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AUDIO

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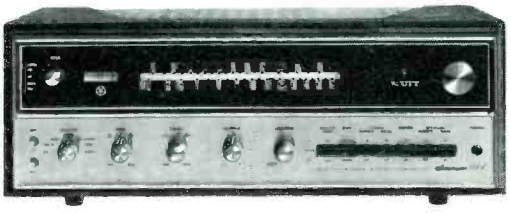

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March 1968 Vol. 52, No. 3

AUDIO

Successor to RADIO, Est. 1917

FEATURE ARTICLES

MUSIC REVIEWS

EQUIPMENT PROFILES

AUDIO IN GENERAL

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Coming in April

Solid-State Power Amplifiers: Component Hi-Fi vs. **Packaged Equipment**—Ralph Hartz and Fred Kamp examine power output ratings and capabilities of component hi-fi and packaged home entertainment equipment.

How to Be Your Own Critic of Synthesized Music — Lewis Harlow discusses the new synthesized music, sometimes called "electronic music," with an eye toward providing evaluation guideposts.

Build a Sheet-Metal Reverberator — Robert Ehle describes a reverberation device he built to obtain high-intensity, long-delay reverb sound. The BIG reverb sound it emits lends itself for use in creating electronic music and/or to meet small recording studio needs. Construction cost is under $50.

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EQUIPMENT PROFILES:

Crown Model CX822 stereo tape recorder

Acoustic Research stereo integrated amplifier

Plus: Audioclinic, Tape Guide, ABZs of FM, Music and Record Reviews, and other regular departments.

ABOUT THE COVER: This month's cover illustrates a steam-pipe welder's handiwork in designing and constructing a room that combines good sound reproduction and attractive appearance. F. A. Mason of Riverside, Calif., created a diamond pattern on the ceiling with use of "Gold Bond" acoustic tile. Speaker systems are hidden behind cabinet grilles.

AUDIOCLINIC

JOSEPH GIOVANELLI

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

Sibilant "S"

Q. My high fidelity system performs well except that it has a definite sibilant "S" when I am playing records.

Can you explain this fault, which is the only trouble I have, and the remedy? — Alan Schoffman, Brooklyn, N. Y.

A. Sometimes a strongly dominant "S" is heard when it was intentionally put on the record that way during the recording process. Some record manufacturers seem to think people like it that way. Also, they sometimes exaggerate the "S" sound so that the cheaper playback equipment, lacking in good high-frequency response, will sound more normal.

Sometimes the "S" sound will be exaggerated when the tracking force you are using is insufficient. It just may be also, that your tweeter has a sharp peak in its response.

It is possible that something is wrong with your preamplifier's equalization, leading to an exaggeration of high frequencies. And it is also quite possible that you just don't like the sound produced by your present cartridge, and you should, perhaps, obtain another one.

Mike cable trouble

Q. My friend added 10 feet to his 15-foot microphone line. When he tried to record, he could get no signal from the microphone.

I use a transformer with my microphone and have no trouble, regardless of how much cable I use. He does not use a transformer, but still, I thought he should be getting a weak or distorted signal.

What happened in his case?—John Beck, Pittsburgh, Pa.

A. I think your friend has done something besides adding the 10 feet of cable. Ten feet of line cannot make that much difference in the operation of any microphone, even if it is a high-impedance mike. There might be a loss of highs or there might be a slight increase in hum level, but that is about all you could and should expect from adding so small an amount of wire.

I suggest that you consider that possibly, when your friend added extra connectors needed to splice this cable into the mike line, he shorted these lines at the connectors or that he spilled some solder down into the connector itself, thereby shorting it out. Perhaps he used too much heat while soldering. This would cause the insulation between the shield and the cable's inner conductor to melt. The two would then short. In addition, the center conductor might have been improperly soldered, resulting in an open circuit.

If your friend is using a crystal mike, do not use an ohmmeter to check for this condition. You will have to give the connector and cable a visual inspection only. An ohmmeter should not be used to check a crystal microphone because of the d.c. which is used in these instruments. When d.c. flows in a crystal mike, the current may damage the elements.

While on the subject, it is possible that your friend did not use connectors, but merely spliced in the extra piece of cable. This should not be done because the splice will be unshielded. This, in turn, will lead to the introduction of additional hum over that which would normally be present. Again, this is especially true in the case of a high-impedance microphone line.

I usually tell people when they are looking for difficulties with equipment that the difficulties are usually rather simple to find. Yours is a typical illustration. You probably reasoned that something is wrong with the idea of adding the 10 feet of additional cable to the mike. You did know—as I can see from your letter—that it should have worked. The next step in the logical process should have been to examine what else might have happened. This is what I did as soon as I read your letter and I came up with the aforementioned conclusion.

Of course, even here, it is possible I am wrong. If so, what else might be wrong? You should think in terms of the opposite condition to a short; that is, an open-circuit. Perhaps one of your solder connections did not take, and the circuit is not complete.

For any cartridge... first class transportation

Insert the most critical, most sensitive cartridge in the Garrard SL 95, and be assured it will travel the intricate convolutions of the grooves easily and flawlessly. The advanced ultra-low mass, gyroscopically gimballed tonearm system has just three controls, to balance it exactly to the weight of the cartridge, adjust it precisely to the recommended stylus force, and counteract the natural skating tendency, providing perfect tracking, distortion-free reproduction.

The SL 95 gives your records a perfect ride, too. The synchronous Synchro-Lab Motor™, matched kinetically to the oversized, balanced turntable, guarantees absolutely constant speed, unwavering pitch, freedom from rumble. Simplified cueing and pause control, and the exclusive safety record platform, protect your records both in manual and automatic play, making the SL 95 Automatic Transcription Turntable the ultimate in performance and dependability. Price: $129.50, less base and cartridge. Other Garrard models as low as $37.50.

For a complimentary Comparator Guide to all models, write Garrard, Dept. AC-1, Westbury, N.Y. 11590.

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counterweight
Sliding counterweight is infinitely adjustable, makes precise dynamic balancing practical; locks into place, isolated in rubber from the arm.

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Patented anti-skating control, of spring-free sliding weight design, has ½ gram calibration to nullify side pressure on stylus and groove walls.

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Top-reading stylus pressure gauge sets tracking force precisely with audible/visible click stops at ¼ gram intervals.

cartridge
New cartridge clip guarantees safe, convenient mounting, in perfect alignment. Tone-arm and "shell" are of rigid, resonance-free, one piece construction.

50/60-Hz operation

Q. I am planning to go in for a good stereo/hi-fi system (tuner, amplifier, tape recorder, etc.). There are very few manufacturers who provide both 50/60 Hz operation. In my job, I have to go to countries where there is a 50 Hz supply. I can foresee the operation of a changer or tape recorder and what this will mean under these conditions, but I cannot figure out all the other effects this frequency change might have on the operation of the other equipment. Can you please comment on how the change in operating frequency will affect their operation?—Vinod Batra, Cooksville, Canada

A. As you know, phonograph and tape recorder motors are frequency-dependent in terms of the speed at which they will turn. Voltage plays little part in this until it is way below operating level.

Transformers, however, which are specifically designed for operation at one frequency, may not operate well at frequencies lower than that specified as their operating frequency because of a lack of sufficient iron. Inductance decreases with frequency. Decreased inductance will mean that the transformer will not run as efficiently as before, leading to the production of heat. All too many transformers are made to run too hot as it is. Decreasing the line frequency will make this situation even worse, to the point where the transformer may fail.

Second, some equipment is designed to meet a certain price. Poor filtering of the plate or collector supply is sometimes effected to push the price down. Filters decrease in effectiveness as the frequency of operation is decreased. Therefore, the amount of residual hum will increase as frequency decreases. Further, the amount of "flywheel" effect will also decrease because the capacitor cannot store up enough energy to carry it along between charging pulses. This means that the peak, or music power of the amplifier will be reduced, especially where the power supply has been poorly designed to start with. As you know, it is possible for such an amplifier to have a rather good music power rating because of the manner in which these tests are carried out. However, the power supply may not be capable of sustained output at anywhere near the level of the music power rating. This level will be further decreased when the equipment is operated below its designed power line frequency.

I know of no steps which you can take if you have a piece of equipment which is not recommended for operation on 50 Hz. You could write the manufacturer to see if he might happen to have a better transformer which he can install to improve the situation insofar as heating of the transformer is concerned. You should also inquire whether or not it is a good idea to add more filtering.

You will just have to hope that if a larger transformer is needed or if more filtering is called for, that there is sufficient physical space on the equipment chassis to accommodate the necessary changes. Of course, it is best to buy a piece of gear which will need no modification.

Auto tape gear polarity

Q. I would like to know if a stereo tape-radio unit can be satisfactorily installed in my positive ground automobile. If this installation is possible, please let me know how this can be done.—W. H. Sorensen, Oklahoma City, Oklahoma.

A. In reply to your recent letter to *Audioclinic,* I must say that it is not likely that you can install your tape player in your car; you will have some difficulties to overcome. You must insulate it from the frame of the car. This requirement is also true of the antenna system. If you can find a way to accomplish these two tasks, you will have no other major troubles.

Do not attempt to connect the equipment as though it was intended for a negative ground system. By doing so, the output stage will surely be damaged, and probably other parts of the equipment as well.

If the antenna shielding is returned to the car's frame and ground, remove this and connect it to ground once again, but this time in series with a disc capacitor having a capacitance of perhaps 0.001 μF. If the ratio portion of the equipment is designed to cover the standard broadcast band along with the FM band, you should make the capacitor's value in the order of 0.05 μF.

When mounting the speaker, do not allow the car's frame to be one of the conductors. Further, be sure that the speaker's frame is not connected to either one of the inputlugs. Some speakers are made that way, so don't use one. In conclusion, if you are not sure about any of these factors, do not try it. You will ruin the equipment. Æ

SUPERB

superb (soo-purb), **adj.** 1. Possessing or exhibiting nobility of birth, mien, position or character. 2. Of supreme excellence, goodness, value or beauty of the highest quality.

You might feel "Superb" too strong a word to use in describing an FM/stereo receiver. But then you haven't heard the Studio Pro 120. It was born rich in a 30-year tradition of excellence. It is equal or superior to receivers costing up to $600, yet it is priced at only $379.50**. Its performance specifications have been certified by Nationwide Consumer Testing Institute, Inc., a subsidiary of United States Testing Company, Inc. — to give you proof positive that it will perform exactly as we say it will. Is superb too strong a word to use in describing the Studio Pro 120? Listen to it and we think you'll agree "Superb" is the word. Your franchised University dealer is waiting to show it to you.

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The speaker systems shown are University's Mediterraneans, also superb.

**Manufacturer's suggested resale price.

AMPLIFIER SECTION: IHF Power Output: 120 watts total, IHF Standard at 0.8% THD, 4 ohms (60 watts per channel). RMS Power Output: 8 ohms: 30 watts per channel at 0.3% THD. Frequency Response: +0, -3 dB from 10 Hz to 100 kHz. Power Bandwidth: 10 Hz to 40 kHz, IHF Standard. Intermodulation Distortion: Less than 0.5% at any combination of frequencies up to rated output. Tone Control Range: ± 18 dB at 20 Hz and 20 kHz. Damping Factor: 50 to 1. Noise Level: (Below rated output) Tape monitor: -83 dB — Auxiliary: -80 dB — Phono: -60 dB — Tape Head: -63 dB. Input Sensitivity: (For rated output) Tape Monitor: 0.4 Volts — Auxiliary: 0.4 Volts — Tape Head: 1 mV at 500 Hz — Phono: 4 mV at 1 kHz. Input Impedance: Phono and Tape Head: 47,000 ohms — Tape Monitor: 250,000 ohms — Auxiliary: 10,000 ohms. Load Impedance: 4 to 16 ohms. FM TUNER SECTION: Sensitivity: 1.6 μV for 20 dB of quieting, 2.3 μV for 30 dB of quieting, IHF. Frequency Response: ± ½ dB from 20 to 20,000 Hz. Capture Ratio: Less than 1 dB. Image Rejection: Greater than 90 dB. IF Rejection: Greater than 90 dB. Separation: 40 dB at 1 kHz. Selectivity, Alternate Channel: 55 dB. Drift: .01%. Distortion: Less than 0.5% at 100% modulation ± 75 kHz deviation. Multiplex Switching: Fully automatic logic circuit. GENERAL: Dimensions: 4½" H x 16⅜" W x 12" D (including knobs). Weight: 17 lbs. Amplifier Protection: Three 1-ampere circuit breakers. Complement: 31 Silicon & MOSFET transistors, 21 Diodes, 2 Integrated circuits (each containing 10 transistors, 7 diodes, 11 resistors).

WHAT'S NEW IN AUDIO

Garrard "Module" Turntable

The Garrard "Module SLx" combines a new automatic record playing unit with a magnetic cartridge/diamond stylus assembly, simulated walnut and ebony base, and pre-wired a.c. power and audio signal wire leads. The three-speed turntable incorporates a "Synchro-Lab Motor," dynamically balanced tone arm, cueing and pause control, adjustable stylus force gauge, and a speed-and-record size selector.

As with other Garrard units, it features interchangeable spindles for playing single records manually or for automatic play.

The compact module measures 15-in. wide by 13¼-in. deep by 7¾-in. high. Price is $69.50 complete with cartridge and base. An optional, clear styrene dust cover ($4.95) and a 45-rpm automatic spindle ($3.80) are also available.

Check No. 22 on Reader Service Card

IC's for tone arms

An integrated-circuit amplifier designed for use in phonograph tone arms, stereo and mono, has been introduced by RCA Electronic Components and Devices. The IC mounts directly on the phono cartridge, minimizing the need for shielded leads to the amplifier and greatly reducing hum and distortion, according to a company spokesman. Each channel features a typical voltage gain of 26 dB at 1 MHz.

Sound absorbing material

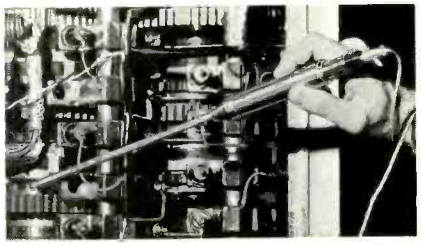
Acoustic insulation, sold in packages containing six sq. ft. of one-in. thick material, has been introduced by

Conwed Corp., St. Paul, Minn. Called "Acoustical Felt," the material can be cut with scissors to fit any size and shape cabinet or speaker enclosure, and can be attached quickly with staples, nails or adhesive. According to the company, it can reduce cabinet reverberation, resonances, and standing waves. $2.79 per package.

Check No. 26 on Reader Service Card

Sound pressure measurement microphone

The Sennheiser Model MD 321N dynamic microphone, equipped with a 12-in. long probe with a 5/16-in. diameter, is designed for sound pressure measurement applications. It also lends



itself to sound registration in confined areas and localization of acoustic leakage. Frequency range extends from 50 to 15 kHz (an individual calibration curve is supplied with each microphone). Output level is −68 dBm referred to 1 mW/10 dynes/cm². Net price is $145.00.

Check No. 28 on Reader Service Card

Company Moves/Expansions

The Electronic Instrument Co., Inc. (EICO) opened its new headquarters plant — a one-level, 100,000-sq. ft., air-conditioned structure — in Brooklyn, N. Y. from Flushing, N. Y. . . . The Seeburg Corp. leased a one-story 130,000-sq. ft. plant at Elk Grove Village, Ill. as a suburban wing to its existing complex in Chicago for its consumer products . . . Jensen Manufacturing moved to new plant facilities in Chicago, Ill., more than doubling its footage to 174,000 sq. ft.

Check No. 7 on Reader Service Card →

This suggestion is made only to those who have top-flight integrated amplifiers with an electrically separate preamp and power amplifier, or individual preamp and power amplifier components. It involves your present equipment and three Sony components: the TA-4300 electronic crossover and two TA-3120 stereo power amplifiers. It's for those venturesome enough to break away from conventional approaches to sound reproduction. If we've described you, then these Sony components can bring you just that one iota closer to realism in home music.

Here's why.

The electronic crossover goes between the preamplifier and the power-amplifier portions of your present stereo amplifier. It divides the audio-frequency spectrum into three ranges, and sends each range to a separate amplifier: your existing power amplifier, plus the two Sony TA-3120's. Each amplifier feeds a speaker expressly designed to handle that particular part of the audio spectrum. By not forcing a single amplifier to handle the full range of frequencies, IM distortion is reduced. By eliminating the inductor-capacitor-resistor crossover networks built into ordinary speaker systems, speaker damping is not distrubed. The speakers' motions are always fully controlled by the amplifiers. Speaker impedance variations have less effect on the amplifiers.

Also, you can select crossover frequencies to suit the speakers of your choice, or experiment to discover the audible effects of varying crossover points. The points provided are 150, 250, 400 or 600 Hz between woofer and mid-range, and 3, 4, 5, or 6.5 kHz between mid-range and tweeter. A bass turnover control fits the system's response to the characteristics of the woofer, and a bass-boost control lets you experiment with extending the woofer's bass response.

The Sony TA-4300 solid-state electronic crossover costs $199.50; the two TA-3120 solid-state amplifiers $249.50 each. Sound extravagant? Maybe just a bit. But so are the results. Interested? Write for literature on how to upgrade your system. Sony Corporation of America, 47-47 Van Dam St., Long Island City, N.Y. 11101.

Get drunk with power

SONY®

Letters from Readers

Magnetic tape ridges

• Referring to "Color me lemon," December AUDIO, page 12, I have experienced the same problem, and found it to be caused by "ridges" bent into the tape by the slot in the tape reel hub. Solution: check tape for ridges (mine were easily visible) and remove tape toward the middle of the reel until no more ridges are found.

GORDON RICHARDSON
Kingston, R. I.

Reverberation

• In reading "Tape Guide" in the January 1968 issue of AUDIO, I spotted the question from the gentleman on the reverberation unit he had seen in some studio. He explained in his letter that an engineer had indicated the long narrow box contained a loudspeaker and a microphone.

This long, wide and narrow "beaver board" box was in reality the EMT reverberation unit from Germany, imported and sold in this country by Gotham Audio Corp., New York, N. Y. The EMT reverberation plate is housed in a beaver board "box" such as your writer described.

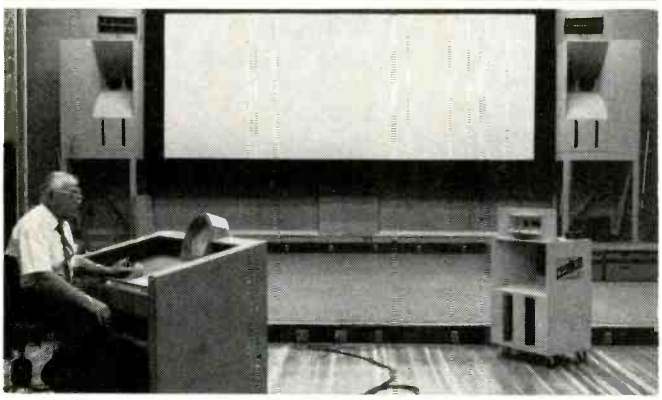
THOMAS H. JONES
Rochester, Minn.

• The January 1968 "Tape Guide" column asked plans for an audio delay-line echo chamber. Mr. Burstein answered that he knew of no such plans. The plans for such a device were published in the March 1961 issue of *Science and Mechanics* Magazine.

This echo chamber works on the same principle as described in the "Tape Guide" column except that the delay line is a 75 foot, ½-in. garden hose which is coiled up in a 24-in. x 20-in. x 12-in. box to make a very compact unit. The delay time is between 50 and 65 milliseconds and the amount of echo is controlled by a mixer. Estimated cost of building this unit is $25.

HARRY SCHELLBERG
Houston, Texas

Disney's Magic World of Sound... from Altec.



The magic that is Disney is not just a pat formula. It is a form of perfectionism that pervades everything which carries the Disney name. Certainly, there's a Disney look. But just as certainly there's a Disney sound. And that's where we come in.

For example, the new control console at the Disney Studio's orchestra stage is made up of 29 Altec slide-wire attenuators, 7 rotaries, and one 4-gang master. The works are powered by rack-mounted banks of Altec amplifiers. Monitoring in the control room is done in a big way—with three giant Altec A4 "Voice of the Theatre"® systems butted together in a single plane of the most powerful, pure sound you can get.

The stage itself uses three more A4's for monitoring, re-recording, and playback. (That's one good way to keep the musicians happy.) Eight caster-mounted A7 "Voice of the Theatre"® systems are mobile, may be moved where and as needed.

And that's not all. On the back lot Altec PA equipment provides the paging. Dialog stages at the Studios also use A4's, with Altec's space-saving 844A Monitor Speaker Systems in the compact transfer room. The list could go on, but the point is made.

So who listens when Altec Lansing sounds off at Disney? Everybody, that's who. And if you understand the remarkable expertise of Disney sound engineers, perhaps you should listen too. Let's hear from you.

ALTEC LANSING, A Division of LTV Ling Altec, Inc., Anaheim, California 92803 Dept. A-3

ALTEC LANSING®

Check No. 9 on Reader Service Card

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.

Reverse-channel spillover

Q. I recorded an opera on a fresh roll of tape. When it was finished I flipped my tape machine switch from record to play. At that point I had unrecorded tape, and I should have had silence, but instead I could hear the two channels on side 1 playing backwards. I don't know if this is crosstalk or reverse-channel spillover, but I'd like to get rid of it. Is this simply a matter of tape head alignment, or is it one of the drawbacks of an inexpensive tape deck (mine is a modest $100 unit)?—Joseph J. Fullam, St. James, N. Y.

A. Your difficulty appears to be reverse-channel spillover, due to vertical misalignment of the tape head with respect to the tape. I take it that you have a quarter-track machine. You are more likely to run into this difficulty with a quarter-track machine than with a half-track one because the islands between tracks are only about 25 mils (thousandths of an inch) in the case of quarter-track, compared with about 80 mils (per the NAB standard) in the case of half-track.

The tape head would appear to be riding too low with respect to the tape. Thus when you are playing tracks 4 and 2 (which you call side 2), the gaps are close enough to tracks 1 and 3 to pick up signals from the latter. You might try re-positioning the tape head so that the upper edge of the top gap is just about even with the upper edge of the tape. You have to be careful not to upset azimuth alignment. Azimuth should be checked and corrected with the aid of an azimuth alignment tape. If you aren't up to all this, a visit to a service agency or return of the tape machine to the seller is in order.

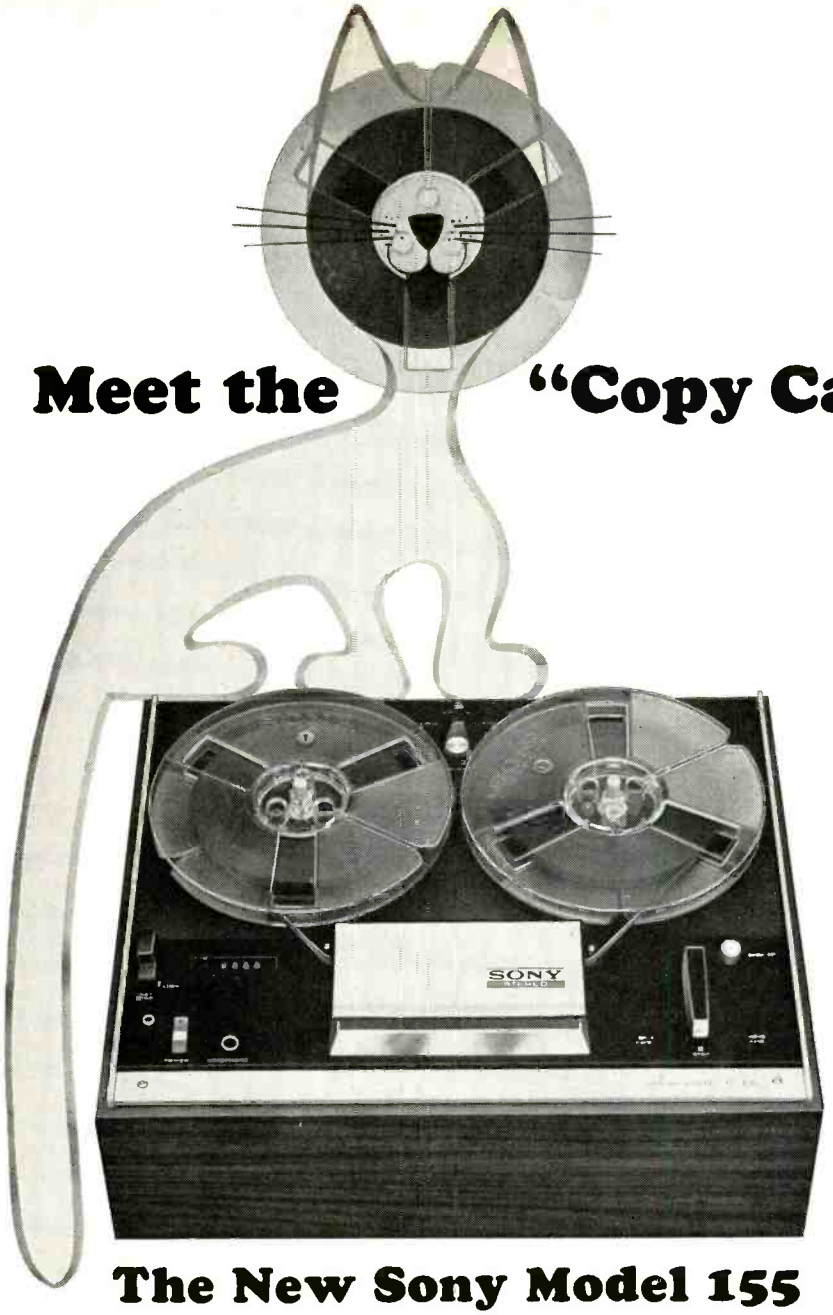
Symptom: distortion, no gain

Q. I have a 1290 Wollensak tape recorder and am using it with a Scott 348 receiver. When playing back from the recorder preamp output jacks into the receiver tape-input jacks, I get distortion and hardly any gain. But when I also connect the recorder speaker output jacks to the "extra" input jacks of the receiver, and switch to the tape monitor position of the receiver, everything sounds o.k. When my recorder is playing back through its own speaker it also sounds o.k. When I connect my recorder preamp-out jacks to the receiver "extra" input jacks, again I get distortion and virtually no gain. Things work right only when I have two sets of cables connected from the recorder to the receiver, as described before. What might be the reason, and what can I do?

A. After puzzling over your problem I still can't come up with an obvious answer. In general, the difficulty must lie in one of three areas: (1) your tape machine, (2) your receiver, or (3) your manner of connecting the two and your operation of their controls. To ascertain in which of these general areas the trouble lies, and to then find the specific cause within that area, I would need to know a number of things, including:

1. What happens when a signal is fed from the speaker outputs of the recorder into the extra inputs of the receiver?
2. What happens when a good signal is fed into the tape input jacks of the receiver?
3. What happens when a good signal is fed into the extra jacks of the receiver?
4. What happens when signals from the recorder preamp output and speaker outputs are separately fed into another amplifier (not into your receiver)?
5. Have you perhaps confused the tape-head (low-level) input jacks of the receiver with the tape input (high-level) jacks of the receiver)?
6. Have you perhaps confused the play with the monitor position of the tape-monitor switch on the receiver?

It would probably also be necessary to have schematics of your recorder and receiver in order to make a reasonable guess as to the cause of your problem. In view of all the foregoing, it seems wisest to submit your components to a competent service agency for actual testing. Æ



Meet the "Copy Cat"

The New Sony Model 155 Playback/Dubbing Stereo Tape Deck!

If you now own a stereo tape recorder, you can become a "copy cat" for only **$99.50** For the cost of about fifteen pre-recorded tapes, you can own your own complete 4-track stereo tape duplicating system and build a fabulous stereo tape library at a fraction of the cost of pre-recorded tapes! The Sony Model 155 is a complete stereo transport deck *with* solid-state playback pre-amplifiers *specifically designed to be used together with your present stereo tape recorder for dubbing!* ■ The Model 155 has features and performance never before heard of at under $100.00! For example . . . Three speeds . . . Special filter for virtually flutterless performance . . . Retractable pinch roller to permit tape threading with one hand ease . . . Stereo headphone jack for private listening, and . . . the flexibility of vertical or horizontal operation! These are all features normally found on only much higher priced equipment. ■ The Model 155 can also be used just for stereo tape playback through your existing components or package stereo music system. Imagine . . . Sony quality true-fidelity stereo tape playback for under $100.00! Complete with handsome walnut finish, low-profile base and optional dust cover. Let the Model 155 Playback/Dubbing Stereo Tape Deck make a "copy cat" out of you! And, as always . . . you can count upon the extraordinary "Sound of Sony"!

AMERICA'S FIRST CHOICE IN TAPE RECORDERS

SONY® SUPERSCOPE® The Tapeway to Stereo®

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AUDIO, ETC.

EDWARD TATNALL CANBY

"Flame" loudspeaker

SPEAKING OF LOUDSPEAKERS (this is our loudspeaker issue), the management has put me onto the zaniest speaker yet—so zany I can only gasp and sort of try to blow it out, before it sets me on fire. It's a flame.

Now we've all heard of the odd ways in which a signal may modulate air to produce audible sound. Even some flames screech all by themselves. There was a sound *amplifier*, modulating a stream of compressed air, 'way back before audio history began. Recently, we have had that curious device, the ionic speaker. Ionized air (aha! Is it plus or minus?) produces a tweeter signal with no solid moving parts.

A practical flame speaker first reared its hot head about two years ago, to our knowledge, developed by the Sonics Department of Stanford Research Institute, Menlo Park, Calif. Called a "pyroacoustic loudspeaker," it uses flames to modulate the air stream. Reports say that it can amplify sound many times more than can a conventional loudspeaker.

The newest flame speaker twist started, believe it or not, in some underwater experiments by United Technology Center, Sunnyvale, Calif.

Acetylene torch, tungsten electrodes fed with an amplifier signal. You can hear it all over a big room. And presumably under water. Great future. Super-fi in the highs—no mass to get in the way, other than the air itself or the flame gases. May revolutionize the home market.

Now wait a minit—an *acetylene torch* in the living room? But let me go on! Guess it doesn't have to be quite *that* dangerous; maybe other, lesser flames might do as well. Especially with an air conditioner attached. But what got me instantly, and relegates the idea to fantasyland for the moment, unless well North of the Arctic Circle, is this: With the small, experimental flame, signal output rolls off at *6 dB per octave from the mid-range area*. That is, from 2- or 3-kHz downwards. All highs, no bass.

Why? Why of course! Not enough physical cross section at the sound source. Doesn't couple to the air at lower frequencies. The flame needs a baffle, or equivalent.

So all you need for the most revolutionary home speaker of all, the absolutely *perfect* speaker, with no solid moving parts, is one of two things, as I see it. (1) You must enclose your flame in a box, preferably hermetically sealed, though maybe an old-fashioned vented bass reflex might be more plausible, the vents venting up the chimney; or you can put your flame inside an exponential horn. (2) Or else get yourself a bigger flame.

That last is not unlike the problem of the electrostatic speaker, isn't it? Cross-section and area. The bigger the area, the lower the bass. How big? Well, if you'll just provide a flame about *seven feet square*, uniformly modulated with signal, you'll have the finest full-range home speaker ever created. And no home.

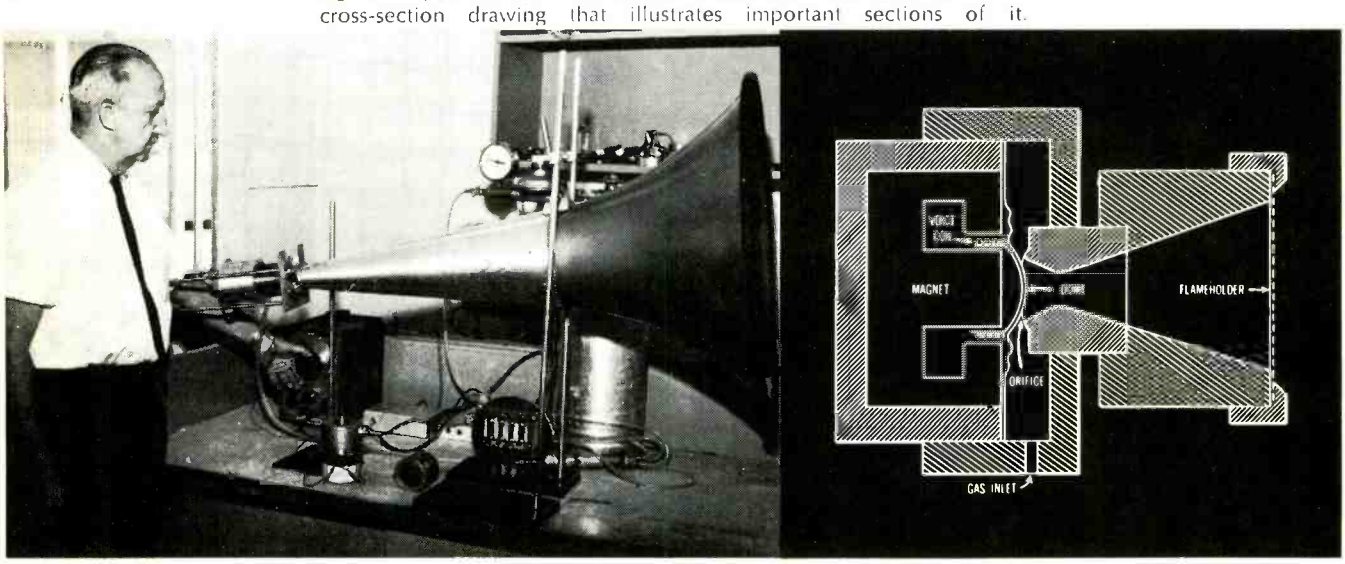
Let's see what developers have to offer, when and if. (Maybe a combination speaker/hand warmer to spark outdoor hi-fi in the winter?) Meanwhile, lay in a stock of asbestos.

Flash!! (delayed)—EVR

EVR? Two minutes of info on it and I flipped clean over. Fantastic. Of course, EVR isn't directly in our proper field, audio. But it does manage to carry two stereophonic sound tracks along with it, so you can scarcely call it non-audio. You know, this multiple-medium business (plural: multi-media) is inexorably carrying each one of us straight into everybody else's technical bailiwick.

EVR is one of those things. It's home entertainment. It's sound in stereo. It's pictures. It's magnetic recording. It's photography. It's TV. It's organized

Fig. 1–A "pyroacoustic" loudspeaker is pictured here, together with a cross-section drawing that illustrates important sections of it.



