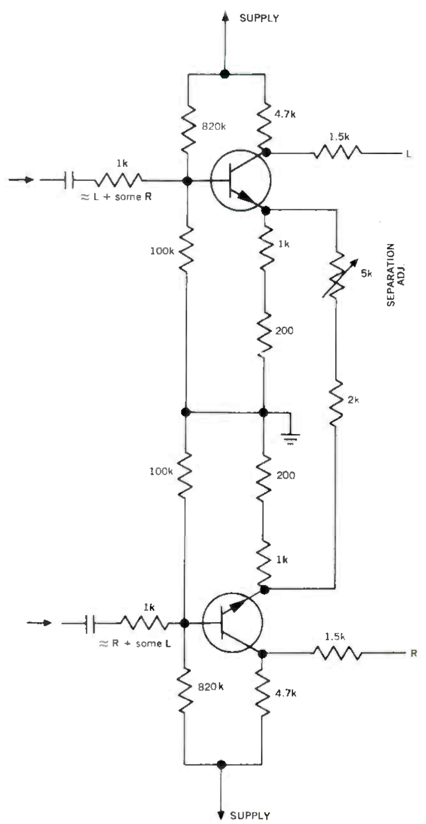
will be some R in the L line and some L in the R line. How Sony compensates for this "impure" separation will be shown shortly.

You will recall that up to this point, no de-emphasis has been applied to the signal, since to have done so previously would have resulted in nearly total attenuation or elimination of the vital super-audible frequencies which are a part of the composite signal prior to stereo demodulation. That process is accomplished now, after demodulation, and because two distinct signals now exist, a de-emphasis network is required for each. The networks themselves consist of nothing more than the usual R-C network to "roll off" the high frequencies in a prescribed manner (75-microsecond time constant, just as in monophonic FM).

At this point in the circuit, Sony introduces a HIGH BLEND switch which, by means of a small capacitor connected *between* the L and R circuits, permits the mixing together of the higher audio frequencies. Since this, in effect, ruins separation at these high frequencies, you might wonder why such a "partial stereo defeat switch" would be introduced. It can be shown that the high-frequency noise associated with stereo FM, in the presence of a weak signal, appears in opposite phase in the L and R channels. Thus, the switch is only intended to be used for such poor-reception situations. When the switch is shorted, some of the high-frequency noise of one channel cancels that in the opposite channel, albeit at the expense of high-frequency stereo separation. The philosophy here is that it is better to enjoy noise-free stereo with poor high-frequency separation than to have to listen to noisy stereo with optimum separation. As with most such niceties, the switch in a consumer-actuated control, so the listener still has the option.

The next stage, though labelled preamplifiers, really serves a more important function than just straight amplification. A schematic of this portion of the circuit is shown in Fig. 4. The resistor-potentiometer combination connecting the emitters of the L and R channels provides a form of negative feedback between the channels. You will recall that up to this point, there may be some residual L in the R channel and some R in the L channel. For purposes of illustration, let us assume that the L channel contains 0.9 L and 0.1 unwanted R, and that the converse is true of the R channel. Now, if the amount of negative feedback is such that −0.1 (0.9R + 0.1L) is introduced into the (0.9L + 0.1R) channel (10 per cent feedback), the resultant signal coming out of the "L" line will be (0.9L − 0.01L + 0.1R − .09R), or, (0.89L + 0.01R). Although we have reduced the amplitude of the desired L signal from 0.9 to 0.89, we have simultaneously reduced the undesired R content from 0.1 (10 per cent) to .01 (1 per cent. In "dB" terms, this represents an improvement from 20 dB of separation to 40 dB. It should be obvious that while all this improvement is taking place in the "L" channel, the same feedback correction is symmetrically taking place in the "R" channel. In theory, at least, proper adjustment of potentiometer in Fig. 4 should result in complete elimination of unwanted L in R and unwanted R in L. In practice, however, there are not only amplitude differences to be compensated for, but phase differences at different audio frequencies as well. Only careful initial design can take care of these phase-response differ-

Fig. 4—Symmetrical negative-feedback circuit optimizes separation.



ences between channels and between main- and sub-channel components, so that a separation figure of 40 dB

(Continued on page 91)

Equipment Profiles

This Month:
- **Jensen Model S-100 Stereo Speaker System**
- **Concord Model "Mark III" Stereo Tape Deck**
- **Kenwood "Supreme I" Multi-Channel Stereo Amplifier**
- **H. H. Scott Model Q-100 Speaker System**

Jensen Model S-100 "Stereo 1[R]" Stereo Speaker System

Fig. 1

MANUFACTURER'S SPECIFICATIONS: **Input Impedance**/channel: 8 ohms. **Power Rating**/channel: 35 watts program material. **Frequency Range:** 30-20,000 Hz. **Finish:** Walnut Veneer. **Dimensions:** 13" H x 21¾" W x 11 9/16" D. **Weight:** 26½ lbs. **Price:** $124.95.

A scientifically legitimate "one-speaker system" stereo reproducer has been sought for many years. Small-apartment dwellers, and other decor-conscious high fidelity enthusiasts had long hoped for it, while self-sacrificing wives of audio buffs fairly begged for it.

The Jensen Manufacturing Div. of the Muter Company, amidst a flurry of publicity, introduced its answer to this quest recently. Dubbed "Stereo 1[R]", the first of what will probably be a series of "one-enclosure" stereo speaker systems is the modestly priced (when one considers that only *one* unit is required) Model S-100. Smartly styled and constructed in the "bookshelf"-enclosure tradition, the system looks quite conventional from the outside, as shown in Fig. 1.

The first clue to its uniqueness is, perhaps, the wrap-around grill-cloth treatment, which covers about half the side surfaces as well as the front radiating surface of the enclosure. This suggests loudspeakers oriented to produce "side firing." Our first skeptical conclusion was that Jensen had merely reverted to the old technique of "mixed lows" directed forward, with middles and highs of Left and Right radiated sidewards by means of two lesser speaker elements mounted on the left and right inside walls of the enclosure. This "compromise" solution has been used by console manufacturers for years and about all that can be said for it is that you sense some stereo effect if you put your nose about six inches from the surface of the console face.

Happily, the system introduced by Jensen is much more sophisticated than that—and, more importantly, IT WORKS! Although we read a full description of the theory behind this acoustic "break-through," we had to examine it for ourselves, and so we opened the back of the enclosure. On the inside of the back, we found a transformer hooked up to the input terminals and to the speaker elements below. A detail photo of this "matrixing" transformer is shown in Fig. 4. Inside the enclosure, about half way down the "depth" dimension of the enclosure, we saw a single, 8-inch loudspeaker with its hind end facing us, as can be seen in the photo of Fig. 2. We removed this baffle, turned it over, and saw what is depicted in Fig. 3, photographically, as well as the line diagram of Fig. 5, which we shall now use to explain how single-box stereo is not only possible, but in some ways actually gives a more total "surround" illusion than the more conventional two-speaker arrays.

Acoustic Matrixing

As mentioned, the larger 8-in. speaker element affixed to the main baffle is a front radiator. A "median plane baffle," mounted perpendicular to the 8-in. unit and directly across its diameter, houses two 5-in. wide-range speakers facing in opposite directions. Electrical connection to these two speakers is made in *series*, but the two speakers themselves are connected out-of-phase. Furthermore, thanks to the transformer matrix network, the signal fed to this array is actually a *difference* signal, or (L−R), whereas the signal fed to the forward radiating 8-in. element is a *sum* signal, or (L+R). There are, therefore, three acoustic output signals present, as follows:

(L+R) from the 8-in. unit radiating in a forward direction.

(L−R) from the "median plane array" aimed to the left.

−(L− R) from the "median plane array" aimed to the right.

If you are at all familiar with stereo FM transmission, you will realize that

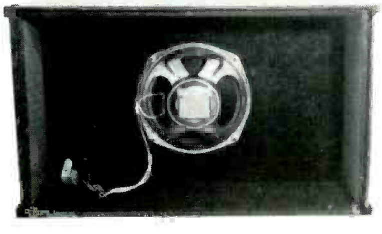


Fig. 2—With the back of the new Jensen S-100 "Stereo 1[R]" removed, only about ½ the total cubic volume acts as an acoustic enclosure for the 8-in. speaker element.

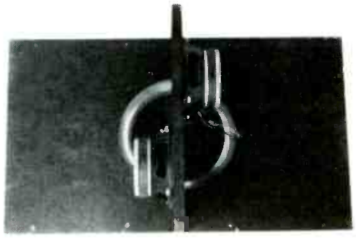


Fig. 3—The inner structure reveals positioning of two side-firing 5-in. wide-range speakers, as well as the 8-in. (L+R) speaker.

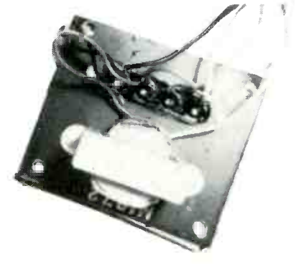


Fig. 4—Shown here is the matrixing transformer located on the inside of the enclosure's back.

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Yes, you'll like what you hear on this one. Including the price. (That part sounds almost as good as your favorite tapes.)

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Fig. 1—The Mark III head cover is hinged to provide access to the heads for cleaning and editing. Note the cleaning pad/flutter filter at the left of the assembly.

Concord Model "Mark III" Three-Head, Four-Track Stereo Tape Deck

MANUFACTURER'S SPECIFICATIONS:
Speeds: 7½, 3¾, 1⅞ ips; **Motor:** Hysteresis synchronous; **Speed accuracy:** 99.7% with line-voltage variation from 100 to 128 V; **Frequency Response:** 7½ ips, 20-23,000 Hz; 3¾ ips, 20-14,000 Hz; **Wow and flutter:** 7½ ips, under .09%; 3¾ ips, under 0.12%; **Signal-to-Noise Ratio:** 52 dB; Bias frequency: 200 kHz; **Reel Capacity:** 7 in.; **Dimensions:** 18½" wide, 13" high, 6⅝" (over knobs and head cover). **Weight:** 25¾ lbs. **Price:** Under $260.00.

Replete with practically everything the recordist could want in a tape machine, (except power amplifiers and speakers) the new Concord Mark III offers three speeds, low wow/flutter, sound-on-sound facility, echo facility, tape or source monitoring, and dynamic muting. This is the first machine we have examined which incorporates an integrated circuit in the electronic lineup, which serves mainly to reduce the total number of transistors as separate elements. Even so, there are 13 discrete transistors, the two integrated circuits, and 15 diodes in the circuit, not to mention the four additional diodes in each of the integrated circuits, as well as five transistors.

Each of the record circuits requires four transistors, while each playback circuit employs two plus the integrated circuit. The metering circuits require one diode for each channel, and four are used in the power supply. The remainder of the diodes are in the dynamic-range-expansion circuit, as are two additional transistors; the final transistor is used as a voltage regulator.

Basically the circuitry is fairly conventional. The microphone input jack in each channel feeds the base of the first transistor in the record circuit, with the auxiliary inputs feeding the same points through the open-circuiting microphone input jack and a resistor to make up for the additional sensitivity of the mic inputs. A slight amount of bass boost is provided by feedback around the first pair of transistors, while the high-frequency boost is provided by bypassing the output emitter with a resonant circuit which is switched to provide compensation for the three speeds.

In the playback circuit, which operates even during recording to provide for tape monitoring, the playback head feeds the integrated circuit directly, with playback equalization being provided by feedback to one base of a differential amplifier in the IC. The turnover point is switched for the three speeds. The IC is followed by one transistor which feeds the line outputs, and the headphone monitoring circuit requires another transistor which drives a transformer to furnish the low impedance for the usual stereo headphones, while the record-level meter is driven from the emitter of the transistor directly through a calibrating resistor and a diode. The meter indicates record level when the monitor switch is in the SOURCE position, although it also indicates the output from the playback head either during playback or while recording if the monitor switch is in the TAPE position.

The "dynamic range expander" circuit takes its input from the line-output jacks, amplifies it, and applies it to a pair of diodes which offer a high impedance whenever there is any signal present, and thus effectively disconnect a 1-μF capacitor from shunting the output. In the absence of signal, the diodes are biased positively and the capacitor shunts the output circuits, reducing the tape hiss appreciably. This circuit employs eight diodes and two transistors, but is relatively simple, and effective enough to reduce hiss by about 4 dB, which is sufficient to be an improvement to the ear.

