AUDIO

SEPTEMBER/1965

60¢

...the original magazine about high fidelity!

"BLOOD, SWEAT AND TEARS" IS WHAT ITS OWNER-DESIGNER CALLS IT. FOR 5 G's, AND 5 YEARS OF B, S, & T, YOU TOO CAN HAVE A COMBINED HEATING SYSTEM AND NUCLEAR SHELTER, AS WELL AS GOOD MUSIC.

SEE PAGE 57

Zip through Scott's new solid state FM stereo tuner kit in one afternoon

Four to six hours! That's all you need to zip through Scott's new LT-112 solid state FM stereo tuner kit. All you do is complete five simple wiring groups and breeze through an easy new 10-minute alignment. You can actually start after lunch and enjoy superb FM stereo at dinner.

Scott solid state circuitry is the key to the LT-112's superior performance. Costly silicon transistors, three IF stages, and three limiters give the LT-112 a usable sensitivity of 1.9 uv, selectivity of 45 db . . . performance unapproached by any other kit on the market. The LT-112 is actually the kit version of Scott's best-selling 312 solid state factory-wired stereo tuner, of which AUDIO said, ". . . it is one of the finest tuners Scott makes. And that means it is one of the finest tuners anywhere."

All Critical Circuitry Pre-Wired

To insure perfect results, your LT-112 arrives with all critical circuitry pre-wired, pre-tested, pre-aligned, and mounted on heavy-duty printed circuit boards. Wires are all color-coded. pre-cut, and pre-stripped to the proper length. Scott's exclusive life-size, full-color construction book fully details every step . . . makes perfect wiring almost automatic.

You'd never believe a kit so easy to build could be so packed with features. Built right into the LT-112 is a brand-new Scott invention . . . the Tri-modulation Meter. A convenient front panel switch lets you use this Scott exclusive as:

1. A signal-Strength Indicator . . . for proper antenna orientation and coarse tuning.
2. A Zero-Center Indicator . . . for extremely accurate fine tuning of very weak or very strong stations. Accurate tuning is essential to minimum distortion and maximum separation.
3. A precision Alignment Meter that enables you to align your tuner, anytime, with absolute accuracy . . . a procedure that previously required the use of a $500 test instrument.

For your further listening enjoyment, the LT-112 is provided with three stereo outlets . . . one of them conveniently located on the front panel (you can connect a portable tape recorder without disturbing the installation of the tuner). Output level controls on the rear of the unit need be set only once, so you don't have to be bothered about duplication of controls.

Stop in at your Scott dealer's today, and pick up an LT-112 tuner kit . . . $179.95 plus one enjoyable afternoon will net you a lifetime of listening pleasure.

SCOTT®

For complete specifications on the LT-112, write:
H. H. SCOTT, INC., Dept. 35-09- 111 POWDERMILL RD., MAYNARD, MASS.
Export: Scott International, Maynard, Mass. Cable HIFI. Prices slightly higher west of Rockies. Prices and specifications subject to change without notice.

Circle 100 on Reader Service Card

AUDIO

September, 1965 Vol. 49, No. 9

Successor to RADIO, Est. 1917

AUDIO Articles

AUDIO Reviews

AUDIO Profiles

AUDIO in General

MEMBER INSTITUTE OF HIGH FIDELITY INC.

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COMING

ARTICLES

The Wooden Monster — a description of the kind of low-frequency horn we would all like in our home systems, if we had the room. By C. William Phillips.

Converting the Uher 4000-S to Stereo Playback, by C. G. McProud. How-to-do-it, without detracting from the normal versatility of this multi - purpose portable tape recorder.

Hi Fi and the British: Showmanship. An amusing comparison (or differentiation) between U.S. and British hi-fi shows. By Britisher (of course) Alan Watling.

Also continuing Norman Crowhurst's series on the **Development of a Pulse-Modulated Audio Amplifier**

PROFILES

SONY 250-A
Tape Recorder

Empire 888-P
stereo cartridge

KSC speaker system

In the October Issue

On the newsstands, at your favorite audio dealer's, or in your own mailbox

AUDIO CLINIC

Joseph Giovanelli

Send questions to:
Joseph Giovanelli
2819 Newkirk Ave.
Brooklyn, N. Y.
Include stamped, self-addressed envelope.