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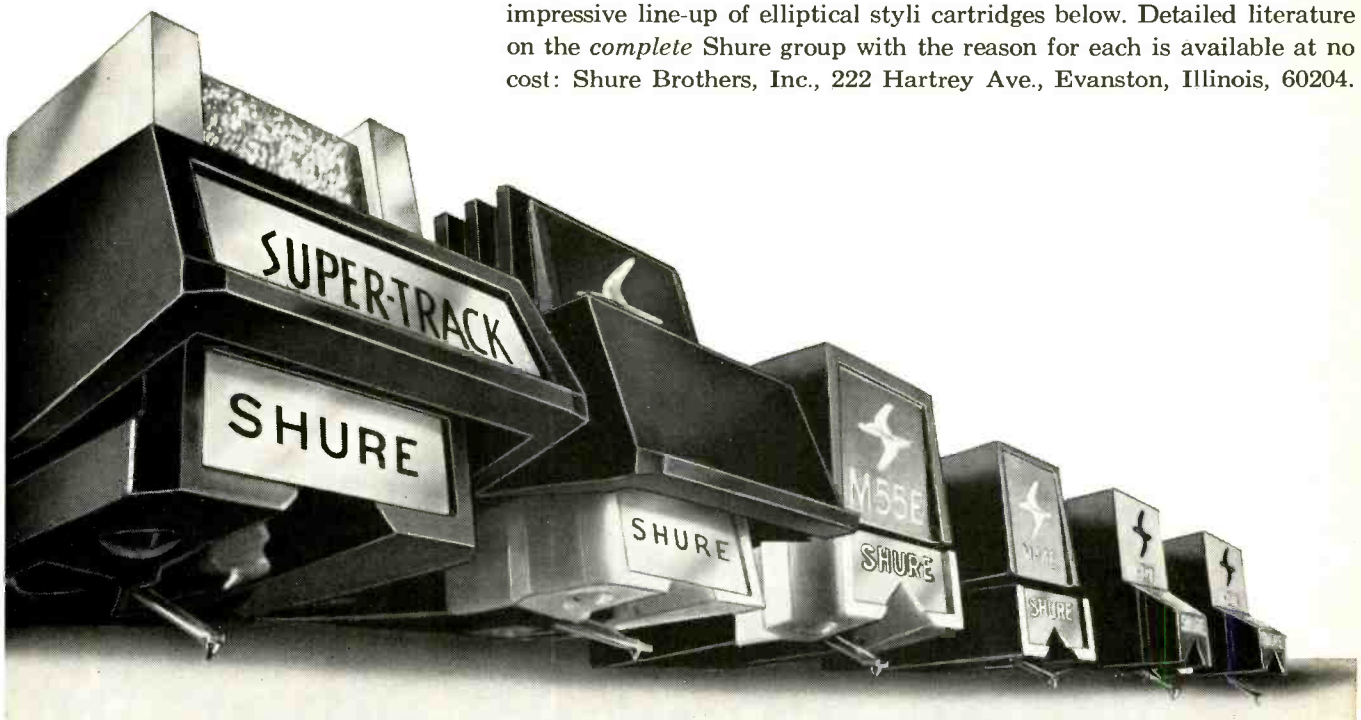

V-15 TYPE II	M75E	M55E	M44E	M31E	M32E
$67.50	$39.50	$35.50	$34.50	$27.50	$25.00
¾ to 1½ gms.	¾ to 1½ gms.	¾ to 1½ gms.	1¾ to 4 gms.	1 to 2 gms.	2½ to 5 gms.

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education. It's libraries. It's black and white and it's color. It comes on a 7-inch reel and it's a cartridge, with a hole in the middle. It plays at 5 ips and runs a half hour, or an hour a reel (cartridge). It's 8 mm., more or less, and it has photo frames, 90,000 per reel. It plays into your home equipmnet like a tape recorder. Or into a school system. It gets developed and printed at the factory just like super-eight, and it turns out pictures like a home projector. And, if I am right, it packs more straight *information* per square inch than any consumer-educational device ever before perfected.

Information! If I understand the preliminaries, EVR is a direct product of the sort of thinking that goes under the heading of information theory. It is not a direct image, plain and simple, but a *coded* image.

. . . Well, sure, so is a tape recording, if you want to look at it that way. A video taping is coded, too, images in black and white or color coded into "audio" signals. But EVR seems to be much trickier. *Maximum* compression of info. Economy plus. EVR, for instance, makes color out of black and white, right in front of your eyes. 'Nuff said?

What IS this EVR? Well, go look for yourself—all the news media should be full of it by the time this is in print. As for me, I'm going to wait until I can get a first-hand accounting. This thing is much too big to write about from press descriptions.

Or at least it *ought* to be big. That's my overwhelming first impression. *Tree*-mendous possibilities! (And what of videotape?) On the other hand, maybe EVR is just another bomb. Could be. So if you hear nothing further in this department you can assume that I have quietly eaten my words, down to the last exclamation point.

The Phonogram

An old lady friend of mine, around 86 now (I've known her all my life), makes a hobby of collecting relevant clippings for all her friends and mailing them out at suitable intervals in batches. To be sure, her ideas of "relevant" are not always quite up to date. With me it is first of all trolley cars. Then photography. And, as an afterthought, the phonograph. She remembers me as a child, you see.

The lady's clippings are suitably ancient. In fact they never date later than approximately 1900 and they almost always come from old copies of *Harper's* magazine or the *Century*. However, the latest batch of yellowed sheets I got from her was really *quite* relevant. Take this, from the *Century*, I think. (The page was cut off.)

"THE PHONOGRAPH. This novel and remarkable instrument has quite passed the experimental stage and is now practically successful in every respect and must be regarded as instrumental in opening up a new field for scientific research and making one more application of science to industry."

Er—*what?* That's what it says. So the phonograph was to be a purely scientific instrument, for industry? No music? Obviously impossible at this date, as witness the particulars:

"The speaking phonograph is a natural outcome of the telephone, but, unlike any form of telephone, it is mechanical and not electrical in its action. . . .

"In using the phonograph it is found best to speak in a loud, clear voice, and with distinct enunciation, that the vibrations may be sharply and deeply impressed on the foil. Attention must also be given to the movement of the handle, so that the passage of the foil under the stylus will be uniform and steady. . . . If in turning the instrument swiftly, the speed at which these marks pass under the stylus is increased, then the pitch of the resulting tones will be raised and the bass voice may reappear as a soprano, or in a high, piping treble far above the pitch of any human voice. In a contrary manner, by turning the handle slowly, a soprano voice may reappear as a very deep bass. This curious circumstance, in connection with the speech of the phonograph, will undoubtedly make it necessary to employ clock-work to move the apparatus. . . .

"The tone of the phonograph is usually rather shrill and piping; but this defect will undoubtedly be corrected by improved instruments. It must be observed that, marvelous as this instrument is, it is still quite new, and it is impossible to say to what degree of perfection it may yet be carried. It has already opened the door to an entirely new and untried field in the physics of sound. . . . Already it has suggested many valuable uses in trade, manufactures and social life, and it will be the aim of this department to report the progress of this, one of the most remarkable inventions of this century, and to show its applications to science and industry."

Science and industry? The gentleman was slightly off the beam, at least as far as the future of cylinders and discs was concerned! (Let us hope that *this* department's prophecies are no worse. I sometimes wonder.) It is amazing to see how weak the editorial vision can sometimes be. I doubt if we are much better today. Edison himself, for that matter, was pretty mixed up as far as the phonographic future was concerned. He had mainly such things as office dictation in mind initially (the Edison Dictograph), and he was no music enthusiast. Music came slowly and painfully to the Edison recordings, even long after "clock-work" was in fact applied and the pitch steadied. As for the musical classics in general, excepting operatic excerpts, they didn't get to first base on discs until the electrical era. But *then* look what happened.

However—and here is another clipping from the same batch—other minds in the later Nineteenth century were on the right track, more or less. In the *Century* there was an "open letter," written later, shortly after home Edison cylinder machines became available and headed grandiosely: "What the Phonograph Will Do for Music and Music-Lovers." It is by one Philip G. Hubert, Jr., and it goes on for column after column of densely packed, very small type.

"Looking at the phonograph from the point of view of a person professionally interested in music," he begins, "I cannot see room for doubting the tremendous rôle which this extraordinary invention is to play in the future of music and musicians. Few people seem to realize that the phonograph, even in its present stage—which is admitted to be one of imperfection as compared with what may be expected before many years have passed—has really title to be called a musical instrument."

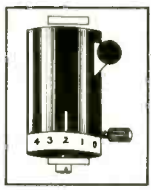
Revolutionary idea, at that point! Edison was then issuing "dance music and operatic fantasias," in addition to the corny songs, monologues and what-not that filled up much of his catalogue to the end. Says Mr. Hubert of the sound, "It is really *music,* and not a mere suggestion of music. The different instruments employed are perfectly distinct, while the time is, of course, perfect." Perfection of tempo seems to have been one of the first things that then caught up the imagination—for until then, only the metronome could give even an approximation of the right speed for any given piece. Tempo preserved for the ages! The phonograph as a super-metronome.

Mr. Hubert was entranced by the Edison fi. "Taking, for instance, a chord of the piano, not only are the notes of the chord heard, but the after-vibrations, lasting for several seconds. When a small funnel is used to magnify the sound, every person in a large room can hear distinctly, and the music

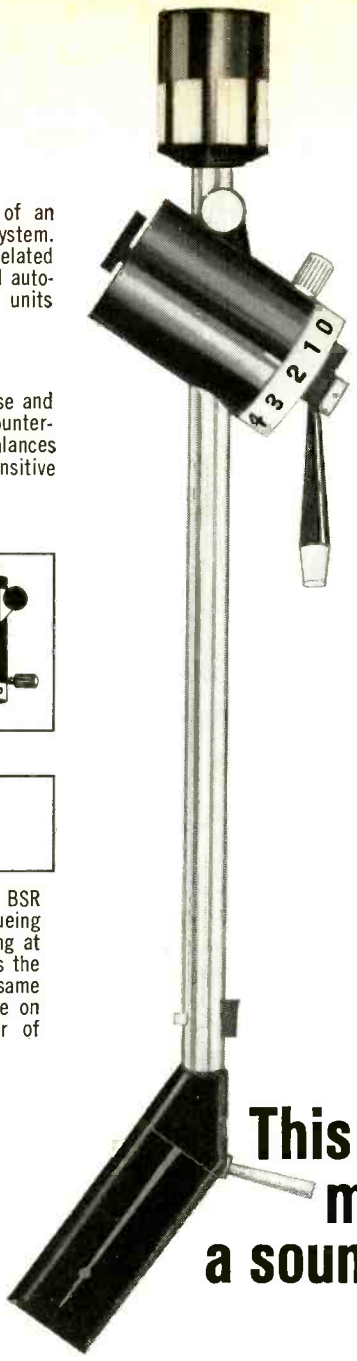
A vital determinant of the quality of an automatic turntable is the tone arm system. Here are some of the tone arm and related features that make the BSR McDonald automatic turntables the sophisticated units they are.

A resiliently mounted coarse and fine Vernier Adjustable Counterweight delicately counterbalances the tone arm assuring sensitive and accurate tracking.

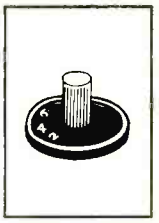
Micrometer Stylus Pressure Adjustment permits ⅓ gram settings all the way from 0 to 6 grams. This important part of the tone arm assures perfect stylus pressure in accordance with cartridge specifications.

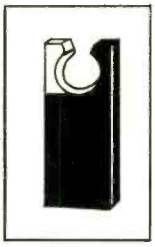


A much appreciated feature built into all BSR McDonald automatic turntables is the Cueing and Pause Control Lever. It permits pausing at any listening point and then gently permits the tone arm to be lowered into the very same groove. Positioning of the stylus anywhere on the record is accomplished without fear of damaging the record or the cartridge.



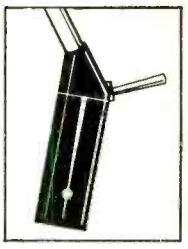
To achieve the ultimate in performance, BSR McDonald has brought to perfection the Anti-Skate Control. This adjustable dynamic control applies a continuously corrected degree of compensation as required for all groove diameters. It neutralizes inward skating force and eliminates distortion caused by unequal side wall pressure on the stylus. All of the BSR McDonald automatic turntables incorporate anti-skate.





After the last record has played on any of the three BSR McDonald automatic turntables, the tone arm automatically returns to the Locking Rest. In conjunction with this action, the On-Off-Reject lever automatically shifts into the Off position which securely locks the tone arm in its cradle to protect it from accidental drops and resulting stylus damage.

All BSR McDonald automatic turntables have a Clip-In Cartridge Head. This lightweight tone arm head, with finger lift and clip-in cartridge holder, provides universal mounting and quick change facility. It can accommodate practically every contemporary cartridge currently on the market.



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is almost loud enough to be used for dancing. . . . Every minute change of time, every shade of expression, is heard in the echo *(i.e. the playback)* as plainly as in the original. It is no exaggeration to say," he continues, in a monumental anticlimax, "that an expert can distinguish between the playing of two *different* pianists, as reproduced in the phonograph." Some fi!

It isn't easy to realize how very little there was to hear on that early phonograph and yet how impressive it seemed to an imaginative person like Hubert. The interesting thing is that this man had what we might call real vision. He was not at all deterred by the primitiveness of the machine; he barged straight into the future, accurately, as though the phonograph were already in a state of modern perfection. It wasn't. His really excellent perception makes up for Edison's notable lack of the same in respect to this particular invention.

He was enormously impressed by the then-new perspectives opened up by the multiple pressing of the wax phonograms. He points out that if each phonogram had to be made individually—as had been the case before—every one of them representing an actual separate performance (this, indeed, did go on for many years), or if the phonograms wore out quickly after a few plays, then the machine could never be more than a "toy for the rich." But since by "a special electrotyping process, facsimiles of a good phonogram can be made in large numbers at almost nominal cost, and since the music comes out 'the hundredth time as perfectly as the first' " (a pardonable exaggeration), "the cost per play was astonishingly low; and thus music was within the reach of everyone, beyond any previous age, giving, surely, in the near future, musical pleasure past present computation to the millions." How right he was! As of more than a half century later.

And so his imagination, on the basis of those thin, barely audible squeaks from the primitive machine, ran far ahead. "When the phonograph goes everywhere, and phonographic music is cheap, the housewife can listen to Rubinstein *(Anton—not Artur)* as she darns the stockings in the evening, and get superb lessons at the great fountains of musical art, if she has any taste that way. There is no reason to suppose that it will be any more difficult to record a performance of 'Die Meistersinger' than a recitation by Coquelin, or a Beethoven symphony under Bülow's baton. There is a good time coming for the poor men of good taste."

Amazing, I say. It is the fate of most good prophecies to sound utterly prosaic when they have been fulfilled to the letter. (I remember one of my own, quoted here recently, to the effect that the plastic disc record definitely was going to be important in the future—this in shellac days.) Mr. Hubert's remarks, in turn, require our best imagination to be appreciated in their true perspective, at a time when music of quality for the millions was simply nonexistent and unthinkable. *He* thought of it.

Indeed, he almost stumbles upon one of the subtlest artistic factors in recorded music today, and one that is still very slightly understood by most of us, musicians, technicians and laymen alike, the fact that a recorded performance has its own unique and timeless value, in its own terms, quite removed from the so-called "original." As old readers know, I have been blowing this particular horn myself for a long time, and intend to blow it more. But here is a man writing before any of us were born, and already edging towards the same idea. An interesting question, he says, is the differences between a good and a bad (live) performance, whether of a piano piece or an opera; often enough, he observes, performances "fail" when there seems no observable reason for it, and vice versa—he cites a "Faust" at the opening of the Met season of 1883, an inexplicable flop, and the repeat performances, a great success. We could cite many other similar anomaly, throughout musical history.

The phonograph, he thinks, would give an objective account of the performance, which could thus be judged after the fact and, he implies, away from the passions of the moment.

Prescience! That very timelessness is precisely the special quality that has, indeed, developed in recorded music today, though we have carried it one step further, virtually eliminating the original performance as a thing to listen to "live."

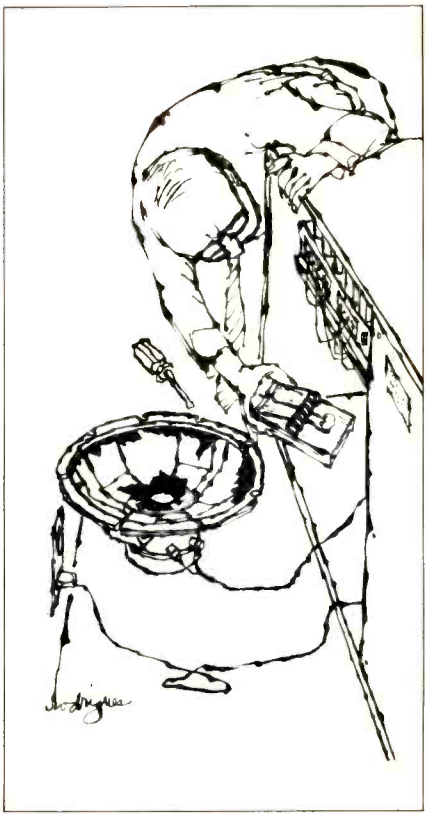
Hubert elaborates on his clear vision of the future of recorded music. "In a very few years," he says, "I fully expect to receive from Europe not only written accounts of the new operas of Berlin, Vienna, and Paris, but phonograms enabling me to hear them from end to end. As the wide distribution of literature which followed the cheap books of modern times has helped the author to a living income, so this wide distribution of music through the phonograph will probably do the same thing for the composer of good music. Then the future Wagner may perhaps receive as much for the composition of a music-drama as the author of another 'Silver Threads Among the Gold' gets for his gibberish."

Well, there Mr. Hubert dreamt a bit too well. Substitute "performer" for "composer" and he would, however, be quite correct. The composers of enormous classical music dramas have not yet caught up with Elvis, Richard Rodgers and Cole Porter in terms of income. But the big performers do very nicely via their records.

As for us millions, who patronize the present spate of phonograms, disc, tape or what have you, we are only proving that some people, like Philip G. Hubert, Jr., whoever he was, can see the future just as easily as most of us see the present.

Now does anybody want to start talking about the year 2020? It's on the way; it'll be here any moment.

P.S. My old lady friend clips too carefully; she removes all the margins, and with them both names and dates. But I figure that Mr. Hubert's letter was composed some time in the very early 1890s. Æ



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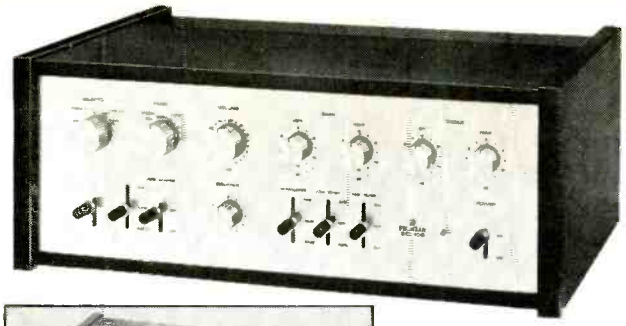
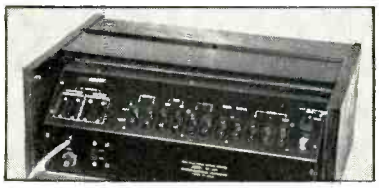
- Signal-to-noise ratio throughout phono input (at maximum gain): 70 dB
- Price: $375.00





Rear View
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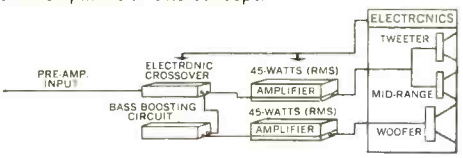

- A system of wide linear response, with extremely low distortion. The entire system produces a maximum of 1% harmonic distortion throughout the acoustic frequency range of 30 Hz to 20,000 Hz, heretofore impossible to achieve in conventional loudspeaker systems.
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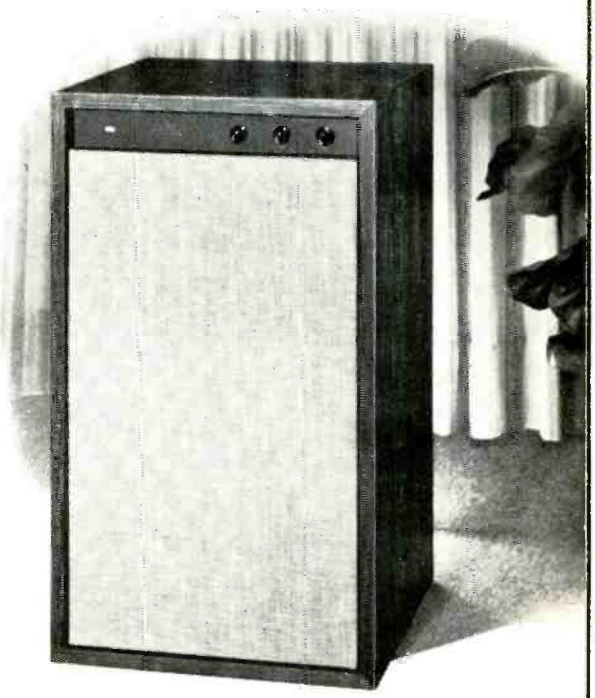
- The precision combination of these components accurately matches, for the first time, the electronic damping factor of the amplifiers with the mechanical damping factor of the speaker system, resulting in superb speaker control at all dynamic levels.
- The IS-80 has two inputs to accommodate any preamplifier on the market.
- Price: $375.00



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EDITOR'S REVIEW

Records in The Year That Was

It would take 274 days, listening 24 hours each day, to hear all the new LP records entered in the *Schwann Record Catalogs* in 1967, estimates the cataloger's publicity people. The new listings totaled 6,596.

The most recorded single piece of music was the Beethoven 7th Symphony (seven performances), followed by four new performances each of the Beethoven Violin Concerto, Beethoven 3rd Symphony, Dvorak 9th Symphony, Prokofiev 5th Symphony, Stravinsky's Petrouchka, and Tchaikovsky 4th Symphony. Old war horses—Ravel's Bolero and Rimsky-Korsakov's Scheherazade, for example—took a surprising drop from their former front-runner positions. (Only two new recordings of the two examples were made in 1967.)

Hayden symphonies, with 44 new recordings, led the pack of the most recorded *group* of pieces. Bach cantatas, with 37 recordings, and Beethoven symphonies, with 29 recordings, trailed the Hayden symphonies.

The most frequently recorded composer in '67 was Mozart (174 new listings), followed by Beethoven (126), John Sebastian Bach (117), Hayden (87), Brahms (67), Schubert (62), Tchaikovsky (48), Debussy (47), Vivaldi (44), Dvorak (43). Wagner lovers enjoyed 38 newly released records, Stravinsky, 36; Chopin, 32; Prokofiev, 31; Bartok, 26; Mahler, 22; Schoenberg, 21; Bruckner, 20; Ives, 19; Nielsen, 18.

Pop and Folk records swelled the listings with 1,970 new releases; Jazz with 509 new discs. Musical show and motion picture soundtracks added another 125. And 87 composers' works appeared for the first time in the 1967 catalog listings.

From the foregoing, there is no doubt that music lovers can now wallow in recordings of any period, satisfying any musical taste. On the evidence, the Year That Was was certainly a great one for the record industry and music lover alike (if a somewhat confusing one for the latter).

Target: Pseudo Stereo

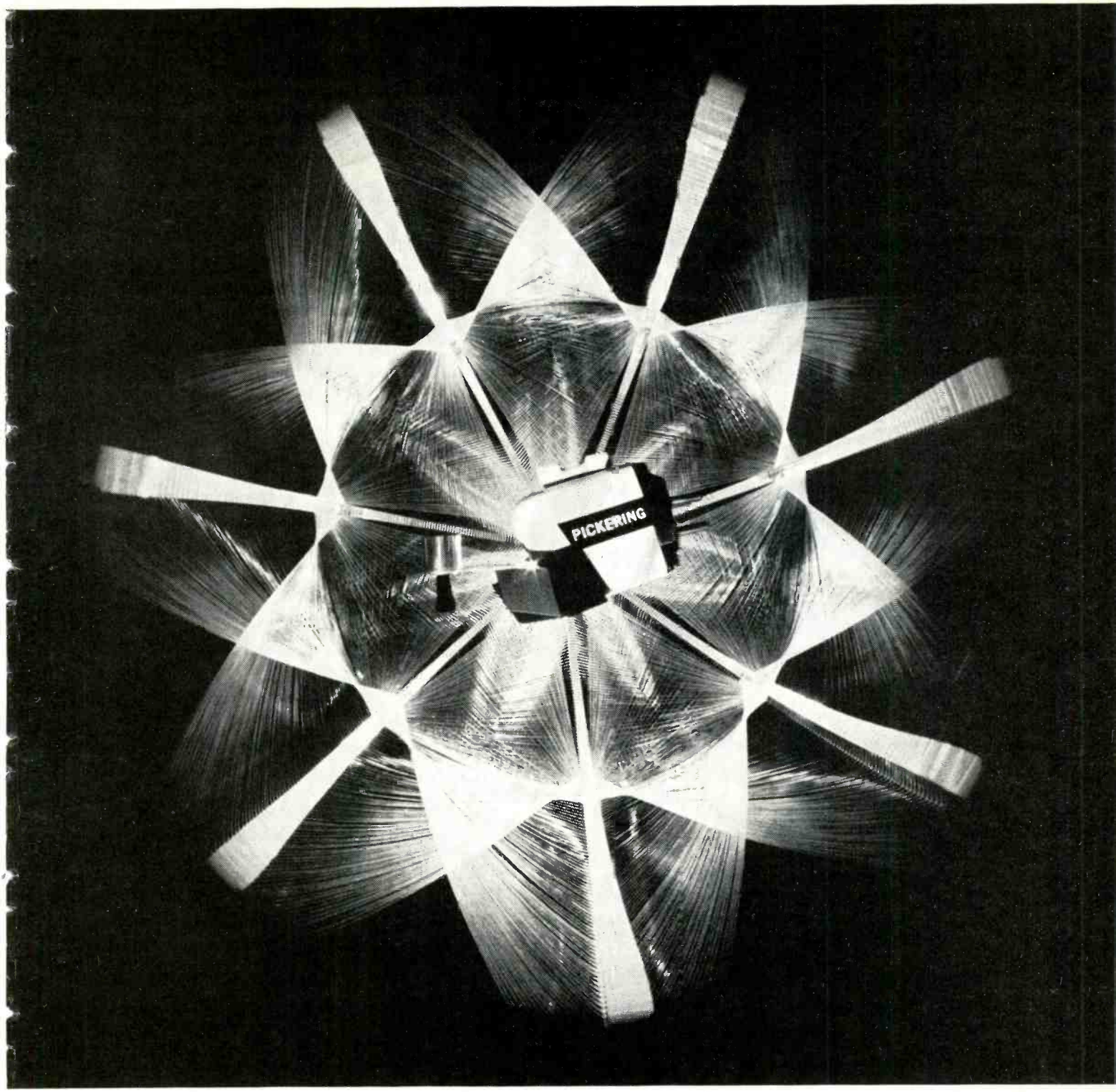
The Federal Trade Commission plans to sit on record companies to prevent them from using the word, "stereo," or a similar phrase, when the original live recording was *not* recorded stereophonically. Good show, FTC! The public has been duped too long by resurrected mono recordings (some of which happen to be excellent) with the word STEREO emblazoned across album front covers, while explanatory copy is relegated to small type size or buried somewhere on the back cover. Now how about restrictions on the use of the word, "high fidelity," which has been used so glibly by some home entertainment equipment manufacturers (not to mention a perfume manufacturer).

More on Edwin Welte's Recordings

Some readers have pointed out that the music of piano "greats" from the Welte Legacy series, mentioned here in January, can be enjoyed over the air in many cities. The radio series, "Keyboard Immortals Play Again . . . in Stereo," is produced by Sony Superscope from a library of almost 3,000 Welte music rolls compiled by the company. Tape recordings of the Welte music rolls were made for the radio series in the home of the company's president, Joseph S. Tushinsky, who owns one of the few *Vorsetzers* in existence. The *Vorsetzer*, which has 80 padded wooden "fingers" that simulate a man's fingers, sits in front of a concert piano and literally "plays" the instrument. It also has *ersatz* feet to control the piano's foot pedals.

A.P.S.

The X factor in the new Pickering XV-15.



The X in the new Pickering XV-15 stands for the numerical solution for correct "Engineered Application." We call it the Dynamic Coupling Factor (DCF).[SM]

DCF is an index of maximum stylus performance when a cartridge is related to a particular type of playback equipment. This resultant number is derived from a Dimensional Analysis of all the parameters involved.

For an ordinary record changer, the DCF is 100. For a transcription quality tonearm the DCF is 400. Like other complex engineering problems, such as the egg, the end result can be presented quite simply. So can the superior performance of the XV-15 series. Its linear response assures 100% music power at all frequencies.

Lab measurements aside, this means all your favorite records, not just test records, will sound much cleaner and more open than ever before.

All five DCF-rated XV-15 models include the patented V-Guard stylus assembly and the Dustamatic brush.

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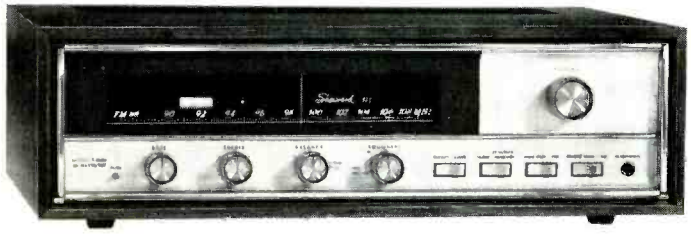
Model S-7800 140-Watt *All-Silicon* FM-AM Stereo Receiver. Features: *Synchro-phase* FM limiter/detector, Field-effect transistors in RF and Mixer stages, separate monophonic speaker terminals, DC coupled *All-Silicon* power amplifiers, instant overload protection, main and/or remote speaker switching, 140 watts @ 4 ohms. Front panel controls: Source selection, Bass, Treble, Balance, Loudness, Stereo/Mono, Tuning, Pre-Amp Sensitivity, and Hush Level. Rocker-action switches for Tape Monitor, Hi Filter, Main Speakers, Remote Speakers.

Custom-mount chassis	$419.50
In walnut leatherette case	428.50
In oiled-walnut cabinet	447.50



Model S-8600 80-Watt *All-Silicon* FM Stereo Receiver. Features: *Synchro-phase* FM limiter/detector, Field-effect transistors in RF and Mixer stages, separate monophonic speaker terminals, DC coupled *All-Silicon* power amplifiers, main and/or remote speaker switching, 80 watts @ 4 ohms. Front panel controls: Bass, Treble, Loudness, Stereo/Mono, Tuning, and Hush Level. Rocker-action switches for Tape Monitor, Phono/Tuner, Main Speakers, and Remote Speakers. Rear-panel preamp sensitivity control.

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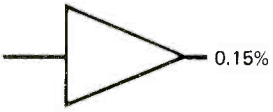

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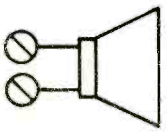

SEPARATE MONO SPEAKER TERMINALS - Independent of main and remote stereo speaker terminals, they offer new convenience in installations requiring powered monophonic center-channel or extension speakers.

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Concrete Behemoth Speakers

JAMES FERGUSON

Stereo sound system in church features four concrete horn-loaded speaker systems which tip the scales at over two tons

SOME READERS MAY recall an article appearing in AUDIO about fourteen years ago *(Concrete Monster,* July 1954) describing a concrete horn I built. It was constructed outside the house, necessitating removal of part of the house wall to allow the horn's mouth to enter. The ceiling and two walls of one corner of the listening room formed an extension of the horn's mouth. The 15-in. speaker at the small end was in a fifty gallon drum below ground.

The horn served me so well over the past years in producing "feelable" bass, that I welcomed a chance to do a concrete horn-loaded system on a grander scale for a church (Culver City Seventh Day Adventist, Los Angeles, Calif.) under construction. The architect's plans showed that there was plenty of room for massive horns in the enclosed spaces on each side of, and high above, the raised platform that accommodates the choir and pulpits, space made available for possible future installation of a pipe organ. (There still is room for one below the horns I installed.) The spaces are 5-ft., 4-in. wide, opening onto the main sanctuary, which has a 45 ft. high ceiling. About 30 ft. separates these spaces.

Horn Construction

I designed and constructed four exponential concrete horns, one large and one small, on each side. The mouths of the large, low-frequency horns filled the opening width and were 11-ft., 6-in. high, giving them a mouth area of more than 61 sq. ft. They were built by first casting two throat sections for each large horn in a sheet metal form. See Fig. 3. The sections were reinforced with #10 steel wire, eight lengthwise strands, with the wires in the corners doubled and left extended from the cast to anchor one end of

Fig. 1—Block diagram of stereo sound system installed in a church.

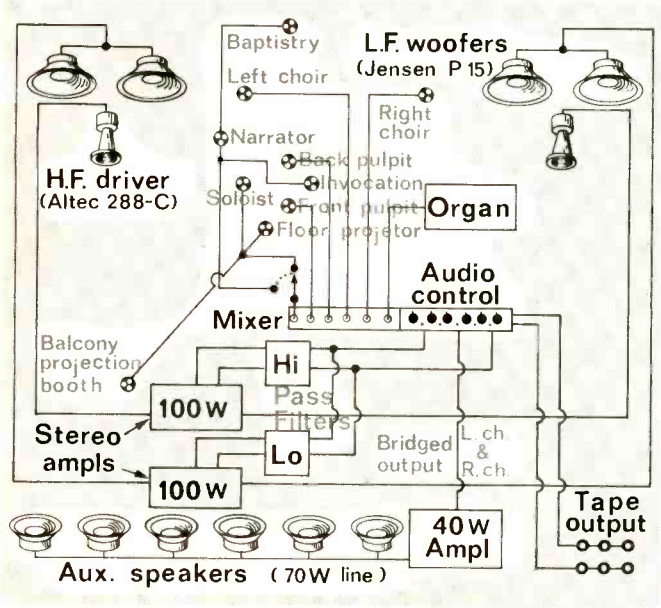
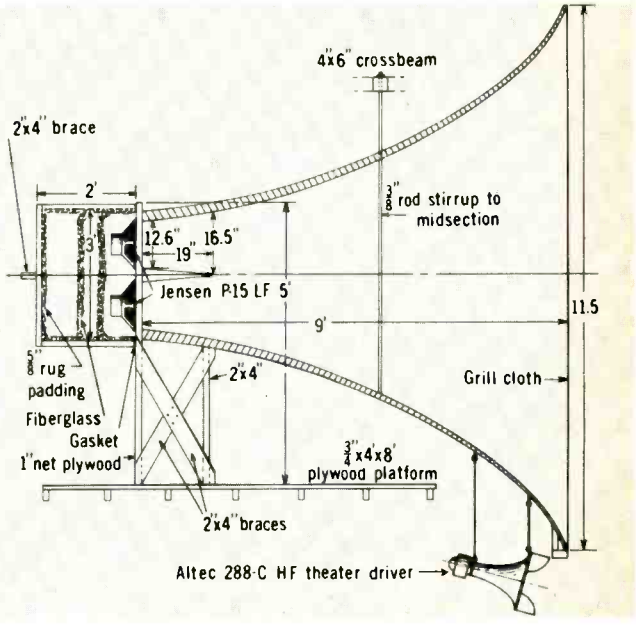


Fig. 2—Cross-section of concrete horn used for bass.