The physical appearance of the recorder is fairly conventional in that there are two reel hubs, the head assembly, the capstan and idler, and the control knob, which is of the bar type. It has five operating positions: to the left of the STOP position is the REWIND function, and to the right are the PLAY/RECORD position, the CUE function, and FAST FORWARD. The record buttons are actually two levers at the lower left corner of the panel, with the digital counter directly above them. One desirable device is the guide roller and tape-tension arm at the left of the head cover. The roller tends to smooth out the tape tension as the tape is drawn from the supply reel, and is aided by the tape-tension arm. A similar tension arm is located at the right of the capstan, so that the effect of warped reels is minimized, and even sticky tape does not affect the tape motion.

At the right of the panel is the amplifier control section, which is mounted directly on the panel. At the top are three switches: one turns on or off the dynamic muting circuit, and the other two select tape or source monitoring on the two channels individually. Below these switches is the

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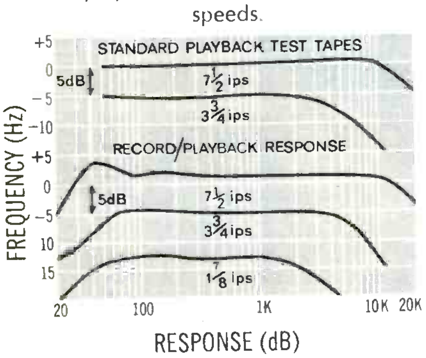
Fig. 2—Input and output connections are made in the recessed panel on the right side of the case, and additional switches and controls for sound-on-sound and echo are on the same panel.

Fig. 3—Frequency-response curves: The two upper curves are response from standard tapes, while the three lover curves show record/playback responses at all three speeds.



left-channel record-level control, and under it is the dual VU meter, with illuminated indicators to show when the machine is recording. Next is the right-channel record-level control, and below it is the power switch—a push-push button—and the headphone jack. At the lower right of the recorder panel are the two microphone jacks. A knob at the top of the panel operates the speed-change function—mechanically for the tape transport, and electrically to change equalization.

The head cover is hinged to provide easy access to the heads for cleaning and editing, as is shown in Fig. 1. The tape path is first past a tape cleaner—a cylinder of felt over which the tape passes, and which also serves as a flutter filter. It is encased in a metal housing which exposes only a portion of the cylinder, allowing it to be turned to a fresh position when it gets soiled. Next the tape passes an automatic shutoff lever, then the three heads, and out to the capstan. During play or record, hinged covers are raised in front of the heads to provide shielding and to carry the pressure pads. A pilot light at the top of the head cover indicates when power is on.

At the right side of the case is a cutout exposing a panel, Fig. 2, which accommodates the auxiliary input jacks, the line output jacks, and the SOUND-ON-SOUND and ECHO switches, as well as the level controls for these functions. The power cord also enters at this panel.

Performance

Figure 3 shows the frequency-response of the Mark III on a standard test tape for 7½ and 3¾ ips, as well as the record/playback responses for all three speeds. Bias frequency measured 190 kHz, which is certainly high enough to avoid the fifth harmonic of the highest frequency likely to be recorded. This has long been the standard criterion, although we have measured a number of machines in the past year which have been over 100 kHz, so there seems to be a trend in the direction of higher and higher bias frequencies.

Wow and flutter measured .075% at 7½ ips, 0.18 at 3¾, and 0.24 at 1⅞, all of which are excellent. THD measured 1.5% at "0" recording level, while the 3% point was found to be at a +6 level. S/N measured 46.5 dB below the 3% distortion level, but this increased to 50.5 with the dynamic range expansion circuit activated. A microphone input of 0.8 mV was sufficient for a "0" recording level, and an auxiliary input of 0.168 V provided the same level. The measured output level was 0.68 V for the "0" recorded level signal. Microphone input impedance is relatively high, measuring better than 10,000 ohms, while the auxiliary input is 100 k ohms. Channel separation was a good 35 dB at 1 kHz, which was also measured from track to track between adjacent recordings—also good.

Operation

The Mark III is easy to operate, easy to thread, and easy to listen to. The dynamic muting circuit helps the tape-hiss problem appreciably. It is surprising what only 4 dB can do, particularly when the hiss is already fairly low. The echo function works as would be expected, although this type of action always gives a slight repetitive

Fig. 4—Appearance of the mechanism with the panel removed. Note the accessibility for servicing from this side.

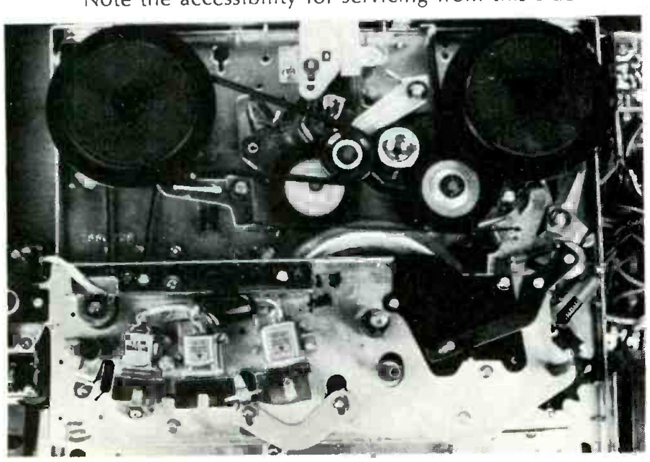
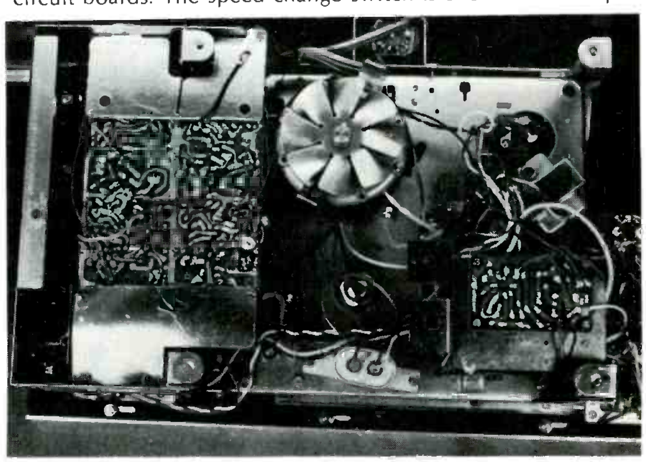


Fig. 5—View of rear of the recorder showing motor and printed circuit boards. The speed-change switch is shown at the top.



sound which is easily recognizable as the result of any tape re-entry system. It is most satisfactory at 7½ ips, and unless a special effect is desired, it should not be employed at the two lower speeds. The sound-on-sound function operates equally well on all three speeds with adequate control of level and a simple selection of R to L or L to R by means of a single slide switch.

The machine starts quickly, and the tape-tension arms effectively eliminate any "burble" as the tape starts to roll. For editing purposes, the accurately marked head-gap positions — arrows on top of the head assembly—are a great help in locating the exact gap locations. The pressure-sintered ferrite heads are claimed to be non-magnetizeable—a problem that exists with usual laminated iron heads. In any case, we could notice no increase in hiss over the many hours we used the machine in testing and listening.

A handsome dust cover of transparent plastic of a slightly smoky hue covers the mechanism when desired, leaving the amplifier controls accessible to the user. This cover helps keep dust off the tape and out of the mechanism, both while playing and when not in use.

For an additional $70.00, the user can obtain all the facilities of the Mark III plus automatic reverse play in the Mark IV. To users, who like extra-long play time, the extra cost would be well worth while. Either unit would make a fine addition to a hi-fi system which lacks a tape deck.

Check No. xx on Reader Service Card

Kenwood "Supreme 1" Multi-Channel Integrated Stereo Amplifier

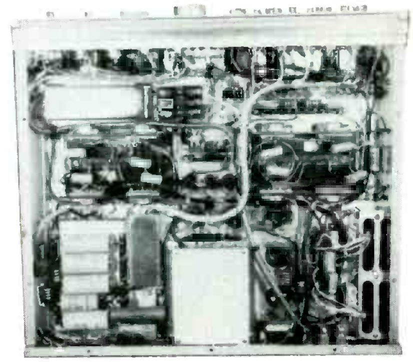


Fig. 2—Internal construction makes efficient use of available space, while vertically mounted p.c. boards provide easy servicing.

MANUFACTURER'S SPECIFICATIONS:

MAIN AMPLIFIER SECTION—Power Output (rms)/ channel: Low-Range Amplifier, 33 watts; Mid-Range Amplifier, 23 watts; High-Range Amplifier, 15 watts. **Music Power:** Low-Range Amplifier, 80 watts; Mid-Range Amplifier, 50 watts; High-Range Amplifier, 35 watts. All referenced to 0.5% THD. **Frequency Response:** Low-Range Amplifier, 10-100,000 Hz, 1±1 dB; Mid-Range Amplifier, 100-100,000 Hz, ±1 dB; High-Range Amplifier, 1000-100,000 Hz, ±1 dB. **Signal-to-Noise Ratio:** 90 dB. IM Distortion: 0.2% at 3 dB below rated output.

CONTROL AMPLIFIER SECTION—Input Sensitivity: Phono 1, 2 mV; Phono 2 (low-level setting), 0.1 mV; Tuner, 200 mV; AUX; 200 mV; Tape Head, 2 mV; MIC, 2 mV; Tape Play, 200 mV. Bass Control: ±12 dB at 100 Hz. Treble Control: ±12 dB at 10,000 Hz (with selectable cross-over frequencies of 2000 and 5000 Hz). **Equalization:** RIAA 20-20,000 Hz ±1 dB, NAB 20-20,000 Hz ±1 dB. **Signal-to-Noise Ratio:** Phono, 60 dB; Phono (Low), 50 dB; Tape Head, 60 dB; Tuner, 90 dB: AUX 90 dB. Frequency Response: 20-50,000 Hz ±1 dB.

FILTER SECTION—Low Filter: 12 dB/octave with 40- and 80-Hz cut-off points. **High Filter:** 12 dB/octave with 6-kHz and 9-kHz cut-off points. **Cross-over Filters:** Low Crossover: 12 dB/octave at 400 or 800 Hz. High Crossover; 12 dB/octave at 2500 or 5000 Hz.

GENERAL—Dimensions: 16¾" x 6 5/32" x 12". Weight 36.3 Lbs. Price: $695.00.

Proponents of electronic cross-over amplifiers should have a field-day with the new Kenwood SUPREME 1. While the idea of dividing the various frequency ranges electronically instead of by means of L-C passive filters positioned *after* amplification is not new, this new unit from Kenwood incorporates so many flexible features that it may, perhaps, encourage heretofore trepidatious audiophiles to try this approach to feeding woofers, mid-ranges, and tweeters.

To begin with, the SUPREME 1 is the first integrated amplifier we have tested that actually includes six powerful amplifiers on one chassis (three for each channel). What's more, just in case you are not ready to discard the inductance-capacitance crossover networks present in your existing speaker systems, the so-called "low range" pair of amplifiers can be used as wide-range amplifiers simply by setting the "low" crossover switch to "flat." This first pair of amplifiers boasts 33 watts per channel RMS and, with its capability to act as a wide-range (flat-response) amplifier, could actually be used as a conventional stereo amplifier all by itself. Taking it one step further, the second cross-over switch, besides providing mid-high crossover frequencies of 2500 and 5000 Hz *also* has a FLAT position, so that owners of two-way speaker systems (as opposed to three-way) can also use these amplifiers to advantage.

A front view of the SUPREME 1 does not in any way disclose its unique multi-amplifier construction. The attractive silver-banded and dark olive front panel, shown in Fig. 1, is equipped with modern, metal-turned controls, push buttons, and levers, all of which combine to denote extremely flexible but uncluttered design. The six pushbuttons at the upper left select signal sources while the two, two-position levers directly below are

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power and tape-monitor switches. At the lower right area below the selector push buttons is a five-position mode switch which includes such long-abandoned positions as mono, reverse, stereo, left only (to both speakers) and right only. The volume and balance controls are concentrically mounted, but use huge front and rear knurled knobs. It is obvious that these are intended to be (and, in fact, are) the most-often-used controls. Separate bass controls (for each channel) and treble controls occupy the right area of the panel, each calibrated in dB of boost or attenuation. Directly below the bass controls are the low-filter switch (with cut-off settings at 80 and 40 Hz) and a tone-defeat switch which eliminates the bass control action entirely. Similarly, below the treble controls, are the hi-filter switch with cut-off selectable at 6 or 9 kHz and a treble cross-over switch enabling treble action to start at either 2 or 5 kHz or permitting defeat of the treble control altogether.