Reducing Amplifier Hum and Noise

Q. I get hum with the level control of my amplifier at "zero". It is not proportional to level control settings, and occurs without a program source connected to the amplifier. Hum is more pronounced in the left channel. The amplifier has hummed since it was new.

I wrote to the manufacturer about the problem. They gave me instructions on how to cut down the gain of the amplifier by means of resistors. I obtained full room volume at the 9 o'clock position of the level control before these resistors were installed. The resistors cut out the hum and noise, but they cut down the gain of the amplifier so much that I could not obtain normal listening level, even with the level control in full clockwise position. Therefore, I removed them from the circuit.

I've tried all the elementary hum-reducing tricks; amplifier grounded to waterpipe, line cord reversed, and so on. Leigh A. Wax, Hialeah, Florida.

A. The hum you are hearing is probably generated within the amplifier. Perhaps if your speakers were less efficient, the problem would not have cropped up because the noise would not appear as significant background noise. This is not to say that the noise would not be fed into the speakers, but their inefficiency would make its effects almost inaudible.

It seems to me that the manufacturer is correct in simply throwing away gain. If the manufacturer recommended the use of a voltage-divider circuit, the values in the circuit will have to be adjusted so that the amplifier's gain will be somewhere between what is present before modification and what is present after using the manufacturer's recommenced circuit modifications.

Let us assume that the total resistance of the divider was one megohm. You must keep the total value of the divider the same regardless of the values of the two resistors employed. What you must do in your particular case is to increase the resistance value of the resistor on the ground side of the divider while decreasing the value of the resistor on the top branch of the divider, still maintaining the total resistance value as one megohm. You may find that the best compromise between background hum and noise and good gain characteristics results with a reduction of 6 db below full amplifier sensitivity, in which event you should make each resistor equal in value to the other one in the pair. Therefore, each resistor in the divider should equal 0.5 megohm.

Feedback and Output Transformers

Q. I wonder if you could clear up a few problems for me. I built Mr. Kauder's amplifier from an articule in Audio. *I used all first-grade parts, but I could not obtain the Peerless output transformer specified in the schematic. Therefore, I used foreign-made high fidelity output transformers. Using these, I had to reduce the feedback by increasing the value of the feedback resistor. The amplifier sounds fair but not good. The amplifier requires a transformer which can handle 40 db of feedback.*

All output transformers I ran across have permissible feedback ratings of 30 db. I would like to know if the use of a 40 or 50-watt output transformer rather than a transformer rated at 20 watts will allow me to increase the feedback beyond the manufacturer's specs? Joe Bay, Clifton, New Jersey.

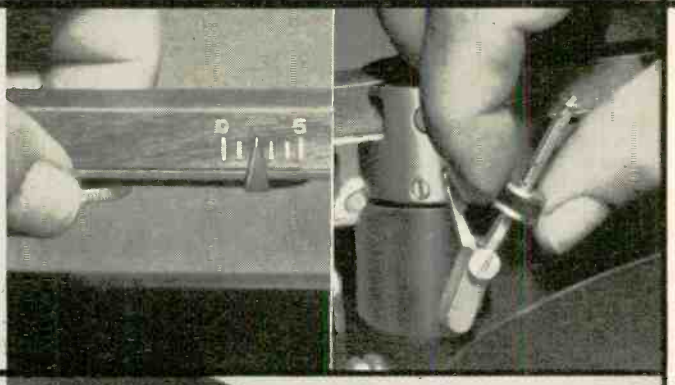
A. When a design calls for a transformer which has some special characteristics, this is the transformer which should be used unless the unit is being constructed by a person who can predict and make allowance for malfunction of the equipment. The builder should at least have sufficient knowledge to allow him to adjust the amplifier's performance after construction if he encounters poor performance.

The amount of feedback which can be applied around an output stage is largely a matter of the output transformer's performance. The transformer must have a minimum of capacitance

Exclusive! Anti-Skating Demonstration with the Garrard® LAB 80

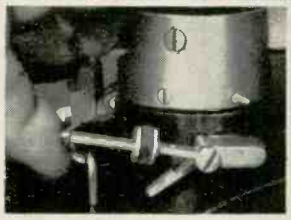
Here's how your dealer can show you what skating force is; how the Lab 80 eliminates it; protects your records; tracks both stereo channels more evenly — more perfectly than any other integrated record playing unit.