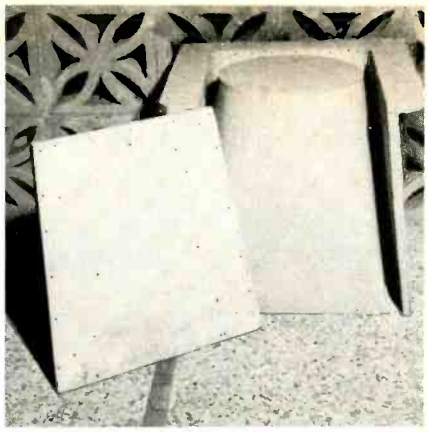


Fig. 3—Form in which low-frequency throat sections were cast.

Fig. 4—Form in which halves of high-frequency horns were cast. Part of the template may be seen at the top of the photo.

⅜-in. reinforcing bars, and three spaced around the circumference. The wires were tied together with smaller gauge wires where they intersected. Four ½-in. foundation bolts, such as are used by builders to fasten a house to its foundation, were imbedded in the castings, with the threads left projecting 1¾-in. to secure the sections to 1-in. plywood uprights.

The two sections were bolted together to form the double throat that couples the two 15-in. woofers to the main body of the horn. These throat sections had round openings at the speaker ends with a gradual transition to square, with rounded corners at the end. This was joined to the rest of the horn, the part that was built in place by installing a metal cage of ⅜-in. steel reinforcing bars at the corners, filled in with vertical and horizontal bars about two feet apart each way. These were wired in place, then covered with 3.2-weight, galvanized, expanded metal lath, sewn to the metal bars with #18 galvanized wire. The laps in the metal lath were sewn together in a similar manner. The metal lath was also sewn to a 3-in. projection of ½-in. mesh hardware cloth, cast into the large end of the throat sections.

Cement mortar (1 part plastic Portland cement to 2½ parts plaster sand) was troweled onto the metal lath in layers or coats about one-half inch thick. Each coat was left roughened or "scratched" to insure a better bond to the succeeding coat until a thickness of approximately 2-in. was attained. The last inside coat was troweled smooth and with rounded corners. A round glass bottle makes a fairly good corner tool.

The large horns were supported at the mouth, center and throat. Support at the throat was by a 1-in. net by 24-in. wide plywood board having two round openings (12½-in. diameter) to which the throat sections were bolted on one side and the speakers fastened to the other with screws. See Fig. 2. The bottom end of the board rested on a platform built to support the horn. A strut built of two-by-fours and braced from the plywood upright by one-by-fours also helped to support the throat end of the horn. A U-shaped stirrup of ⅜-in. steel rod was placed near the center of the horn. The top ends were threaded and passed through a 4-in. by 6-in. wood cross-beam with nuts and washers on top to help support the mid-section. (These were placed in the early stages and, thus, imbedded in the concrete.) The horns were supported at the mouth by anchoring the reinforcement rods to the wood frame around the opening, with the bottom of the bell resting on a wood cross-beam. A coat of sealant was applied on the inside to make the surface more reflective. The finished horns weighed well over a ton each.

A box for the back cavity was constructed of 1-in. plywood, measuring 2 by 2 by 3 ft. (outside measurements), glued and screwed together. The open side was secured to the plywood upright by 14 ¼-in. studs, nuts, and washers. The studs were made by driving cadmium-plated wood screws (#14 x 3-in.) into the open edge of the box to a depth of 1¼-in., sawing off the heads and threading with ¼-in. by 20 threads. A gasket made of strips $^{5}/_{16}$-in. thick by 1-in. wide Temlock (a compressible insulating board) made a tight seal. To absorb most of the back-wave, a two-by-four brace was put around the box at mid-point for extra stiffness against vibration. The inside was lined with thick jute rug padding and a couple of "curtains" of 1-in. thick fibre-glass were placed back of the two woofers used with each horn.

The smaller horns are sectorial horns (see Fig. 4) made by casting identical halves, cemented and bolted together. They are also reinforced with #10 steel wire, spaced roughly 6-in. apart each way and bent to the contours of the horn. The wires were tied together at their intersections. A wood-backed sheet metal sweep template was used to develop the compound curve of the horns in a plaster positive, over which a plaster negative or mold was cast, and into which the concrete horn halves were cast. Some wooden pieces were added to complete the form. The template was mounted so it would rotate about a ⅜-in. rod at the throat end, shaping the plaster while still soft. Two boards cut to the template curve were fastened to the working platform to set the bounds of the horizontal angle of the finished horns. The boards were cut about ⅛-in. below the template so it would pass over them while removing the surplus plaster. Threaded brass insert nuts (size ¼-in. x 20) were embedded in the casts at the throat end, to which the aluminum driver mounting was attached.

The design for the small horns was largely copied from the article: *Ton-and-a-quarter of Sound* by Walter Wysoczanski (AUDIO, January 1964). Our designs differed in the horizontal angle. I used an 85° horizontal angle instead of the 100° he used. And, too, I used a different type mounting for the 288-C, Altec high-frequency drivers.

The high-frequency horns were

Fig. 5—Control console and part of the rack-mounted cabinet which houses amplifiers are shown here. Switches on panel control lights.

Fig. 6—For readers who never saw the outboard "concrete monster" referred to in the text, here is the author, in 1954, standing next to it.

suspended just below the large low-frequency horns, using three #10 steel wires. The HF horns were tilted at a slight downward angle to include the balcony in the vertical dispersion angle, as well as most of the seats on the main floor. They are mounted approximately twenty feet above the floor. The grill cloth reaches from floor to ceiling (and cost about 300 dollars). When the horns are in use, it is difficult for the listener to pinpoint exactly where the sound is originating.

The four woofers and two high-frequency drivers are driven by two 100-watt stereo amplifiers with 500 Hz electronic crossovers ahead of the amplifiers. The low-frequency amplifiers and horns are chiefly useful for producing the electronic organ's pedal clavier tones and for later playback of musical events which are recorded stereophonically in the church, as well as other taped music.

Sound System

The control console, consisting of mixer and audio control, is located in the sound room at the back-left of the balcony. This adjoins a shelf-table with signal jacks and electrical outlets to accommodate a number of tape recorders for those wishing to record the services. It also provides space for a tape machine for playback through the system. See Fig. 5.

The mixer was custom-built with high-quality, low-leakage coupling capacitors, and low-noise metal film resistors in all low-level circuits, direct current on all heaters, shielding on input transformers, and with the power supply on a separate chassis (removed three feet from the mixer to guard against possible hum).

The mixer will handle seven microphone inputs plus the organ. The microphone inputs are divided, part being fed to the left and part to the right output channels of the mixer. The choir is picked up by two microphones. The outputs of the left and right channels of the mixer may be combined when desired to produce monophonic sound. The organ signal, which is mono, is fed to both channels of the mixer through 300k-ohm isolating resistors.

Pulpit microphones have switchable filter and limiter. Two resistors form a voltage-divider attenuator to balance the loss in the speech filter so that a difference in volume will not be noticeable when it is switched in or out of the circuit. A level-setting potentiometer accomplishes the same purpose in the limiter circuit. Output of the mixer and other sound sources are fed into a master audio control, then to a pair of dividing networks with crossover at 500 Hz, then to the four main audio amplifiers. A bridged output in the audio control feeds both channels to a 40-watt amplifier with 70-volt output, which drives nine auxiliary speakers located in the lobby, mothers' room, choir room, pastor's study, etc. The speakers have individual output transformers with secondary taps to obtain from ⅛ to 4 watts each. Three speakers have volume-pad controls.

The general layout of the system is shown in the block diagram of Fig. 1. Twelve-gauge Romex house-wiring was used for long runs to the main speakers to keep resistance low. The microphone cables, consisting of two conductors in a braided shield for each microphone, were run metal conduit, the latter embedded in the concrete floor. An 18-pin Cannon connector couples the microphone cables to the 200-ohm primaries of the mixer's input transformers. The other end of the microphone cables are terminated in a distribution panel located in a riser just below the back pulpit, and from there to the various microphones and the organ.

For persons with impaired hearing, headphone receivers with volume controls were installed on the back of the first pew on each side. The sound room has a plate-glass window looking onto the auditorium. A section of the window can be slid back to enable the operator to judge the level of sound. The three amplifiers are housed in a rack-mounted, fan-cooled, cabinet which is located in the sound room. Interconnecting cables between console and amplifiers are run in ducts for overall neat appearance.

The large cavity of the main nave and transepts contains about 176,000 cubic feet of space. With its 45-ft. high ceiling of 4-in. thick spruce, sidewalls of hardwall plaster and stucco, rear wall (facing speakers) of acoustic plaster, carpeted floors and upholstered oak pews, we have a combination which contributes to outstanding acoustics for music.

Operators of professional recording studios have used the auditorium to record master tapes of musical performances. The conditions for good speech reinforcement are not so ideal. Speech intelligibility is, however, degraded somewhat by a little more reverberation than is desirable. A few absorbent panels may have to be added here and there in strategic places to strike a compromise between good speech and good music reinforcement and reproduction. Even in its present state, however, visiting choirs and musicians have praised the "big" sound. Æ

DR. BOWES' AMATEUR HOUR

EDWARD TATNALL CANBY

IN COMES A NEW RECORD and on the cover it says *"THE SUNDAY TIMES — Musical Addict Overcomes His Aggressions! Noted American Psychiatrist Conducts Verdi, Rossini Concert in London . . ."* I bit, like in a hurry. This is the stuff psychiatrist's dreams are made of! Wouldn't you bite? The record was on my turntable in ten seconds flat.

Now for all I can say, this Dr. H. Angus Bowes may be totally fictional and the whole thing a grand leg pull. But you have to take their word sometimes. So let's.

Dr. B. (it says) was Director of the Institute of Neurology and Psychological Medicine at Grand Forks, North Dakota and a hi-fi buff. Collected tapes. And gear. Now Dr. B. went on vacation to London. Business must have been good for he obviously was loaded. He found out, all of a sudden, that for a mere $50 per man per day he could *hire his own orchestra to play with,* and to record his favorite hi-fi items. Wow! What an idea! He went straight out, bought up most of the Royal Philharmonic and, presumably, a recording team and studio, and barged right into big-time conducting, first class. Wouldn't you? That is, if *you* were a hi-fi fan with the cash dribbling out of your pockets?

Well now, maybe you hadn't just quite thought of it yet; but you'll have to admit the idea is intriguing. And just think of it—playing those tapes on your own rig, in your living room, when you got home! Irresistible.

'Course nobody could pay *me* to stand up in front of the Royal Philharmonic; I'd be rooted to the podium in sheer terror. Not Dr. H. Angus Bowes. He wheeled out a whole LP side of stuff, and nice stuff, too. A long ballet score from Verdi's *I Vespri Siciliani* and more from Rossini's *William Tell* (You usually hear only the Overture). He hoped to sell the tapes to English Decca (it says).

After the recording session, he went out and bought a Rolls-Royce for $15,800 to run around England in. Then he died. Yep, passed away (it says). Guess it was just too much of a good thing. And Everest picked up the Legacy, Decca presumably having turned it down.

Now all this brings up some mighty nice questions. Just how necessary *is* a conductor? Not half as necessary as we've grown up to think. And yet essential in unspectacular ways, especially in unfamiliar music.

A conductor's work, remember, is like the iceberg. At least seven eighths of it is behind the scenes in terms of long, long rehearsals where the music is shaped, pointed, polished and made plausible; given an over-all unity and consistency which is more than 80 or 100 individuals players can do on their own, each blowing his horn or scraping his string.

The stage stuff a conductor goes through is all very inspiring and decorative, and it counts; but the previous rehearsing counts more.

In music that is simple, transparently styled for smaller ensembles, the conductor is less necessary and, indeed, usually did not exist in earlier times. Moreover, a top-quality experienced orchestra, having played everything, can take on a new work in a familiar style and bring it off virtually by sight reading, with at least very passable results, if not perfection. That is what the hypothetical Dr. Bowes gets out of his Royal Philharmonic players (alias, for contractual reasons, the Westminster Symphony Orchestra). His record is quite charming! You'd never know.

Indeed, the miracle is a sort of negative one—that Dr. B. didn't get seriously in the way. Leave an orchestra to itself and it'll play right along; but stick a tyro up front, waving his arms out of time or blasting out outrageous suggestions, and there'll be chaos in seconds flat. *Far* better to have no conductor at all than a foolish, meddling know-nothing.

I rather suspect, therefore, that the good Dr. Bowes being, after all, a psychiatrist and thus a very good listener, just stood himself up with a beatific smile before his multitude of hirelings and said, in his most mellifluous couch-side manner, "How do *you* think it should go?" And they were off.

Or else the man (or whoever did conduct this recording, if Dr. Bowes is a figment . . .) simply knew how to drive well enough to stay on the road. To set the right tempi, to bring in the orchestra all together, and get them out together at the end. That'd do it. With the Royal Philharmonic, anyhow. An intelligent, tactful tyro, hiring such an outfit for his first try at conducting, would very likely turn out exactly this sort of recording.

Unfortunately, Dr. B. didn't make enough music to fill up Side 2, and Everest had to make do with music by Gluck, conducted by a professional, name of Marcel Bernard. He was probably OK, but the engineers, or somebody, fouled things up. I thought my turntable had gone bad when the seasickness began, the excruciatingly slight wavering of pitch, the sudden jump at edit points, and the dismal sags and jags. It wasn't the turntable. The patterns were precisely repeatable. And the next record sounded just fine. Too bad—the Gluck ballet suites from *Don Juan*, complete, are not often heard this way and a lot of the music was pleasingly unfamiliar to me.

A Musical Addict Overcomes His Aggressions! Everest 3188 ($4.98)

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(Read about a pro's efforts with the same type of music on page 68.)

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ABZ's of FM

LEONARD FELDMAN

Noise in Frequency Modulation

EVEN IN THE complete absence of "external" noise sources, there is a practical limit to the weakest signal that can be received by an FM tuner or receiver. This limit, usually set by the first r.f. (radio frequency) stages of the set, is determined by two main sources of noise: *thermal agitation*, and internally-generated *tube* or *transistor noise*.

Thermal noise

Thermal agitation arises from the random motion of electrons in any conductor having a finite resistance or impedance. The amount of voltage developed by thermal agitation in a source impedance at room temperature (27-deg. C.) can be simplified from a lengthier equation to:
$V = \sqrt{1.6 \times 10^{-20} BR_s}$, where "B" is the bandwidth involved (200-kHz per channel, for FM) and "R_s" is the source impedance at the antenna input terminals (usually 300 ohms, but sometimes 75 ohms). By solving this equation we find that the thermal voltage at the input to a receiver is about 0.98 microvolts for a 300-ohm input circuit and about 0.49 microvolts for a 75-ohm input circuit. Note that the wider the bandwidth, the larger the amount of thermal-noise voltage developed. As far as this one point is concerned, narrow-band FM produces less intrinsic noise than wide-band FM, all other factors being equal. As observed previously, however, all other factors are not equal, and the advantages of wide-band FM far outweigh this minimal noise consideration.

Tube and transistor noise

In the case of tube r.f. amplifiers, current flow from cathode to plate is not uniform and continuous, but rather a movement of separate particles: the electrons. Instantaneous fluctuations of the number of electrons flowing (even when "steady-state" current is flowing) represent a noise component. In transistors, too, excess noise is produced by thermal noise in the external lead resistances and by "shot noise" from charge carriers entering and leaving the base element of the transistor. In both cases the energy of the noise is distributed throughout the frequency spectrum and therefore resembles noise arising from the more easily calculated thermal agitation. For our purposes, therefore, we can combine both forms of noise under the general heading of *random noise*.

Random noise includes many frequencies. When no carrier is present, the various frequencies present beat with each other to produce the loud hiss normally associated with the act of tuning between stations. This is true of both AM and FM receivers. In the case of FM sets, interstation noise is actually greater because of the wide bandwidth designed into the circuitry. To eliminate interstation noise, many manufacturers incorporate "muting" circuits which, in one way or another, block the audio output stages in the absence of a station carrier signal.

When a station is received, interactions occur between the station carrier and each of the random voltages. Two effects are thus produced: amplitude modulation of the carrier, and phase modulation which indirectly results in frequency modulation. In the presence of a sufficiently strong station, amplitude modulation will be removed by the built-in limiters. As for the FM produced, it will depend upon the separation in frequency between the noise voltage and the carrier, increasing in amount with this separation in frequency.

The graph in Fig. 1 illustrates this principle and, while it does not purport to show actual amplitudes, it does illustrate the fact that the noise interference becomes greater as the frequency between the carrier and the noise voltages increases. While the end of the diagram extends to 75 kHz, our hearing extends, for all practical purposes, to only 15 kHz. Thus, we can disregard the noise content above 15 kHz.

In Fig. 2, all the audible noise associated with AM transmission (assuming that the receiver was able to respond up to 15 kHz) has been superimposed upon the "noise triangle" of Fig. 1. Since total noise represents the *area* encompassed by each plot, it is evident that the FM gives less noise in the output. Mathematically, the difference can be shown to be a ratio of 8.65 to 1, or approximately 19 dB. In other words, because of the intrinsic characteristics of FM, it is more effective in

Fig. 1—Noise in an FM set increases with frequency between carrier and interfering signal. Shaded area is **audible** FM noise.

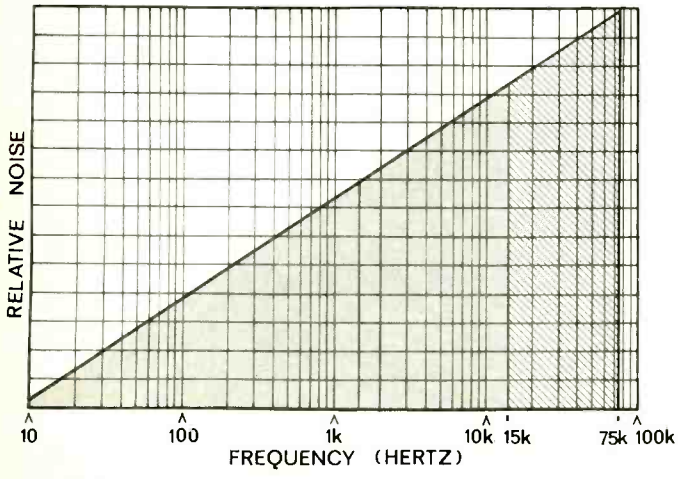
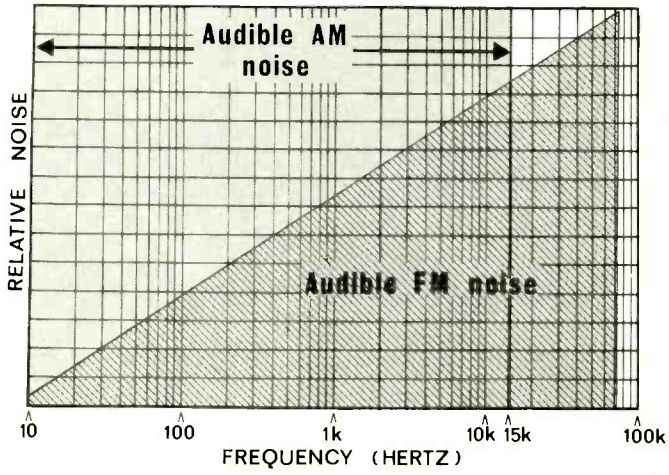


Fig. 2—Comparison of noise **audible** in FM and AM. Triangular portion represents FM noise; entire rectangle (to 15 kHz), AM.



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The 681 is completely new, from its slim-line configuration to the incredibly low-mass moving system. The 681A with conical stylus is $55.00, the 681EE with elliptical stylus, $60.00.

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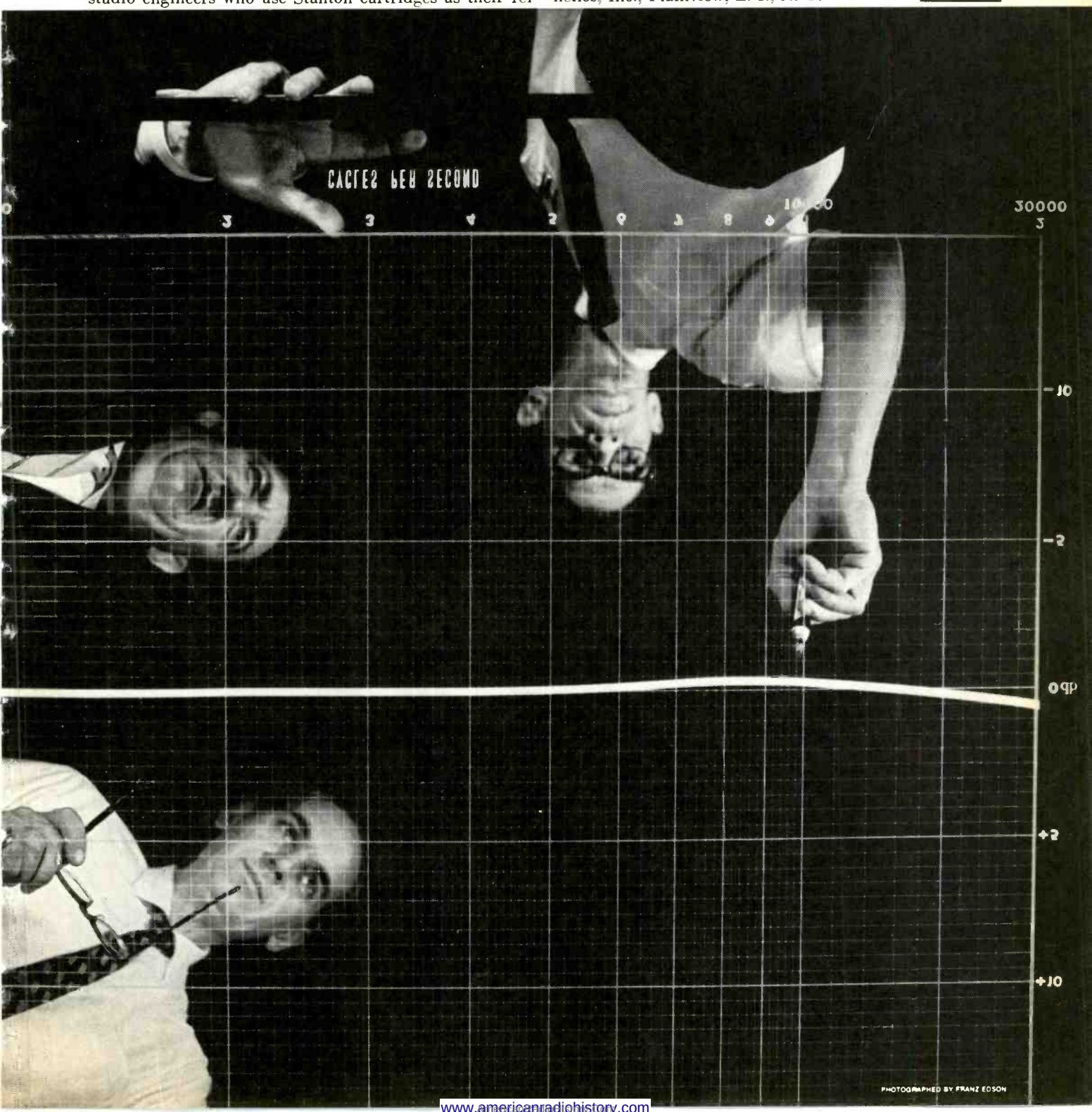


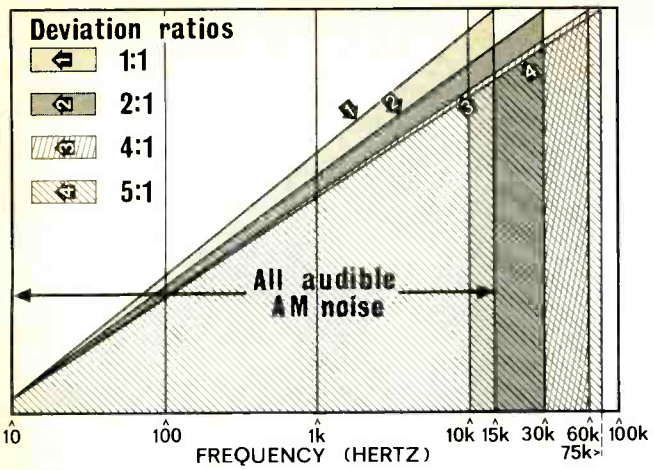


Fig. 3—As deviation ratio decreases, signal-to-noise ratio is degraded. At 15 kHz deviation, audible noise for FM is still considerably below equivalent noise on AM.

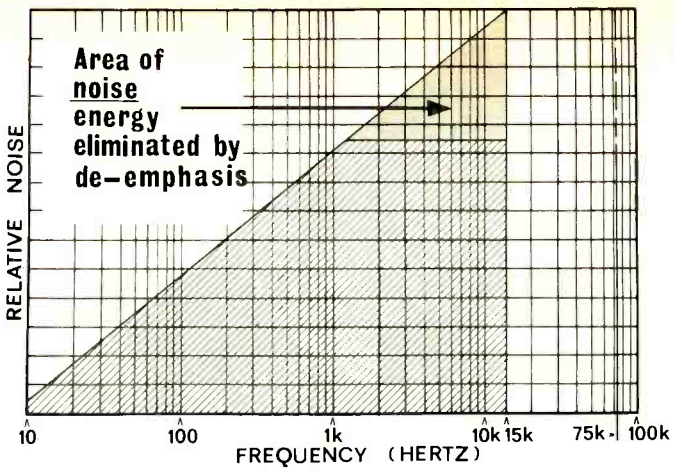


Fig. 4—Noise reduction brought about by de-emphasis. Compare shaded area with that of Fig. 1.

reducing noise than the AM methods of transmission, providing, of course, that a carrier is present.

Noise and deviation

Deviation (extent of modulation above and below the main carrier frequency) has a direct bearing on signal-to-noise ratio. As mentioned earlier, present FM practice employs a deviation ratio of 5:1. That is, a maximum carrier shift of ±75 kHz is permitted and the highest audio frequency transmitted is 15 kHz (75/15 = 5).

If we were to limit the maximum deviation, the signal-to-noise improvement over AM would diminish correspondingly, as illustrated in Fig. 3. Note that even if the deviation maximum were reduced to 15 kHz (a deviation ratio of 1:1), we would still obtain a better signal-to-noise ratio than is possible with AM. Conversely, if we were able to utilize deviation ratios in excess of 5:1, the improvement in signal-to-noise would continue, but then we would run into spectrum assignment troubles. For example, if we attempted to use a deviation ratio of 8, with a maximum audio frequency of 15 kHz, we would need 120 kHz on each side of the carrier. If we still utilized a 25-kHz guardband at each extreme, we would have a total bandwidth of 290 kHz instead of the present 200 kHz. This would effectively reduce the number of possible stations in any given geographical location.

Pre-emphasis and de-emphasis

In studies of the frequency and energy content of music and speech, it was determined long ago that most of the energy is contained in the low and middle frequencies. In addition, it is well known that the noise which irritates listeners most is that found at the higher audio frequencies, above 4 or 5 kHz or so.

These two facts clear the way for use of pre-emphasis and de-emphasis. Pre-emphasis involves boosting the relative level of high frequencies during the process of transmission in accordance with the curve shown in Fig. 5. Bear in mind that this curve represents the response of some audio amplifier ahead of the modulating stage of the transmitter. It does not mean that the high frequencies will overmodulate the transmitter because, remember, the high-frequency energy content of music and speech is generally so much lower than the low and middle tones that, left unaccentuated, they would never even come close to effecting a 75 kHz deviation of the main carrier.

A typical circuit for accomplishing the correct amount of pre-emphasis accompanies the response curve of Fig. 5. Now, perhaps, you can understand why an FM tuner's response curve is anything but "flat," but rather follows the curve shown in Fig. 6. This curve was first mentioned in an earlier installment (AUDIO, Oct. 1967) when we were discussing the measurements of frequency response in a tuner or receiver.

By *de*-emphasizing the high frequencies in the receiver, the overall frequency response of the system (including transmitter and receiver) is restored to the desired "flat" or uniform characteristic which is a prerequisite to all high fidelity equipment. More important, however, is that by including de-emphasis, the objectionable high-frequency noise is considerably reduced compared to what it would have been had we not bothered.

The "triangular" response originally illustrated in Fig. 1 is effectively changed to that of Fig. 4, wherein a large portion of the noise has been "sliced off." The circuit generally used to accomplish de-emphasis is shown in Fig. 6. Note that it consists only of a resistor and a capacitor, chosen so that the product of R and C equals 75×10^{-6}. This product, referred to as a time constant, is expressed as 75 microseconds. Æ

NEXT MONTH: PROPAGATION CHARACTERISTICS.

Fig. 5 – Standard FM pre-emphasis, as practiced in the U. S. by FM broadcasters.

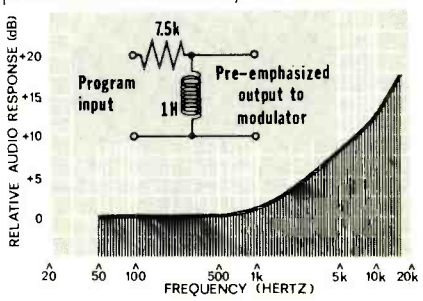
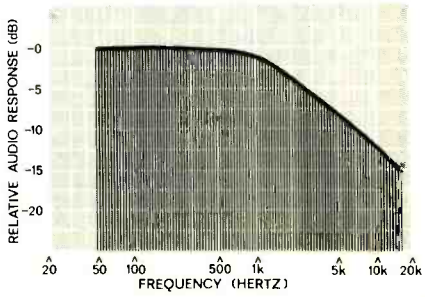
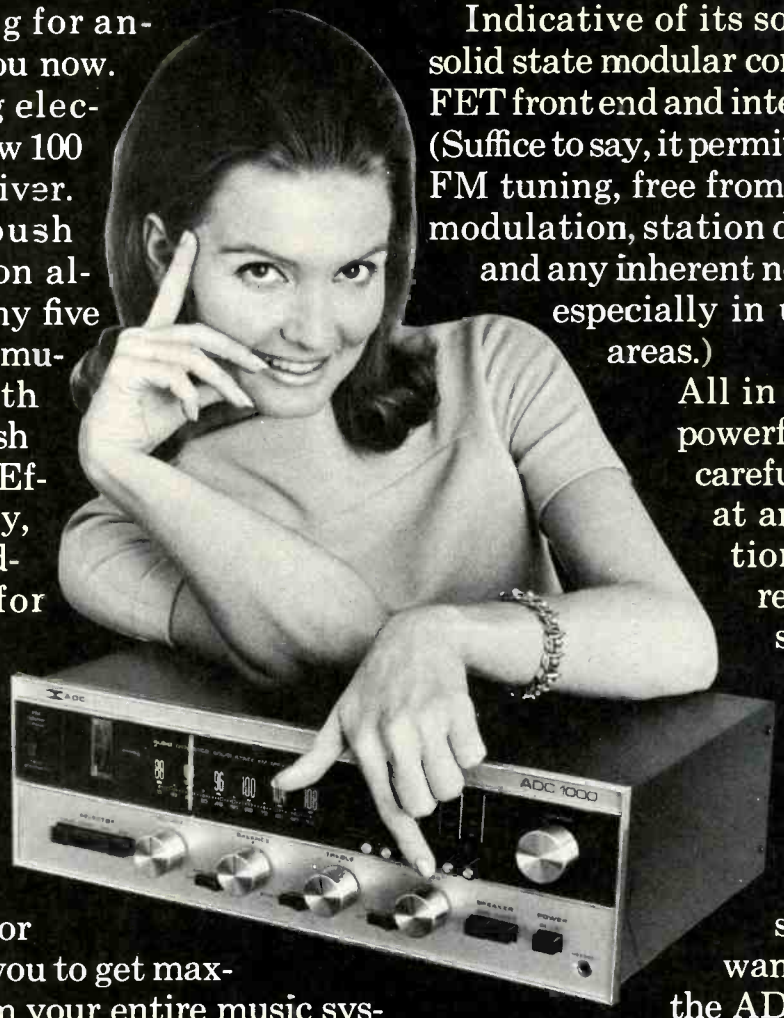


Fig. 6—Standard 75-μS de-emphasis built into FM tuners to restore "flat" response.



Take a poke at your favorite FM station

If you're a well-versed music lover there have probably been times when you felt like strangling the dial on your FM receiver. Tuning back to Bach, forward to Beethoven, losing one station while searching for another, is all behind you now. ADC is introducing electronic tuning in its new 100 watt FM stereo receiver. This Dio-Matic push button tuning section allows you to pre-set any five FM stations and have music as you like it with one little poke or push of a finger. Instantly. Effortlessly. (Naturally, there's a smooth gliding manual tuner for dialing all the other stations.)

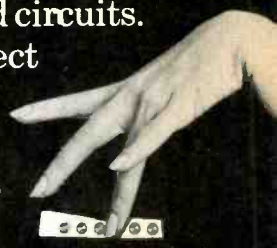


And what's more, the ADC 1000 is all professional. It represents the heart of a total music center for your home, enabling you to get maximum enjoyment from your entire music system. And, the complete unit has been engineered with your comfort in mind. All function controls are positive smooth-action push buttons.

We've even added selector push buttons for two individual sets of speakers, for sound here, there or everywhere.

There are full tape facilities including a tape head input and, of course, a headphone socket for your own private world of entertainment.

Indicative of its solid performance is its solid state modular construction including an FET front end and integrated circuits. (Suffice to say, it permits perfect FM tuning, free from cross modulation, station drift and any inherent noises... especially in urban areas.)

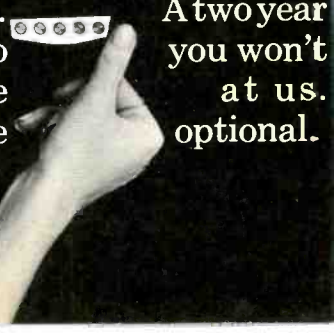


All in all, the ADC 1000 is a powerful 100 watt (IHF) unit, carefully designed to perform at an extremely low distortion (less than 0.3%). The result is a more superior sound.