The lower brushed aluminum band of the panel turns out to be a hinged door which, when swung downward, discloses less-often-used controls, such as a phono input switch (for low- or high-gain operation of the second phono input), a phase reversal switch, (How long since we've seen that, even on expensive equipment?), six tiny level controls for balancing low-, mid- and high-frequency speakers of each channel (set only once, at installation, or when changing speaker complement), and microphone input jacks and tape playback jacks which eliminate the need for getting at the rear panel every time you want to play a tape through this amplifier.

In addition to the usual imput jacks and convenience outlets located on the rear panel of this amplifier, there are *six* sets of output terminals (binding post type). The crossover frequency switches are also back here, since they will be adjusted only once. Recorder output jacks as well as preamp output jacks (for those wishing to drive other stereo amplifiers), a line fuse and a DIN multiple tape recorder socket (standard with many foreign makes of tape recorders) complete the rear panel layout.

In case you're wondering how six power amplifiers and two professional preamplifiers can be crammed into the small confines of this unit, Fig. 2 discloses that every cubic inch of inner chassis surface and volume is most efficiently and neatly used. Vertically mounted p.c. boards abound and highest-quality components are in evidence. Heat sinking of output circuits was found to be quite adequate and extended use of the instrument at high power levels (even under instrument and continuous testing) did not raise the temperature of the case by more than a few degrees.

Fig. 3—THD measured separately for the three amplifiers associated with each channel.

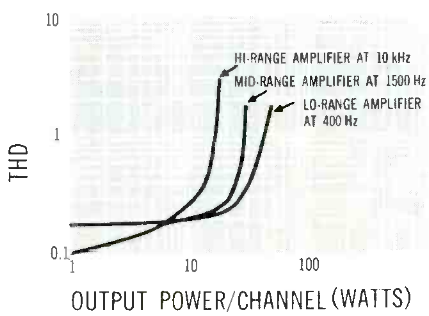


Fig. 4—Tone-control action. Note variable crossover action of bass control. Dotted curves represent 5-kHz setting of treble switch. Solid treble curves are at 2-kHz setting.

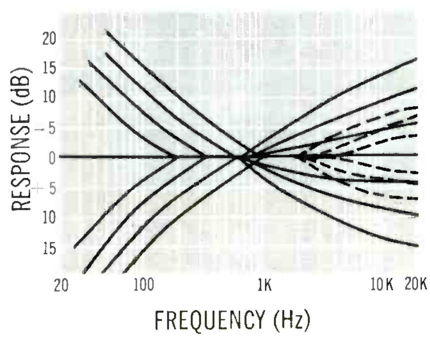


Fig. 5—Filter response curves of Kenwood "Supreme I" multi-channel amplifier.

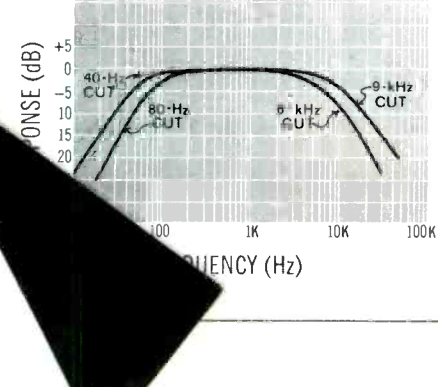
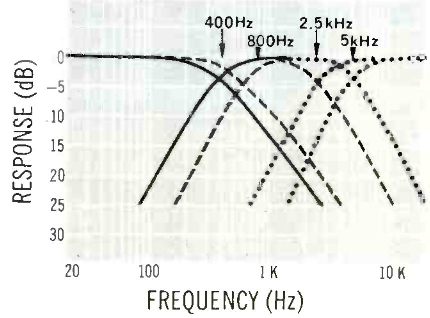


Fig. 6—Response curves of electronic crossover system illustrating selectable crossover frequencies for low-mid and mid-high crossovers.



Electrical Measurements

In general, we found the Kenwood SUPREME 1 to be conservatively rated in just about every specification. For example, individual power amplifier ratings measured 35, 25 and 15 watts for low, medium and high channels of each stereo channel before total harmonic distortion (THD) of 0.5% was reached. Results are shown in Fig. 3. Tone-control action was balanced and symmetrical, as shown in Fig. 4 and, for our listening tastes, we preferred the 5-kHz crossover for the treble control because it enabled us to add just a bit of emphasis at the extreme highs without "lifting" the middles. A plot of the high- and low-filter responses is shown in Fig. 5 and, unlike most "rumble" and "scratch" filters, these "12 dB per octave" circuits are legitimate and useful, enabling the user to eliminate "scratch" on older records without sacrificing musical content.

The crossover response for each position of both the low-mid and mid-high crossover circuits is shown in Fig. 6, and is seen to conform to published specifications. As will be noted later, however, using the six amplifiers to drive two sets of woofers, midrange and tweeters is not all that easy. Intermodulation (IM) distortion in a multi-channel amplifier has relatively little meaning, since the two frequencies used in measuring this form of distortion will actually be fed to two different amplifiers, and resultant IM should be negligible. Our listening tests disclosed that this was so—for

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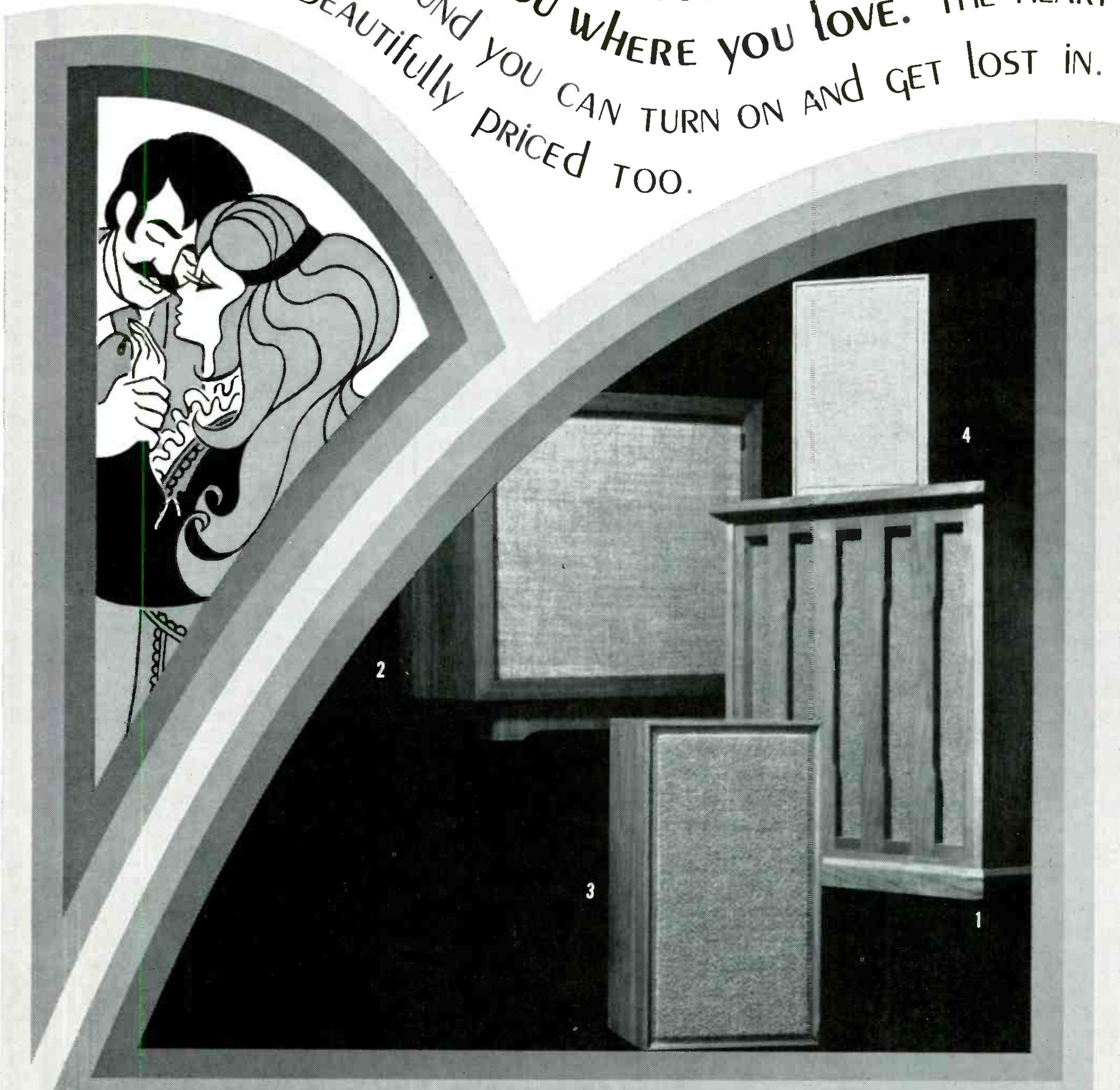

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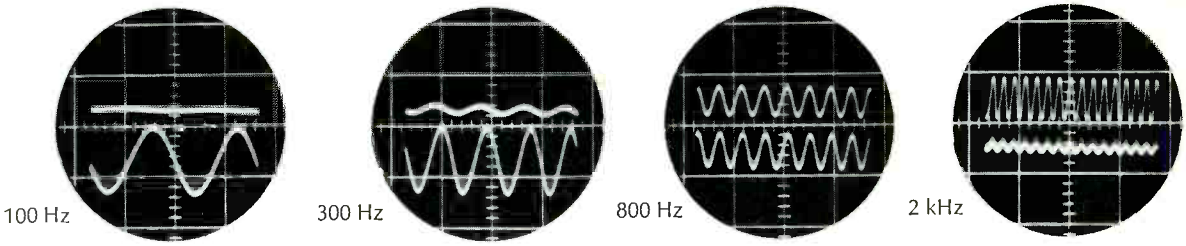
Fig. 7—Upper trace represents output of mid-range amplifier; lower trace is output of bass amplifier. Frequencies applied as noted.



we could detect no evidence of IM and, when attempting to overload the amplifiers, THD seemed to appear long before we could detect any evidence of IM distortion (the reverse is usually true in conventional wide-range single amplifiers).

Power-bandwidth, that much respected IHF specification, also has little significance in a multi-channel amplifier of this type, since the manufacturer readily admits that the mid- and high-range amplifiers have less power-handling capacity than the low-range sections, so no attempt was made to derive a power response curve for this equipment.

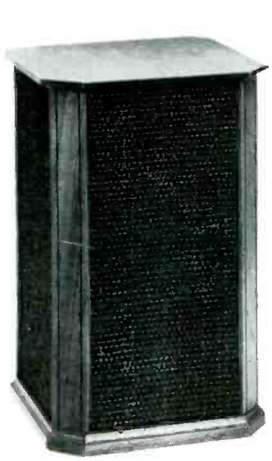
Listening Tests

Since using the Kenwood SUPREME 1 involved disconnecting all crossover networks, we could not use "sealed" air-suspension type speaker systems. We therefore employed a venerable but well-respected pair of infinite-baffle, three-way systems, and proceeded to tear out the coils and capacitors from each one. Following connection instructions, and using the six-wire cables supplied by Kenwood for each system, we turned the amplifier on, not knowing what to expect.

Our immediate disappointment was totally shattering! The highs were too penetrating, while the mid-range tones seemed like we had a double "presence control" in the circuit. Only then did we open the hinged "trap door" and attack the six little level controls put there for just this kind of situation. For reasons which are not readily apparent, we found, after about a half hour of careful adjustment, that the mid-range controls wanted to be at about 1 o'clock, while the high-range controls settled in at about 12 o'clock—all the while the low-range controls were fully clockwise! Admittedly, *electrical* measurements had disclosed that output power was balanced for all frequency segments when these controls were all set identically, but evidently the efficiencies of the woofer, mid-range and tweeter elements used were nowhere near identical, and perhaps built-in losses in the crossover networks no longer present had served to compensate for these differences before. After careful adjustment of these level controls, however, we must confess that the balance was as smooth over the entire frequency spectrum as anything we had ever heard. It should have been—since we were really able to custom-tailor it to our own individual taste—something you just can't do with tone controls alone.

We were so intrigued with the electronic crossover principle that we decided to take a set of dual-trace scope photos to illustrate just what happens between the low-range and mid-range amplifiers as one sweeps from low to higher frequencies. The results are shown in Fig. 7, and the captions are self explanatory. Note, that at 800 Hz (the crossover point we selected), the amplitudes of output in low and mid-range channels are just about equal, which is as it should be.

Summing up, the Kenwood SUPREME 1 will enable the patient and discriminating user to "shape" tonal response to a degree not possible with conventional wide-range amplifiers. It has adequate power reserve, excellent control flexibility, and is most attractive in appearance and in price. If you've already selected a "sealed" speaker system that you don't want to break into, this unit is obviously *not* for you. If, however, you plan to build up your own speaker arrangements, buying either "ready made" but accessible multi-element speakers or purchasing your own woofer, mid-range, and tweeter systems, piecemeal less crossover networks, the SUPREME 1 will be a most fitting way to supply them with precisely balanced quantities of clean-sounding, distortion-free audio power.