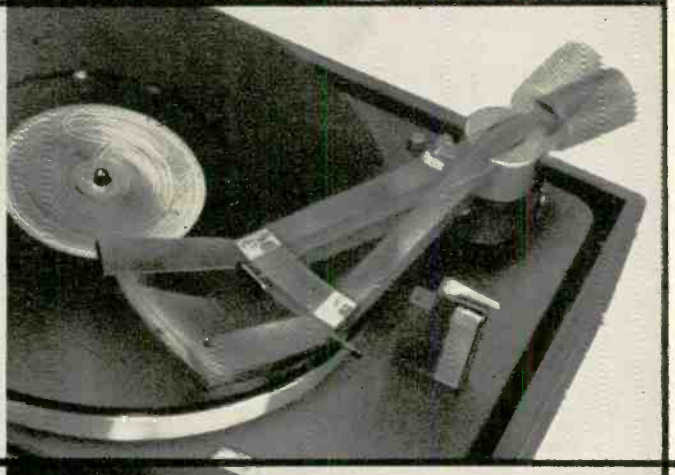
1. "This is a blank record with no grooves. I place it on the Lab 80."



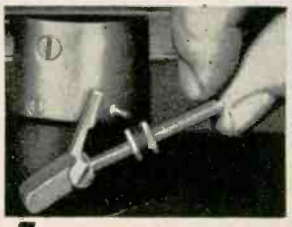
2. (left) "I set the tracking force at 2 grams, (as an example). Since each click of the stylus pressure gauge on the tone arm equals ¼ gram, I turn it for 8 clicks."

3. (right) "I slide the counterweight on the anti-skating device to the second notch... for a compensation of 2 grams ...equivalent to the tracking force I have just set on the tone arm."





4. "Now you can actually watch the strength of the skating force. I start the Lab 80, but flip the anti-skating device over and out of operation. Note that as soon as I put the stylus on the grooveless record, the arm moves rapidly... with force, toward the center."



5. "Now watch me neutralize the skating force. I swing the anti-skating device back into position...and the arm tracks as perfectly as if there were a groove in the record! If I were playing a regular record—with the side pressure gone and resulting distortion eliminated—the sound would be cleaner."

Due to the offset angle of any cartridge, and the rotation of the record, all tone arms have an inherent tendency to move inward toward the center of the record. This skating force, a definite side pressure against the inner wall of the groove, is a major cause of poor tracking, right channel distortion, and uneven record wear. Now, Garrard dealers have been supplied with grooveless records which make it possible to visualize the skating force and how it is overcome in the Lab 80. The demonstration takes only a few minutes, but it is well worth seeing before you decide on any record playing unit.

Oscilloscope readings (using 1000 cycle, 30 cm 1 sec. test record as signal source) **verify effects of skating force on record reproduction.**

Tracking without the anti-skating compensator, sine wave form shows considerable distortion.

Tracking with anti-skating compensator, sine wave form becomes a clean picture of the output of the cartridge.

The patented Garrard method of neutralizing skating force is but one of a number of Lab 80 developments exclusive today but sure to be imitated tomorrow by other manufacturers. Compare! You'll find this Lab 80 feature is simple and foolproof... works perfectly without springs, balancing devices or other delicate mechanisms.

AUDIO says: *"Special features set this arm apart from the other automatics (and quite a few manuals). The first is an adjustable skating-bias control. This can be set for the proper stylus force used. It works effectively, without binding on the arm."*

HI-FI/STEREO REVIEW says: *"I found that the bias compensator was quite effective... When adjusted, the distortion was very low even at the highest velocities, and was observably lower than when no compensation was used."*

HIGH FIDELITY says: *"Tracking is well nigh perfect; the machine can handle cartridges of all weights, including the lightest, and of all compliances, including the highest; the assembly has a high immunity to external shock."*

Visit your dealer to see the anti-skating device in operation, or send $1.00 to Garrard for your own grooveless demonstration record. For your complimentary copy of our new 32-page Comparator Guide, write Garrard, Dept. GM-15, Westbury, New York 11591.