Crisp. Alive. Brilliant. Absolute!

This week, drop in at your local ADC dealer and take a poke at your favorite FM station. We'll bet you'll want to lay both hands on the ADC 1000 after that.

Oh yes, one more thing. A two year guarantee. That's so you won't want to take a poke at us. Price: $379.95. Walnut case optional.



ADC

The ADC 1000
Push Button Stereo Receiver

Audio Dynamics Corp., New Milford, Connecticut 06776

How Negative Feedback Affects Amplifier Performance

Part 2
Different approaches to analyzing negative feedback

NORMAN H. CROWHURST

THE DIFFICULTY IN analyzing feedback with the method described last month is that the calculating must be made from the completed system performance expression, accepted as a complete entity. From there, it is not at all easy to see what does what in an endeavor to change or improve the system. This was the purpose behind the author's development of the interaction concept, and the charts that went with that approach.

The system performance can be reduced to an equivalent system of non-interacting elements, with interaction added, whether in the form of feedback or due to local circuit interaction. This means that the system can be represented as an equivalent number of independent roll-offs, some high-frequency and some low-frequency, with interaction figures for high- and low-frequency response that can each be given in dB, and which will be added to by increasing negative feedback, or subtracted from by reducing feedback.

The effective amount of interaction in dB has an effect on response that depends on the relationship between the time constants of the roll-offs in that direction (low or high frequency). In basic theory, the greater the number of effective roll-offs, the more complicated are the possible variations in time constant relationships.

However, changing some time constants has more definite or noticeable effect than changing others, which means that certain simplifications can be made toward arriving at better overall relationships (or approximations to them). In this way the factors that make the most difference to performance are isolated.

For each of these major groupings of roll-off time constants, curves are plotted which show two zone boundaries related to time-constant roll-off ratio for the number of elements involved and the interaction or feedback in dB. The first boundary is that at which the system goes from non-peaking (gain never greater than that at zero phase shift) to peaking (gain greater at some frequency than at zero phase shift).

The second boundary is that at

Fig. 1—Chart shows the two boundaries of performance in a feedback system. It's for a system with three reactance elements acting at the same end of the frequency response, with one of them acting sooner than the other two by the time-constant ratio in the scale along the bottom. Note a hypothetical system point, to define the use of the term "excess dB" for the next chart.

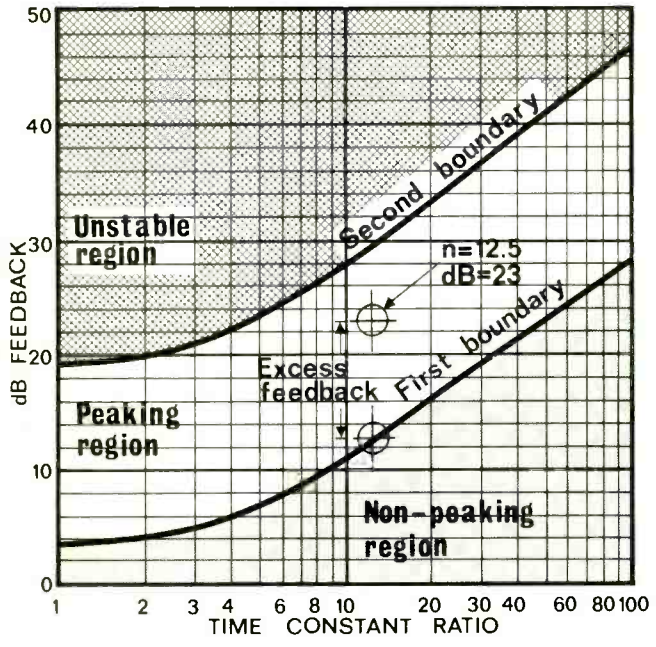
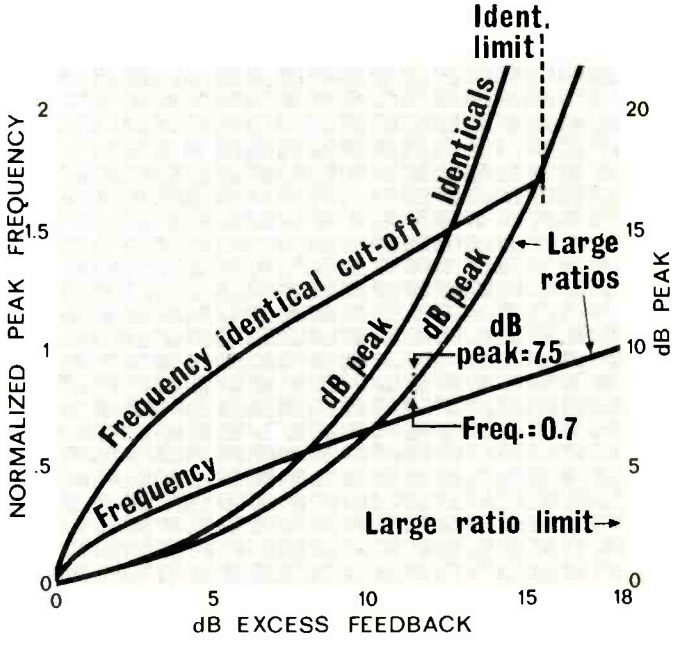


Fig. 2—Chart gives close approximation of performance within the middle region of the chart of Fig. 1. For that example, the response shows a 7.5-dB peak at a frequency 0.7 (assuming high-frequency roll-off, reciprocal for low-frequency cases) of the frequency of the two identical roll-offs (the more remote). This is the frequency to which peak frequency is normalized here.



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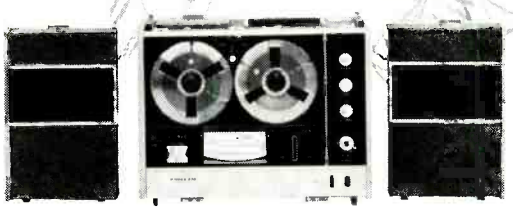

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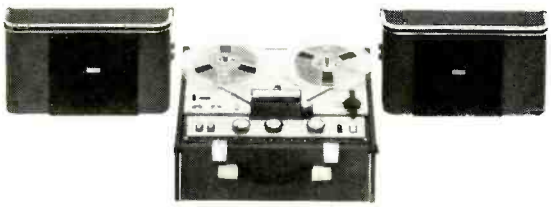

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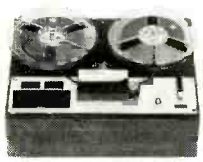

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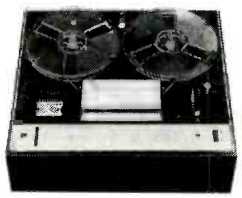

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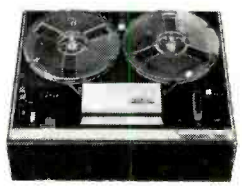

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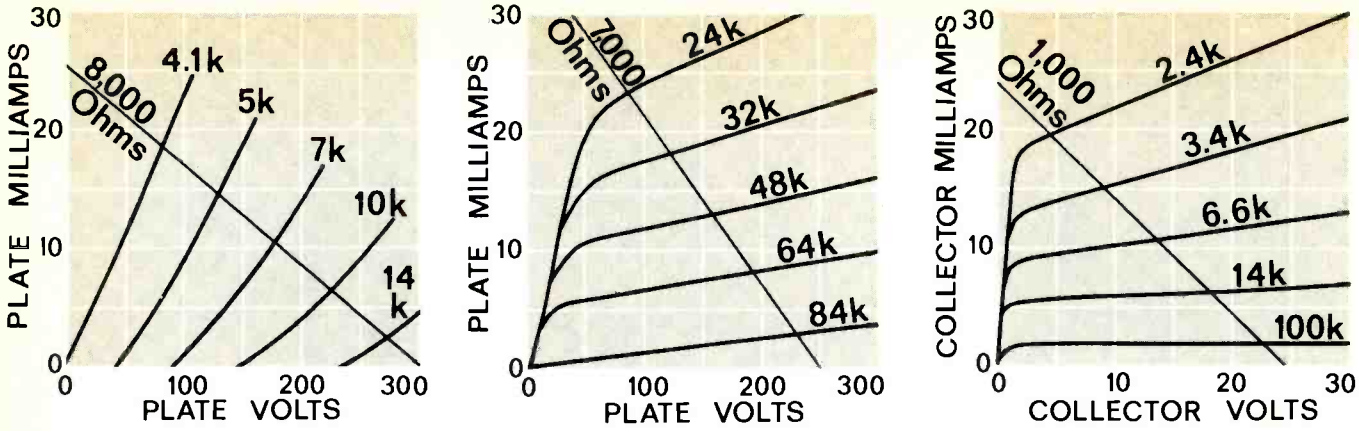

Fig. 3—Current/voltage characteristics, with load lines applied, for triode and pentode tubes, and for a transistor. Note that the spacings along the load lines are uniform, representing perfect linearity for amplification. The impedance designations against the curves are the values of plate or collector resistance at the point where the load line crosses that curve. This change of impedance can be very important in feedback systems.

which the system become unstable, by going into oscillation (Fig. 1).

The greatest interest is generally in the peaking zone, between these two boundaries. That's where we'll usually "finish up"! One chart of the type shown in Fig. 1 will indicate the lower boundary condition for the type of circuit (in this case it's a 3-element, with one element acting before the other two). Any feedback more than that needed to reach the first boundary is called "excess feedback" in this design approach, for the purpose of this particular calculation.

A further chart (Fig. 2) for the same type of circuit relates the performance as degree of peaking (in dB) and frequency of peak (normalized in terms of the circuit time constants) to the amount of excess feedback in dB.

In this way, use of the relevant charts can quickly show very closely what performance will be and also indicate how changing various circuit elements is likely to change performance and which elements can most usefully be changed. These charts have proved their usefulness in developing good feedback systems.

Frequency or time domain

Thus far we have briefly covered a "state of the art" review, based on a postulate that performance can be analyzed into a synthesis of behavior over the range of frequencies from zero to infinity.

This is exploration in the frequency domain. In substance, whether we realize it or not, we argued this way: we recognized as fact that any audio signal (or any other electronic or elctrical signal) can be analyzed into component frequencies (Fourier style) having various amplitudes; and from this fact we deduced that, therefore, we can synthesize overall performance on the basis of what the system does to each of the component frequencies that may appear in the signal, taken indivdually. Isn't this assumption valid?

To be true, for a start, all systems must behave in exactly the same way when handling a composite wave as they do when they handle each of its elemental parts separately. The basis can break down in other ways, as we shall see, but this "loop-hole" is sufficient to see that synthesis doesn't necessarily "work."

Any system involving non-linear circuit components does not handle a composite wave as the sum of its parts, although for certain purposes it may be regarded as approximating that behavior. In this statement, tubes, transistors, diodes and components with magnetic cores, such as transformers or chokes, are all non-linear circuit components.

Types of non-linearity

The non-linearity that matters in this connection may be within the working range of the component, or it may be a discontnuity that appears only beyond the normal working range. But non-linearity is always there, and it can never really be ignored.

Every one of the analyses we have discussed has assumed we have pieces of amplification, resistances, capacitances, inductances (if used), that don't change either with frequency or during the handling of signal. Some components are recognized as changing value with frequency, and an equivalent circuit can usually be validly assigned to cover this effect. We have charts to aid in making this substitution.

But the fact is, every non-linear component changes some of its elements during the handling of waveform. For example, the a.c. resistance of a tube or transistor invariably changes over the waveform excursion, even though the amplification over the same excursion is perfectly linear. The non-linearity that concerns us here is something else. Further, this change in value may be gradual and within the operation range of the device, or it may be abrupt or sudden, beyond the normal working range, such as by saturation or cut-off. Or the device may possess both kinds.

We repeat that the gradual variation within the range of operation is not the same as non-linearity in its essential (amplifying) function. Let's illustrate with the plate current curves of a tube, triode or pentode (Fig. 3) or the collector char-

(Continued on page 78)

If our new SC740 is just another compact, then the Ferrari is just another car.

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But the new SC740 is something else. It has all of the convenience of a compact. But it's designed within performance parameters usually reserved for only the most sophisticated component equipment.

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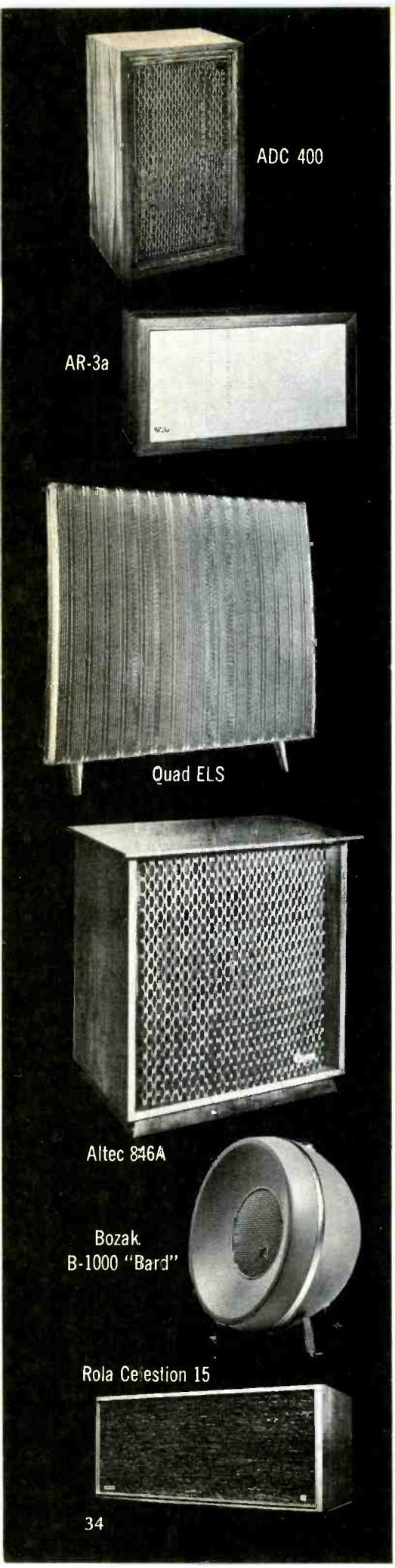

How to Choose Speaker Systems

AL FANNING

Here are the performance specs to watch for—and sounds to listen to—when you examine speakers

OF ALL HIGH FIDELITY components, loudspeaker design more nearly approaches an art form than a science. This is reflected by the fact that no set of speaker specifications truly gives an accurate picture of the performance you can expect.

This problem is compounded by the nature of the beast to change performance characteristics according to its environment; sort of an aural chameleon.

It's really the first link in the mechanical end, with the room becoming an acoustic circuit. Top this off with the fact that hearing ability, listening taste and judgment differ from one person to the next, and you have a skeleton view of some problems confronting anyone shopping for speakers. In spite of these hurdles, potential buyers must evaluate speaker performance, so let us start with a quick look at some speaker specifications to see what we can and cannot learn from them.

Frequency-response range is probably the most common speaker specification listed. It generally refers to a *usable* range, perhaps 40 Hz to 18,000 Hz. In truth, this is a meaningless spec unless you're using it as a reference point to compare with specs of other speakers in the manufacturer's (and only this manufacturer's) line. An overall response variation figure, say ± 5dB, would compress the range to a practical specification of, hypothetically, 70 Hz to 11,000 Hz.

Since it is possible to have as much as a 10 dB rise in a key frequency range with the above spec, it is important to examine the speaker's frequency-response curve. If a high peak occurs in a midfrequency, 4,000 Hz for example, it would emphasize harmonics of instruments in this region, giving it an unrealistic sound.

Transient response may be considered to be a measure of a speaker's reaction to an abrupt change in electrical input signal. If a speaker continues to vibrate in response to a signal that is no longer present, it produces sound where no sound exists in the program material. Poor transient response may show up as a psycho-acoustic irritant after lengthy listening sessions, or it may reveal itself quickly by apparent "hangover," depending on how bad it is.

Directivity relates to a speaker's frequency response at various listening locations. Plotting this on a polar curve, a directivity pattern can be determined for different frequencies. The narrowest dispersion angle is exhibited by high frequencies, the very frequencies that impart a sense of spaciousness in stereo systems. The wider the angle, with uniform frequency response, the greater the stereo illusion.

Insofar as *distortion* is concerned — harmonic, IM, FM — due to, among other things, non-linearity of moving elements in a direct radiator, they're in whole numbers (contrasted with the zero-point-what-have-you of audio amplifiers).

Knowing the cone *resonance* of a speaker will give some indication of how much bass you might be able to

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get out of the speaker (though it does not mean a thing in regard to distortion), since response tends to drop rapidly below it.

Speaker *efficiency* is a helpful spec. You rarely find it, though. Sometimes a manufacturer will advise using an amplifier with a certain power output rating, perhaps 20 watts. This probably means the speaker has low efficiency (nothing to do with response or distortion). Twelve watts would be a clue to what may be a medium-efficiency speaker; 5 watts to a high-efficiency speaker.

Power-handling-capacity specifications give you an idea of how much power a speaker can handle before it burns out or pops its moving elements. If you have a 100-watt amplifier and plan to purchase a speaker with a maximum power rating of 30 watts, don't worry. Just keep the baby away from the knobs and don't satisfy a yearning to find out how much acoustic power you can blast into your room with the gain control wide open.

A speaker's *impedance*—4 ohms, 8 ohms or 16 ohms—is an important factor. It determines the efficiency of power transfer from an audio amplifier.

Thus, an amplifier (one channel of a stereo pair) may be stated as having a power output of 20 watts "into an 8-ohm load," perhaps 30 watts into a 4-ohm load. In this instance the latter would be rated at 60 watts of total power. But with 8-ohm speakers, the usual kind, the amplifier in this example would actually produce only 40 watts of total power.

You may now own a solid-state amplifier which seems to contradict some of the statements made here. That is, it may very well contain multiple output taps labelled "4," "8" and "16," in much the same way as was true for tubed amplifiers. However, there is really only *one* true output impedance; the so-called 4-ohm tap is nothing more than a form of "safety" arrangement wherein a 4-ohm resistor of high power rating has been added in series with the loudspeaker terminals so that even with a 4-ohm speaker connected, the total impedance looking back into the amplifier is 8-ohms. There is nothing wrong with this procedure if you don't mind a 50% reduction of power to your loudspeaker, since that is exactly what will take place over most of the audio frequency range of the amplifier. Half the power will be dissipated as heat across the built-in 4-ohm resistor. Damping factor in this arrangement can never exceed 1.

To get the most out of your amplifier when it is used with multiple speakers you should, first, plan to have the total impedance of all your speakers (operating simultaneously) equal to the impedance of the amplifier at which it supplies its maximum audio power.

While speaker manufacturers clearly denote the "impedance" of their products, this impedance is not true for *all* frequencies which are likely to be encountered in the reproduction of music and speech. In the high-frequency region, the impedance often rises to a value much higher than the nominal one quoted by the manufacturer. In the low-frequency region, the impedance rises to a rather startling value as the resonant frequency of the speaker system is approached. Actually, in terms of impedance mis-match with solid-state amplifiers, this rise in impedance (and its attendant mis-match) is not too serious, since speakers also tend to increase in acoustic efficiency at or near their resonant frequency. The resultant increase in acoustic output tends to compensate for the decreased power transfer brought about by the impedance mis-match.

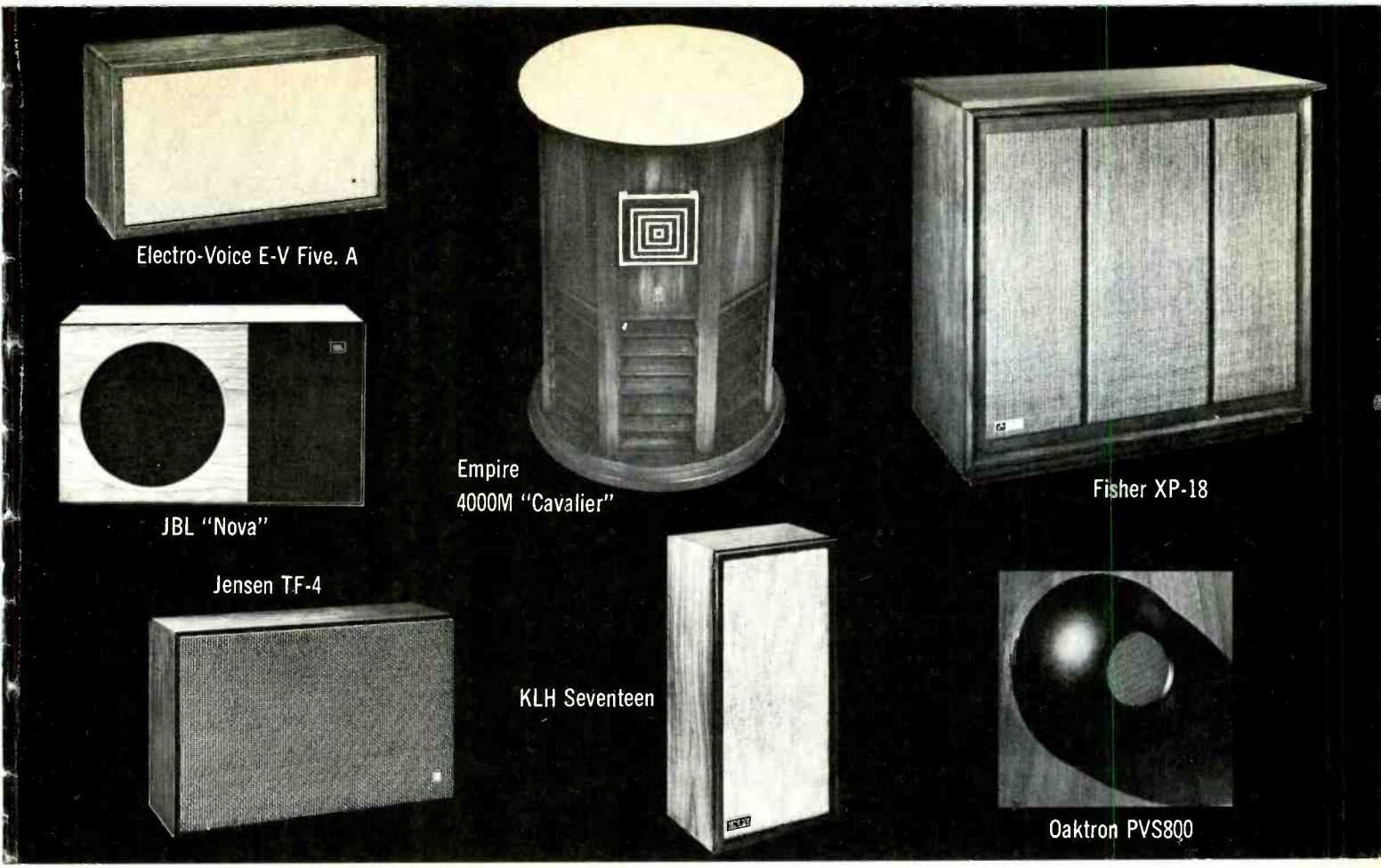
Of far more serious consequence is the lower-than-normal impedance of the typical loudspeaker shown at frequencies below resonance or at a trough, say, at 400 Hz. For example, the impedance of a "nominal" 8-ohm loudspeaker might drop to a low of 2.5 ohms at some frequency.

This is dangerously low. So low, in fact, that we have heard of instances where this condition caused failure of the output stages of a perfectly well designed solid-state amplifier.

Now, before you panic, be assured that speaker manufacturers in general are well aware of this modern problem, making certain that the impedance of their products never falls to dangerously low levels. The problem faced by the user is in using multiple speakers—main and remote—in parallel. This halves the impedance and may create a situation where a fuse pops on occasion. A 2-ohm resistor with sufficient wattage rating can provide protection if placed in series with the extension speaker. ("It'll degrade damping, however.)

To check approximate impedance of a speaker requires only an a.c. VTVM and an audio oscillator having a frequency range of from 20 to 20,000 Hz. A non-inductive power resistor (having a power rating equal to about 10 watts) of ohmic value equal to the nominal impedance of the speaker system under test is also required.

Apply a signal from the audio oscillator to a high-level input of your amplifier and adjust the level to produce a non-ear-shattering voltage of 2 volts rms across the combination of "R" and your speaker system. Suppose you have an 8-ohm speaker and an 8-ohm resistor, "R." At 400 Hz



the voltage across "R" should be 1 volt (it will also be one volt across the speaker since the sum of the two voltage drops must equal 2 volts, the total voltage across both elements in series).

Now, proceed to repeat the two voltage measurements (first across the combination of "R" and speaker, then across "R" alone), readjusting the levels to maintain the two-volt reading across the combination for each frequency. As an example, suppose that resonance of the speaker is at 100 Hz, and that at that frequency you still measure 2 volts across the combination, but only 0.2 volts across "R." Since you know that "R" is eight ohms, Z may be solved for in the following ratio equation:

$$Z_{spkr} = \frac{R\ (V_{total} - V_R)}{V_R}$$

where, Z_{spkr} is the unknown speaker impedance at a certain test frequency, R is the resistance of the test resistor (8 ohms, in this case), V_{total} is the rms voltage read across the combination, and V_R is the rms voltage noted across the resistor.

Thus, in the example just given, $Z_{spkr} = 8\ (2 - 0.2) = 8\ (1.8) = 14.4/0.2 = 72$ ohms! This isn't unusual; speakers generally do exhibit resonant impedances many times larger than their nominal mid-frequency impedances.

Impedance at other frequencies can be checked out in the same manner.

As noted earlier, specifications alone can't be used to "rate" a speaker system. They're only guidelines.

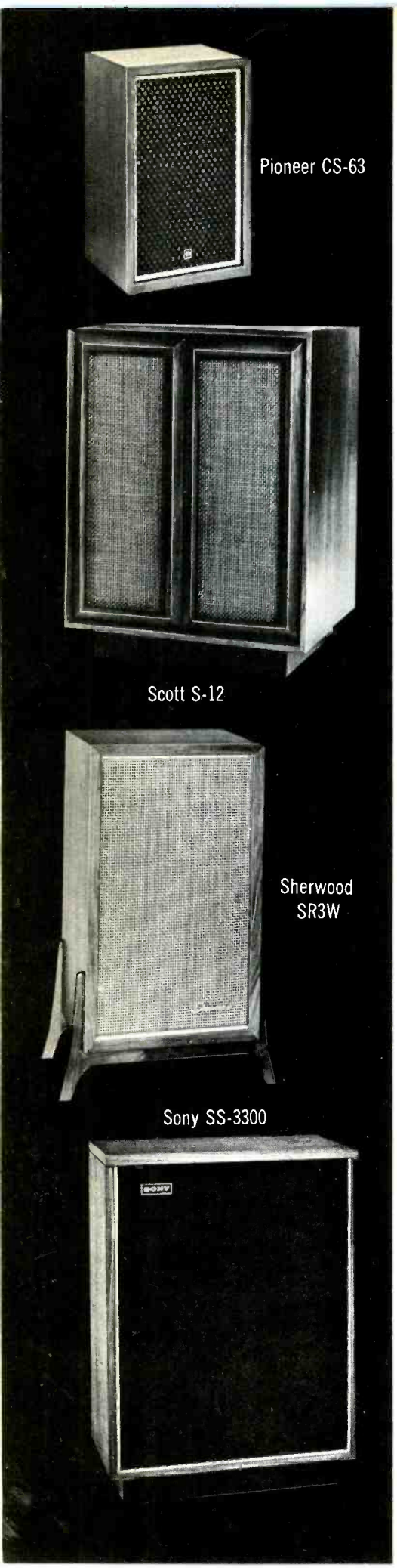
An interesting rating proposal was made a few years ago in a paper presented to an electronic trade association. The author presented a loudspeaker quality-rating concept that, in three ratings, would give a clear, comparative idea of a speaker's capabilities. The ratings were Gamut, Power, and Fidelity Index.

Gamut, it was suggested, would be rated in octaves. For example, 10 octaves (20 to 20,000 Hz), 3.3 octaves (30 to 300 Hz), etc. Acoustic power output capacity would be expressed in milliwatts, say, 20 acoustic milliwatts. A fidelity index would be a number which takes into consideration all the measurable factors in a speaker's performance. A perfect speaker would earn a rating of 10; a fair speaker might even get a 7 rating, etc. To arrive at this rating, each characteristic would have to be divided into specific ranges, each with a point rating. Though inviting, this proposal was never accepted.

Speaker evaluation

Today's speakers differ in some respects from speakers available only a few years ago. Lower-cost speakers, with less ability to reproduce extreme ranges of sound than more costly units, are cleaner than they used to be. Aside from having fairly smooth responses, they appear to give up on extremes rather than reproduce them with high distortion—bass doubling, for example. Highs are generally pleasant, without the harshness normally associated with lesser speakers of only a few years ago. Here, again, the sheen of very high frequencies produced by more expensive, higher quality speakers, is not attained.

To make some intelligent judgments, it is necessary to observe a variety of speaker attributes. Compare a speaker in your $$ class with lower-cost and higher-cost speakers while playing the same selection,



A-B'ing back and forth. Be sure to judge each speaker at the same approximate sound output level. Some dealers maintain equal speaker output levels through use of resistors. However, this may influence speaker damping. Be sure to listen to speakers at high sound levels as well as at normal levels. This can show up some glaring deficiencies.

Consider bass frequencies, for a starter. They will show up woofer traits as well as give an excellent indication of transient response. A woofer has to move a lot of air to produce the resounding thump of a drum pedal. It does this by combining relatively large cone size with high compliance and a long voice coil that permits substantial cone movement without losing magnetic control. Compare the naturalness of the deep bass sound of the better speaker system with the lesser ones. You might notice a change of pitch. This could be due to a speaker quitting at the bottom, that is, having a response so far down in decibels that you would to place your ear against the speaker to hear any sound. Possibly, it is actually reproducing some overtones. Another speaker's deep bass may sound mushy. Its bass may seem to extend across many cycles. Perhaps this is caused by the speaker cone not operating as a true piston for one reason or another, a voice coil partly out of the magnetic gap, or some other design limitation that prevents clean bass from being produced.

There is no real substitute for good, solid deep-bass reproduction. However, you may not be willing or able to pay for it (invariably, it costs more whenever a frequency range is widened while maintaining low distortion). In this case, you have to compromise. The choice here is generally between speakers that cut off rather cleanly before very low bass is reached or speakers that produce deep bass but exhibit higher distortion than speakers with less apparent bass.

Middle-frequency reproduction has been largely ignored by devotees of high fidelity reproduction, probably because these frequencies have been reproducible for many years. Since so many of our frequencies fall into the mid-frequency range, however, it is a decidedly important part of the audio spectrum and deserves more attention. Choosing an arbitrary range of 500 Hz to 5000 Hz as comprising mid-frequencies, almost every instrument type—string, wind, reeds, horns, and many membrane instruments — has some part of its range falling into mid-frequencies. Voices, too, should be included, though female voices may span to high frequencies and male voices to bass frequencies.

Listen for projection of certain mid-frequencies when a passage from a particular instrument is reproduced. A satisfactory speaker should not accentuate frequencies.

In addition to favoring certain frequencies over others, the effectiveness of crossover networks, if any, should be checked out. These are the electrical circuits that allow one speaker's output to drop off at a prescribed frequency while another speaker's output gradually takes over. Thus, at a particular frequency, say 1000 Hz, a woofer's sound output will gradually decrease until at, say, 1200 Hz, the crossover frequency, a higher-frequency speaker will reproduce as much of the sound as the woofer does. Past the crossover frequency, the higher-frequency speaker will gradually reproduce more of the output while the lower-frequency speaker produces less. At some point, perhaps, 2000 Hz, the higher-frequency speaker carries all the frequencies while the lower-frequency speaker carries practically none of the 2000-Hz-and-above frequencies.

The transition of sound from one speaker to another in a speaker system should not be conspicuous. Sound level should not increase or decrease. Tone characteristics should not be noticeably changed.

Treble frequencies, the "highs,"

This beautiful four-headed monster does away with amateurs.

Once you've met up with our monster with four heads, you're done for. Your amateur days are over. That's because the 4-track Solid State stereo RS-790S has just about everything you need to do a professional job of taping.

First, there's 3-speed Dual Capstan drive. It ends audible flutter and wow. And the sound is all the better for it.

Four heads are better for sound, too. And the Console-Aire delivers 30-18,000 cps and a signal-to-noise ratio of more than 52 db's. It all adds up to the greater fidelity the pros listen for.

Another great thing is continuous Automatic Reverse. Records and plays back in both directions. It means no more interruptions. And you'll never have to flip over a reel again. At any point on the tape you can manually punch up reverse, too. Of course, if you don't want it to run on forever, use the automatic shutoff.

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After all, it's what you'd expect from the world's largest manufacturer of tape recorders.

So go into any dealer's we permit to carry Panasonic. We have a feeling that once you come face-to-face with our beautiful four-headed monster, you'll lose your amateur standing forever. (And for just $329.95.*)

PANASONIC

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*Suggested list price. Canadian price higher.

are tricky to evaluate. Unlike very low frequencies, which can scoot around furniture, high frequencies can be stopped dead by obstacles. Added to this, radiation angles of high frequencies are much smaller than that of low frequencies. Consequently, they beam sound in a narrow path. The upshot of this is not hearing high frequencies at the side of a speaker with the same sound level experienced when standing in front of the speaker. To check this out, walk to one side, to the center and to the other side of a speaker to determine if there is an appreciable difference in treble response.

Tweeters are not always made of the same basic material as woofers. Therefore, careful consideration should be given to achieving tonal characteristics that are similar to each other. A pronounced difference may be ear-striking at first, but it is not natural and shortly loses its dramatic appeal.

Listen for transparent sound, shimmering highs that give the illusion of the instrument actually being there. A sound like steam due to dropping water on a heated brick is not a realistic reproduction of a cymbal struck by brushes. Do not, however, expect extreme highs from a relatively inexpensive speaker. Here, again, your choice among some of the lower-cost speakers might be between speakers that do not produce delightful extreme highs, but clean highs up to their maximum, say, 12,000 Hz, before disappearing, and a speaker that goes way up in frequency while exhibiting harshness in certain high-frequency ranges.

To obtain reasonably pleasant sound requires a smooth frequency response over a balanced part of the audio spectrum. Having an extreme low-frequency reproduction capability without being able to reproduce extreme high frequencies simply results in an unreal illusion, and vice-versa.