Scott Model Q-100 "Quadrant" Speaker System

MANUFACTURER'S SPECIFICATIONS:
Impedance: 6-8 ohms. **Dimensions:** 14¼" x 14¼" x 22" high. **Weight:** 37 lbs. **Price:** $149.95.

Scott's "Quadrant" loudspeaker system offers an unconventional solution to the problem of sound dispersion (or, rather, the lack of it). Ideally, it would be nice for a speaker to radiate sound omnidirectionally from a point source. What the Scott Model Q-100 does is to radiate high frequencies from all of its four sides, and lows from two sides. The result is nearly omni-directional sound radiating from these units, with very pleasing results.

The speaker system is a small, walnut, floor-standing console with dark gold and brown grille-cloth panels on four sides. The panels are removable, exposing the six speaker complement. A 3-in. cone-type tweeter is built into each of the sides, near the top of the enclosure, while an 8-in. acoustic suspension woofer is built into each of two opposite sides near the bottom. The speakers are all connected in phase, and the crossover network which separates the 8-inchers from the tweeters

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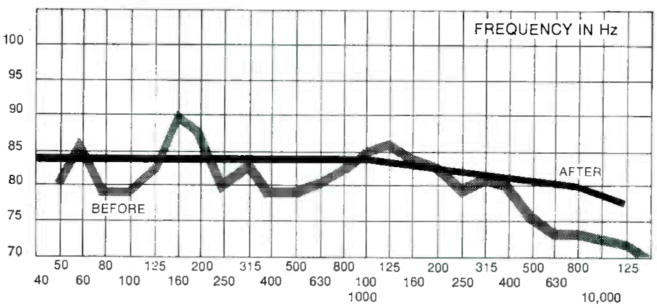

Let Paul Martinson, Empire Photosound's sound department manager, tell it. "Because of our company's overall production versatility, tracks recorded in our studio may be completed on film, tape or disc, and may be replayed under a great variety of playback conditions.

"A principal problem in balancing tracks for these varying situations is compensating for differences in stages to be reached in later recording or playback systems (low and high end roll-off, mid-range peaking, or laying down everything possible). In attempting to establish proper compensation for these differences the engineer is greatly aided by a monitor playback system that doesn't demand additional compensation for itself. I know that what I hear is what is being recorded; this has saved me time and effort way out of proportion to the cost of installing *Acousta-Voice.*"

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It is the only system using calibrated, fully-adjustable, critical bandwidth, band rejection filters. What's more, the *Acousta-Voicing* method is unique in its ability to insure integrity of transient response in the total system after equalization. The results of *Acousta-Voicing* are positive and dramatic. Witness the response curves as recorded by a precision sound level meter in Empire Photosound's studio. Those two curves might have been recorded at any of the many recording and playback studios where *Acousta-Voicing* has been employed. It has also proved to be the answer for many churches and auditoriums with "impossible" tonal balance problems. And not only is the Altec method more effective than other systems, it is generally a far less expensive means of achieving well-balanced sound reproduction in the smallest studio or largest hall.

Only authorized Altec Lansing CE Contractors offer *Acousta-Voicing*. For more information about this revolutionary equalization system, and the name of your nearest Altec CE Contractor, write Altec Lansing, 1515 So. Manchester Avenue, Anaheim, California 92803.

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BEHIND THE SCENES

(Continued from page 16)

reason for recording with the Dolby System to avoid the build-up of noise. Have you ever entertained the idea of building the Dolby System right into your electronics?

SCULLY: We have thought about this, but feel that it would be very expensive in its present form and it is best to leave this sort of thing as something the customer would acquire on his own.

Larry, I know that because of current practices in this country you must equip your recorders with standard VU meters, which we all agree leave something to be desired in ballistics and accurate reading, many people prefering the peak-reading European meters. Have you heard about the electronic light system of Altec that is used as a super-visual level meter?

SCULLY: Yes, but like the Dolby System, building it into a recorder is a matter of money and as yet the light-indicating system has had limited usage. Perhaps it will become low enough in cost someday to be a worthwhile addition to a recorder.

One other subject that has come up recently in regard to innovations on tape recorders is the use of electrodynamic braking, instead of the classic brake-band concept. Have you given any thought to this?

SCULLY: Yes, we have done quite a bit of work on it, and it is a complicated business. In fact, we have worked out a simple tape motion-sensing system that does about as well as electro-dynamic without all the trouble and expense. You know, the best way to stop tape on any conventional recorder is, if you were in rewind, by hitting your fast-forward button. The tape rapidly slows down and virtually stops, and if you hit your stop button, then everything is very positive and gentle. Well, we have a little sensing device, and it determines tape motion and goes through all that sequence I just described automatically. You know there are all sorts of devices and techniques that can be added to a tape recorder, but they are only worthwhile if they can be applied reasonably to a machine to effect a genuine improvement in either tape motion, signal-to-noise ratio, harmonic and IM distortion, and tape-handling controls. That is what a good tape machine is all about. Æ

Disc Mastering

(Continued from page 29)

of acetate, or if suction is changed.

Positioning of the stylus in the cutterhead is very important. A fast and safe method is to use a stand which securely clamps the cutterhead and provides a microscope with a calibrated hair-line reticle. It is a simple matter to rotate the stylus in relation to the hair line to position the cutting edges. The cutterhead is positioned in its suspension by watching reflections of the cutterhead and stylus on an acetate. Another method is to place a small non-metallic block on the turntable under the cutterhead and line up the cutter as it is lowered. The stylus should be perpendicular to the disc surface in all planes. The heater wires should be left slack so that stylus motion is not affected.

The chip pickup tube should be positioned within a quarter of an inch behind the stylus and barely off the acetate surface. The suction should be adjusted to the lowest air flow that will still remove the chip. Excessive air flow can tear the chip out of the groove, or can actually modulate the stylus. In any case the noise it causes makes monitoring difficult. With a low suction it is usually necessary to blow on the stylus as the cutter is lowered to get the chip picked up, but a switching device can be used to increase the vacuum just at the time the cutter is lowered.

The electrical performance of the transfer channel should be checked regularly to make sure it is operating within specifications. Measurements should be made on the whole chain, in addition to individual units. A most important check is an A/B comparison between the master tape and test cuts played on a calibrated turntable.

Mastering is perhaps the most important single step in record production. It is during this process that the product takes its form for the consumer. The most important ingredients are accurate reliable equipment and an engineer with an intimate knowledge of his equipment and the entire process. Æ

ACOUSTICAL MATCHING

(continued from page 42)

possible for easy operation. The rotary control has been generally abandoned and straight-line attenuators which are easy to operate by touch are in more-common use, allowing the operator to see the action on the stage. It is possible to operate several such controls at one time. Control consoles should be so laid out that they become a map of the stage, perhaps with five or seven controls in front representing the footlight microphones and several others spaced above representing upstage hanging microphones, offstage microphones, or other sources operating through the sound-reinforcement system. An operator running such a control can easily correlate what is happening on the stage and what he is doing on the control console. He can "play" the system, minimizing the number of microphones that are live at any one time and raising the gain on just those microphones that are nearest the actors, so that clarity is maximized. The fewer microphones on at any one time, the higher the clarity will be.

Costs

The cost of a minimum reinforcement system for a high-school auditorium used as a performing-arts hall might run around $15-20,000 today. Cost of reinforcement systems can run as high as $100-200,000 if stereo effects are required for reinforcement and electronic reverberation is provided. If costs must be cut on a system, it is strongly recommended that it be done by removing elements of the system, for example, providing only the basic reinforcement system initially. By providing for future reverberation facilities, as well as possible future tape recorders and disc playback equipment, can reduce costs appreciably. Cutting back on quality can result in the investment for equipment which is not suitable for the purpose and which must be replaced if the system is to perform as required. In the long run, this can raise the cost of the installation. Æ

AUDIO MUSIC REVIEW

Classical Records

Edward Tatnall Canby

Familiar Classics Revisited

Tchaikowsky: Romeo and Juliet; Theme and Variations from Suite No. 3. Moscow Philharmonic, Kondrashin. **Melodiya Angel SR 40090 stereo** ($5.98)

If a pair of attractive cover nudes, young male and female, can sell you on Tchaikowsky you'll go out and buy this one quick. Betcha that cover wasn't made in Moscow. More like out of Capitol in Hollywood.

Once past the nudity and into the music, you'll find an interesting and thoughtful performance of the early Tchaikowsky classic, old fashioned in the best sense, done with all leisure, allowing a full impact for every musical effect. The slow, ominous portions, notably at the beginning, are given their full head as only Willem Mengelberg could do it many years ago (he is still audible on records); the fast, violent parts go at breakneck speed but never are merely hysterical. In our day of mass-production standard classics, this performance surely stands out for its integrity and freshness. I liked it. The Theme and Variations, with violin solo (Boris Simsky) is done in a similar mellow fashion and should also please you on side 2.

The Russian sound is expansive and impressive but, curiously, also mildly old fashioned for the hi-fi ear. Not easy to say just how. I'd guess (a) that the microphoning is somewhat "out of date" by our taste, reminding of ours, say, around 1960; (b) the very loud parts are not quite as clean as we now expect; (c) and there is perhaps some moderate compression—hard to avoid in a contrasty piece like this. I also note (d) what seems to be less than hard transients, the familiar *ker-thump* of kettledrums, though the trouble could well be to some extent in the large, rather tubby acoustic surround. None of this will bother your musical enjoyment in the least—pure curiosity impels a mention. The over-all sonic effect is well suited to the style of the performance.

Performance: B+ *Sound:* B

Goldmark: Rustic Wedding Symphony. New York Philharmonic, Bernstein. **Columbia MS 7261 stereo** ($5.98)

Just lovely! It has been years since I last heard this old ex-chestnut. (It used to be played all the time in symphony concerts.) I had forgotten how genuine a work of sheer Teutonic corn it is. Under Bernstein's loving hands, the music really glows with gentle life, a kind of fruity Brahms but less consequential and much more lush. Nearest to it is perhaps that perennial favorite opera, Hansel and Gretel by Engelbert Humperdinck (*not* the pop singer, please!—the original man). That work exudes the same kind of nostalgic schmalz; but this one is somewhat more complex and of a more turn-of-the-century harmonic substance, a German version of Sir Edward Elgar. (The work begins with variations, faintly reminiscent of Elgar's Enigma Variations).

Believe me, it takes the special near-sentimental sincerity of Leonard Bernstein to make this old fashioned music shine as it does in this recording.

Performance: A *Sound: B*

Stravinsky: The Rite of Spring; Scherzo a la Russe (the composer's two-piano arrangements). Michael Tilson Thomas, Ralph Grierson, pianists. **Angel S 36024 stereo** ($5.98)

It is always astonishing to find how much of a well known orchestral piece can be suggested by the monotone coloration of the piano, whether via two hands, four hands, or two keyboards. In the case of this new Angel recording, however, the musical cart comes before the horse. These were working arrangements made *before* there was any orchestral music. The Rite of Spring for two pianists at two pianos dates from 1912. It was this piano score (or various alternative one-piano versions) that was heard by all those who were working on the ballet production to come, rather than the orchestral version now so familiar. In the early spring of that year, Stravinsky played it with none other than Claude Debussy as the second pianist.

On its cover Angel makes a good thing of the youthfulness of the two brilliant West Coast pianists who play it here. Some of the photos are apparently several years old; a pair of longhaired page turners, at each piano, accentuates the "now" quality of the scene. Actually, the two are at this point 25 and 27, old enough for maturity, and their playing is of an incredible, machine-like accuracy

throughout that oddly suits the musical substance. As always, dissonance familiar in orchestral form is accentuated, made even more acerbic, by the piano's percussiveness. No wonder the music impressed the experts who first heard it! Virtually all of those last faint traces of Romanticism still observable in the slow parts of the orchestral work are here suppressed, partly by the nature of the piano, more positively in the nature of the playing. These boys are cool customers, seemingly nerveless, totally competent with both rhythm and fingering.

The piano sound is ideally distributed in the stereo with just enough separation so that we can tell which pianist is playing what, yet with an over-all blend that presents the whole music as it should be heard, in one piece. The sound is hard and precise, properly in line with both the music and the performance. I'd rate the whole project as impressively cool, almost chilly, rather than hot-blooded —but this is surely part of the music's message, especially in this one-color piano form. The Scherzo a la Russe is a brief much later commissioned piece, originally for Paul Whiteman's band in 1944.