Circle 103 on Reader Service Card

between turns and adjacent layers of the windings. The transformer must have a low leakage inductance and must possess heavy wire so as to introduce the least possible amount of resistance. The more capacitance, leakage inductance, and resistance which are present in the transformer, the less the amount of feedback which can be applied around the transformer.

These factors, rather than the power handling capacity of the transformer must be considered when setting up the feedback in an amplifier.

Noise in AM reception

When I play my communications-type AM-shortwave receiver, the volume increases considerably when certain room lights in my house are switched on. The cellar lights are especially guilty in this regard, causing a loud rise in sound level.

Also, when my electric razor or can opener is in operation, a loud, very annoying, buzzing sound comes from the radio. This buzzing sound does not occur on all stations. I am mainly interested in applying corrective measures, if possible, to the AM mode of operation because I seldom, if ever, listen to shortwave. Kenneth Wiener, Baltimore, Maryland.

A. If you get a rise in sound volume from your communications receiver when a light is switched on, it may be that the click or transient, produced by the closing of the switch causes a capacitor in the receiver to come back to its normal capacitance and feed its normal signal into some portion of the circuit. Let us assume that the diode coupling capacitor has partially opened. This will reduce the volume, or signal voltage, appearing on the grid of the first audio stage. A transient on the power line can cause this capacitor to operate properly for a time, thereby resulting in an increase in sound level.

The interference caused by appliances can often be corrected by using a brute force line filter. Circuits for such filters can be found in *The Radio Amateur's Handbook*, published by The American Radio Relay League, West Hartford, Conn. It is a relatively inexpensive book and is one of the best investments one can make if he is interested in electronics. Much of the material in the book deals with radio amateur theory and practice, but the theory of operation of a vacuum tube is the same regardless of whether it is to be used in a transmitter or in an audio amplifier.

Another method by which this type of interference can be suppressed is simply to increase the effectiveness of the receiving antenna. If the antenna is now located indoors, place it outdoors and make it at least 30 feet long. The increase in signal strength will then be sufficient to override line interference.

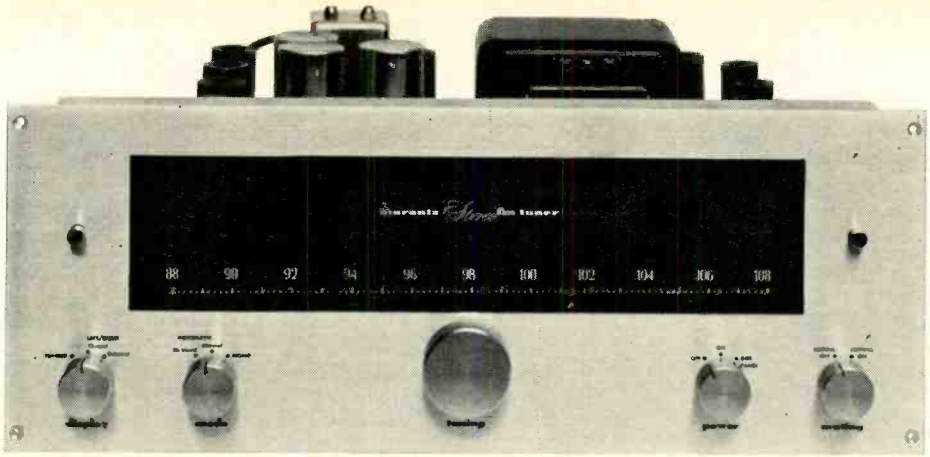
Line-Surge Eliminators

Q. I am considering the purchase of some sort of tube-saving device, such as a surgistor, for my stereo system. After seeing the low cost of these devices, I wonder whether it is not already built into most tube-type electronic equipment. If not, what type would you recommend, which contains a 50-watt integrated stereo amplifier, tuner, turntable and tape deck? Kenneth Wiener, Baltimore, Maryland.

A. If I were going to use a line-surge eliminator, I would use one for each piece of equipment I owned. The wattage of each device used will depend on the wattage taken by each piece of equipment in the system. Do not use a device having a wattage much greater than that required by the equipment because the device will then not be heated sufficiently to provide correct line voltage after warmup.