Speaker cone material, enclosure type, and other factors cause speakers to have distinctive characteristics. Some people say they can distinguish between the sound from a reasonant enclosure, infinite baffle enclosure, and acoustic suspension enclosure blindfolded. There are speakers that tend toward a bright sound, others that lean to mellow sound. You will have to determine which type you prefer. No one else can do it for you.

Since speaker characteristics can be changed by the size of a listening room, furnishings, and speaker placement, they may sound different than they did in your dealer's showroom. Therefore, it is a good idea to try to arrange with your dealer for an exchange of speakers in the event you find the tonal characteristics unsatisfactory in your home within a short period of time.

Most speaker systems available today have taken into account the desire to blend units into a room's overall decorating scheme. Small speaker enclosures can be placed on a bookshelf or attached to a wall; many have interchangeable grilles, with choices of color and/or design. Many floor speaker units follow furniture stylings: French provincial, modern, etc., for easy blending into existing decor. Interchangeable grilles are sometimes offered here, too. A third type, the disguised speaker system, is also available, taking the form of an end table, a writing desk, a hassock seat, etc.

So often as not, you are considering both sound quality and appearance (not to mention price). Clearly, buying a speaker system can be a challenging adventure. Æ

University "Cantada"

Utah HS4

Wharfedale W90D

Viking 4400

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We designed a new automatic transcription turntable for men of hi-fi.

But, we didn't forget the ladies.

A his and her automatic turntable? Well, why not?

For him, the PE-2020 is a turntable that tracks like a manual, acts like an automatic and works like a charm. An exclusive little device in the cartridge shell lets him dial the perfect tracking for each record in the stack, at a precise 15° vertical stylus tracking angle. What this all means is maximum precision. Minimum distortion. And minimum record wear.

For her, the PE-2020 is styled to fit beautifully into any decor. But beyond its form is its function. The PE-2020 operates so simply for her. Thanks to an exclusive command center. Just one handsome lever is all she touches to start, stop, repeat, cue, pause and lift.

There's also an automatic anti-skating device. An automatic scanner. A four-speed setting control with pitch contro . . . and much more The PE-2020 only $129.95 less base.

Test and see the PE-2020 for yourself at your local Elpa dealer. If you don't know who he is and wish further information just ask us.

And when you visit him, be sure to bring her along. There's something in the PE-2020 for both of you. ELPA MARKETING INDUSTRIES, INC., NEW HYDE PARK, N.Y. 11040.

ELPA

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SPEAKER SYSTEM BUYING GUIDE

Product specifications and photographs presented here represent an expanded, updated version of the speaker system product preview which appeared in the August 1967 issue of AUDIO Magazine. The same tabular format is used to simplify comparison of specifications. All specifications have been supplied by respective manufacturers. For more information, a circled number under a manufacturer's name directs you to the page on which his advertisement appears.

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance	WOOFER Cone Material	MID-RANGE Diameter, In.	MID-RANGE Diaphragm Material	TWEETER Diameter, In.	TWEETER Diaphragm Material	Enclosure Dimen., In. W x D x H	Wood Finish	Grille Material, Color	Overall Frequency Response, Hz, ±dB	Crossover Freq's, Hz	Impedance, Ohms	Weight, lbs.	Price	SPECIAL FEATURES
ACOUSTECH	X	All-Electrostatic Stereo System							30 4 72	walnut	Beige	30-30k	1300	–	225	$1690.00	Incls. 4 built-in s/s ampls; 500W music power; electr. crossover.
ACOUSTIC RESEARCH (AR)	AR-3a	12	44	Paper	1½	Phen. dome	¾	Phen. dome	25 11⅜ 14	Var.	Burlap Beige	–	575-5000	4	52	225.00 250.00	Price depends on wood finish; walnut highest, unfinished lowest.
	AR-3	12	44	Paper	2	Phen. dome	1⅜	Phen. dome	25 11⅜ 14	Var.	Saran off white	–	1000 7500	4	50	203.00 225.00	Same as above.
(45)	AR-2a[x]	10	57	Paper	3	Paper cone	1⅜	Phen. dome	24 11½ 13½	Var.	Burlap Beige	–	1750 7500	8	36	109.00 128.00	Same as above.
	AR-2[x]	10	57	Paper	–	–	2½	Paper cone	24 11½ 13½	Var.	Burlap Beige	–	1500	8	32	89.00 102.00	Same as above.
	AR-4[x]	8	68	Paper	–	–	2½	Paper cone	19 9 10	Var.	Burlap Beige	–	1200	8	17	51.00 57.00	Same as above.
ACOUSTICAL MANU-FACTURING	Quad ELS	All Electrostatic System							34½ 10½ 31	–	–	45-18k	–	15-30	35	–	
ALTEC	846A	15	25	Paper	Cast-alum. horn 8⅝ x 18⅜ x 13½		–	–	29¾ 27½ 19	Walnut	Fret-work Brown	35-22k	800	8-16	100	333.00	A7 "Voice of the Theatre" Components; fretwork grille.
(9)	A7-500 W-1	15	25	Paper	Cast-alum. horn 8⅝ x 18⅜ x 13½		–	–	42 32 25	Walnut	Fret-work Brown	30-22k	500	8-16	170	498.00	A7-500 "Voice of the Theatre" Components; fretwork grille.
	847A	12	30	Paper	–	–	Horn	Mylar	26 19 14	Walnut	Fret-work Brown	40-22k	3k	8	60	237.00	Fretwork grille.
	890B	10	28	Paper	–	–	Horn	Mylar	25¾ 12 14½	Walnut	Fabric snap-on Neutral	40-22k	3k	8	30	179.00	Incls. 10-in. free-suspension phase inverter for low-end resp.
AMPEX	815	6	70	Paper	–	–	3½	Paper Cone	9½ 13½ 7½	Walnut	Fabric Tan	50-15k	1500	8	22 pr	59.95 pr.	
	4010	12	55	Vinyl Paper	(2) 3	Paper	4	Horn	24 14 12	Walnut	Fabric Eggsh. White	30-15k	1800 8k	8-16	58 pr.	189.95 ea.	
AUDIO DYNAMICS (ADC)	404	6	–	Paper	–	–	1½	Mylar dome	7¾ 8¼ 11⅞	Oil Walnut	Cloth Light	45-20 ±3	–	8	12	56.00	
	200	6	–	Paper	–	–	1½	Mylar dome	10½ 8 19	Oil Walnut	Cloth Light	40-20k ±3	–	8	18	79.50	
(29)	303A	8	–	Paper	–	–	1½	Mylar dome	11¾ 13 22¾	Oil Walnut	Cloth light or dark	35-20k ±3	–	8	34	99.95	
	400	10	–	Paper	6	Paper	1½	Mylar dome	14½ 11⅞ 25	Oil Walnut	Cloth Dark	30-20k ±3	–	8	48	159.50	
	18A	12 x 16	–	Poly-styrene	–	Paper	1½	Mylar dome	27 17 39½	Oil Walnut	Cloth Light or Dark	20-20k ±3	–	8	80	250.00	

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Wharfedale

Achromatic* Speaker Systems

W20D
Achromatic Two-Way
Minorette
$49.95

W30D
Achromatic Two-Way
Compact
$59.95

W40D
Achromatic Three-Way
Bookshelf
$94.00

W60D
Achromatic Three-Way
Bookshelf and Floor Standing
$135.25

W70D
Achromatic Four-Way
Hi and Low Boy
$188.00

W90D
Achromatic Four-Way
Six Speaker Consolette
$294.00

*A quality of sound you may never have heard before ...except in a concert hall

You know what achromatic sound is. You've already heard it... from live musicians. It's *uncolored* sound ... pure, clean, acoustically satisfying, free of spurious resonances or artificial modulations. Wharfedale Achromatic Speaker Systems are uniquely designed to give you this wholly natural sound, utilizing various special constructional features and techniques. For example: in certain systems, white sand is packed densely between layers of hardwood, creating an inert mass which cannot resonate, no matter how deep or strong the bass backwave projected against it. All vibrations are damped; speaker and cabinet perform together as a single unit, in correct musical balance, to preserve faithfully the performance capabilities of the high quality components enclosed.

The eye, too, is delighted by the new Wharfedale cabinets. Proportions are perfect; the woods are treated as in the finest furniture; the new grille fabrics (removable at will) provide refreshing relief from the usual "speaker-box" look.

You'll want to hear, as well as see, the newest Wharfedale models. For a list of dealers in your locality, and a Comparator Guide showing all the Achromatic Speaker Systems in full color room settings, write: Wharfedale, Div. British Industries Corp., Dept. HC-1 Westbury, N.Y. 11590.

SPEAKER SYSTEMS (continued)

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance	WOOFER Cone Material	MID-RANGE Diameter, In.	MID-RANGE Diaphragm Material	TWEETER Diameter, In.	TWEETER Diaphragm Material	Enclosure Dimen, In. W X D X H	Wood Finish	Grille Material, Color	Overall Frequency Response, Hz, ±dB	Crossover Freq's, Hz	Impedance, Ohms	Weight, lbs.	Price	SPECIAL FEATURES
BENJAMIN (EMI) (51)	62	10¾ x 6⅝	30	Alum. & Paper	–	–	3⅜	Paper	20½ 11⅛ 10	Oiled Walnut	Plas. Black	60-20k ±3	5000	8	30	79.95	Alum. center-cone PVC edge suspension.
	92	13½ x 8⅛	25	Alum. & Paper	–	–	3⅜	Paper	23⅛ 11 13/16 10¾	Oiled Walnut	Plas. Black	50-20k ±3	4500	8	36	109.95	Same as above.
	DLS 629	13½ x 8⅛	20	Alum. & Paper	–	–	(2) 3½	Paper	24¼ 13½ 12½	Oiled Walnut	Plas. Black	30-20k ±3	4500	8	43	164.50	Same as above.
	102	13½ x 8⅛	15	Alum. & Paper	–	–	(2) 3½	Paper	25 14 13¼	Oiled Walnut	Plas. Black	30-20k ±3	4500	8	50	199.50	Same as above.
BOGEN Cover (III)	SS250	10	20	Paper	–	–	3¼	Paper Cone	23 10 13	Walnut	Cloth Beige	30-20k ±3	1200	8	27	444.75	
BOZAK (47)	B-4000 Classic	12 (2)	40	Felted Paper	8	Metal Cone	2½ (8)	Metal Cone	26¼ 15⅝ 44½	Var.	Cloth w/met. grille Light	35-20k	200-2500	8	150	555.00	Two woofers, 1 mid-range, 8 tweeters, interchangeable grille.
	B-305	12 (2)	40	Felted Paper	8	Metal Cone	2½ (4)	Metal Cone	28 36 20	Var.	Cloth	35-20k	800-2500	16	140	415.00	Two woofers, 1 mid-range, 4 tweeters, interchangeable grille.
	B-302A	12	40	Felted Paper	8	Metal Cone	2½ (2)	Metal Cone	31 28 19	Var.	Cloth w/met. grille	40-20k	800-2500	8	100	280.00	One woofer, 1 mid-range, 2 tweeters, interchangeable grille.
	B-313	12	40	Felted Paper	8	Metal Cone	2½ (2)	Metal Cone	24½ 17¼ 12½	Wal.	Linen	45-16k	800-2500	8	76	222.50	1 woofer, 1 mid-range, 2 tweeters.
	B-410	12 (4)	40	Felted Paper	8 (2)	Metal Cone	2½ (8)	Metal Cone	36 52 19	Wal.	Cloth w/met. grille	28-20k	400-2500	8	225	862.00	4 woofers, 2 mid-range, 8 tweeters, interchangeable cloth.
	B-1000 Bard	Wide-range 8-in. Metal Cone							18 21 12	–	Metal Screen	50-10k	–	8	–	87.50	All-weather use.
ELECTRO-VOICE (1) & Cover (IV)	E-V Eight	6	33	Paper	–	–	2½	Paper Cone	15¼ 6½ 8¼	Wal.	Cloth White	60-20k	2000	8	16	44.00	Gen. walnut veneer w/polymer coating. Double-damped tweeter.
	E-V Seven-A	8	30	Paper	–	–	3½	Paper Cone	19 10 8½	Wal.	Cane Nat.	50-20k	2000	8	19	66.50	Cab. finish as above. Brilliance control.
	E-V Five-A	10	24	Paper	–	–	2½	Paper Cone	21¾ 10⅜ 12¾	Wal.	Cloth White	30-20k	1000	8	22	88.00	Cab. finish as above. 4-layer woofer voice coil.
	E-V Four	12	17	Paper	Horn	Mylar	5	Paper Cone	25 13½ 14	Wal.	Cane Nat.	30-20k	800-3500	8	39	138.00	Etched-circuit crossover with step-type level controls
	E-V Six	18	15	Foam Polystyrene	8 Cone & Horn	Paper Mylar	Horn	Phen.	32 17½ 30	Oil Walnut	Cane Nat.	30-20k	250-800-3500	8	107	333.00	Woofer has 4 lb. 10 oz. ceramic mag.
EMPIRE	2000 M	10	30	Paper	–	–	3	Paper	18½ 12 12	Satin Wal.	None	35-18k	1500	8	44	109.95	Marble top or cushion top; comb. mid/tweeter.
	4000 M	10	30	Paper	–	–	3	Paper	18 D x 25 H	Satin Wal.	None	30-18k	1500	8	75	159.95	Pedestal encl. w/wide-angle lens, comb. mid/tweeter, marble top.
	8500	12	25	Paper	4-in. Comp	Phen.	1	Comp.	18 3 30	Satin Wal.	None	30-20k	450-5000	8	60	174.95	Built-in wall unit.
	8400	12	25	Paper	4-in. Comp	Phen.	1	Comp.	13⅞ 12¾ 25	Satin Wal.	None	25-20k	450-5000	8	70	219.95	Front-loaded hyperbolic horn w/wide-angle acoustic lens.
	8000 P	12	25	Paper Cone	4-in. Comp	Phen.	1	Comp.	16D x 29	Satin Wal.	None	25-20k	450-5000	8	85	249.95	Pedestal encl. w/wide-angle acoustic lens & marble top.
	9000 M	15	20	Paper	4-in. Comp	Phen.	1	Comp.	22 D x 29	Satin Wal.	None	20-20k	450-5000	8	120	299.95	Same as above.
L.W. ERATH	II	15	19	Paper	6	Paper	4	Plastic	17 H 25 L 12 D	Oil Wal.	Unbleached Linen	20-20k ±5	–	4	141	550.00	HF, MF, LF Controls.
	I	15	19	Paper	6	Paper	4	Plastic	24 H 36 L 16 D	Oil Wal.	Unbleached Linen	25-20k ±5	–	4	61	250.00	HF, MF, LF Controls.

AR INC.

SPEAKERS ARE CHOSEN FOR CRITICAL PROFESSIONAL USE—BUT THEY WERE DESIGNED FOR THE HOME.

Professional

Studio at WTFM in New York, one of the world's pioneer radio stations in FM stereo. AR-3 speakers monitor the audio quality throughout WTFM's studios and control rooms, as they do at many other broadcast stations. WTFM cannot afford to use speakers that provide false information.

Domestic

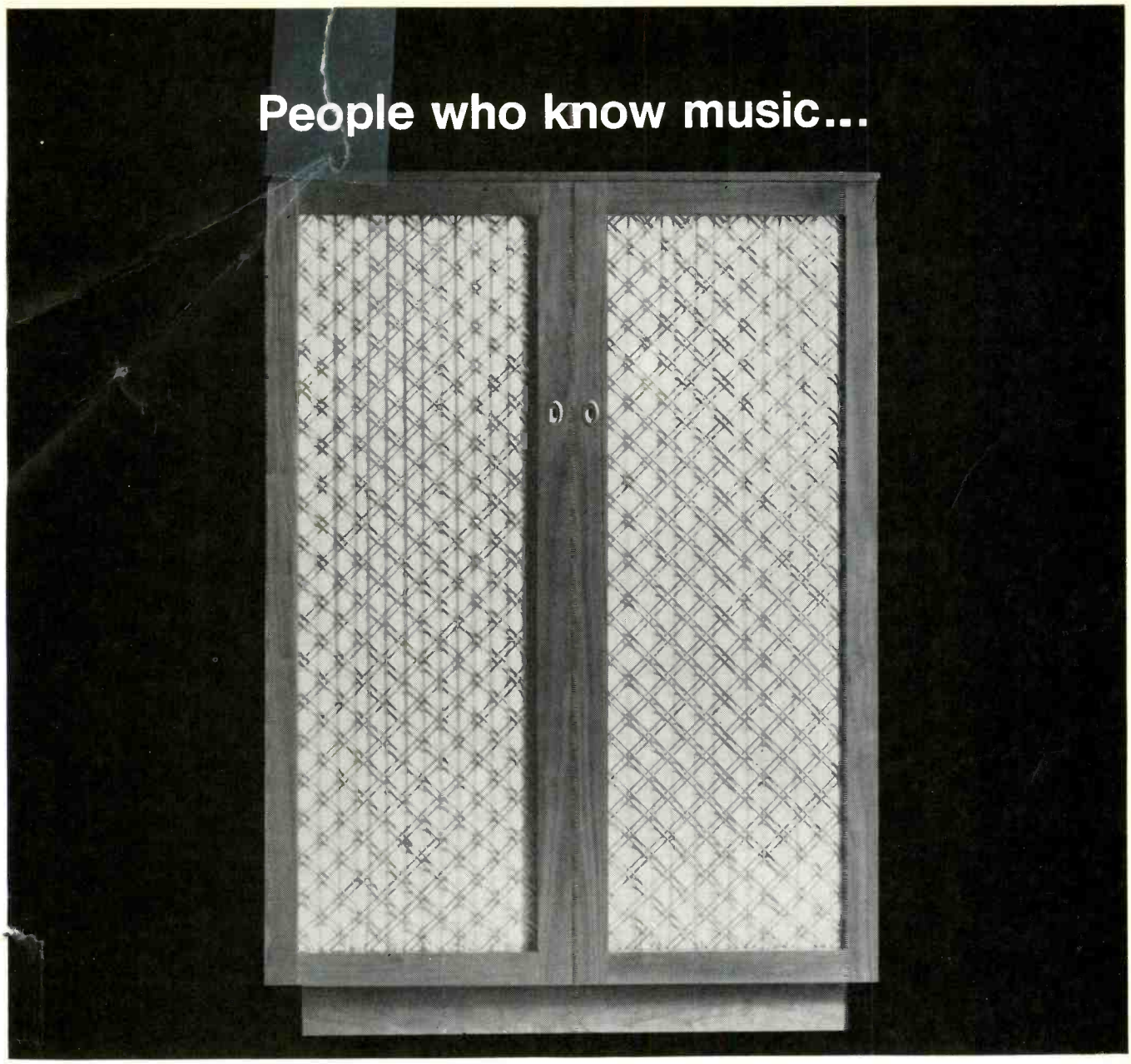
Library in the home of Virgil Thomson, distinguished American composer and dean of music critics. The speakers over the bookcases are AR-3's, chosen for their non-electronic, musical sound. Reflection in the mirror is Mr. Thomson watching the photographer.

AR speakers are $51 to $250. A catalog of AR products—speakers, turntables, and the AR amplifier—will be sent free on request.

ACOUSTIC RESEARCH, INC., ***24 Thorndike Street, Cambridge, Massachusetts 02141***

SPEAKER SYSTEMS (continued)

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance	WOOFER Cone Material	MID-RANGE Diameter, In.	MID-RANGE Diaphragm Material	TWEETER Diameter, In.	TWEETER Diaphragm Material	Enclosure Dimen., In. W x D x H	Wood Finish	Grille Material, Color	Overall Frequency Response, Hz, ± dB	Crossover Freq's, Hz	Impedance, Ohms	Weight, lbs.	Price	SPECIAL FEATURES
FISHER (53)	XP-33	6	35	Paper	–	–	2½	Poly Cone	13 6 7	Wal.	Woven Cloth Wal.	38-18.5k	2000	8	10	99.00 (pair)	Compact, half-roll surround on woofer; plasticized surround., urethane ctrd. on tweeter.
	XP-55	8	33	Paper	–	–	2½	Poly Cone	20 9 10	Wal.	Woven Cloth Wal.	37-19k	1000	8	20	59.50	Compact, long-throw, wide excursion, half-roll surround. on woofer. Tweeter uses low-mass poly. foam.
	XP-7	12	16-18	Paper	5 (2)	Paper	1½	Soft Cotton Dome	24½ 12 14	Wal.	Woven Cloth Wal.	30-20k	300-2500	8	45	149.50	3-way system w/2 mid-range drivers. Woofer has outside-surround. butyl impregnated. Tweeter soft-cloth dome.
	XP-15	12 (2)	15-17	Paper	(2) 6 (2) 5	Paper Paper	1½	Soft Cotton	27 14 27	Wal.	Woven Cloth Wal.	26 to beyond aud.	300-1000-2500	8	90	299.50	4-way consolette sys. w/7 spkrs. Eddy-crnt. damped woofer. Sep. low-mid,upper-mid, and treble bal. controls.
	XP-18	18	14	Paper	8 5¼	Paper Paper	2 (2)	Mylar	30½ 16¼ 29⅜	Wal.	Woven Cloth Wal.	14-20k	150-1500-3000	8	105	349.95	Sep. low-mid, upper-mid, and treble bal. controls. Both tweeters angled.
HARMAN-KARDON (33)	HK 40	10	26	Paper	–	–	3½	Phen. Cone	13⅝ 8 22⅞	Oil. Wal.	White	30-18k	2500	4	30	70.00	
	HK 30	8	29	Paper	–	–	3	Phen. Cone	16½ 18 11⅛		White	40-18k	2500	4	23	100.00	
HARTLEY	Concert-Master V-A	24	8	Poly-mer	10	Poly.	7	Poly.	39 29 18	Oil. Wal.	Cloth Brown	16-25k	300-3000	16	125	730.00	Dual cone, dual voice coil in mid-range and tweeter.
	Concert-Master III & IV A	18	17	Poly.	10	Poly.	7	Poly.	38 29 16	Oil. Wal.	Cloth Brown	16-25k	300-3000	16	110	495.00 525.00	
	Holton Jr.	10	Co-Axial Speaker						30 15 13	Oil. Wal.	Cane Tan	30-25k	2000	8	45	195.00	
HEATHKIT (69)	AS-37	8	–	Paper	–	–	3 x 6¾ Horn	–	23 11⅛ 11½	Wal.	–	50-12k	1600	8	27	39.95	Preassembled cabinet, high freq. bal. contr.
	AS-16	8	31	Paper	3½	Paper	–	–	19 9 10	Wal.	–	45-20k ±5	1500	8			Acous. susp.
	AS-21	(2) 12	–	–	Horn with Driver		–	Alum. Diaph.	32 19 32½	Wal.	–	30-22k	800	16	98	239.95	Altec Lansing mechanisms; network and cab. completely assmbld.
JBL	Nova	12	28	Paper & Lans-a-plas	–	–	1.7	Paper Cone	23½ 13⅜ 14¼	Oil. Wal.	Fabric Brown	–	2000	8	46 *	180.00	Avail. w/SE408S energizer. * Shipping weights.
	Festival	8 Passive Rad.		–	8 Full Range	Paper/ Lans-a-plas	–	–	22 10 22	Ivory & Green	Slotted Alum.	Full Range	–	8	46 *	144.00	Full-range weather-resistant system. Portable; tilts for opt. coverage.
	Caprice	8 Passive Rad.		–	8 Full Range	Paper/ Lans-a-plas	–	–	22 10 22	Oil.Wal. Rose-wood	Perf. Alum.	–	–	8	46 *	174.00	Tilts for optimum coverage.
	Sover-eign II S7	15	20	Paper	–	–	Horn	–	26½ 20 26½	Pecan Oak	Fabric Gold	–	500	8	100 *	657.00	Avail. w/SE408S Energizer.
	Lancer 101	14	25	Paper/ Lans-a-plas	–	–	Horn	Alum.	17½ 12⅜ 23	Oil. Wal.	Wood Fretwrk. Walnut	–	1500	8	88 *	378.00	Imported marble top; compact.
	Lancer 77	10	20	Paper/ Lans-a-plas	–	–	1.7	Paper Cone	22½ 11¾ 14	Oil. Wal.	Fabric Dark Brown	–	2500	8	42 *	162.00	JBL passive radiator; 14-element HF lens.
	Olym-pus S7R	15	20	Paper	–	–	Horn	Alum.	40 20 26½	Oil. Wal.	Wood Fretwrk. Walnut	–	500	8	165 *	678.00	JBL passive radiator; slant-plate treble lens.
JENSEN (49)	TF-4	10	30	Paper	8	Paper	(2) 3½ 1	Cone Sono-Dome®	25½ 8¾ 16	Oil. Wal. or Unf.	Pleated Cloth Olv.Gry.	25-20k	600 4000 9000	8	38 *	142.00	5-spkr, 4-way, slender book shelf. * Shipping weights.
	PR-400	15	20	Paper	5½	Sono-Dome®	1	Sono-Dome®	34 14¼ 29½	Oil. Wal.	Cloth Brown	20-20k	1000 5000	8	89 *	335.00	3-spkr, 3-way console.
	PR-300	12	25	Paper	5½	Sono-Dome®	1	Sono-Dome®	26½ 14 5/16 19¼	Oil. Wal.	Cloth Brown	20-20k	2000 9000	8	65 *	237.00	3-spkr, 3-way hi-boy/lo-boy.



Know BOZAK'S Concert Grand

There is only one loudspeaker system that is fully capable of reproducing all the subtleties of sound that characterize a "live" performance — the Bozak Concert Grand. That is the overwhelming consensus of people who know music best; that is why the overwhelming majority of them have Concert Grands in their own home music systems.

The sheen of the highs, the natural balance of the midrange, the careful enunciation of the bass tones — if they are present in your program source and if your amplifier can reproduce them — you'll hear them with a Bozak Concert Grand speaker system.

It may be far less expensive than you think to begin enjoying the richness of an unsurpassed music system based on Bozak loudspeakers. Ask your dealer about Bozak's unique "speaker growth" plan.

Bozak®

Darien, Connecticut

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SPEAKER SYSTEMS (continued)

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance	WOOFER Cone Material	MID-RANGE Diameter, In.	MID-RANGE Diaphragm Material	TWEETER Diameter, In.	TWEETER Diaphragm Material	Enclosure Dimen, In. W x D x H	Wood Finish	Grille Material, Color	Overall Frequency Response, Hz, ±dB	Crossover Freq's, Hz	Impedance, Ohms	Weight, lbs.	Price	SPECIAL FEATURES
KLH	17	10	60	Paper	–	–	1 3/4	Stiff Paper	23 1/8 9 11 3/4	Oil. Wal.	Cloth Off White	–	1500	8	27	69.95	Finished 4 sides; 3-pos tweeter cont.; acous. susp. woofer; min. of 12 W.
	6	12	55	Paper	–	–	1 3/4	Stiff Paper	23 1/2 11 7/8 12 5/8	Several	Boucle Clth.Off White	–	1500	8	34	122.00/ 134.00	Acous. Susp. woofer; 3-pos tweeter cont. Finished 4 sides; avail. in unf. bir, mahog, cherry, wal, and oiled walnut.
	5	12	44	Paper	3	Stiff Paper	1 3/4	Stiff Paper	26 11 1/2 13 3/4	Oil. Wal.	Cloth Light Brown	–	500, 4000	8	51	180.00	Finished 4 sides; acous. susp. woofer; (2)-3-pos level controls, changeable grille cloth.
	12	12	35	Paper	3	Stiff Paper	1 3/4	Stiff Paper	22 1/4 15 29	Oil. Wal.	Boucle Clth.Off White	–	500, 4000	8	109	275.00	Sep. contour cont. w/4 switched level conts.
	9	20 Electrostatic Bass and Mid-Range Radiators					2 Electro-static Tweeters		23 1/2 2 7/8 70	Oil Wal/ Mah.	Boucle Off White	–	–	16	–	1140.00	Bal. pair bi-laterally symmetrical, full-range electrostatic speakers.
KLIPSCH	Klipschorn K-347	15 Horn	–	Paper	2 Horn	Phen.	1 Horn	Phen.	31 1/4 28 1/2 52	Oil.Wal. Mahog. Blond	Several	30-19k	400, 6000	16	180	519.00/ 875.00	Depending on finish.
	Cornwall	15	–	Paper	2 Horn	Phen.	1 Horn	Phen.	24 18 36	Maple Birch Unf.Fir	Several	30-19k	600, 6000	16	105	311.00/ 415.00	Depending on finish.
	H	12	–	Paper	2 Horn	Phen.	1 Horn	Phen.	15 13 1/8 21 1/2	Same as above	Several	45-19k	700 6000	16	47	188.00/ 225.00	Depending on finish.
	Rebel 7	12	–	Paper	–	–	1 Horn	Phen.	15 13 1/8 21 1/2	Oil. Wal.	Cloth White	45-13.5k	650	16	40	174.00	
KNIGHT	KN 2380	15	–	Paper	Horn	–	–	Dome	20 1/2 14 30 1/4	Oil. Wal.	Cane Straw	20->aud.	2000 10k	8	55 *	149.95	* Shipping weights.
	KN 2390	12	20	Wool, Cellul.	6	–	1 1/4	Dome	14 13 1/2 25	Oil. Wal.	–	–	500, 3000	8	50 *	129.95	Acous. susp., var. contrs. mid-rg., tweeter.
	KN 2300 LK	12	–	Paper	Horn	–	–	Dome	25 13 1/2 14	Wal. Ven.	Cloth Choc. Brown	25-20k	1000-5000	8	46 *	89.95 69.95 K	Assembled Kit
LAFAYETTE	Criterion 3X	12	30	Plastic Coated Paper	6 1/2 Cone	Paper	3 Dome	Alum.	22 1/2 11 3/4 13 1/4	Oil. Wal.	Cloth White	20-25k	1200, 6k	8	–	89.95	Acous. susp. HF and mid-range contls. Finished 4 sides.
	Criterion 200A	12	40	Foam Treated Paper	8 Cone	Paper	3 Dome	Alum.	24 12 14	Oil. Wal.	White & Gold	20-25k	700, 5k	8	30	69.95	As above, but no acous. susp.
	Criterion 100A	10	45	Paper	–	–	4 Cone	Paper	21 1/2 10 1/2 11 3/4	Oil. Wal.	White & Gold	20-19k	2800	8	25	44.95	HF brilliance cont. Finished 4 sides.
	Criterion 50	8	45	Paper	–	–	4 Cone	Paper	19 8 5/8 10 3/4	Oil. Wal.	White & Gold	35-18k	3000	8	9	29.95	Finished 4 sides.
LEAK	Sandwich MK. II	13	–	*	–	–	3 1/2	*	15 12 26	Wal. Mah. Teak	Boucle Brown	35-18k ±3	900	15	49 1/2	199.00	* Cones are "sandwiches" of polystyrene foam between alum. foil skins.
	Mini-Sandwich	12 8	–	*	–	–	3 1/2	*	18 1/2 7 11	Teak	Woven Plas. Brown	50-18k ±3	900	15	22	135.00	* As above.
MAXIMUS (UTC Sound)	Maximus 33	8	35	Paper	–	–	4	Paper	18 9 11	Oil. Wal.	Boucle Cloth White	35-15k	2k	8	26	56.00	
	Maximus 55	12	35	Paper	6	Paper	4	Paper	24 12 14	Oil. Wal.	Boucle Cloth White	30-20k	2k 5k	8	39	99.50	
	Maximus 5	12	28	Vinyl Paper	4	–	4	Paper	24 12 14	Oil. Wal.	Pattern Olive & Blk.	30-20k	1.8k 5k	8-16	52	129.00	
	Maximus 7	12	26	Vinyl Paper	(2) 3 1/2	Paper	–	Horn	24 14 12	Oil. Wal.	Cloth Seran Brown	20-35k	1800 8000	8	58	189.00	Remov. grilles, all controls on fr. panel behind grilles.

Listen!

We didn't skimp on anything—and it sounds like it

If you want the best you don't fool around. That's the way we made our newest loudspeaker system—the Jensen 700 XLW.

And it sounds like it.

A multi-way network combines four speakers to achieve thoroughly brilliant reproduction of everything from 20 to 20,000 cycles.

And for precise musical balance, there are controls for both mid- and high-frequencies.

The four-way system commands a 12-inch FLEXAIR® acoustic suspension woofer with a 3.6 lb. DP-Alnico-5 magnet; a horn-loaded midrange; a compression-driver, horn-loaded tweeter and a SONO-DOME® ultra-tweeter.

Skimp somewhere? No sir. Even the bookshelf cabinet is creatively styled in open-grain oiled walnut. (Size 16½" H. x 25½" W. x 12" D.)

What more can we tell you than to say the Jensen 700 XLW loudspeaker system is a masterpiece. At only $275. (Suggested price.)

See it. Hear it! At your Jensen dealer today.

Jensen Manufacturing Division, The Muter Company, 6601 South Laramie Avenue, Chicago, Illinois 60638.