Performance: A *Sound:* A−

Entremont Plays the Chopin Waltzes. Columbia MS 7196 stereo ($5.98)

The record cover on this one shows Philippe Entremont, dressed in his tails and white tie, standing up at the piano keyboard, playing (presumably) the Chopin Waltzes in a most undignified position. We trust he didn't record them that way. It doesn't sound so. They flow and purr and dance with the nicest *elan*, all grace and elegance but never either effete—as in some performances—or metallic and explosive—as in others. Entremont is a natural-born musician and perceiver of musical meaning, showman or no.

The sound is unusually gracious for Columbia, which tends towards a hard, close-up piano in many dozens of its recordings. Here, there is smoothness and sheen, plus a good concert hall liveness to place the music in a sort of ball room perspective. Fine disc.

Performances: A− *Sound:* B+

Pablo Casals conducts Schubert Unfinished Symphony, Mozart Symphony No. 40. Marlboro Festival Orchestra. **Columbia MS 7262 stereo** ($5.98)

A number of unusual circumstances obtained in this recording from the "live" summer Marlboro Festival of 1968. Pablo Casals, now in his 90s, still was able to conduct—which takes plenty of sheer physical energy. The Marlboro orchestra is, if I am right, a mixture of seasoned pros and brilliant young players who come to sit at the feet of the mighty and absorb their wisdom. The oldest form of education in existence! Thus here we have the musical style of the late nineteenth century in the person of Casals himself, grafted onto generation upon generation of younger musicians who do the actual playing. (Youth, remember, is quick to absorb, even when it is the style of the ancients.) Their earnestness is at once evident.

Columbia has done well with the sound, which somehow is a lot better than most concert tapings. Could they have added some artificial reverb? It would help, and maybe does. There is almost no audience noise (though the background is not exactly Dolby-silent) and only those occasional gentle swishes that represent the remains of an edited cough suggest, most unobtrusively, that there was indeed some interference of an audience type.

The music is very much in a familiar vein (to me, an older ear), a good old performance of the Unfinished with all the pathos and none of the nerves and mannerisms of more recent attempts. Only the fairly rapid tempo of the slow movement might indicate that Casals here is playing in the sixties instead of, perhaps, 1910 when he was merely middle aged. Because the Unfinished is quite a leisurely symphony in both its two movements, there are no problems with the Marlboro ensemble.

The Mozart G Minor is less happy. Partly it is because this work is much more demanding in terms of orchestral accuracy in all its movements. Partly, it just sounds old fashioned and out of style as Casals conducts it.

Too symphonic—in the Romantic manner—is the best way to describe what I have in mind, even though the orchestra is physically not very large. It is a manner of playing that is no longer suitable, less crisp, more sprawling in detail than the best Mozart and Haydn performances today, forcing the music to sound bigger than it should.

Keep in mind that in Casals' day the G minor was *the* great Mozart symphony, seemingly a serious and proto-Romantic work in contrast to what seemed the frivolity of most of the other symphonies. The G Minor, accordingly, always got the "heavy" treatment, to emphasize its profundity of emotion. We no longer think that way today. We see profundity beneath even the lightest-hearted Mozart. And so there is no longer any reason to perform the G Minor with that doomful sound that somehow implies it is striving to be the Unfinished of Schubert, far ahead of its time. The Symphony is great enough without such anachronisms.

Note an occasional curious growling noise. It is Casals at work. Most of the great performers seem to suffer from vocal incontinence, especially on the Columbia label! Glenn Gould is a famed vocalizer and even Rudolph Serkin, Marlboro's head man, has been known to sing his own accompaniment before the stereo mikes.

Performances: B+, B− *Sound:* B−

Beethoven: Symphony No. 6 "Pastoral." Boston Symphony, Leinsdorf.
RCA LSC 3074 stereo ($5.98)

Perhaps it was unconscious mental indigestion on my part—but I did not react with any favor to this Sixth Symphony. It is all too American in an opulent sense, played by this self styled "aristocrat of orchestras" in a fashion that somehow says to me, look how good *we* are, how big and powerful, too. It is not, for my ear, dedicated to Beethoven. It is dedicated to Erich Leinsdorf and the BSO.

The whole thing is both too hard and too smooth, too much the mailed fist in the nylon glove. The Pastoral is the toughest of all the Symphonies to project convincingly, for it is both subtle and naive, a wonderfully organized and yet utterly trusting work; it must be approached, somehow, with a compassionate humanity of feeling, in the playing as in the conducting.

Instead, when this disc began to spin I received a strong mental image of the prosperous BSO, best pro players in the world, sitting there sleekly doing their thing, professionally perfect, even if this was the 99th time that old chestnut had hit the Boston boards. An evil approach to any Beethoven, but especially the Sixth. As for Leinsdorf, my inner ear tells me he is fussily self-conscious about effects, exaggerating each *pp*, each *sf*, as though double strength might give double value. The opening movement is pure Madison avenue. The jolly scherzo in the village is violent enough to sweep Beethoven's peasants off their jolly feet. As for the famed storm, it is as you might expect, literally the loudest, fiercest version imaginable—and insincere for it. Beethoven does not make good Berlioz. Only the quiet, gentle finale variations begin to take off into sincere, meaningful musical expression. So I heard it.

Sorry. I'll have to take a tums next time.

Performance: C+ *Sound:* B

Smetana: The Moldau and Other Works. Slovak Philharmonic of Bratislava, Ladislav Slovak, Ludovit Rajter.
RCA Victrola VICS 1443 stereo ($2.98)

Well, I dunno. The Czechs, of course, usually do a splendid job conducting their own national music—but these are the Slovaks, from the other end of the country. (Very confusing: one of the two conductors here is named Slovak. Bet he's a Czech.) I found the record reasonably pleasing, but no more. The Slovak orchestra isn't too accurate in detail, though its playing is intelligent and easy, and the recorded sound has some typical East-Europe drawbacks, a bit of distortion of a metallic sort in the loud passages, a slightly thumpish variety of percussion sound (transients) and, if I am right, quite a dose of volume compression. This makes the softer parts of the music, the cleanest in sound, rather unnaturally loud and close as compared to the climaxes. We have moved well away from these familiar faults, and a good thing too.

The disc includes, besides Smetana's old favorite Moldau, Murmurs of Spring (Sinding), the Secret of Suzanne Overture (Wolf Ferrari), the familiar Dances of Galanta by Kodaly and something called Donna Diana, the overture to an opera by Reznicek. It turns out to be very familiar light-music stuff. As the notes say, consider this to be a comfortable concert . . . It is, generally speaking. But not very exciting.

Performances: B− *Sound:* C+

The Richest Sound on Earth. (Six Acclaimed Triumphs of the Recording Art from the Fabulous Philadelphia Collection on Columbia Records.) Philadelphia Orchestra, Ormandy.
Columbia MGP 7 stereo (two discs)

This, we note, is the Columbia version of the "Richest Sound on Earth," not the current RCA variant. Not much more need be said, except that these two discs, which I assume are specially priced, contain the big sound-sensations you might expect:

Side 1, the Pines of Rome by Respighi. Side 2, the Bach Toccata and Fugue in D Minor (transcribed by Ormandy, succeeding the famous Philadelphia-Stokowsky transcription), and the Prokofieff Classical Symphony. Side 3, Tchaikowsky's Capriccio Italien and the Dance of the Apprentices and Entrance of the Meistersingers from the Wagner opera. Side 4, Ravel's Bolero. No doubt between them all these items have already sold millions of copies. Guaranteed to please.

Emanuel Bach

T. A. Arne and C. P. E. Bach. (Arne: Harpsichord Concerto No. 5 in G Minor; Sonata No. 1 in F; Overture No. 1 in E Minor. C. P. E. Bach: Symphony No. 2 in B flat; Vars. on Folies d'Espagne; Concerto in C Minor.) George Malcolm, hps., Academy of Sy. Martin-in-the-Fields, Marriner.
Argo ZRG 577 stereo ($5.95)

C. P. E. Bach: Four Hamburg Symphonies. (B minor, A, C, B flat). Gustav Leonhardt, hps. Collegium Aureum.
RCA Victrola VICS 1453 stereo ($2.50)

Carl Philipp Emanuel Bach, usually called Emanuel Bach, was the middle son among the three highly gifted children of old Papa Bach, J. S. himself, out of the fabled 21 offspring produced by the old man via two wives. Emanuel's influence on the musical art, in the intense transition period between late Baroque and that gallant and sometimes near-Romantic music which led to Mozart, Haydn, and Beethoven, was tremendous in his lifetime and even on into the Beethoven period, the early 19th century. Now, Emanuel, like so many others, is coming out of the history books into renewed musical life once more, as witness these two among many recent recordings.

It is a curious style of symphony, highly original but also rather conservative in format, removed from the familiar tradition founded (or better, consolidated) by Haydn. Three movements like a concerto, fast slow fast, often running into one another and cast in the binary form familiar in Scarlatti, Handel, and Papa Bach as well as a thousand other Baroque composers, these works are more like the brief Italian *Sinfonia*—with far more seriousness and content, however, than the charmingly frittery little works which the Italians wrote to preface their musical stage pieces. Emanuel's most profound music here is in the slow movements, which are full of his marvelous experiments in expressive harmony. The outer movements go like the wind are very "busy" in that bustling style which was the beginning of the Mozart-Haydn allegro.

Argo's record offers the same B flat Symphony as that on side 2 of the RCA disc, for an interesting comparison. (RCA's orchestra of "authentic" strings plays the music a half tone low, in A, which is the original pitch intended in Bach's time.) Argo also offers a harpsichord concerto (much like the symphonies) for George Malcolm, the featured artist, plus a set of solo variations on the familiar "La Folia" theme set by Corelli for violin. RCA's record, from the German Harmonia Mundi label, is all symphony; another well known harpsichordist, Gustav Leonhardt, presides modestly at the continuo keyboard. I found the British orchestra somewhat more sensitive in its playing, the German group a bit on the driving, nervous side—though to be sure, Bach writes plenty of nervousness into his music. Argo's British sound is closer and drier than the expansive German sound. The two discs are close to an equality as far as communication is concerned. (The price difference is all the sillier.)

As for Thomas Arne, the history books have long pigeonholed him as just another British second-rater under the shadow of Handel; somebody's ears were unsubtle when that judgment was made, a long while back. (No LP records to help.) Arne is more conservative and far less original than Emanuel Bach but, surprisingly, he sounds out very clearly of his own generation, 25 years younger than Handel. He writes in an outwardly Handelian manner but the sound—to our ears now—is clearly different, already implying the turn to *gallant* music which was to overwhelm England a dozen or more years after these works were composed. The Arne side of the Argo record parallels the Bach, with an orchestral work, a concerto and brief solo sonata, for Mr. Malcolm's harpsichord.

Performances: A−,A− *Sound:* B, B,

Electronic-Plus

Charles Wuorinen: Time's Encomium. For synthesized and processed synthesized sound.
Nonesuch H 71225 stereo ($2.98)

Andrew Rudin: Tragoedia. For electronic music synthesizer.
Nonesuch 71198 stereo ($2.98)

Kenneth Gaburo: Music for Voices, Instruments, and Electronic Sounds. New Music Choral Ensemble, Univ. of Illinois Contemporary Chamber Players, Gaburo.
Nonesuch H 71199 stereo ($2.98)

Morton Subotnick: The Wild Bull. For electronic music synthesizer.
Nonesuch H 71208 stereo ($2.98)

Three of these four Nonesuch commissions are here reviewed late—and for good reason. They arrived at a time when suddenly the air was full of electronics. Dozens of records were hurled onto the market all in a rush to get on some sort of sales bandwagon (as far as I can figure) and no honest reviewer in his senses could possibly have listened to such an enormous barrage with any intelligent reaction, even if there weren't parallel masses of Beethoven, Mozart, and the rest!

Better late than never. Luckily, a private project came up that brought me to these discs with extended attention. I was very decidedly impressed. The Nonesuch series, I would suggest, is qualitatively far ahead of a lot of the stuff that still is being thrown out at us.