Jensen

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SPEAKER SYSTEMS (continued)

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance	WOOFER Cone Material	MID-RANGE Diameter, In.	MID-RANGE Diaphragm Material	TWEETER Diameter, In.	TWEETER Diaphragm Material	Enclosure Dimen., In. W x D x H	Wood Finish	Grille Material, Color	Overall Frequency Response, Hz, ± dB	Crossover Freq's, Hz	Impedance, Ohms	Weight, lbs.	Price	SPECIAL FEATURES
NESHAMINY	Z-900	2-11	–	Paper Cone	4 Janszen Model 130 Electrostatic Radiators				31¼ 15½ 28	Oil. Wal.	Cloth	27-30k	1200*	8	110	399.95	*Mechanical crossover on woofer, elec. on mid/high radiator. Reqs. 117V, 60 Hz 5-ply, 4W.
	Z-600	11	–	Paper Cone	2 Janszen Model 130 Electrostatic Radiators				20 13 26⅝	Oil. Wal.	Cloth	30-30k	1200*	8	65	208.95	Equals ½ of above system.
	Z-700	11	–	Paper Cone	Same as above				26 13¼ 15	–	Cloth	–	1200*	8	54	154.95	Bookshelf style; similar to above in componentry.
	Jan Kit 41	11	–	Paper Cone	Same as above				16 7½ 19½	User's Choice	User's Choice	30-30k	1200*	–	18	114.95	Component ass'y same as Z-600; for installation in user's cab. of approx. 2 cu.ft. vol. Mtd. on ½-in. panel.
OAKTRON	PVS 800	8-in. Twin Cone							12⅛ dia 5⅝ depth	Molded Royalite		45-15k	–	8	3½	29.95	Weatherproof. Incls. wall-mount.
PIONEER (17) (82)	CS-20	5	70	Paper	–	–	2	–	8 8½ 13¼	Oil. Wal.	Cloth Black	70-20k ±5	2500	8	7½	35.00	High efficiency. Matched-grain cabinet.
	CS-24	8	70	Dual Paper Cone	–	–	–	–	16⅛ 4¾ 10⅝	Wal.	Metal Black or Silver	70-15k ±5	–	8	7½	27.50	Slim-line design, spun metal grille.
	CS-63	15	15	Paper	6½ plus Horn	Paper	2½	Paper	19¼ 13¼ 28⅞	Oil. Wal.	Cloth	25-20k ±5	700 3000 12000	8	75	246.25	Complete 4-way bookshelf system w/15-in. woofer.
	CS-88	12	15	Paper	5	Paper	2x1½ Horn 2 Cone	Paper	14 3/16 13 24 3/16	Wal.	Cloth Wood Brown	25-20k	600 4000	8	48	175.00	Genuine wood lattice screen in front of grille cloth.
RECTI-LINEAR	Recti-linear III	12	22	Paper	5	Paper	2½	Paper	12 18 35	Oil. Wal.	Fibre-glass White	22-18.5k ±4	250 3000 11000	8	65	279.00	
	Recti-linear VI	10	26	Paper	5	Paper	2½	Paper	11⅜ 14 25	Oil. Wal.	Fibre-glass White	26-18.5k ±4	250 3000 11000	8	40	239.00	
ROLA CELESTION	Ditton 15	8	8	Plastic	8	Paper Plastic	¾	Phen.	21 9¼ 9½	Teak Wal.	Cloth Blk. & Gold	30-15k	60 3000	4	20	–	Aux. bass radiator, 30-60 Hz. Handles 30 watts peak at 30 Hz.
	Ditton 10	5	30	Paper	–	–	¾	Phen.	12¾ 6¼ 6¼	Teak Wal.	Perf. Alum. Pale Gold	35-15k	3500	4 16	13	–	Compact monitor system.
SANSUI (61)	SP-100	10	–	Paper	5	Paper	2 Horn	Mylar	14 3/32 11 45/64 24 7/16	Oil. Wal.	Fret-work Walnut	45-20k	1500 5000	8	34.6	139.95	Hand-carved grille, three-position level cont.
	SP-200	12	–	Paper	(2) 5	Paper	(2) 2 Horn	Mylar	14 15/16 12 19/32 25 25/32	Oil. Wal.	Fret-work Walnut	35-20k	1500 5000	8	40.6	179.95	As above with 5 speakers.
SCOTT Cover (II)	S-12	15	19	Paper	5½	Paper	3	Paper	21 16 27	Cont. Wal.	Syn. Cane, Lt. Br.	30-20000	750 3500	6-8	68	274.95	Controlled impedance.
	S-11	12	20	Paper	4½	Paper	3	Paper	14 11¼ 24	Cont. Wal.	Acyr. Reinf. Cotton, Beige	35-20000	800-3000	6-8	36	149.95	Controlled impedance.
	S-10	10	22	Paper	–	–	3½	Paper	11¾ 9 23⅓	Cont. Wal.	Acyr. Reinf. Cotton, Beige	35-18000	1200	6-8	21	79.95	Controlled impedance.
	S-14	6	39	Paper	–	–	3	Paper	10 6½ 16	Cont. Wal.	Acyr. Reinf. Cotton, Beige	50-20000	2000	6-8	13½	49.95	Controlled impedance.
SHERWOOD (20)	SR-1	10	23	Paper	–	–	4	Paper	24 9½ 13	Oil. Wal.	Plastic Cane Brown	53-17k ±2.5	1800	8	33	84.50	Birch and utility models avail. Air-susp. woofer.
	SR-2	10	23	Paper	8	Paper	3½	Paper	24 9½ 13	Oil. Wal.	Plastic Cane Brown	53-18k ±2.5	800 3000	8	36	99.50	As above.
	SR-3	12	21	Paper	8	Paper	3½	Paper	26¼ 13¼ 15	Oil. Wal.	Plastic Cane Brown	48-18k ±2.5	800 3000	8	55	139.50	As above, w/omni-polar tweeter.
	SR-4	(2) 10	19	Paper	8	Paper	3½	Paper	24 13 31½	Oil. Wal.	Plastic Cane Brown	38-18k ±2.5	200 800 3000	8	73	219.50	As above, w/omni-polar tweeter, 2 air-susp. woofers.
SONY (7)	SS-3300	12	27	Paper	5	Paper	2 Horn	Plastic	22⅞ 14½ 31½	Oil. Teak	Black	30-20k	500 3000	16	82	349.50	Sep. sw. for multi-channel use.

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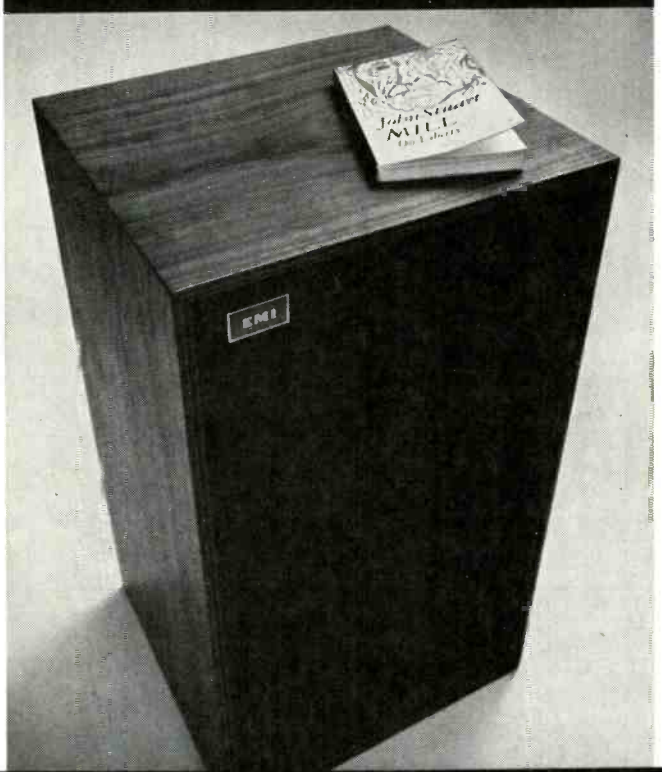
Liberator.

New EMI DLS 629 the speaker that frees your amplifier to do a better job



Some of today's most popular speakers are of low-efficiency design. This simply means they take more power from your amplifier to produce the same level of sound in your living-room.

That's the problem. These speakers may sound fine, but what about your 20-watt-per-channel amplifier, forced to hover around its maximum output every time you listen to *Night on Bald Mountain*? It's generating far more distortion than it would if it had to put out only about 5 watts for the loudest sounds, which would also give you a 6-db margin for peaks before the amplifier overloads.

So that's why we say the new EMI DLS 629 is "the speaker that frees your amplifier to do a better job." Among all its other virtues, it's also a more efficient transducer than most. It converts electrical power from your amplifier into sound power with less waste. Your amplifier doesn't need to work as hard, no matter how little or how much power it has.

If you're acquainted with our model 529 (the well-regarded "dangerous" loudspeaker) you'll be pleased to know that the EMI 629 has an 8-ohm nominal impedance instead of the 529's 4 ohms. This makes it especially desirable for use with modern, solid-state amplifiers.

In addition, we fitted the 629 woofer with a larger voice coil, increased the gap, and doubled the size of the magnet — greatly increasing power-handling capacity. But we retained the unique elliptical woofer construction, with its rigid aluminum center cone and molded PVC (polyvinyl chloride) edge suspension, which contribute so much to the low frequency performance of EMI speakers.

Two damped 3½-inch cone tweeters provide smooth highs to the limits of audibility. A 3-position brilliance switch lets you tailor the response to the acoustics of your listening room. The crossover network is an inductance/capacitance type with 12-db-per-octave slope. Tweeter and woofer have been electrically and acoustically matched to provide smooth integrated performance over the entire sound spectrum.

All this adds up to an efficient system that offers presence unmatched by any speaker in its price class. Sound is free, natural; does not have the constricted effect that some low-efficiency speakers exhibit in the mid-range. The handsome oil finish walnut cabinet 24½h x 13½w x 12¼d, has braced ¾-inch walls. All of this for $164.50.

Visit your hi fi dealer and hear the new 629 and other fine EMI speaker systems starting at $79.50. Ask for the "volume-control" test, it will prove our point about high-efficiency speakers. For brochure, write: Benjamin Electronic Sound, Farmingdale, New York 11735.

EMI
the natural sound

SPEAKER SYSTEMS (continued)

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance	WOOFER Cone Material	MID-RANGE Diameter, In.	MID-RANGE Diaphragm Material	TWEETER Diameter, In.	TWEETER Diaphragm Material	Enclosure Dimen. In. W x D x H	Wood Finish	Grille Material, Color	Overall Frequency Response, Hz, ± dB	Crossover Freq's, Hz	Impedance, Ohms	Weight, lbs.	Price	SPECIAL FEATURES
TANDBERG	114/ 116-8	10	–	–	–	–	2½	–	27½ 11 13¾	Teak or Rose-wood	Teak	45-16k	–	4	–	106.50	
	113/ 106-10	6½	–	–	–	–	2	–	7⅛ 9⅛ 9⅛	Teak or Rose-wood	Teak	60-16k	–	4	–	52.50	113/106-11 same specs. w/12⅝ x 6 x 8½ dimen.
TANNOY	GRF	15	26	Paper	–	–	2 Horn	Dura-lumin	23¾ 17 42	Oil. Wal.	Woven Plastic Nat.	35-20k ±3	1000 350	8	120	393.00	Rear horn – loaded; 15-in. dual – concentric.
	STUART	12	28	Paper	–	–	2 Horn	Dura-lumin	4⅜ 16⅞ 25½	Oil. Wal.	Woven Plastic Nat.	35-20k ±3	1000	8	85	272.00	Bass reflex; 12-in. dual concentric.
	CADET	10	30	Paper	–	–	2½ Horn	Dura-lumin	13½ 11 23¾	Oil. Wal.	Woven Plastic Nat.	35-20k ±5	1200	8	43	172.00	Infinite baffle bookshelf; 10-in. dual concentric.
UNIVERSITY SOUND	Mini-ette	6½	–	Mass-Loaded Paper	–	–	3½	Paper	15 6 9½	Oil. Wal.	Cloth Brown Gold	40->aud	2000	8	12	49.50	RRL enclosure bookshelf size.
	Ultra D	10	16	Stiff Paper	4	Stiff Paper	3½	Stiff Paper Cone	23 13/16 11 7/8 9¾	Oil. Wal.	Cloth Egg Shell	30->aud	1000 5000	8-16	24	69.95	Air susp. bril./pres. con. 5-yr. warranty, all speakers.
	Mediter-ranean	12	18	Stiff Paper	8	Stiff Paper	Horn	Phen.	24⅜ dia. 22½	Butter-nut	Cloth Beige	20->aud	800 5000	8	74	269.50	Mediterranean commode doubles as end table – 3-way elect. conts.
(5)	Cantada	12	25	Stiff Paper	8	Stiff Paper	Dome	Phen.	23½ 15¾ 12¼	Oil. Wal.	Cloth Applique Beige, Br.	23-40k	600 4000	8-16	40	145.00	Applique grille cloth rrl encl. Bril. pres. cont., tweeter ±2 db to 22 kHz.
	UR-4	8	40	Stiff Paper	–	–	2½	Stiff Paper Cone	19 10½ 9	Oil. Wal.	Cloth Beige Gold	35->aud	2000	8	14	58.95	RRL enclosure. Weighted moving system.
	Laredo	12	40	Stiff Paper	8	2-way Paper Cone	Dome	Spher-icon	15¾ 12½ 24	Oil. Wal.	Cloth Brn.	30-30k ±4	600 1500* 3000	8	38	109.50	*Mechanical crossover between main 8-in. cone and subsidiary free-edge radiator.
	Estoril	12	30	Stiff Paper	–	Diff. Cone Paper	Dome	Spher-icon	14 12 26½	Oil. Wal.	Cloth Brown Maroon	25-40k	1000* 3000	8	40	164.50	*Mech. crossover; sep. 12-in. "Aerodynamic Bass energizer" non-elect. mass-loaded cone reinforces l. f. range.
	Sorrento II	12	18	Stiff Paper	8	Paper	Horn	Horn	26⅛ 16⅜ 22½	Seville Blue	Cloth Lt.	20->aud ±3	800 3000* 5000	8	60	289.00	*Mech. crossover in mid-range unit. Slate top, brass screen in front of grille cloth.
UTAH ELECTRONICS	HS4	12	45	Paper	–	–	5	Paper	25¾ 14 15	Oil. Wal.	Cloth Gold	30-18½	4500	8	46	94.50	
	AS-1	10	25	Paper	3 x 5	Horn	–	Compr. Phen.	24 12 12	Oil. Wal.	Cloth Brown	30-19½	500 4000	8	40	79.95	
	AS-6	12	22	Paper	3 x 5	Horn	–	Compr. Phen.	25 13½ 14	Oil. Wal.	Cloth Gold	35-20k	800 4000	8	49	120.00	
	AS-8	12	22	Paper	3 x 5	Horn	–	Compr. Phen.	12¾ 30¼ 25½	Semi-gloss Wal.	Cloth Brown	35-20k	800 4000	8	60	189.00	
VIKING (71)	4400	8	80	Paper	–	–	3½	Paper	16 14 5	Oil. Wal.	Cloth Brown Cane	20-20k ±2	2500	8	25*	120.00*	Sold as system – 2 encls w/ built-in pwr. ampl; ster phone jack, on/off switch, vol cont, bass boost sw. * Price and Weight for pair.
WHARFEDALE	W90D (4-way)	12½ 12½	20 22	Poly. Paper/ Cloth Cmpd.	(2) 5	Bake-lized	(2) 3	Mylar Dome	30 13½ 23¾	Oil. Wal. Pol. Wal. Unf. Bir.	–	20-Aud.	75 1000 4000	4-8	115	294.00 315.00 279.00	Oil. Wal. Sand-fill encl. acous. Pol. Wal. susp. treble, mid-rg. Unf. contrls.
	W70D (4-way)	12½	22	Paper/ Cloth Cmpd.	8 5	Paper/ Cloth	3	Mylar Dome	22¾ 13⅝ 24	Same as above	–	25-20k	175 1250 3500	4-8	74	188.00 203.00 175.00	Oil. Wal. Sand-fill encl. acous. Pol. Wal. susp. treble, mid-rg. Unf. contrls.
(43)	W60D (3-way)	12½	22	Paper/ Cloth Cmpd.	5	–	3	Mylar Dome	24 13 14¼	Same as above	–	30-20k	1000, 3500	4-8	52	135.25 146.75 123.00	Oil. Wal. Sand-fill encl. acous. Pol. Wal. susp. treble, mid-rg. Unf. contrls.
	W40D (3-way)	10	35	Paper/ Cloth Cmpd.	5	–	3	Mylar Dome	23½ 10⅛ 12⅛	Same as above	–	35-20k	1250 3500	4-8	40	94.00 98.70 86.00	Oil. Wal. Acous. susp., treble, Pol. Wal. mid-rg. contrls. Unf.
	W30D (2-way)	8	35	Paper/ Cloth Cmpd.	–	–	3	Mylar Dome	10 9¼ 19	Oil. Wal.	–	40-18.5k	2000	4-8	22	59.95	Oiled Walnut Treble contrl., acous. susp.
	W20D (2-way)	8	35	Paper/ Cloth Cmpd.	–	–	3	Mylar Dome	14 8½ 9¾	Oil. Wal.	–	45-18k	1600	4-8	14	49.95	Oiled Walnut Acous. contrl. Acous. susp.

Nine facts about the Fisher XP-15 that make advertising claims unnecessary.

Seven drivers. The new XP-15 incorporates seven speakers. Two 12″ free-piston woofers; four mid-range units; one tweeter. Each driver an exclusive Fisher design.

21 pounds of magnet structure. Each woofer is powered by a 6 lb. magnet structure. A total magnet weight of 6 lbs. drives the mid-range speakers, and there are 3 lbs. for treble reproduction. These unusually large magnets provide increased power handling capacity, efficiency, and tighter control over voice-coil excursion.

Four-way system. The new XP-15 is a true four-way system allowing each driver to reproduce only one specific portion of the frequency spectrum. The woofers from 26 to 300 Hz; lower mid-range from 300 to 1000 Hz; upper mid-range from 1000 to 2500 Hz; high frequencies from 2500 to beyond audibility.

All-electrical crossover design. Each crossover point of the XP-15 (300, 1000, 2500 Hz) is treated like a two-way system. High frequencies above the normal operating range of the woofers and mid-range speakers are filtered out with precisely wound coils. Low frequencies below a driver's operational limit are filtered through series condensers. There is a total of twelve electrical elements.

Five pounds of copper wire. There are two air-core coils and two condensers in each network, providing a taper of 12 db per octave at the crossover frequencies. The six low-pass filter coils utilize nearly 5 pounds of copper wire!

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Sub-enclosure design. All four mid-range drivers and the soft-dome tweeter are completely sealed off within the main enclosure to prevent interaction with the back-pressure of the woofers.

Solid 5 cu. ft. cabinet. The XP-15 weighs 90 pounds! Its sturdy construction eliminates enclosure resonances that could result from low-frequency modulation. The cabinet measures 27″ high, 27″ wide, 14″ deep, and is finished in hand-rubbed oiled walnut.

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EQUIPMENT PROFILES

H. H. Scott Models 2505 and 2504 Compact Stereo Music Systems

MANUFACTURER'S SPECIFICATIONS– System: FM receiver/automatic turntable with stereo cartridge/speaker systems (2). Total Music Power: 40 watts at 4 ohms. FM sensitivity, Usable: 2.0 microvolts. Prices: Model 2504 (with Scott S-14 speaker systems), $349.95; Model 2505 (with Scott S-10 speaker systems), $419.95. Optional smokey-gray plastic cover.

The so-called "compact" music system has earned an important place in the home sound entertainment market. Obviously, by offering equipment that requires only a single buying decision instead of the need to choose a variety of components to make up a system, component manufacturers can appeal more strongly to people who have very little knowledge of hi-fi.

Thus, "component" quality can be carried over into the somewhat less sophisticated approach of compacts, trading off what one might choose in the way of components for what the manufacturer has established as a whole system.

H. H. Scott has five compact music systems in its stable. They all appear to share the same audio amplifier. One is a phono-only system; two models are AM/FM/Phono, differing only in speaker systems; and two models are the same as the AM/FM/Phono units minus the AM broadcast function. The latter two are being examined here.

Scott offers, as a whole package, an FM stereo receiver/changer module with a pair of its S-14 loudspeaker systems, calling the ensemble "The 2504 Compact." The same receiver/changer module when purchased with a pair of Scott's larger S-10 speaker systems, is dubbed "The 2505 Compact."

The fact that these speakers are from Scott's regular line suggests that no audio modifications have been employed in the design of the receiver to alter the response of the amplifier to improve loudspeaker performance. Thus, one can change speakers at some future time without concern that frequency-response doctoring will create any problems. We can, therefore, still treat these compacts from a conventional component viewpoint, though it must also be judged as a whole system.

Features

The gold-anodized brushed heavy aluminum front panel of the receiver-changer module slopes backward in the tuning dial area (see Fig. 1), matching the contour of the smartly styled oiled-walnut cabinet. The slope makes station selection highly visible when the unit is mounted on a table top or on a shelf, below eye level. Dual clutch-type controls are used for bass, treble and loudness. By making the loudness control a clutch-type dual control, there is no need for a separate balance control, since each channel's loudness can be adjusted separately. It was found, however, that optimum balance was obtained with both loudness knob pointers perfectly in line with each other, indicating that the two amplifier sections are very closely matched, electronically, with respect to gain. As a result, unusual room acoustics, speaker placement or unbalanced program material would be the only reasons to off-set the separate sections of the loudness control. On this point, a special switch located underneath the module cabinet allows the listener to instantaneously switch from "left channel only" to "right channel only," which is a great aid in adjusting for equal levels from both channels.

Fig. 1–H. H. Scott's Model 2505 solid-state FM stereo compact with S-10 speaker systems.

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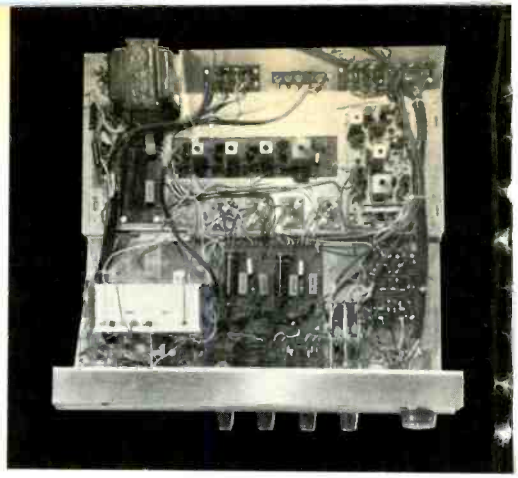


Fig. 2—Inside view of the Scott 2504/2505 compact's receiver chassis shows its modular printed-circuit board.

Other rotary controls include the function switch and the tuning knob. In addition to PHONO, FM, SUB-CH. FILTER (for use under noisy stereo FM reception conditions) and EXTRA (for tape, TV sound, etc.), there is a position for MIC/GUITAR. And sure enough, Scott has provided for this very popular form of home music entertainment by providing front-panel jacks for either a microphone or a guitar or any other instrument requiring electronic amplification. In the stereo mode, if both a microphone and a guitar are used, the microphone will be heard from one of the loudspeakers while the guitar is heard from the other.

Of course, availability of these unusual inputs makes home recording of family talents quite simple, since direct connection can be made from the tape output jacks of the receiver (located at the rear underneath the receiver) directly to the high-level inputs of a tape recorder.

Selection of MAIN and REMOTE speaker system is made by "rocker" switches. If two pairs of speakers are connected, either or both pairs can be switched on by means of these switches. Another "rocker" switch is used to turn on power to the unit, enabling the user to leave all other controls at optimum settings between listening sessions.

Two more "rocker" switches select mono or stereo mode and tape monitoring for those tape recorders equipped with monitoring facilities. The now-standard stereo headphone jack and stereo FM indicator light complete the front panel layout. The softly illuminated tuning-dial area also features a tuning meter which is adjusted for maximum indication and the familiar 0-100 logging scale which many users find more easy to use than the mHz or direct-reading frequency scale. While tuning meters are always a welcome addition to a receiver, maximum indication is somewhat more difficult to set accurately than is the center-of-channel type of meter movement. Too, the meter action was found to be highly non-linear. That is, the first 40 or 50 μV of incoming r.f. signal pushes the needle almost to the top of the scale, with very little additional deflection taking place for higher signal strengths. Thus, with reasonable signal strengths (the more usual situation), it is difficult to determine precise center-of-channel.

The record changer, mounted above the chassis, is manufactured by Garrard and, though imprinted with the Scott name, is a first cousin to the Model 40 MK II, available separately from Garrard. It is equipped with a Pickering Model V-15/CAC stereo cartridge and a diamond stylus. The changer is properly shock mounted above the receiver, and circuitry is so positioned that there is no danger of any motor hum fields being induced in the receiver's preamp.

This Garrard changer plays all four speeds, manually or automatically. A separate "stub" spindle is supplied for manual operation. The tubular tone arm has a removable cartridge head and is adjustable for tracking of different cartridges, should the user decide to change cartridges at a later date. Automatic operation of this changer is controlled by just two levers. The first selects speed while the second turns on the motor and starts the changer mechanism (when it is moved all the way to the "reject" position). A locking device clamps the tone arm in place on the tone arm rest, preventing accidental damage to the cartridge and stylus should the arm be pushed off its rest accidentally or during transport of the compact.

An added feature is incorporated on this specially-made version for Scott; a tiny soft-bristle brush is affixed right to the changer base plate in such a location that the diamond stylus of the Pickering cartridge passes through the bristles each time the changer goes through its changing cycle. Since most people ignore the need for "flicking off" dust particles which tend to collect on the stylus tip, this feature is worth a good deal more than its negligible cost. It's a lot safer for the stylus than the right forefinger which many record enthusiasts use in lieu of a proper brush.

As for the cartridge, it is one of a series in the V-15 group popularized by Pickering. Intended primarily for changer applications, it is designed for tracking pressures at between 2 and 5 grams. As adjusted in the 2504/2505 compact, it tracked successfully on even the most dynamically recorded passages of Moussorgsky's "Pictures at an Exhibition" as well as the old standby, "The 1812 Overture" recorded with the

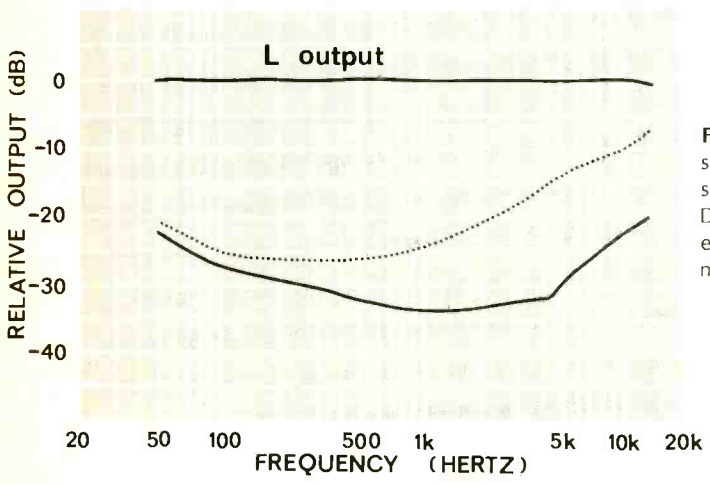


Fig. 3—FM stereo separation with "L" signal applied. Dashed line shows effect when the multiplex filter is "on."

West Point Cannons in the finalé. Tracking pressure was measured at just over 4 grams, a rather high setting, but not unusual for record changers.

One of the advantages of compacts is the popular "automatic shut-off" feature, more common in mass-produced, console equipment. Thus, with the power switch on the main receiver panel in the off/auto position, the unit can be turned on by actuating the record changer on/reject lever. All previously stacked records will play through and, after the last record has been played, both the record changer and the receiver will automatically shut off, even if the user has dozed off or left the room.

The S-10 speaker systems, associated with the 2505, are actually H. H. Scott's "controlled impedance" units, sold separately, too, as components. Unlike many loudspeakers of the air suspension type, it has a relatively high order of efficiency. Consequently, it requires only a few watts of amplifier power to drive it to loud listening levels. The system incorporates a 10-in. woofer and a 3½-in. paper cone tweeter. Crossover frequency is 1200 Hz. The walnut enclosure measures 23⅓-in. by 11¾-in. by 9-in. deep.

The S-14 speaker systems that accompany the Model 2504 compact music system are similar in type to the above speaker systems. However, they incorporate a 6-in. woofer and a 3-in. tweeter, with crossover frequency at 2000 Hz. The smaller systems measure 16-in. by 10-in. by 6½-in. deep.

Circuitry

Figure 2, a photo of the inside of the Scott chassis, discloses that the receiver is constructed of seven neatly arranged printed-circuit modules with carefully positioned interwiring harnesses. The completely shielded module at the upper right of the photo is the FM front end, which features a Field Effect Transistor as the r.f. stage plus two NPN silicon units in the local oscillator and converter circuits.

The i.f. strip employs four identical μA703 integrated circuits, each of which houses the equivalent of five NPN transistors plus a pair of biasing resistors. By proper external connection, these units serve both as amplifiers and limiters, feeding a conventional ratio detector circuit. The multiplex automatic demodulator module follows, and it is a well compensated, sophisticated design with fully twice as many circuit components as the common variety of multiplex decoder. This makes possible excellent stereo separation capabilities over the entire audio spectrum, as well as extremely low distortion and residual 38 kHz and 19 kHz undesired outputs.

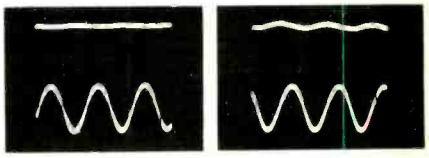
Next, the signals are fed through the Filter Module, which introduces a sharp high-frequency cut-off filter for use with noisy FM stereo signals. This module also includes the special channel-balancing feature mentioned earlier. The tone control and preamp module follows, and includes a dual integrated circuit and two more FET's. Half of the IC is used as a preamp for each channel; each half contains eight transistors and nine resistance elements. In addition to the FM signal input, this module also accepts the phono, tape, guitar and mirophone signals selected by the function switch. The output of the preamp and tone module is fed to a driver P.C. module which is, in turn, connected to the four power output silicon NPN transistors. The output devices, mounted to the surface of the chassis for proper heat sinking, are supplied with 30 volts of d.c. from a power supply P.C. module. The module also makes available the necessary +12 volts d.c. required by the r.f. and i.f. modules. The entire receiver is fused with a 1¼ ampere line fuse, readily replaceable from the underside of the cabinet.

If you were to add the total number of transistor elements in this receiver (including the multiple devices incorporated in the various IC's), it would be a staggering total of fifty eight, not to mention some twenty-two diodes used throughout the circuitry and in the power supply. Hardly a "compromise" compact design, to say the least!

Measurements

While H. H. Scott does not publish many technical specifications for its compacts (the premise being that these units are bought by a less-sophisticated group of audio enthusiasts), we nevertheless measured some of the more important parameters of the receiver. FM sensitivity (IHF) proved to be 2.8 μV at just about any point in the FM band. This compares favorably with the 2.0 μV spec Scott lists, taking into account production tolerances and test generator leakage. Ultimate signal-to-noise on FM was a respectable 60 dB. Distortion at full deviation was a very satisfactory 1.2%, while capture ratio was a mere 1.8 dB.

Fig. 4—Good FM stereo separation at 1 kHz (left) is somewhat degraded when the multiplex filter is activated to reduce noisy stereo reception, as shown at right.



Automatic stereo switching takes place with only 5 μV of r.f. signal input and, it should be noted, the stereo indicator light only comes on when stereo is actually received and switched on. There are no false indications caused by interstation noise or other extraneous effects.

FM stereo separation exceeds 30 dB throughout the important upper-low, middle and medium-high audio range, as can be seen in the curves of Fig. 3. The dashed curve shows the reduction in separation caused by introducing the MPX filter. The photos in Fig. 4 compare separation with and without MPX filter. We found, however, that all the stereo stations received in our area (a total of eleven) were so free of reception noise that the filter was never

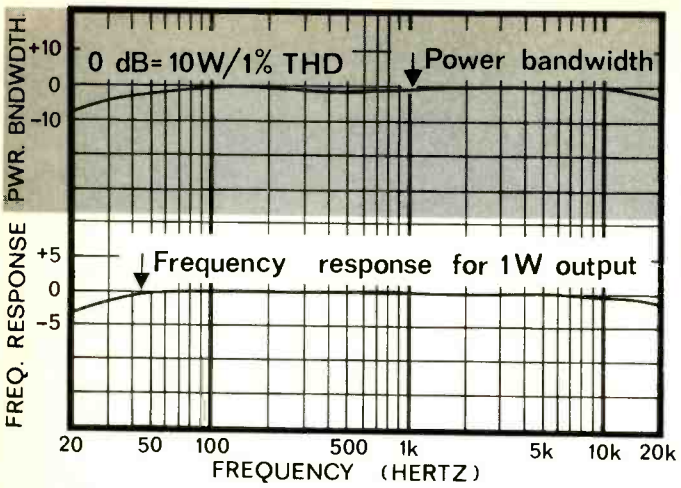


Fig. 5–Power bandwidth and frequency response.

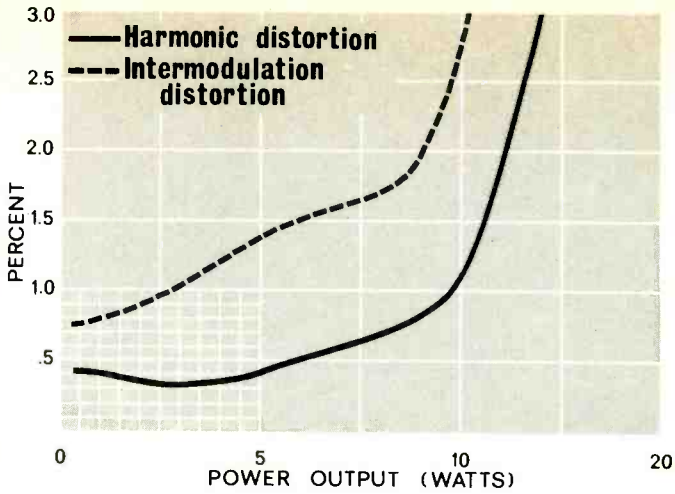


Fig. 6–Per cent distortion vs. power output.

required to be used. While the 2504/2505 receiver is equipped with an "indoor" FM antenna (a small capacitor coupled to the power cord), a proper outdoor FM antenna should be used for distant FM stereo reception (over 25 miles or so).

The power rating of the amplifier section of the receiver was found to be a total of 32 watts (IHF) music power at 8 ohms—40 watts (IHF) at 4 ohms—or just under 10 watts rms *per channel,* with both channels operating, at 1% total harmonic distortion. Power bandwidth at the 10 watt figure extends from 20 Hz to 30 kHz, as shown in Fig. 5. Frequency response at a nominal 1 watt level is 30 Hz to 20 kHz, within ±1 dB. IM distortion is 2.4% for 9 watt rms output, as shown in Fig. 6. PHONO and GUITAR/MIC hum levels both measured 60 dB below full output, and the input sensitivity for full output for these two services measured 5 mV and 7 mV, respectively.

Figure 7 shows the total range of the bass and treble controls and Fig. 8 is a plot of the loudness contour compensation built into the loudness controls. The compact's versatility would have been enhanced even further if this loudness feature was defeatable, for while it may approximate desired compensation for FM listening (since the unit has full control over FM audio levels, providing all FM stations modulate properly), recordings, especially tape recordings, exhibit widely differing signal levels. Thus, a "heavily" recorded disc may make it best for the listener to lower the loudness control to, say, the mid-point and still achieve "live" listening levels. Under such circumstances, loudness compensation would not be desirable. Yet, with the control at this setting, about 8 dB of bass boost (at 100 hZ) would be present—like it or not. The only solution would be to turn the bass control counterclockwise to compensate for the added bass introduced by the loudness contour action.

Performance

At first, one might wonder whether a nominal ten watts rms per channel would provide adequate levels of sound in a reasonably large living room. In the test listening set-up, possibly the worst of all L-shaped areas for treble dispersion and good coverage, it can be stated unequivocally that a setting of about two o'clock on the loudness control provided sufficient volume on both recorded selections and FM listening. The control was even cranked to full level and, though we were treated to "louder than life" sound, there was no evidence of "break-up," either from the amplifier or from the S-10 speaker systems.

Wandering about the listening area, searching for "holes in the middle" and loss of highs, it can be reported that, even positioned at the far end of the "short leg" of the "L-shaped area with one speaker totally out of view, the highs were very much in evidence. Extended listening in a more suitable location in the room caused no evidence of "fatigue," further indication that distortion, considered in terms of the total system, is extremely low. Although a "tweeter" adjustment is provided on the enclosures, factory setting (about mid-way) seemed right for this acoustic environment.

The Model 2505 compact's S-10 speaker systems can stand alone as a clean-sounding "bookshelf" type. Its high-frequency element exhibits excellent angular dispersion. Clean, fundamental bass was measured down to 40 Hz (below which, severe doubling occurred). They did not exhibit any "peaking," nor did they create any of the "barrel-boom" effects sometimes associated with small enclosures. The middle frequencies were good, not projected or depressed.

The 2504's S-14 speaker systems are much smaller in size (and price) than the 2505's. They exhibited good fundamental response down to about 60 Hz before falling apart. While the ultra highs did not seem to extend quite as far as in the S-10's, angular dispersion was nevertheless excellent and overall

Fig. 7–Bass and treble tone control range.

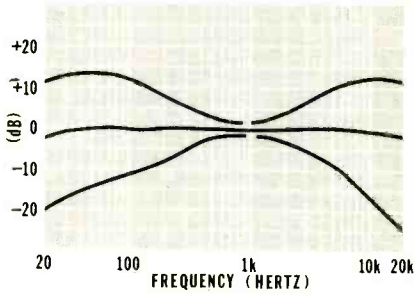
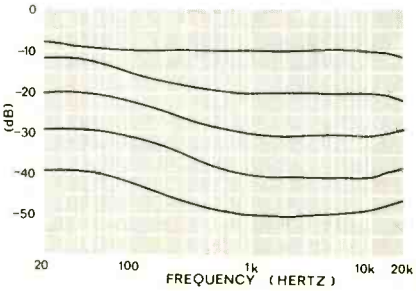


Fig. 8–Loudness contour for enhanced bass response at low listening levels.



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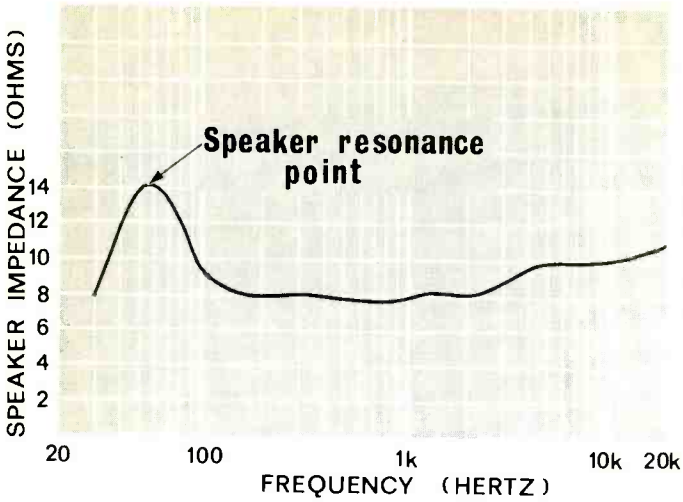

Fig. 9—Speaker impedance of the S-10 system remains 8 ohms or more throughout the audio range, affording high protection to power output transistors.

frequency balance was quite saisfactory. Middles were not as good as the S-10's, as might be expected. Probably the low-middle frequencies are being masked a bit by the bottom end.

Both sets of loudspeaker systems were also tested by extended operation with a different receiver from that offered in the compact system. In this way, they were also judged independently, as loudspeaker systems per se. No audible difference was detected.

From an equipment protection point of view, the manufacturer claims that these speakers have an impedance of 8 ohms or greater at all audio frequencies, so that there is no danger of approaching a "short circuit" condition across the output transistors. By this time most everyone knows that extremely low impedances (under 4 ohms) across most power output solid-state circuits can damage the output devices. The speakers were put to the test and impedance was measured at all significant frequencies. The results are plotted in Fig. 9 and, as can be seen, the curve is so smooth it could be mistaken for an amplifier frequency response curve rather than a loudspeaker's impedance curve (which usually is full of extreme mountains and, what's worse, valleys).

FM reception is flawless and noise free. A total of 35 FM stations were logged, 11 of which were broadcasting noise-free stereo. The least powerful of these (but nevertheless quite listenable) registered a meter indication equivalent to only 10 μV of signal at the antenna terminals.

In terms of the compact's record-playing facility, we would have liked to see the music system employing the next grade or two up in the Garrard and Pickering lines of automatic turntables and stereo cartridges, respectively. (Scott's AM-FM stereo compact *does* incorporate a more sophisticated Garrard changer.) That's one of the shortcomings of buying a fixed system. With separate components, it is axiomatic that various components be matched in terms of quality and cost.

Still, at $349.95 for the Model 2504 and $419.95 for the Model 2505, it must be admitted that overall performance and sound quality rivals that of component systems in which these prices were for the receiver alone. Also, the views expressed here have to be tempered by considering the wider, less-demanding audience that many of the compacts are headed for.

Both compact systems represent excellent value, reproducing records or FM broadcasts in a very satisfying manner. There is no doubt that "component" quality has been incorporated into the units. Refinements such as tracking as low as ½ gram, an elliptical stylus, anti-skating control, etc., are absent, of course. But then the compact end-user will probably not even miss it, or if he does, console himself with a "that'll be next when I have the money" rationalization.

Choice of speaker systems made a distinct difference in performance. Judging the compacts as systems rather than as components, the more expensive Model 2505 ($70 more) clearly produced better sound. Whereas the Model 2504 with its S-14 speaker systems sounded very much like a good receiver played through $49.95 speakers (which it is), which is not to be sneezed at, the Model 2505 with speakers at $79.95 each (if bought separately as component speakers) could well pass for, say, $109.95 speakers.

A-B'ing the two compact music systems, the less expensive Model 2504 (with S-14 speakers) just didn't exhibit the sparkle and crispness displayed by the S-10 speaker systems when they were substituted. The 2504's S-14 speaker systems came off sounding relatively dull; certainly less realistic than the S-10s did.

The lesson here is that a stereo hi-fi system is only as good as its weakest link. In our estimation, therefore, the Model 2505 offers better value if you've got the extra $70 and truly care about good sound. The S-10 speakers are bigger than the S-14 ones, of course, defeating compactness somewhat. But they're worth it. Combining tasteful design (an optional smokey-gray plastic cover is a *must*), nice overall performance (especially with the S-10 speaker systems), and modest cost, the compact Scotts should find their way into many apartments and homes where space is at a premium.

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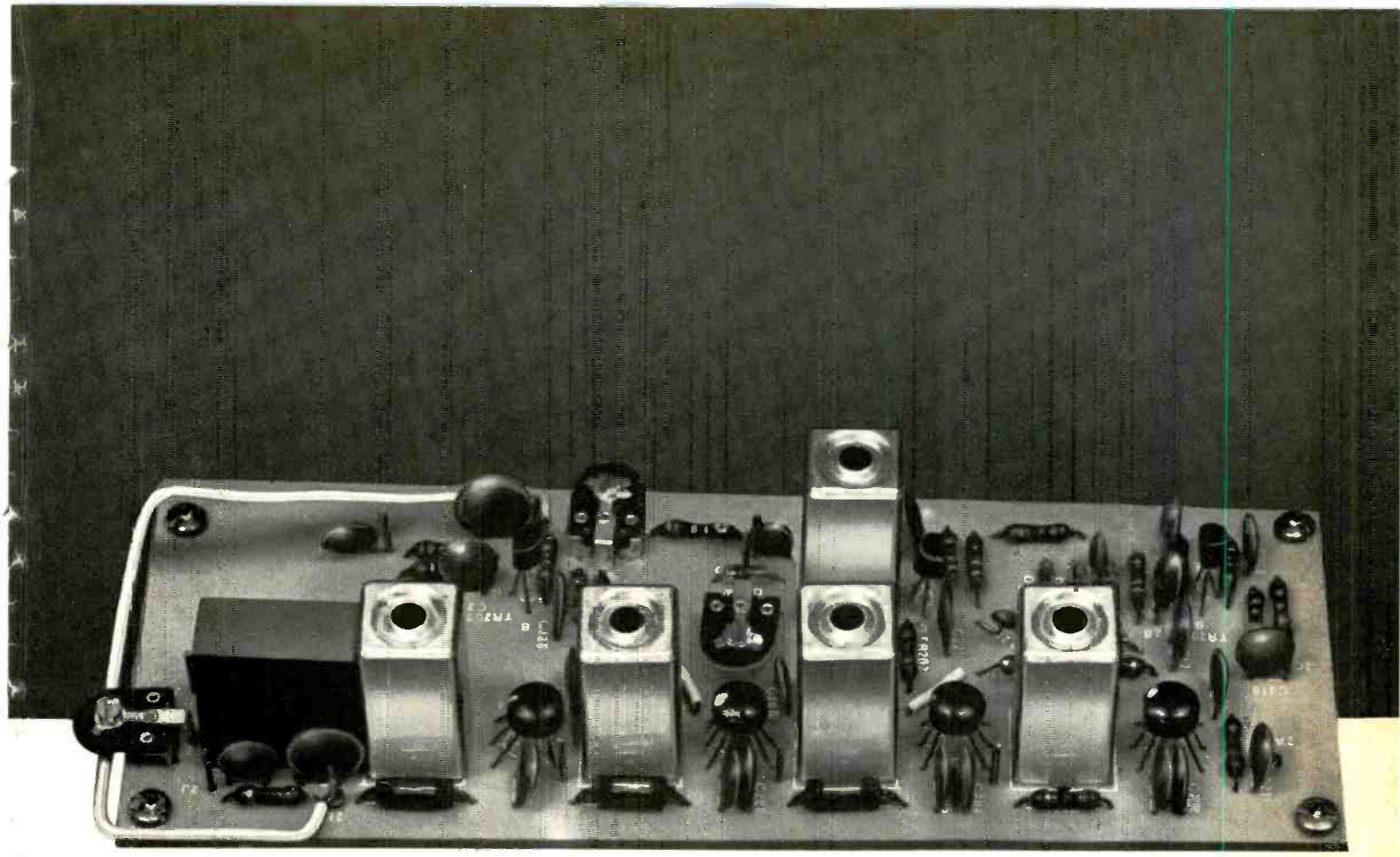
Ampex Micro 85 Stereo Cassette Recorder Player

MANUFACTURER'S SPECIFICATIONS—Frequency response: Playback, 6-dB envelope; Overall 8-dB envelope, 100 Hz to 8000 Hz. S/N ratio: 40 dB min. Crosstalk: 50 dB min., mono, at 100 Hz (side 1 to side 2); 20 dB min., stereo, at 1000 Hz. Mic input sensitivity: 1 mV min. Line input sensitivity: 200 mV min. Input impedence: Mic, 1000 ohms; line, 1 megohm. Line output level, 500 mV min. (100k ohm load). Speaker output level, 800 mW min. Speed accuracy: 5%. Flutter: 0.4%. Price: $199.95.

This is the first time we have been able to study a home-type stereo cassette player, and it is really an eye-opener. Not that it is *really* high fidelity, but it is nevertheless a fine compact instrument for playing cassette tapes, *and* recording them as well. The unit is furnished complete with a stereo microphone, a table stand, two patch cords—about which more later—and two speaker systems.

By compact, we mean just that. The recorder/player measures 14¾ in. wide by 8½ in. deep by 4¼ in. high over the knobs, of which there are four—recording level, balance, volume and on/off switch, and tone. There are also seven piano-key operating controls—record, cassette, play, rewind, fast forward, pause, and stop. The record key is red, and must be depressed along with the play key when you wish to record. The cassette key releases the cassette holder to allow a cassette to be inserted or removed. The other keys are self explanatory, with the possible exception of the pause key, which allows the recordist to set levels with the controls in the record position but without actually recording the tape. It also serves as a momentary stop key to allow the user to answer the ubiquitous telephone call so often mentioned in the ads. A digital counter with a push-



Suddenly it's 1969...

Look closely at this photograph and you will notice four Integrated-Circuit* components which are part of the IF section of the new Sansui MD 5000 solid state, stereo receiver. These small hat-shaped objects are filled with a number of diodes, transistors and resistors integrated into a functioning sub-miniature circuit. They are just one of the latest advances introduced by Sansui along with such advanced audio circuitry as the specially selected FET FM front end. Consider these specifications: 160 watts IHF music power (75 watts per channel continuous power); 1.8 μV sensitivity; selectivity better than 50 db at 98 MHz; stereo separation better than 35 db; flat frequency response from 15—40,000 Hz.

The MD 5000 includes output connections for three separate sets of stereo speaker systems which you can select separately or in pairs. In addition to inputs for tape, phono and auxiliaries, Sansui gives you extra input and output tape connections for recording or playback using extra recorders. You may monitor tape machine 1 or 2 from front panel when you record through your Sansui receiver . . . all the features which will make it the nucleus of your most comprehensive hi-fi music system for years to come. This new Sansui MD 5000 has been created for the sophisticated connoisseur who demands the ultimate in tonal magnificence and clarity of sound. $449.95.

Sansui

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Fig. 1--Ampex "Micro 85" stereo cassette recorder/player.

button reset is located at the upper left corner of the panel, and a record-level meter is at the lower right.

The rear of the unit is fitted with four jacks—two speaker jacks which accommodate phone plugs to feed the speakers, and two DIN receptacles which accommodate 5-pin DIN plugs for the inputs and line outputs. Two adapter cords (as mentioned previously) are furnished, with 5-pin plugs on one end and two phono cable receptacles on the other. An ingenious wiring arrangement permits the use of one of the sockets for both microphone inputs and line outputs, while the other is only for radio and phono inputs. The stereo microphone, with its folding tripod stand, has an attached 10-ft. paired cable and a DIN plug. (DIN is Deutche Industrial Norm, corresponding to our ASA, and the plugs are usually referred to in U. S. literature as Hirschmann types, although they are made by a number of manufacturers.)

The instruction book is exceptionally clear, since it is undoubtedly intended for the beginner to tape recording. And we were surprised to find taped to the bottom of the inside of the housing a complete schematic — undoubtedly for the use of a service man if the need should ever arise.

Cassette standards

Most AUDIO readers are already familiar with the track arrangement of the cassette, but for the information of those who are not, the drawing of Fig. 2 should make this arrangement clear. In the usual ¼-in. reel-to-reel machine, the right and left tracks for one direction straddle each other, so that tracks 1 and 3 are the left and right tracks for one direction of tape motion, and tracks 2 and 4 are the corresponding tracks for the other direction. On the cassette, however, the two 24-mil tracks for one direction occupy the upper half of the tape, being spaced by 11 mils, and two similar tracks for the other direction occupy the lower half. This arrangement permits a mono machine to play a stereo recording monophonically by playing the two tracks at once, thus giving a L + R output, since the mono head has a 55-mil gap which covers both the L and R stereo tracks simultaneously. This makes for a much more difficult head construction, and accounts for the relatively low stereo separation—20 dB, instead of the 50-dB separation on mono. The 20 dB is adequate for stereo, although it would not be enough if it were possible to record all four tracks as separate mono tracks. (Actually, one *could* record all four tracks separately by simply feeding only one of the stereo inputs at a time, and then playing back through a separate amplifier using the line output, but this would not be a normal technique, and not likely to be done by a cassette user. The crosstalk would be much too great for satisfactory recording.) Note that the cassette tape is only 150 mils wide.

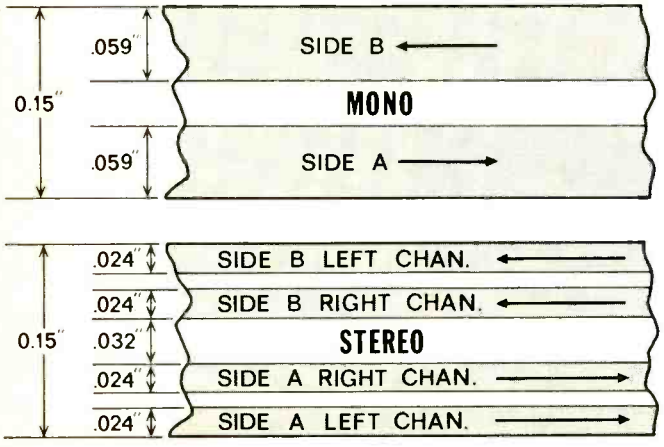

Fig. 2--Here is the cassette system format, illustrating track width for mono or stereo (the system allows a mono recording to be played on a stereo unit, and vice versa).

Circuitry

In spite of the over-all small size of the Micro 85, one must realize that there is just as much circuitry as in the larger reel-to-reel machines. Both require preamps, equalized stages, controls, an output or power amplifier, a power supply, a bias/erase oscillator, and a record-level indicator, all in addition to the motor and the necessary pulleys, belts, and so on which are required to transport the tape. This unit uses a BC 109 transistor as a preamp stage, followed by the record level control when in the record mode, or coupled directly to the equalized two-transistor amplifier section which uses a BC 109 followed by a BC 108. This constitutes the recording section and the playback section up to the line output. Following this are the balance control, the compensated volume control, and the tone control, which simply rolls off the highs. These are followed by a driver stage which uses another BC 108, and the complementary-symmetry output stage using an AC 187 and an AC 188. All transistors are npn types except the AC 188, which is pnp. Both channels are identical.

A BC 107 serves as the bias/erase oscillator, working at approximately 55 kHz, and the two record amplifier outputs are mixed in a two-transistor circuit with the emitters tied together to feed the record level indicator. In the power supply, there is no conventional power transformer—the four-pole motor has four sets of coils. Two of these coils are the "primary" and the other two are the "secondary," feeding a bridge rectifier which provides 19.4 V and 16.4 V for the output stages, and a pair of diodes which are connected as a voltage doubler to provide 28.6 V for the preamp and recording stages and the record-level meter-driver circuit. The bias/erase oscillator is powered by

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the 16.4-V output. The motor is provided with a two-step pulley to serve on both 50- and 60-Hz line frequencies, and the "primary" coils of the motor/transformer are tapped for line voltages of 110, 127, 220, or 245 volts. The speaker-output jacks are fitted with a shorting contact which connects a 15-ohm terminating resistor across the output circuit when the plug is removed. On the whole, the circuitry is extremely compact, and with respect to the motor/transformer, unique.

Operation

For the purpose for which this unit was designed, everything necessary is provided. While there are no separate controls for right and left channels, they are not really necessary for this type of usage, nor are separate record-level meters essential. In addition to normal recording and playback operation, it is also possible to use the Micro 85 as a public address amplifier, although with an output of only 800 mW it would not cover a very large audience. For the average home user, however, it is a plus feature which could be useful and entertaining.

Performance

We found that the Micro 85 exceeded its specifications to a pleasant degree. The frequency response curves of Fig. 3 show it to be within an envelope of 6 dB from 45 Hz to 9500 Hz, whereas the claimed response is only 100 Hz to 8500 Hz. This is at the line output, and was measured on an in/out basis, since no Standard Frequency Tape seems to be readily available. The speaker output, at the claimed 8-dB envelope, extends from 50 to 8200 Hz, and this with the tone control in the mid-range position. In the "maximum highs" position, the 8-dB envelope extends from 50 to 9100 Hz. Signal-to-noise ratio, measured from the recording level at which 3% distortion was measured overall, was 54 dB instead of the claimed 40-dB minimum. The line-output signal measured 1.7 V at 400 Hz at the 3% distortion point.

We had some misgivings about the claimed flutter figure of 0.4%, and before making any measurements, we recorded (from a phonograph record) a piano selection and then played it back in sync with the record. The differences were certainly minimal, and the flutter did not seem to be particularly disturbing. In later measurement, we found that flutter was actually only a shade over 0.3%, which is about normal for 1⅞-ips machines of any type.

The speaker systems

Little mention has been made of the speakers furnished with the Micro 85, but only because they are fairly conventional and about as would be expected for their size—14½ x 9 x 7⅛ in. Each consists of a single 6 x 9 cone, and their performance is satisfactory. Their impedance is 8 ohms, so any other 8-ohm speaker of fairly high efficiency could be used.

Our considered opinion of this entire system is that it is, foremost, convenient to use and attractive looking. The pop-in cassette, like continuous-loop cartridges, invites people who are not inclined toward things mechanical—say, the housewife—to use the machine; its walnut-grain body and overall design bespeaks high quality which should fit in well with one's home furnishings.

Audio performance, while not comparable to that of a hi-fi component system, is nevertheless satisfying if you're not too picky. Even here, however, it is easy *not* to be too critical when the Micro 85's favorable attributes are considered. Too, a tape *deck* (Micro 50) is available for $60.00 less than the complete system; that is, $139.95 vs. $199.95, for playback through a stereo hi-fi system. This would provide better sound, of course.

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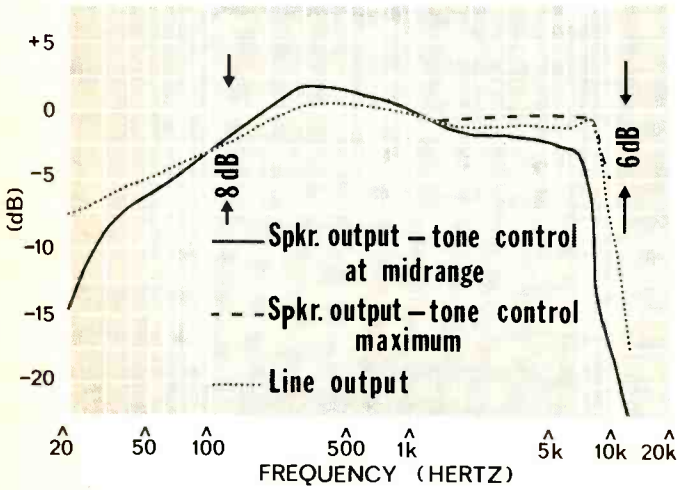

Fig. 3 – Response curves, in/out, of the Ampex Micro 85 player/recorder.

Electro-Voice RE-15 Dynamic Cardioid Microphone

MANUFACTURER'S SPECIFICATIONS– Element: Dynamic. Frequency Response: 60-15 kHz. Polar Pattern: Super Cardioid. Impedance: Lo-Z (150 ohms). Output level: −55 dB (0 dB-1mW/dyne/cm²). EIA Sensitivity Ratings: −149 dB. Dimensions: 6" long, 1⅜" diameter. Net Weight: 8 oz. Cable: 18-feet 2 conductor, shielded, rubber-jacketed, with Cannon XLR-11 connector. Cable Connector: Cannon XLR-3-12 Accessories Furnished: Protective metal carrying case, Model 310 clamp. Opt. Access: Model 311 "Snap Out" clamp. Net Price: $153.00.

The E-V RE-15 is a dynamic supercardioid microphone that is ideal for use in tough assignments, such as recording, broadcasting, or amplifying voices in areas where either background noise or probability of feedback requires good directional control. It should also serve well in most other recording, broadcast, or PA applications. Light weight and small size enhances its utility.

Dynamic is the principle of operation in which a suspended diaphragm moves an electromagnetic coil within the gap of a permanent magnet. It is this motion which produces the electrical currents that are proportional to the acoustic waves impinging on the microphone's diaphragm. This is exactly the reverse process of a dynamic loudspeaker.

Dynamic microphones are probably the most practical and economical of the microphone types to use, despite relative frequency-response irregularities and frequency-dependent directivity (which stem from the near-impossible requirement of keeping a system under control over a nine-octave

(Continued on page 66)

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AN ASTOUNDING NEW AUDIO NOISE REDUCTION SYSTEM WHICH IS MAKING BACKGROUND NOISE YESTERDAY'S PROBLEM.

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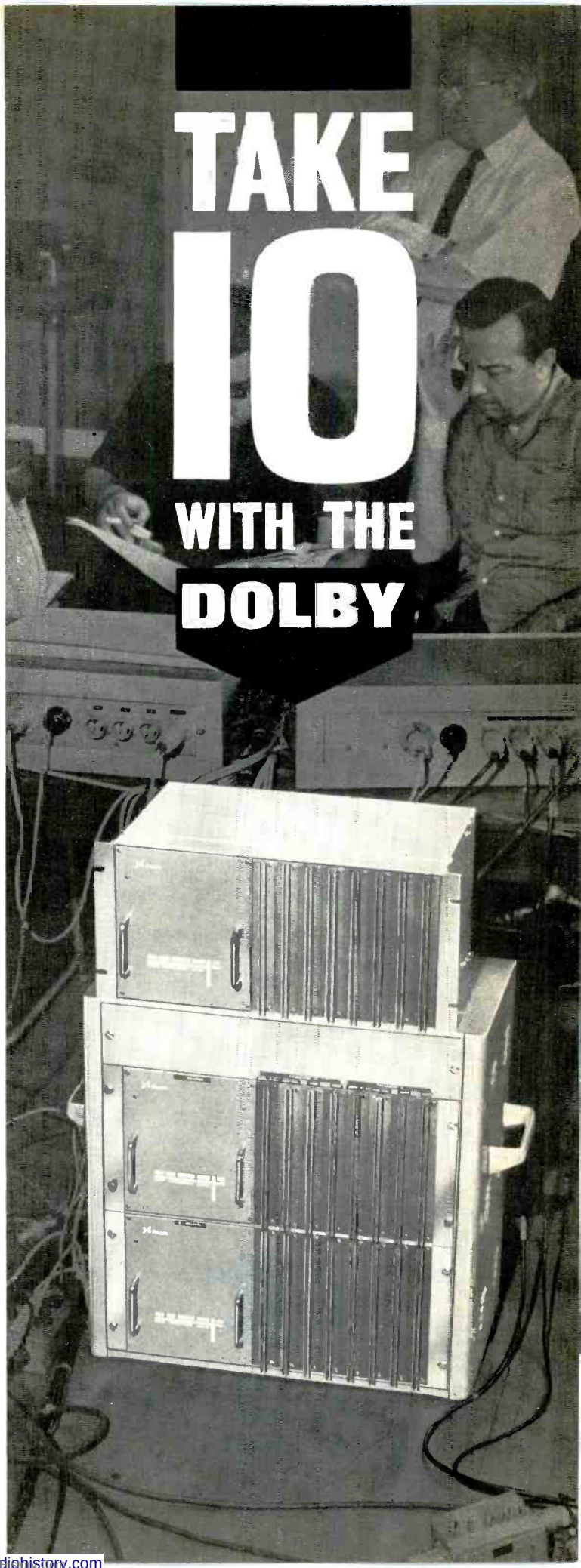
PLUS generally cleaner, more transparent recordings—with unaltered frequency response and signal dynamics.

Recording engineers and musical directors are so enthusiastic about the Dolby S/N Stretcher system that the network of users is growing at an astonishing rate—on an international scale. Master tapes made with the system now fly regularly between the major recording centers of the world, such as New York, London, Rome, and Vienna.

The basic principle of the system is simple. Low-level signals are amplified in four independent frequency bands during recording and attenuated in a complementary way during playback—recording noises being reduced in the process. High-level signals are unaffected by this procedure (no distortion or overshooting), and the symmetrical design of the circuitry ensures that the signal is restored *exactly* in all details—high-level *and* low-level, amplitudes *and* phases. The result is a noise reduction system with ideal characteristics—perfect signal handling capability which can pass any line-in, line-out A-B test, and a genuine 10dB noise reduction.

In short, the Dolby system offers an entirely new area of sound for the recording engineer. Get to know more about it fast by writing directly to Dolby Laboratories or contacting your nearest agent.



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U.K.: Dolby Laboratories, 590 Wandsworth Road, London, S.W.8. **Europe and the Middle East:** Impetus SA, 2 Via Berna, Lugano, Switzerland. **Australia:** General Electronic Services Pty. Ltd., 5 Ridge Street, North Sydney. **Japan:** Sakata Shokai Ltd., No. 10, 2-Chome, Kandakaji-Cho, Chiyoda-Ku, Tokyo. **South Africa:** Vitaphone Pty. Ltd., Cape York, Jeppe & Nugget Sts., Johannesburg.

EQUIPMENT PROFILE

(Continued from page 64)

range). Having several degrees of freedom of motion, as represented by a diaphragm which is locally weighted by a voice coil, the dynamic microphone type has the handicap of not being an elegant oscillator mechanism. This is especially true for directional microphones, which require a vibrating system with a low resonance. When compared to microphones using different operating principles, however, dynamic microphones exhibit reliable operating characteristics, are capable of excellent performance, are rugged, and come in small sizes and light weights. Thus they have found wide popularity among amateurs and professionals alike.

"Super cardioid" is the shape of the RE-15's pickup pattern when plotted on a polar coordinates graph, as shown in Fig. 3. The super cardioid is, in effect, a cardioid that has slimmed down its heart shape in trade for a little tail. For the user, it means that the super cardioid is least sensitive to sound coming at about 30 deg. away from the rear. This assures greatest rejection in the horizontal plane when the microphone is tilted in its most natural position: 30 deg. from the horizontal (as on a boom or floor stand).

The cardioid pattern is obtained by built-in openings at the rear of the microphone diaphragm. The openings are baffled so that sound coming from the front of the microphone is allowed to hit one side of the diaphragm. Sound coming from the sides or rear, drives both sides of the diaphragm in phase, causing cancellation of diaphragm motion and, therefore, less output from the microphone system.

The RE-15 has a tiny, neatly recessed, "bass-tilt" switch. When activated, it throws in a filter network across the line, resulting in additional low-frequency attenuation. Such attenuation is desirable to compensate for the bass rise when talking at close range to the microphone.

The Model RE-15 was tested by direct comparison with a calibrated wide-range ribbon microphone, using several linear loudspeaker elements as sound sources. Tests were performed both outdoors and indoors, and results "normalized." The resultant response, illustrated in Fig. 3, shows that the RE-15 is able to cover most of the audio range with ease, well within its specifications. With the bass-tilt switch in its flat position, a response of ±5 dB from 100 to 17,000 Hz was measured. With the bass-tilt switch on, we got an additional 6 dB of attentuation at 100 Hz, with no effect above 500 Hz. The resonant peaks at 6 kHz and 11 kHz are typical of dynamic microphones, but smaller than most.

Sensitivity, as measured relative to our calibrated microphone, at 1 kHz, was calculated to be −55 dB referred to 1 mW/10 dynes/cm² or 1 mW/10 μBar/1 kHz. This hefty output is as specified and should be enough to drive most recording or PA amplifiers. The RE-15 has a low-impedance output, making it suitable for long cable runs between it and the recorder or amplifier. When the microphone is used in conjunction with a high-impedance recorder input, an impedance matching transformer is called for at the recorder.

The RE-15's polar response was checked at the following points: at approximately 30, 45, 90, 150 and 180 degrees, at 3, 5 and 15 kHz. Our results came to within the manufacturer's specifications, a curve of which is shown in Fig. 2. We measured about 20 dB attenuation at 150 deg. from the major axis and about 15 dB at 180 degrees, both at 3 kHz. At higher frequencies there was a little more attenuation at the sides, improving the microphone's

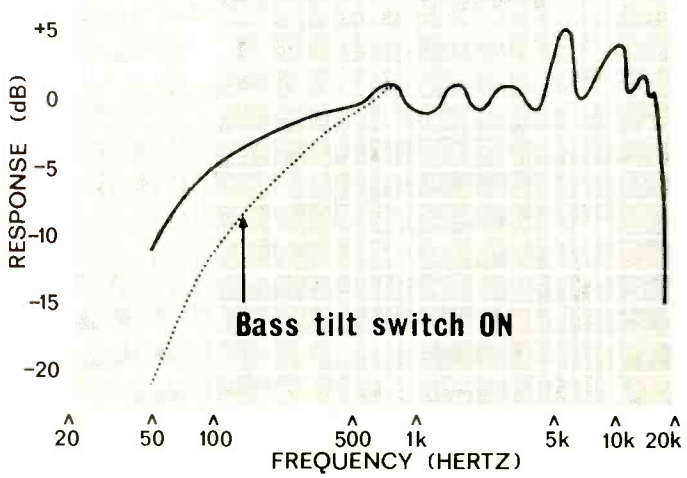

Fig. 2 — Measured frequency response of the RE-15, with bass tilt switch on and off.

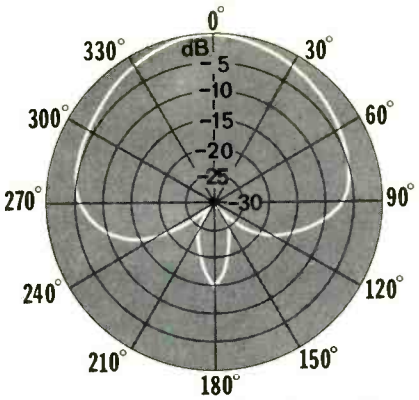

Fig. 3—Polar response of the Electro-Voice RE-15 dynamic microphone.

directivity at the expense of a little less attenuation at the rear.

The RE-15 was found to have low sensitivity to hum, pop, wind, and shock, all factors in its favor. We then compared the RE-15's output to that of other high-quality microphones, using a mixer-preamp and professional quality headphones, as the RE-15 was fed music reproduced by various full-range loudspeakers. Relative to other microphones in its price class, the RE-15 acquitted itself very well, adding about the same amount of mid-range projection to the music as did most other microphones under the severe test conditions. We concluded that the RE-15's peaked presence range, so useful in reproducing the voice, traded off some smoothness in pickup from a large orchestra—a use for which it is probably not intended.

Feeling that really the best way to check out a microphone is to use it, we installed the RE-15 in place of microphones which have been established as favorites in recent years and are in the same price range as the RE-15. The existing 3-mike setup, with an excellent sound system, covered a jazz trio which was performing in an intimate cocktail lounge. Each man in the trio sang into his own mike, with the RE-15 substituted for each, in turn. Any sensitivity difference was compensated for at the mixer. In every case, the RE-15 performed very well. In fact, its high directivity made it possible to increase the acoustic gain of the place a little.

For our second application, we used the RE-15 to record a male speaking voice, followed by several percussion instruments — all in a relatively live room. The bass-tilt switch was utilized for the voice, with audible effect. Results were most gratifying because we had ourselves a very *realistic* recording, the end result of using an especially fine microphone.

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CLASSICAL RECORDS

EDWARD TATNALL CANBY

Bizet: Symphony No. 1 in C; Jeux d'Enfants: La Jolie Fille de Perth (Suite). London Symphony, Roberto Benzi.
World Series PHC 9086 stereo ($2.50)

'Sfunny. Just as I finished writing about Dr. Bowes' amateur hour with the Royal Philharmonic (see page 24) I picked up this disc of similar music played by another London orchestra—under a "real" conductor. Very interesting. For if you play this after Everest's Bowes recording you will hear clearly what an experienced and positive leader can do to intensify and concentrate musical communication.