I would suggest, however, that you admire the sensitive cover designs of Elaine Gongora on several of these, as you listen, and studiously ignore the "program notes" on the reverse until your own ear has had a chance to adjust to these new sounds. It is the habit of most young composers, and many middle aged ones, to write preposterously pretentious annotations of a sort designed to impress their professional colleagues rather than reassure the unknowing outsider (who buys the record, after all). Not that the notes are false, or in the end lack usefulness. But it is so easy to be snobbish and obscure in *words*, where the musical product itself—even electronic—is a far more direct and honest presentation to the ear. I warn you that if you read these accounts *before* listening, you will merely be intimidated. Put off. Even horrified. Like, say, "The poem, with regard to

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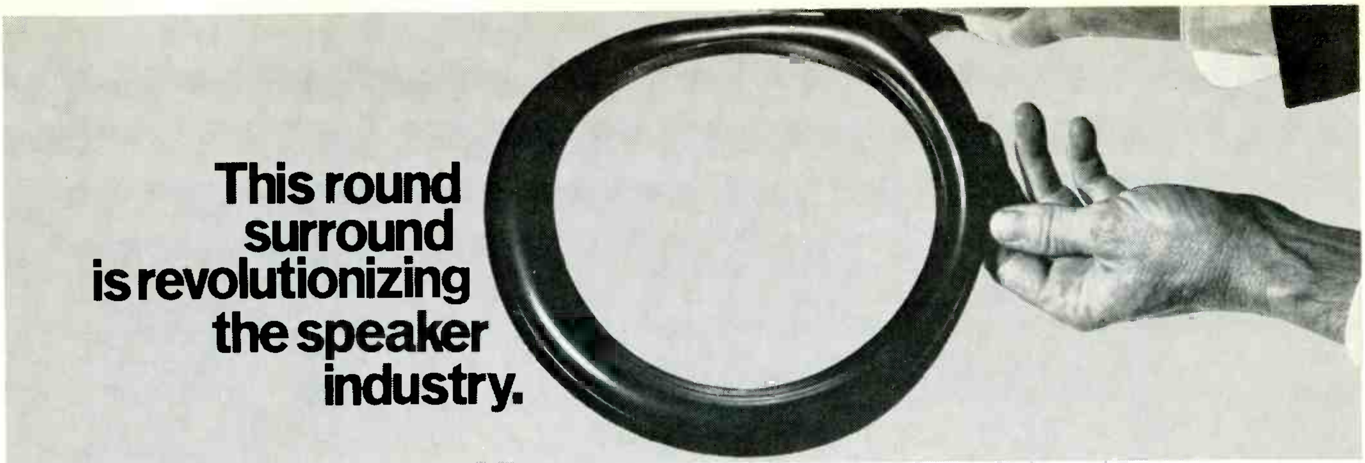
its formal design, semantic and phonetic content, morphology and articulatory potential (governed on one level by concern for intelligibility), to a large extent determined the structure of the composition." OK, OK, but how about saying it in English? That would help.

These are works of the new and much improved generation of electronic sound, cleanly synthesized, richly varied, bright, percussive, no longer with that dull "recorded" sound of the early attempts, so often lifeless in color and lacking in any transient impact. Impossible to characterize each in detail—but speaking generally, there are several further points. Not only is the sound clean and varied but the style of sound is now more fully in line with electronic capabilities, full of short, sharp twitters, blops, twangs, sizzles, with a minimum of those dismal dun-colored wailings so common in the older music. Moreover, the shift from tempered pitch to all-inclusive pitch—no fixed scales—is marvelously well accomplished, again very much in line with the medium's own nature. This is a lot more important than we may yet realize.

Further: the greatest single element of dramatic exposition in these very long works is *tempo*, the sense of speed or slowness of motion which has governed traditional music of all sort and here reasserts itself in new terms. Morton Subotnick, for instance, has some of the most purely *fast* music I ever hope to hear on side 1 of his splendid "Wild Bull," an absoletly breathtaking tempo and one of the most powerfully exciting displays of sound-power I have ever heard. Similarly and oppositely, Kenneth Gaburo's Music for Voices, Instruments, and Electronic Sounds includes a long slow movement that is full of the most startlingly silent pauses, briefly interrupted at precisely the right rhythmic intervals to produce an *ultra-slow* feeling of tempo. (And what gorgeously silent record faces! Not a breath of sound for seconds at a time, as though the amplifier were turned off.)

Finally, in this last work, there is the now-triumphant combination of electronic and "live" sounds that has been working itself out in terms of performance needs these last few years. (Composers, generally still oriented towards live audiences, object to a "live" performance solely via loudspeakers in a hall. Who wouldn't?) The choral movements, the startling single voice of a soprano, the sudden bray of brass, are beautifully integrated with the electronic elements of the Gaburo piece.

Only Charles Wuorinen's recent "Time's Encomium," worked out on the relatively ancient Columbia-Princeton (RCA) Music Synthesizer, has a curiously academic and non-electronic sound to it, one of relative conservatism. The reason is interesting. In the composer's words, "The RCA Synthesizer . . . is prejudiced by its design toward 12-tone equal temperament." And so his music is composed in the tempered scale like "old fashioned" music. Who would have ever thought it would sound *strange*, as electronic music, because of this very fact? It does. That's how far we have come.



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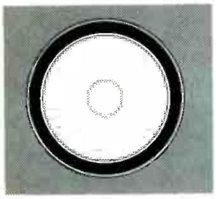

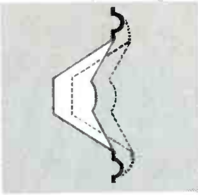

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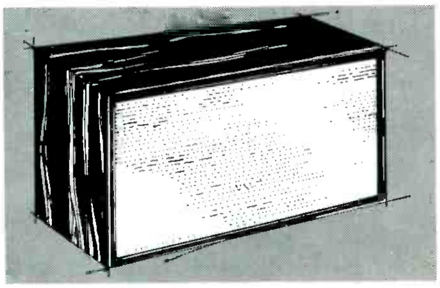

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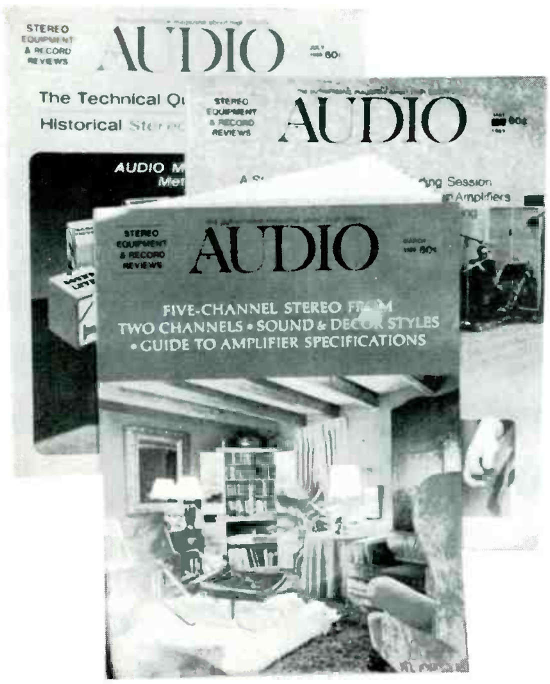

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LAYMAN'S GUIDE TO SPEAKER SYSTEMS

(Continued from page 24)

Driver Unit—Speakers with relatively small, light diaphragms designed for use in horn speakers (see definition). Also used on occasion to refer to a direct-radiator speaker itself to distinguish it from the assembly of a speaker or speakers in an enclosure, or speaker system.

Dynamic Speaker (Moving-Coil Speaker)—A speaker in which the varying magnetic field produced by the varying signal current in a coil of wire interacts with a surrounding fixed magnetic field produced by a permanent (or electro-) magnet, to produce motion of the diaphragm. The *voice coil* is generally composed of a number of turns of wire forming a cylinder. Some unusual designs use a zig-zag metal ribbon as a voice coil; "printed-circuit" construction has also been used.

Ducted Port—A tube or duct joining the air outside the cabinet to that inside. In small bass-reflex cabinets designed to produce extended bass response, the required size of a simple port is so small that there are excessive energy losses due to friction as the air oscillates back and forth in the port. A duct permits the opening to be made larger and the losses reduced.

Edge Damping—A viscous compound applied to the surround of a cone speaker. When a signal current starts in a speaker, the motive force generated by the voice coil is applied to the apex of the cone. Because of the mass and flexibility of the cone, a wave is set up that travels radially outward along the cone to its edge, at the surround. Here it is reflected and travels back toward the voice coil and is reflected outward again. The resulting wave-like motion of the cone surface gives rise to irregularities in the frequency response. A viscous material on the surround absorbs the outward travelling wave and smooths the response because of its internal energy loss.

Electrostatic Speaker—A force is exerted between electrically charged particles: similar charges repel; unlike charges attract. The force is proportional to the intensity of the charge. This effect is utilized in electrostatic speakers. In the simplest type, the diaphragm is a thin, conductive membrane, spaced a short distance away from a perforated metal plate. The signal voltage is applied between the two conducting surfaces, together with a fixed d. c. bias voltage. The push-pull type of electrostatic speaker uses a diaphragm suspended between *two* conducting surfaces or a series of closely spaced wires. It operates much like a push-pull amplifier; distortion is greatly reduced. Electrostatic speakers require a connection to the power line for the high-voltage bias supply but consume very little current and can be left plugged in all the time. The diaphragms are very light. Since they are driven virtually uniformly over their entire surfaces, response can be made very smooth. They are used mostly for the higher frequencies.

(To be continued)

Light Listening

Sherwood L. Weingarten

Rock For All Ages

"Rock" is a veritable melting pot of musical styles and motifs. At times, it acts as a show business garbage can, collecting all the brash trash in sight; at others, it is a perceptive mirror into the future, reflecting the notions of youth; but most often it is a musical flycatcher that with its sticky sales appeal manages to trap classical, folk, jazz, blues, and virtually every other category, in one bag.

Where is rock heading? Even its musicians and buffs are not sure. And the rapid breakup of existing groups, the formation of what seems a galaxy of new ones, and the short leases taken by hit tunes on the charts, all indicate no consensus is possible. But one current trend is the construction of what is termed by the flacks "supergroups," a joining of musicians from defunct but once successful combos. Case in point: Blind Faith, kind of a re-whipped Cream.

The Cream (which consisted of Eric Clapton on guitar, Jack Bruce on bass, harmonica and vocals, and Ginger Baker on drums) for a long time by rocks standards (three years) was *the* group. The trio's albums sold extremely well, and its personal appearances consistently drew throngs of screaming moptops; its material was original (written by Clapton and Bruce) and stood far above that of the many mini-talents.

But the Cream's harmony curdled, with its members creating much verbal noise tinged with egocentricity (each wanted the limelight; each, in truth, merited it). So the triangle, as most human triangles eventually do, broke down.

After the split, Clapton and Steve Winwood, who originally was with Spencer Davis' band before forming Traffic, began jamming together. Red-haired Baker, cooled by time, swallowed his remaining anger and joined in. But the trio, though good, sounded too much like the Cream. Along came Rick Grech, an electric bassist who also had made a small dent in British rock history by his skill with an electrified violin. Voila! Blind Faith, a name reportedly chosen "as an acknowledgment of the inspiration that they find in each other's work."

The quartet's first album, BLIND FAITH (Atco, SD 33-304), shows that Clapton and Baker no longer vie with each other for attention, each integrated better as a group member, each still shining as a soloist. The frenzy of Cream is gone, but the virtuosity lingers on.

Clapton, who wrote the exciting "Presence of the Lord," the final of four tracks on Side One, is a slight man of 24 who prefers donning bright velvet clothing. A dropout, he played initially with a forgettable outfit called

BLIND FAITH—(l to r), Eric Dapton, Steve Winwood, Ginger Baker, and Rick Grech.

the Roosters, which lasted but two months. He then joined the Yardbirds and moved on to John Mayall's blues group, where he first played with Baker. Says Clapton: "Really I am a freak sideshow. An English kid playing the blues just doesn't fit. In any case I am not really any longer a blues guitarist. I went into Cream a blues guitarist and came out a rock and roll player."

Baker, now 29, is a one-man tornado. His expertise is especially evident on "Do What You Like," his own composition and at 15:20 the longest cut of the LP. His musical bag encompassed everything, sitting in with almost every band available at first, then meandering through traditional and avant-garde jazz to his place in rock. "For about two years," he admits, "I just sat on the drums and played nonstop. I didn't care if I was on my own, I just used to play away."

Winwood, only 21, is Blind Faith's voice and, as such, stamps the combo as a partial shadow of Traffic, which also crumbled because of personality clashes. Winwood, author of three of the selections on the quartet's first outing ("Had to Cry Today," "Can't Find My Way Home" and "Sea of Joy"), plays organ, piano, guitar and bass. "It was by playing several instruments," he relates, "that I came to discover that I could not express myself on only one. A small part of me comes over with each different instrument."

Grech, who for five years starred with a group called Family, is 23. The least well known of the four, he claims "it is nerve shattering to play with three of the greats." And he adds that the result of being part of Blind Faith, ironically, "is that I might well not be a better guitarist. It is just that moving from a relatively unknown group to one where the attention is focused on you all the time means that you are likely to get recognition."