Roberto Benzi is about thirty, but has been conducting since he was eleven. He's no longer a prodigy, just a highly energetic pro, and he points up this lovely, easy-going Bizet music in really wonderful ways. It scintillates, it sparkles with warmth and freshness. He's French-trained, after all, and so was Bizet.

Why, he even manages to make the early Bizet C Major Symphony sing all the way through, in spite of its well known and very student-like stretches of musical hokum. (Not all of it! The basic ideas are lovely. The young Bizet just wasn't yet able to write the proper connective tissue.) This is a fine example of real conductor's work, shaping up the music as no orchestra could do on its own. E.T.C.

Performance: A— *Sound:* B+

Piano Works

Schubert: Piano Sontata in B Flat, Op. Posth.
Mozart: Piano Sonata No. 10 in C, K. 330. Clara Haskil.
World Series PHC 9076 stereo

Any recording at all of that superb pianist Clara Haskil, a tiny wisp of a lady who died back in 1960, is worth anything you may pay for it. This one, with the great and long Schubert work and the relatively tiny Mozart, is indifferent in sound, if passable enough, but as always is tremendous in musicianship. I would guess the "stereo" is a very gentle synthetic, applied imperceptibly to improve sound distribution via stereo speakers.

The Haskil piano is one of those somewhat modern sounding European jobs, and there are a good many percussive peaks in the sound, resonances at certain notes—you'll find the listening best around a corner or in another room, where the peaks are inaudible but the music comes through fine. E.T.C.

Performance: A *Sound:* C

Bartok: Piano Concerto No. 3.
Ravel: Piano Concerto in G. Julius Katchen; London Symphony Orch., Istvan Kertesz.
London CS 6487 stereo

An excellent Bartok and an outstanding Ravel here.

Curiously, both Bartok and Ravel, within their twentieth century idioms, wrote "old fashioned" piano concerti with all the trimmings. Many performers, taking this too literally, go in for a big, humorless, heavyweight approach. They miss the point.

In Bartok the point is the scintillating crispness of rhythm and harmony, the crackling energy of the music—even in this last and most "old fashioned" of his concerti. Though this performance isn't exactly super-high-voltage, with an urbane British orchestra doing the honors, it never becomes heavily Romantic; the tensions are always clear and evident, both in the piano and the orchestra.

As for Ravel, the point so often missed is that here, beneath an outward "Romantic" format, is sheer Gershwin jazz; the music is full of that snazzy, brassy Americanism that had so delighted Ravel on a visit to the U.S. Many a performance wholly misses out, trying to make the music sound elegantly Viennese. Phew! It doesn't work. Dreadful. But not here. In this recording both pianist and orchestra enter into the real fun-spirit of the music and it is done up to perfection.

For my taste, the piano is a bit too prominent in the over-all balance, sounding closer than the orchestra. But this is a matter of differing taste and choice. E.T.C.

Performance: B+, A— *Sound:* B

Orchestral

Kodály: Concerto for Orchestra (1939); Dances of Galánta; Dances of Marosszék. Phila. Orch., Ormandy.
Columbia MS 7034 stereo

Though Kodály and Bartók are usually mentioned in one breath as the great modern Hungarians (and they were close friends and co-workers in folk song collecting), Kodály's music is far milder, much easier-going, only "modern" in a gentle fashion. He died this year at 85—his music no longer can bother any ear with its dissonance. Far from it!

The unusual item here is the Concerto for Orchestra, somewhat of a prototype for Bartók's similar work of five years later. It is one of those then-popular "neo-classical" pieces—we'd call them semi-Baroque now—with slightly Bach-like rhythms in the fast movements and a lot of solo work within the big orchestra. Attractive, beautifully written, nice listening and not very important, for all its fairly imposing size.

The two sets of Dances on the obverse side are both familiar and more impressive, though technically older-fashioned. Built on modern-type "authentic" Hungarian folk material, they are big, Romantic suits, descended from the old Hungarian Rhapsodies of Liszt, Brahms, with a bit of harmonic tratness to update the sound, a huge orchestral spread and lots of Hungarian tunefulness.

The usual Philadelphia sheen prevails, with especially soulful wind playing; but the unfamiliar Concerto doesn't seem to have been rehearsed very well. The strings play sloppily—that is, for the Philadelphia. You probably won't even notice it. E.T.C.

Performance: B— *Sound:* B+

Orff: Catulli Carmina. Judith Blegen, Richkness; Temple Univ. Choirs, Phila. Orch., Ormandy
Columbia MS 7017 stereo

Those who have heard the now-famed "Carmina Burana" of Orff need merely know that this is the "other" Orff work of the sort, with many of the same qualities. An extremely spicy Latin text (manfully translated here—with reasonable literalness), a big "speaking" choir, soloists, highly colorful orchestra that seems to be mainly big drums and crashing percussion highs in the sound. The chorus intones the words at breakneck speed, with that inimitable rhythmic repeating that is an Orff trade mark—"tui mi cara mi cara mi cara mi cara mi cara" or "Corcule corcule corcule corcule corcule," like a high-speed stylus stuck in a groove. Very effective, if somewhat limited. Orchestra plays the same old chords over and over—stuck in a key—with assorted loud, zinging crashes of fabulous sonic impact. Biggest bass drum you ever heard. Smashing highs

EXPERTS AGREE . . . the Heath AR-15 is the world's most advanced stereo receiver

Electronics World, May '67: "Heath implies strongly that the AR-15 represents a new high in advanced performance and circuit concepts. After testing and living with the AR-15 for a while, we must concur."

Hi-Fi/Stereo Review, May '67: "Several people have commented to us that for the price of the AR-15 kit they could buy a very good manufactured receiver. So they could, but not one that would match the superb overall performance of the Heath AR-15."

Modern Hi-Fi & Stereo Guide, 1968: "I cannot recall being so impressed by a receiver . . . it can form the heart of the finest stereo system."

Audio Magazine, May 1967: "The entire unit performs considerably better than the published specifications."

High Fidelity, Dec. '67: "The AR-15 has been engineered on an all-out, no-compromise basis."

Popular Electronics, Jan. '68: "There is no doubt in your reviewer's mind that the AR-15 is a remarkable musical instrument."

Popular Mechanics, Nov. '67: ". . . Heathkit's top-of-the-line AR-15 is an audio Rolls Royce . . ."

Popular Science, Dec. '67: "Top-notch stereo receiver" . . . "it's FM tuner ranks with the hottest available" . . . "it's hard to imagine any other amplifier, at any price, could produce significantly better sound."

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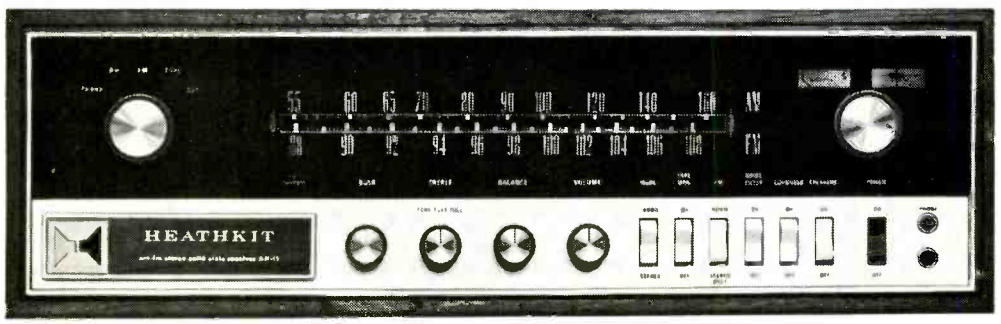

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CLASSICAL RECORDS

(Continued from page 68)

like dropping fifty dinner plates on a concrete floor simultaneously. Quite a sound.

The music is both difficult and fun to sing and the Temple University students have a ball here, mostly keeping the ball rolling crisply and cleanly, though I have heard it done with even more precision. Very good stunt record.

Performance: B *Sound:* B

The Passions of Bach

Bach: St. John Passion. Pears, Harwood, Young, Watts, Alan, Ward et al., Choir of King's College, Cambridge, Philomusica of London, Willcocks.

Argo ZRG 5270/72 (3) stereo

This shorter, leaner, more intense Bach Passion, of the two that survive, is here given a full British treatment—not only sung in English translation but in British style and with an all-British cast. It's rather specialized, I'd say. And a lot of it just goes 'round and 'round in the vast reverb of King's College Chapel. Not the right place for such dramatic, quick-moving music.

The Chorus is, of course, the well known Choir of the Chapel, made up of those heavenly, hooting little-boy boy sopranos and altos, and those somewhat corpulent and wobbly tenors and basses. The two groups do not really blend very well. The solos are among the best in Britain, but veddy British. Under this all-out treatment, Bach tries hard to sound like Handel, but doesn't really make it.

Biggest liability, alas, is the famed Peter Pears, who sings the crucial Evangelist, the Narrator of the story. He is passionate but no longer accurate in pitch; he seems not to hear the discreet organ accompaniment too well, and tends to drift out of tune—net result is that we miss a lot of the harmonic sense of his dramatic recitatives. We shouldn't.

All in all, I'd class this as a noble effort. E.T.C.

Performance: C *Sound:* B

Bach: St. Matthew Passion. Haefliger, Berry, Giebel, Höffgen et al., Netherlands Radio Cho., Boys' Cho. of St. Willibrord's Church, Amsterdam, Concertgebouw Orch, Jochum.

Philips PHS 4-999(4) stereo

Though Bach's original performing forces were small, perforce, the St. Matthew Passion is an inescapably huge work in every sense. It calls for the relatively large forces assembled in this monumental Dutch performance, which combines old-fashioned hugeness with elements of the new "authentic" approach, such as a proper cello-harpsichord continuo accompaniment. In the large, I found it rather typically Dutch; which is to say that it is fervent, well shaped, authoritative and tending towards weight.

No great harm done! Especially with a superb Narrator—the crucial factor in every Bach Passion performance. The solo crew is wisely made up of Germanic voices, rather than local Dutch, and of them all, Ernest Haefliger, in the crucial spot, is the best. His Evangelist-narrator soars, weeps, shouts, whispers the story, all with faultless high-tenor tone and marvelous diction. The others are good standard high-level soloists who know the musical tradition involved.

The Passion alternates Narrator and solo singers with choral passages set forth in double chorus plus, in the enormous opening movement, a third chorus of boys, singing phrases of a chorale (hymn) melody. A curious microphoning deviation arises from all this enormity, plus the use of authentically intimate solo accompaniments: we hear the soloists (including the Narrator) at short range, close-up and intimate, but the chorus is 'way off in an enormous space. It is not easy, therefore, to relate the two aspects into one sonic environment. A solo voice sings passionately about two feet away. The chorus shouts imprecations off in the distance.

The instrumental complement is similarly treated; sometimes we hear an orchestral ensemble, at other moments we hear close-by solo instruments, out of spatial context.

I'd call this interesting rather than disadvantageous. Most listeners won't particularly notice it.

The album includes not only the complete German text, with English running summary, but an extra portfolio of 13 handsome line drawings on the Passion subject by Rembrandt, suitable for framing. E.T.C.

Performance: B+ *Sound:* B—

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Economy Mozart

Mozart: The Magic Flute. Gueden, Lipp, Berry, Simoneau, Bohme, Schoeffler, Vienna State Opera Chorus, Vienna Philharmonic, Bohm.
Richmond SRS 63507 (3) stereo

What a super-bargain — for Mozart fans! At the Richmond "half price" level (actually it is even less than that), this is indistinguishable from the newest and fanciest recording in all essential respects, including its useful stereo.

And I found it a lively, lovely performance. The soloists are imbued with the humorous-serious music, sing with real dedication; and I particularly like the orchestra, which plays a superbly light-footed, incandescent Mozart, alive as all get-out. In such a big work there are infinities of detail in which different performances may be minutely compared—if it is worth it to you. If not, I'd say you can't possibly go wrong here. This is a splendid performance, and a fine recording technically. E.T.C.

Performance: A *Sound:* B—

Sibelius Favorites

Sibelius: Symphony No. 2 in D; The Swan of Tuonela. The Halle Orchestra, Sir John Barbirolli, cond.
Angel S 36425 stereo ($5.79)

Of the seven Sibelius symphonies, this is the most popular. It's easy to understand why when you hear the large tapestry employed by the composer. Gradually building in the first two movements and continuing in the third movement, we run directly into the power and majesty of the *Finale*. All that went before is seemingly an anti-climax to this brilliant and dramatic statement. Sibelius employed a balance that favored the horns, with strings carrying the supporting line. This reaches the boiling point in this last movement—one of the few works that could make one's hair stand on end.

Sir John Barbirolli manages to capture the Finnish flavor without adding British conservatism. Thus, from a musical point of view, this is a recording that belongs right up there with von Karajan (also Angel), Maazel (London), and Schippers (Columbia).

Technically, the disc cannot be faulted. This has some of the cleanest sound, in terms of low distortion, that I have heard. Frequency response is wide and well balanced, stereo spread is big but with a full center fill, and dynamics are appropriately wide. Disc surfaces were quiet.

The *Swan of Tuonela* from the larger *Lemminkäinen Legend* is a melancholy work (Tuonela is the land of death, the Hell of Finnish mythology.) It is scored for an orchestra nearly devoid of the usual bright-toned instruments. The basic theme is carried by the English horn, itself a soulful sounding instrument. Only the oboe, of all bright-toned instruments, is there and, at that, only to strengthen the upper notes of the English horn. There is elaborate sub-dividing of the string sections. All this combines into a work of muted harmony, yet the great clarity of each section provided on this disc displays the structure of the work.

M.R.

Performance: A *Sound:* A

Two Quartets

Debussy: String Quartet in G minor, Op. 10.
Ravel: String Quartet in F. Quartetto Italiano.
Philips PHS900-154 stereo

These two French quartets are often paired on records—this is a particularly fine version. The Quartetto Italiano has been playing with present membership since the War years—even the famed Budapest hasn't been as consistent as that. They do the French pieces, to be sure, with a certain Italian passion, an outgoing intensity, a wide-open drama. Perhaps a French performance would be somewhat more veiled and subtle, at best. (And an American performance steely-perfect). No matter at all—for here you have not four instruments, but one, not mere notes but living music, even if Italian in style. Tremendous, I say.

If you think string quartet music is esoteric, just try these. E.T.C.

Performance: A *Sound:* B+

TO OUR READERS

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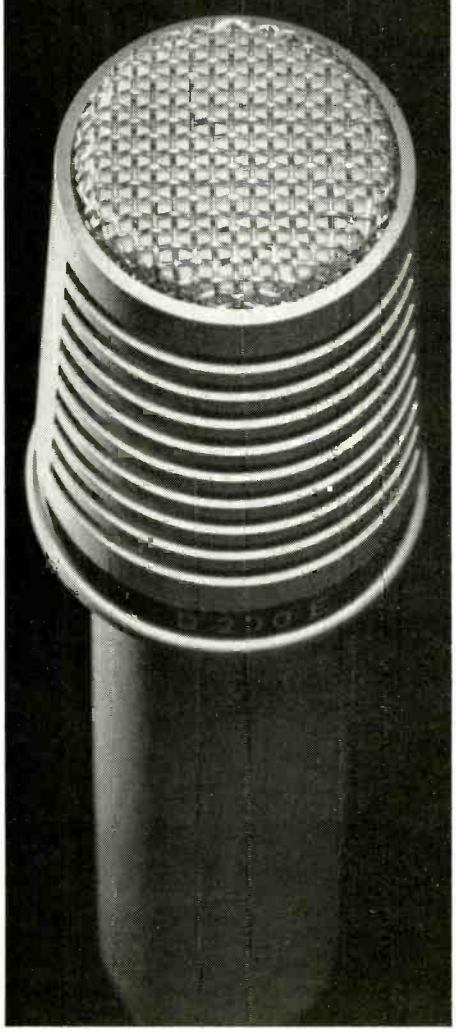

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THE DUKE AND ASSOCIATES

BERTRAM STANLEIGH

SEVERAL MONTHS AGO Verve Records brought out a two-disc album of recordings made at the 1966 Juan-les-Pins Jazz Festival [*Ella & Duke at the Cote D'Azur*, V6-6072-2]. Now another disc from the same French festival offers five additional goodies by the Ellington contingent. Of particular interest are two extended items, *La Plus Belle Africaine*, a lovely composition by the Duke, originally written for his January 1966 visit with his band to the first Negro Art Festival in Dakar, Senegal, and *Skin Deep*, twelve-and-a-half minutes of Sam Woodyard's solo drumming with a politely sympathetic backing from the balance of the band.

Paul Gonsalves' tenor saxophone gets solo billing in two charming, but hardly earthshaking, compositions, *Soul Call* and *West Indian Pancake*, and the platter ends on an appropriate note with *Jam With Sam*, a piece that Ellington has used for the last ten years to sign off and introduce individual members of the band. Only the *Plus Belle Africaine* is major Ellington, but as Norman Granz remarks in his liner notes, it "really makes the whole album worthwhile."

Verbal introductions to each selection add to the "live" atmosphere of the recording. But they are likely to pale after repeated listening. Sound is on a par with the previous set—just good enough to let the musical merits show through.

Recently, Ellington's veteran altoist, Johnny Hodges, was soloist in an outstanding set featuring arrangements by Jimmy Jones [*Blue Notes*, Verve V6-8680]. The set featured a batch of top flight studio sidemen, among them Snooky Young, Ernie Royal, Tony Studd, Frank Wess, Jimmy Hamilton, Jerome Richardson, Hank Jones, and Grady Tate. The sessions worked so well, that Verve decided to repeat the formula.

Just a year after the *Blue Notes* tapings, all of the performers noted above, plus a handful of men of equal caliber, were herded into a recording studio, and, sure enough, the resulting platter is in all respects a worthy successor to its estimable predecessor. The same bright, upbeat mood pervades both discs. Hodges is infallibly, unerringly in the groove. The Jimmy Jones arrangements are colorful, and give everyone ample elbowroom. And the selections include the Ellington-Hodges *The Wonder of You*, Hodges' *Heel Kickin'*, *Some Fun*, and *Eydie-Dee Dee, Wisteria* by Mercer Ellington and Jimmy Jones, and an instrumental version of the title tune, *Don't Sleep in the Subway*, that could give Petula Clark some real competition.

Clark Terry, the former Ellington trumpeter, tries out his new electronic Varitone trumpet in a collection that recalls his past association with a vocal version of Billy Strayhorn's *Take the "A" Train*. With George Duvivier, bass; Dave Bailey, drums; and Don Friedman, piano, Terry swings easily as he puts his instrument through its first recorded paces. By the use of a push button panel, hung from the neck, and a foot pedal, the Varitone is capable of doubling one octave down—producing a sound not unlike a trumpet-trombone duet. It can also vary its tone from bright, to normal, to dark.

All of these features get a real workout in a surprisingly enjoyable version of Grofe's *Grand Canyon Suite*. Two other numbers written by Terry especially for the new instruments are included: *Electric Mumbles* and *Take Me Out to Elkhart*. (Elkhart, Indiana is the home of the Selmer firm that makes the Varitone.)

Duke Ellington: Soul Call
Verve Stereo V6-8701 ($5.79)

Performance: A *Sound:* C

Johnny Hodges: Don't Sleep in the Subway
Verve Stereo V6-8726 ($5.79)

Performance: A *Sound:* A

Clark Terry: It's What's Happenin'
Impulse Stereo A-9157 ($5.98)

Performance: B+ *Sound:* B+

Jazz Piano, The Bird, & Peter Gunn

Robert Shaw: Texas Barrelhouse Piano
Almanac Mono 10 ($4.90)

This is another pressing of the same material reviewed some months ago on the Arhoolie label. Shaw is a great stomping stylist, and this new set is accompanied by an attractive illustrated booklet. For those who may have trouble locating the label, Almanac's address is P.O. Box 7532, Houston, Texas 77007.

Performance: A *Sound:* B

Manhattan Brass Choir: Praise to the Living God
ABC Stereo ABCS-607 ($4.79)

With Clark Terry, trumpet, and Urbie Green, trombone, heading a stellar assemblage of brass players, the Manhattan Brass Choir turns in moving performances of a dozen spirituals performed with true jazz-blues freedom and sincerity. The sound is fabulous.

Performance: A *Sound:* A+

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		40 (8 ohms)	
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More Jazz

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RCA Victor Stereo LSP-3783

Moving performances of *Buzzy, Now's the Time,* and *Wee* recorded at the 1964 Newport Jazz Festival, comments by Father Norman O'Connor on "Bird," and two curiously unrelated New York studio tapings by a group led by Jackie McLean of *Embraceable You* and *Old Folks.*

Performance: Newport: A, McLean: B
Sound: Newport: B, McLean: A

Charles Lloyd Quartet: Love-In

Atlantic Mono 1481

Recorded live at Fillmore Auditorium in San Francisco, the Charles Lloyd Quartet seems to have found an enthusiastic, new, hippy audience for its special blend of modern rhythmic chromaticism. Highly sophisticated music for a mass audience, but the combination of strong rhythm and exotic color has immense appeal.

Performance: B+ *Sound:* B

Willie Bobo: Bobo-Motion

Verve Stereo V6-8699

In his search for a common denominator to jazz, blues, and Latin rhythm, Bobo tries his hand at *Tuxedo Junction, La Bamba, Black Coffee,* and a number of otherwise unrelated numbers that all emerge in much the same propulsive, exhilarating spirit under the Bobo influence.

Performance: B *Sound:* A

Shelly Mann: Jazz Gunn

Atlantic Mono 1487 ($4.79)

Seven or eight years ago, Shelly Mann concocted a couple of suites on the Henry Mancini music for the Peter Gunn TV series. Now Mancini has written a new score for a Hollywood Peter Gunn epic, and Mann once more offers his commentary. With Conte Candoli, trumpet; Frank Strozier, alto or flute; Mike Wofford, piano; and Monte Budwig, bass, Mann provides a neatly-paced, highly enjoyable package in impeccable sound.

Performance: A *Sound:* A

LIGHT LISTENING

CHESTER SANTON
STUART TRIFF

Photo courtesy of RCA Victor Records

PEARLIE MAE'S "DOLLY"

Hello, Dolly!—Pearl Bailey, Cab Calloway, Emily Yancy, Jack Crowder, Winston DeWitt Hemsley & other members of 1967 Broadcast cast; Saul Schectman, cond.

RCA Victor LOC/LSO-1147 ($5.79)

"Hello, Dolly!" is the fourth longest-running musical in Broadway history, threatening now to displace "South Pacific" from its third place niche. It has won all manner of awards, establishing several impressive theatrical records and smashing a few others in its four-year history. But "Dolly" is not a great musical . . . not in the sense that "My Fair Lady," "South Pacific" or "West Side Story" is great. It is pretty much of a formula show; contributing nothing that is really new or original—in fact, it's frankly old-fashioned.

Jerry Herman has supplied "Dolly" with a pleasant, tuneful and undeniably effective score, but, too, offers nothing that is particularly original. What, then, is the mystique that has this musical so flamboyantly successful? I think the essence of it lies chiefly in the audience's ability to see in the leading character a little bit of themselves. The temptation to meddle, at some time or other, in the lives and affairs of other people is a failing in all of us. The fact that Dolly Gallagher Levi can do so with such irresistible charm and enviable good intent, earns for the lady an endearing place in our hearts.

RCA Victor's new recording of the show with an all-Negro cast headed by Pearl Bailey is the company's third waxing of the score, following the "original" with Carol Channing and the version with Mary Martin and the London cast. Absent from the Broadway scene since 1954 and her appearance in "House of Flowers," Pearl Bailey is back in town and better than ever! Sixth in the line of distinguished Dollys in New York, Pearlie Mae is easily the best singer of them all. Her timing, projection and knowing way with a song are nothing short of miraculous, giving new life and added dimension to Jerry Herman's music and lyrics.

Listen to the bits of business she weaves while the waiters are singing her praises in the title song; or her delivery of "So Long, Dearie" — a number that might have been written specially for her, so much authority does she bring to it. It would seem unfair to expect the rest of the cast to operate on the same exalted level, but they provide exceptionally fine support, nevertheless. Cab Calloway is ingratiating in his only solo number, "It Takes a Woman," though I prefer David Burns' sly and insinuating rendition. Emily Yancy and Jack Crowder as Irene Molloy and Cornelius Hackl are the best singers ever to play these roles. Winston DeWitt Hemsley, Roger Lawson and Chris Balloway (Cab's daughter) contribute ably.

In the theatre, "Hello, Dolly" does not begin with the traditional overture, but in this recording we are given a bonus of a four-minute curtain raiser, presumably put together by the show's orchestrator, Phil Lang. Another plus is the crisp and spirited conducting of Saul Schectman. Victor provides a bright, spacious, well-defined stereo disc. Pearl Bailey is back on Broadway and let's hope she'll never go away again! S.T.

Performance: A *Sound:* A

More Show Biz

Henry, Sweet Henry. Don Ameche, Carol Bruce, Robin Wilson, Neva Small, Alice Playten & other members of the Broadway cast; Shepard Coleman, cond.

ABC [S] OC-4 ($4.79)

If a stage full of squealing teen-age girls, their dear little hearts overflowing with unselfish hero worship, is your idea of a memorable evening in the theatre, then "Henry, Sweet Henry" may be your dish of tea. "Bye-Bye Birdie" had the first, and as far as I'm concerned, the last word on the subject of juvenile idolatry.

Nora Johnson's "The World of Henry Orient," concerned with two adolescents who have nothing better to do than pursue a middle-age avant garde composer-conductor all over town, has been fashioned into a dull and tiresome musical by Nunnally Johnson (book) and Bob Merrill (music and lyrics). Don Ameche and Carol Bruce play the leading adult roles; though better than average singers, they have little to do here. Ameche is involved in two duets; one with an old girl friend, and the other with Miss Bruce (her only song). The latter is a *real* charmer that has something to do with Gertrude Stein's poodle piddling in somebody's lap. Robin Wilson, as Miss Bruce's lovesick offspring, is involved in most of the songs, and it is a dreary burden indeed that she's been asked to carry. Her numbers include the title tune "I Love You Astronomically, Though You've Cracked Up Harmonically"; "I'm Blue Too" (an ode to Sandra Dee); "In Some Little World" (a fair tune wedded to a completely inane lyric) and "Here I Am," a song that Barbra Streisand might be able to make something of.

My deduction is that today's Broadway producers are all tone deaf. How else to account for their stubborn insistence, when even a modest productions costs a couple of hundred grand to mount, on commissioning such undistinguished scores. For anyone who cares, ABC's recording engineers have done their work well. S.T.

Performance: C *Sound:* B+

Storyteller Extraordinary

Myron Cohen: It's Not a Question!
RCA Victor LSP 3791 stereo ($4.79)

For how many decades has Myron Cohen been the leading specialist in the Jewish dialect story? Television has done its part in bringing his pungent yarns (delivered in an essentially humane manner) to a wide audience. Yet it may well be the phonograph record that will be his greatest benefactor. In addition to the obvious factor of permanence—for as long as the discs are available—recordings give one a chance to assess in depth the style and outlook of a master story teller.

Myron Cohen, in a sense, has been performing the function of a historian of his generation. The speech patterns and the way of thinking of the people he mirrors in his stories will someday be a vanished bit of Americana. Yet a Myron Cohen record will instantly present a stunningly accurate picture of the period in which he lived. To get this picture, you really have to sample one of the typical night club appearances. Only then do you sense with what compassionate yet surgical objectivity he has probed to the very marrow of his characters.

He covers just about every conceivable human foible from childhood to senility without a wasted word. His stories seldom run longer than two minutes in the telling and are grouped on this record in categories such as "Miami and the Senior Citizens," "Business Stories," "Junior Citizens" or "All in the Family." In this Cohen recording, as in his previous RCA release, *Everybody Gotta Be Someplace,* stereo contributes nothing whatsoever to the material itself. All you get is a audience and a shade more presence in Cohen's inflections while he's handling in the dialects. C.S.

Performance: A *Sound:* B+

NEGATIVE FEEDBACK

(Continued from page 32)

acteristics of a transistor, each with a suitable load line applied and, as we have shown it, perfectly linear in the latter respect.

Linearity, in the conventional amplifying sense, is indicated by the regularity with which the load line crosses the curves representing equal increments of input change, grid voltage or base current. If these spacings are uniform, the device does operate linearly as an amplifier with the load condition represented by this load line, within the limits specified (over which the spacings are linear).

But while the spacings between these crossings may be perfectly uniform, representing linear amplification, the plate or collector resistance, represented by the angle of the curves where the load line crosses them, is not uniform; probably a long way from it. It is true, for open-ended (non-feedback) amplification, this variation makes not a scrap of difference to the performance.

But for amplification where the feedback loop is closed, the impedances represented by these slopes contribute to the frequency response of the various stages round the system loop. So the overall frequency response can actually change at different points on a waveform.

Also, if, even for a moment, an excursion of signal takes one circuit element beyond its relatively linear range to where saturation or cut-off occurs, a completely different system exists, momentarily. This can lead to another variety of effects.

When we discussed Nyquist's presentation we introduced his simple concept of conditional stability. We spoke of gain varying, which indeed it can do, as the amplifier "warms up." But when saturation or cut-off is reached, gain suddenly disappears, for all intents and purposes. Following such blocking, when the gain begins to come back as the system returns to its normal operating voltage and current, amplification may resume in different ways.

If, for example, the cut-off has a relatively long curvature to it, and the normal signal is small enough not to use much of the curve at one time (Fig. 4), the gain will come back gradually.

But more often the cut-off is abrupt and, as the system recovers, part of the waveform will run into normal region, while part of it remains cut-off or saturated. The net result is that the waveform passes through a distorted or discontinuous state of handling while the system goes through its recovery process.

One way to represent the latter effect, to utilize the kind of feedback parameters related only to frequency, is to average the gain over the complete period of signal being amplified. Thus, if half the waveform is amplified normally and half of it gets chopped off, by cut-off or saturation, then the *average* gain during the highly distorted wave that comes out at this moment will be half the normal gain. (See Fig. 5).

This sort of reasoning may enable the conditional stability criteria to be applied after a fashion. But it doesn't take what the waveform looks like into account at all. It may go in as a sine wave and come out looking quite different, which means it contains a lot of frequencies that weren't in the input.

Of course, the part of feedback theory that deals with distortion reduction would take care of this, if it wasn't for the fact that this also assumes a more or less constant condition. This assumption ignores the fact that when gain disappears, as it does during parts of the waveform, the feedback also disappears.

So we have two areas to investigate as the reference variable (what mathematicians call the "independent variable), using time as a basis rather than frequency. And combinations of these two areas. Let's just illustrate them now by examples. In future issues, we'll show in more detail how to analyze them and what can be done in specific cases to overcome problems.

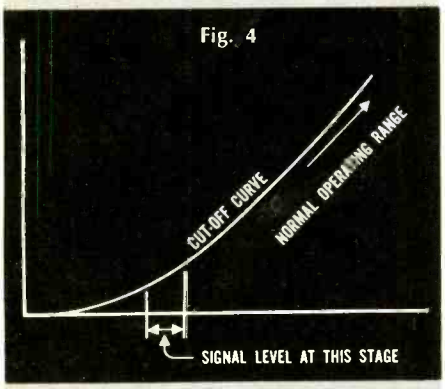
Within the waveform period

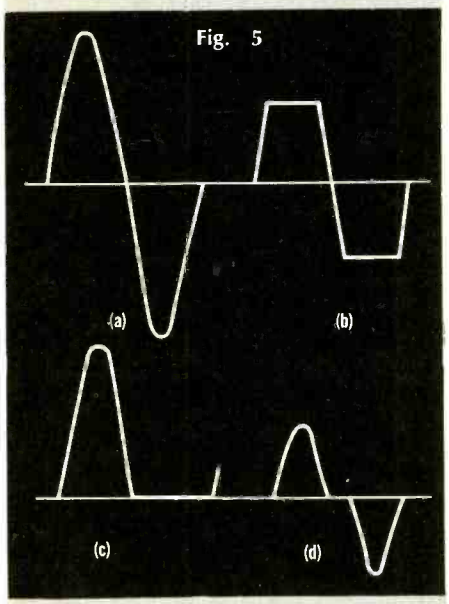
The first area is within the waveform period. We have long trusted the SMPTE test for detecting the particular kind of intermodulation

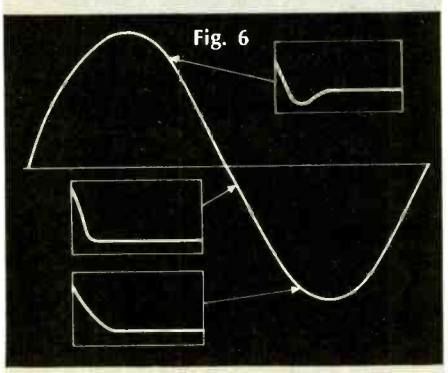
Fig. 4–A gradual cut-off will allow a gradual return to full gain if the signal level is small at this point.

Fig. 5 – Different discontinuities of waveform during recovery from blocking: (a) undistorted wave of full amplitude; (b), (c) and (d) different parts of the wave removed to reduce it to half amplitude.

Fig. 6 – How high-frequency response (in boxes) changes at different parts of a low-frequency waveform, due to the effects observed in Fig 3.







distortion for which it is designed. And it did very well before the advent of feedback. But now that we have feedback, a high-amplitude low-frequency waveform will alter the high frequency response of the system (Fig. 6).

This may have happened to an extent with non-feedback amplifiers. But feedback may have the system swinging nearer and further from its high-frequency instability point during the low-frequency waveform. This variation will only show up at those high frequencies where the amplification is changed as a result. All higher frequencies won't be similarly intermodulated.

In some circumstances the lower frequency may phase modulate the higher frequency rather than amplitude modulate it. Although a corresponding amount of phase or frequency modulation is just as audible as the same amount of amplitude modulation, the conventional measuring equipment does not "look" for phase or frequency shift of the higher frequency; only for amplitude variations.

So this form of distortion may "get by" undetected by the conventional SMPTE test for one of two reasons: either because the high frequency used is different from the ones the system dominantly modulates, or because the modulation at the frequency used happens to be in phase or frequency rather than in amplitude.

That's one example of within-the-period variation that needs to be explored.

Outside the waveform period

The other area to be explored relates to what happens to circuit constants, probably at time intervals corresponding to frequencies below the operating range, when overload occurs. If the amplifier blocks, how does it recover from blocking? Obviously, this will also involve what happens within the waveform period during the recovery interval. So for this kind of example, we may be concerned with both areas of time: that within the waveform period and the longer term consisting of many periods of the waveform.

(Continued next month)

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