Over-all, the LP is excellent rock, technically and acoustically brilliant, harmonic, and definitive—but still a combination of Cream and Traffic. *Someday* it may develop an identity of its own. The record jacket, not incidentally, is available in two formats. The first features a nude photo of an adolescent girl, the second a routine group shot of the quartet.

And for those who haven't soured on the old Cream, a new 10-track anthology, BEST OF CREAM (Atco, SD 33-291), is available. It includes the gold-record-winning "Sunshine of Your Love," the unpronounceable "Swlabr," the chartbuster "White Room," and "Born Under a Bad Sign."

* * *

Rock that can bridge the generation gap is provided by a pair of Flower children (that's their last name, not their social label) on GENESIS (Skye, SK-1006D), part of the recording company's "discovery series." Wendy (age 18) and Bonnie (age 15) actually *sing* (instead of vocalizing with a rasp or shout) and offer gentle harmony. The background of the disc, produced by jazzman Gary McFarland, consists of light strains from drums, fender bass, organ, piano, and guitar.

The duo, who wrote the tunes (and lyrics, which neatly avoid hammer-like references to drugs, Vietnam, black problems, etc.), sing mostly in unison on the 10 tracks, but occasionally one steps to center stage and solos, with the second joining in on choruses.

Best of the songs by the San Francisco pair are "Five O'Clock in the Morning," a slow number whose simulated boredom and loneliness is produced by a melodic repetition; "You Keep Hanging Up On My Mind," a zippy contemporary rocker; "I Realized You," which builds to a crescendo; "Let Yourself Go Another Time," with its driving beat, and "The Paisley Window Pane," a poetic ballad backed by a silky Latin beat.

Ah, maybe there's hope, the oldsters will cry.

Call it gospel-rock or call it blues-rock or call it whatever you want. The only necessity is that you call it good. The music is by THE ORIGINAL DELANEY & BONNIE (Elektra, EKS 74039), who have been packing them in at personal appearances. Both principals sing (Delaney also plays guitar), and they're supported by seven musicians. When group voices are needed, Rita Coolidge and Bobby Whitlock chime in to enhance the D&B rating.

Rock with strings? Sure, two of the 10 tracks ("Ghetto" and "Do Right Woman," a soulful composition), spotlight them. But don't miss "Someday," which has some exquisite big-band sounds.

* * *

More pop-rock variety, with stress on the softening of the type of sound many older music lovers cringe at, is found on IT'S A BEAUTIFUL DAY (Columbia, CS 9768), a disc with seven cuts, all of which (except one) run four minutes or longer. The instrumentation here is the key to the sound, for David Laflamme, the lead vocalist, plays a violin, and Linda Laflamme switches from organ to piano to electric piano to celeste to harpsichord. Others in the sextet are Pattie Santos, who also sings, and plays tambourine, bells, block, and gourd; and the rhythm section consisting of guitarist Hal Wagenet, bassist Mitchell Holman, and drummer Val Fuentes.

Words throughout are intelligible—and intelligent, and there is often more than a hint of classical borrowing that lends an air of melodic cool. The Laflammes composed all the melodies, either David individually or the pair in collaboration.

"Time Is," the longest piece at 9:42, is a somewhat typical mod-ern composition in that a cornucopia of rhythms and styles are evident; its most demanding segment, however, is a lengthy percussion interlude. "White Bird" showcases a Latin beat, and "Hot Summer Day" adds the harmonica flair of Bruce Steinberg. "Girl With No Eyes" is a smooth ballad, contrasting with "Wasted Union Blues," which includes a cacophony at its tail. "Bombay Calling" is a slightly cliched instrumental, with heavy Eastern overtones, and "Bulgaria" is a moody musical treatise.

The album is uneven, but it proves just what can be done within a basic rock format.

* * *

"Uncle Meat," a madcap creation of Frank Zappa, leader of the Mothers of Invention, allegedly is "an album of music from a movie you will probably never get to see." In a booklet that accompanies the LP, which contains a zany film synopsis and photos of the Mothers, Zappa explains that the

MOOG JAZZ *in the* GARDEN

BERTRAM STANLEIGH

There has been so great a proliferation of Moog Synthesizer recordings in the last year or so that no general introduction to these instruments is necessary. Probably the best known of the lot has been Columbia's *Switched-on Bach*, a group of Bach works successfully transcribed for electronic synthesizer by composer Walter Carlos. Original music for these instruments has been recorded on Elektra by Andrew Rudin and others, but serious composition has not been the sole medium for these instruments. Both the Beatles and the Rolling Stones own and use Moog Synthesizers in their musical performances, and a flock of pop and rock recordings with Moog embellishments have been released recently.

Until August 28, however, the Moog Synthesizer was confined to the recording studio, where its older and more cumbersome ancestors had always worked. On that date an important new step was taken in public musical performance. The Moog was introduced to a live audience at the final 1969 concert of the Museum of Modern Art's "Jazz in the Garden" series. The compact, modular construction of the Moog has made it possible to encompass a wide variety of oscillators, filter banks, reverb units, mixers, etc., in a single console and to control these circuits through a pair of organ-like keyboards. As a result, music can be produced directly without the recording, dubbing, splicing, looping, redubbing complications of earlier synthesizers. Any musician who is familiar with keyboard techniques can generate some sort of musical output from a Moog in a very short space of time, and improvisation can be interpolated into a performance as freely as with any conventional instrument.

The first Moog concert featured two jazz composers, Herb Deutsch and Chris Swanson, and their quartets. The instrumentation was entirely electronic, employing polyphonic, bass, and percussion synthesizers, and an electronic piano. The output of each instrument was fed to a separate, large Bozak CM-109 speaker system. The output of these units was in turn picked up by a microphone and fed to the Museum's sound reinforcement system, consisting of several compact acoustic-suspension systems hung along the Fifty-Fourth Street wall of the Sculpture Garden. No prerecorded tapes were employed. Every sound produced was created on the spot, and though this was composed music that had been carefully rehearsed, there were ample breaks in both composers' work for prolonged improvisation.

Interest in the concert had been particularly high. The advance sale of tickets had been greater than for any previous performance in this very popular series, and when this writer arrived at the Museum at 6 p.m. to observe advance preparations for the 8:30 concert, there was already a large crowd gathered on 53rd Street waiting to get in. The public was allowed into the garden at 7 p.m., and long before the starting time, the Museum was forced to turn away would-be attendants. Those lucky enough to get in waited and watched for an hour-and-a-half while Robert Moog, his staff, and the two groups of musicians made various adjustments to their synthesizers, patched modules, turned potentiometers, and flicked switches. All such adjustments were made with the aid of headphones, and not a single sound was fed to the audience until 8:30 when Mr. Moog stepped to the center of the concert platform, offered a few modest words of gratification at the wide interest in his equipment, and introduced Mr. Deutsch, Hank Jones on polyphonic synthesizer, Artie Doolittle, bass synthesizer, and Jim Pirone, percussion synthesizer.

Then, following a few preparatory bleeps, hoots, and grunts, the musicians swung into a pleasantly melodic four-movement suite that seemed strong on treble-bass contrasts but was somewhat lacking in emphatic mid-range voices. At various times, sounds were reminiscent of trumpet, flute, saxophone, harpsichord, accordion, and several varieties of drum, but, in general, one was content to listen to the music on its own terms, without trying to draw any comparisons with conventional instrumentation. These were real musicians playing real music, and it was clear that their message was getting to the audience.

The Chris Swanson group that rounded out the concert was somewhat more raucous than the Deutsch contingent, but their general style reflected the same mainstream jazz - pop - rock orientation, and they brought no new colors or voices to the sounds already heard. They were, however, participants in one of the evening's highlights. Just before the close of their number, someone kicked a power plug loose, and the audience was bathed in sudden silence. Poor Robert Moog was clearly disconsolate as he announced the power failure and advised that the concert as at an end. But he was dealing with an audience that was having too much fun to quit. The plug was reconnected, and another piece was played to everyones' delight. One thing was clear; from now on the Moog will have an established place in live performances.

There were many imperfections in the August 28th Moog concert, and I'm sure they were as apparent to the audience as to this critic. But it was an audience that saw through surface flaws to the concert's real message. Concert history is filled with dazzling debuts ruined by undiscerning audiences. Robert Moog had the good fortune to have a sensitive audience note the promise of an instrument at a concert that was less than a total musical success.

JAZZ RECORDS

Bertram Stanleigh

Charlie Barnet, Volume II
RCA Mono LPV 567

Such bigtime Barnet favorites as *Redskin Rhumba, Cherokee,* and *Pompton Turnpike* were all included in the first volume of Vintage Series reissues (LPV-551). As a result, this new release gives us a chance to reassess the less spectacular portions of the Barnet repetoire. All 15 of the numbers on this platter were originally recorded during the heyday of the swing era, from 1939 to 1941, and they reflect the sound musical judgment and serious approach of this bandleader and saxophonist. Four Ellington numbers are included: *Harlem Speaks, The Gal from Joe's, Echoes of Harlem,* and *Lament for a Lost Love.* Two numbers feature Lena Horne, who sang with the band in 1940 and '41: *Haunted Town* and *Good-for-Nothin' Joe.* Possibly because none of the material ever got to the top of the best seller charts, it sounds less dated today. For this listener, everything, with the exception of *The Wrong Idea,* a satire on the Kay Kyser, Sammy Kaye, Guy Lombardo kind of music, sounds direct and valid as a contemporary musical statement. The excellent sound is a decided factor in creating this impression.

Performance: A *Sound:* A−

A New Sound from the Japanese Bach Scene.
Victrola VICS 1458

The remarkable ability of Bach's music to survive assaults from symphony orchestras, jazz trios, scat singers, and electronic synthesizers has not gone unnoted in Japan. They have organized a frontal attack consisting of two kotos, a shakuhachi, guitar, bass, and drums. And the pieces they fiddle with are pretty much the same ones that every one else knocks about. Not much jazzing up has been accomplished here, although the notes suggest that at one point "a bossa nova rhythm has been added for special seasoning." The music not only sounds quite straight, it also sounds a trifle stiff, particularly when played on the shakuhachi, or bamboo flute, by a player who has difficulty keeping up with the rest of the group. Maybe someday a research psychologist will get a grant to probe musicians' minds and find out why so many music makers have this deplorable compunction to mess around with Johann Sebastian.

Performance: C *Sound:* A

Miles Davis: In a Silent Way.
Columbia CS 9875

With Herbie Hancock and Chick Corea, electric piano, Josef Zawinul, electric piano and organ, Wayne Shorter, tenor, Dave Holland, bass, John McLaughlin, guitar, and Tony Williams, drums, Davis creates a set of ravishing sound impressions. This is beautiful, meaningful musicmaking, flawlessly recorded, and in the grand tradition of Davis' most exalted performances. All of the strength, control, and imagination that characterize this performer's finest work are brought into focus here.

Performance: A+ *Sound:* A

Recorded Tape Reviews

BERT WHYTE

Gilbert and Sullivan: The Pirates of Penzance. The D'Oyly Carte Opera Co. Isidore Godfrey conducting the Royal Philharmonic. Ampex/London, LOD-90156, **2-reels, 7½ ips** ($16.95)

Needless to say, for all devoted savoyards this tape is an absolute must. For those with only a passing acquaintance with Gilbert and Sullivan, or whose memory of it has grown dusty from long silence, this is as fine a passport to their magical world as one could desire. Recording under the banner of the renowned D'Oyly Carte Company gives this production a certain cachet. And the company is as good as my memory serves me. Naturally there have been many changes, but the good basics remain—the sheer ebullience of the performance, the good diction and articulation even when using the various accents, the fine ensemble work and good vocal balances. You know this is a company enjoying themselves and putting their hearts into the performance. Perhaps some nit-picking experts will detect some shortcomings with this version . . . as for me I was too entranced to worry over such bones.

A good portion of the credit for this sonic euphoria must go to London, who have mounted the production with splendid sound. The acoustic perspective was spacious enough to lend liveness, without obscuring the vocal parts, and orchestral detail held up very well. Vocal/choral/orchestral balances were all judicious, one never covering the other. The principals were well projected, but never out of proportion for the mere sake of clarity. Nice clean strings, bright brass, and good solid percussion were noteworthy. The only fall from grace was an occasional bit of stridency and overload from the chorus. Tape hiss in my copy was fairly low considering I like my "G and S" at a good robust level. A little print-through was noted here and there, no audible crosstalk. One of the best tapes of recent months.

Richard Strauss: Don Quixote. Lorin Maazel cond. the Vienna Philharmonic Orch. Ampex/London, LCL80208, **open reel, 7½ ips** ($7.95)

One of the least played of Strauss' tone poems, Don Quixote, has never achieved the popularity of his knightly brother Don Juan or the rascally Till Eulenspiegel. If it does not have their level of inspiration, it is nonetheless an interesting work that grows in stature with repeated listening. Those not acquainted with this score or those seeking an updated stereo recording of it, will be equally well-served with this superb, finely wrought performance. The important cello part is convincingly played by Emanuel Brabec, and the solo viola by Josef Staar. Maazel may be young in years but his reading here is amazingly mature. His balances are all good, he never overpowers in the solo parts, his pace is amiable. Above all he has the Vienna men playing for him as if he were Furtwangler himself. This is music making of high order. It isn't every day you can hear such ravishing strings, mellifluous woodwinds, nor mellow brass!

The sound is equal to the challenge of the playing. Moderately broad acoustics lend a fine round liveness, without blunting orchestral detail. Inner balances in the orchestra were revealing without spotlighting or isolation. Modest directional effects with a good center fill. Quite a wide dynamic range on this tape, so I suggest you not set your gain controls at too high a level at the beginning of the work. Both the cello and the viola are nicely balanced with the orchestra, and both are richly sonorous. Tape hiss pleasingly low here, print-through and crosstalk of no consequence. If you're tired of all the other Straussian fantasies, this may appeal to your jaded palate.

The Sound of Celestial Stereo: American Airlines AstroStereo. Ampex/DGG, CW223, **open reel, 3¾ ips** (24.95)

This is another of those tapes that you are supposed to hear on American Airlines for three solid hours. I can't quite conceive of that on a plane (gives you no time to ogle the stewardesses or drink your booze). But on a rainy weekend at home, this is just the thing if you want some classical background music instead of the 59th version of "hey Jude." This is taken from Deutsche Grammophon albums, and as such is pretty superior recording. The selections are reasonably well-chosen with such items as the Handel Water Music, Finlandia, Blue Danube, Hungarian Rhapsody, and they occasionally jolt you with a Mahler 1st or Prokofiev 5th symphony (excerpts of course). The sound is up to Deutsche Grammophon's high standards and the transfer to 3¾ ips is not too devastating, except in some of the more robust sections where it is all too easy to hear the compressor at work. With a tape machine with automatic reverse, this is a great three-hour escape from the usual and increasingly banal music on FM.

The Anita Kerr Singers. Ampex/Dot, X5951, **open reel, 3¾ ips** ($5.95)

Nothing earth-shaking here, but good solid pop stuff, expertly performed and cleverly arranged. Main blessing is that they don't scream at you, but are actually quite articulate and pleasant-voiced. The group tackles such as "When the World Was Young," "Windmills of Your Mind," "Goodbye," "My Way," and seven others. Orchestral playing is top notch and good balances between voice and orch. Nice, bright, clean sound, low hiss, slight print-through and cross-talk.

West Side Story (Original Sound Track) Columbia, **Cassette** 16 12 0004 ($5.95)
I Love How You Love Me: Ray Conniff. Columbia,**Cassette** 16 10 0612 ($5.95)
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My Name is Barbra: Barbra Streisand. Columbia, **Cassette** 16 10 0168 ($5.95)

This, as you can see, is a batch of cassettes from Columbia. Nothing extra-ordinary about the titles, standard Columbia fare. What is news is that there now are Columbia cassettes, soon to be followed by RCA cassettes, and this marks the entry of the big boys into the cassette derby. It is none of my business what delayed their entry, 'nuff said that with the promotional push that they can and are putting behind their cassettes, the little package is headed for the big time. I still think the price has to come down some before they really catch on with the kids, which is where the big money is, but this is just a matter of time.

Are Columbia's cassettes any better than what has been issued by other companies? They appear to have a little less hiss than most cassettes, the distortion content is fair, but on several I caught what sounded like drop-out or tape making poor contact with the heads. Frequency response seems to extend to 8-9 kHz, but with the still very evident tape hiss, it isn't very usable. There seems to be a fair quotient of mechanical problems with the cassettes themselves; some reel sticking and binding, for example, (a production of "Camelot," was unusable in this respect). In summation, they got their balloon off the ground, and no doubt the product will please those who are less critical. It is obvious they can do better, and with some of the promised improvements in cassettes reportedly not too far off, the medium may soon mature.

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HARPSICHORD: Same as owned by Philadelphia Orchestra and RCA Victor. In kit form for home workshop assembly, $150. Clavichord kit, $100. Free brochure. Write: Zuckermann Harpsichords, Dept. R., 115 Christopher St., New York, N.Y. 10014.

SOLID-STATE audio plug-in octal (1" dia. x 2" H) modules. Mic preamps, disc & tape preamp-equalizers, tape bias osc. & record amp., power amps & power supplies. Send for free catalog and audio applications. Opamp Labs, 172 S. Alta Vista Blvd., Los Angeles, Calif. 90036.

OLDIES—45 RPM. Original hits. Over 4000 available. Catalog 25¢. C & S Record Sales, Box 197, Wampsville, N. Y. 13163.

KENWOOD amplifiers and speakers—discount prices—free catalog and quotations. Playboy Shop, Box 221, Agana, Guam.

CATALOGS Broadcasts, Soundtracks, Personalities of Thirties, Forties. Box 225, New York, N.Y. 10028.

FOR SALE

FOR SALE: Ampex 300-350 ½" 4 Trk—$2500; 602-2 7½-IPS—$450, 350-2 Playback Elecs., $100, 300 Mono Elecs. with meter panel—$75; 350 type sel-sync—$35; 350-3 master bias osc.—$50, Sigma 4-mic mixer—$75; REL Precedent tuner—$100, Guy Heitmann, 12 Lake Rd. Peekskill, N.Y. 10566.

MARANTZ 7C and 8B. **HEATH** IO-14 Scope. Mint condition. Best offer. Shepard, Box 4302, State College, Miss. 39762, 601-323-2756.

OLD RADIO PROGRAMS on tape. Gangbusters, Jack Armstrong, Whistler, etc. Sample: 2 hr. $6.00, 4 hr. $9.00. Hundreds more in Hobby Magazine ($1.25 or free with tape order). NOSTALGIA, Dept. A, 9875 S.W. 212 St., Miami, Fla.

INSTRUCTION

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WALL SYSTEM—Cabinet Builders—New techniques described in booklet, "Cabinet Panel Cutting with Portable Saw." Send 60¢ (Stamps accepted) Independence Specialties, Box 2988, Phila., Pa. 19126.

EQUIPMENT WANTED

YOUR OLD CARTRIDGE IS WORTH MONEY! Send us the following amount now—and your old cartridge AFTER you've received your factory-fresh replacement by return airmail: SHURE V15 Type II, $48.50; M91E, M92E, M93E, $18.50; M55E, $14.75; M3D, $8.75. STANTON 681EE, $34.50; 500E, $19.50. EMPIRE 999VE, $47.50; 888VE, $34.50; 808E, $17.50. PICKERING XV-15/750E, $34.50. ADC 25, $72.50; 10E Mk II, $32.50. When sending us your trade-in cartridge, you may add a pair of KOSS, SUPEREX, SHARPE, etc. headsets to your order for a total savings of up to 50%. INFORMATION WILL BE ENCLOSED. KIMBERLEY ELECTRONIC ASSOCIATES, 101 Oak Street, San Francisco, Calif. 94102.

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The Markgräfliches Opernhaus in Bayreuth, built 1745-48, Germany's only large baroque theater preserved in its original condition.

PHOTOGRAPH BY FRANZ EDSON

The ultimate test of a stereo cartridge isn't the sound of the music.

It's the sound of the hall.

Many of today's smoother, better-tracking cartridges can reproduce instrumental and vocal timbres with considerable naturalism. But something is often missing. That nice, undistorted sound seems to be coming from the speakers, or from nowhere in particular, rather than from the concert hall or opera stage.

It's easy to blame the recording, but often it's the cartridge.

The acoustical characteristics that distinguish one hall from another, or any hall from your listening room, represent the subtlest frequency and phase components of the recorded waveform. They end up as extremely fine undulations of the record groove, even finer than the higher harmonics of most instruments.

When a cartridge reproduces these undulations with the utmost precision, you can hear the specific acoustics of the Markgräfliches Opernhaus in Bayreuth, or of any other hall. If it doesn't, you can't.

The Stanton does.

"The tracking was excellent and distinctly better in this respect than any other cartridge we have tested . . .
The frequency response of the Stanton 681EE was the flattest of the cartridges tested, within ±1 dB over most of the audio range."
Hirsch-Houck Laboratories, HiFi/Stereo Review, July, 1968.

The specifications.* Frequency response, from 10 Hz to 10kHz, ±½ dB. From 10kHz to 20kHz, individually calibrated. Nominal output, 0.7mV/cm/sec. Nominal channel separation, 35dB. Load resistance, 47K ohms. Cable capacitance, 275 pF. DC resistance, 1K ohms. Inductance, 500mH. Stylus tip, .0002" x .0009" elliptical. Tracking force, ¾ to 1½ gm. Cartridge weight, 5.5 gm. Brush weight (self-supporting), 1 gm. *Each Stanton 681 is tested and measured against the laboratory standard for frequency response, channel separation, output, etc. The results are written by hand on the specifications enclosed with every cartridge. The 681EE, with elliptical stylus and the "Longhair" brush that cleans record grooves before they reach the stylus, costs $60. The 681T, identical but with interchangeable elliptical and conical styli both included, costs $75.

For free literature, write to Stanton Magnetics, Inc., Plainview, L.I., N.Y. 11803.

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SPANISH / *Oak*

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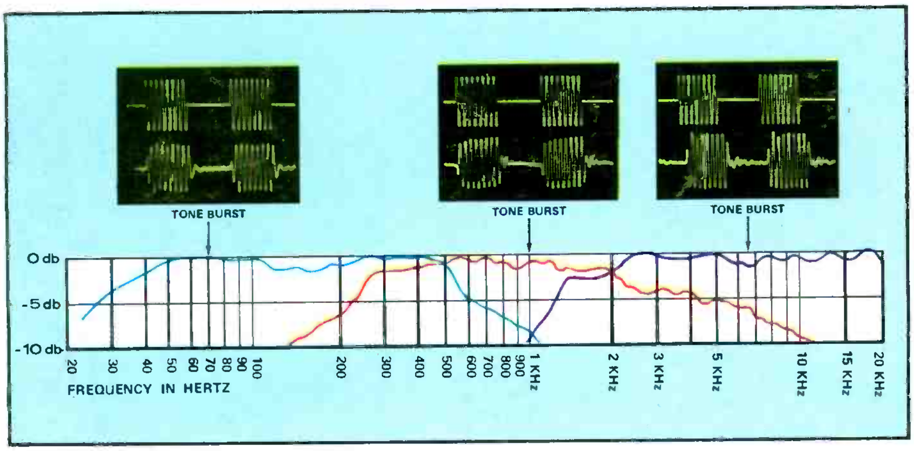
Unretouched photographs and the unvarnished truth about the new ARIES Console Speaker System.



If you are as serious about musical reproduction as we are, the following discussion may help you in choosing your next speaker system. And the actual response curves and tone burst tests may prove most revealing when compared with other speaker systems currently available.

Aries is an uncommon speaker system. Larger than the ubiquitous bookshelf speakers for a very sound reason: greater internal volume permits a worthwhile extension of bass with lower distortion and higher efficiency. Effective use of this volume comes from a 12″ woofer with 9½ pound magnet structure, new sealed-foam half-roll surround, and rigid deep-cone geometry. It's a combination that insures ¾″ linear cone movement, precise transient response, and high power handling capacity without frequency doubling.

The mid-range was designed with equal care. A specially treated 6″ cone speaker is mounted in its own sealed inner enclosure. Speaker resonance is well below the crossover point to insure peak-free response and clean transients in this sensitive part of the spectrum. Oscilloscope testing of every unit is routine so that laboratory standards are maintained in production.

The Aries 2½″ cone/dome tweeter is particularly unique. For instance, to obtain ultimate response, damping compound is metered onto the cone within a tolerance of ±0.001 oz. And control of cone/dome materials insures a radiation area that varies predictably with frequency to insure uniform dispersion at all frequencies.

Even the crossover network is unusual. Four inductors (iron-core type for the woofer to avoid losses), three capacitors (with a Mylar type for the tweeter to maintain response beyond the high frequency limitations of electrolytic types), and a 5-position rotary ceramic switch offers precise control with up to 10 db attenuation at 10 kHz.

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