If a piece of equipment employs a series heater string, connected directly across the a.c. line, the use of such a device is very important because the surges associated with this type of circuit arrangement are greater than those encountered with transformer-operated equipment.

Line-surge reducers are not normally found in audio equipment. Æ



MARANTZ 10-B TUNER: ". . . rather spectacular results."

Q. Mr. Marantz, your new 10B stereo FM tuner has caused quite a stir in the hi-fi industry. Now that a large number are in the field, what reactions have you received?

Mr. Marantz: The overwhelming reaction has been one of surprise from owners who found our claims were not exaggerated. One user wrote he had "...taken with a grain of salt your statement that reception was as good as playback of the original tape or disc. However, after using the tuner for several days I felt I owed an apology for doubting the statement." This is typical.

Q. What success have users had with fringe area reception?

Mr. Marantz: Letters from owners disclose some rather spectacular results. From the California coast, which is normally a very difficult area, we have had many letters reporting clean reception from stations *never reached before*. An owner in Urbana, Illinois told us he receives Chicago stations 150 air miles away with a simple "rabbit ears" TV antenna. Another in Arlington, Virginia consistently receives fine signals from Lancaster, Pennsylvania, 125 miles away; Philadelphia, 200 miles away, and three stations in Richmond 100 miles over mountains, which he said "come in as good as local stations."

Q. For the benefit of these readers interested in the technical aspects, what are the reasons for this improved fringe area performance?

Mr. Marantz: Technical people will find it self-evident that the rare four-way combination of high sensitivity—better than 2 μv, IHF—both phase linearity and ultra-sharp selectivity in our new advanced IF circuit, and a unique ability to reach full quieting with very weak signals—50 db @ 3 μv, 70 db @ 24 μv—virtually spells out the 10B's superior reception capabilities. Engineers will also appreciate the additional fact that our circuitry exhibits very high rejection of "ENSI," or equivalent-noise-sideband-interference.

Q. Considering the 10B's excellent fringe area performance, shouldn't one pick up more stations across the dial?

Mr. Marantz: Yes. The report published in the April edition of Audio Magazine claimed to have logged 53 stations with an ordinary folded dipole used *in the reviewer's apartment*, which was "more than ever before on any tuner!"

Q. I appreciate, Mr. Marantz, that the 10B's built-in oscilloscope tuning and multipath indicator is very valuable in achieving perfect reception. How big a factor is this device in the total cost of the 10B?

Mr. Marantz: Well, first we should note the fact that no manufacturer would offer a quality tuner without tuning and signal strength meters. Therefore, what we should really consider is the difference in price between ordinary tuning meters, and our infinitely more useful and versatile Tuning/Multipath Indicator, which is only about $30! While our scope tube and a pair of moderately priced d'Arsonval meters costs about the same—slightly under $25—the $30 price differential covers the slight additional power supply complexity, plus two more dual triode tubes with scope adjustments and a switch. The rest of the necessary associated circuitry would be basically similar for both types of indicator. The price of the 10B tuner is easily justified by its sophisticated precision circuitry and extremely high-quality parts.

Q. With the 10B's exceptionally high performance, does it have any commercial or professional application?

Mr. Marantz: Yes, very much so. In fact, a growing number of FM stations are already using 10B's for monitoring their own broadcast quality. One station wrote that they discovered their 10B outperformed their expensive broadcast monitoring equipment, and were now using it for their multiplexing setup adjustments and tests.

Q. Just how good is the general quality of FM stereo broadcast signals?

Mr. Marantz: As I have remarked on previous occasions, the quality of FM broadcasting is far better than most people realize. The Model 10B tuner has proven this. What appeared to be poor broadcast quality was, in most instances, the inability of ordinary FM receiving circuits to do the job properly. The Model 10B, of course, is based on a number of entirely new circuit concepts designed to overcome these faults.

Q. In other words, the man who uses a MARANTZ 10B FM tuner can now have *true* high fidelity reception?

Mr. Marantz: Yes, very definitely—even under many conditions where reception may not have been possible before. This, of course, opens up a tremendous source of material for the man who wants to tape off the air, and who needs really good fidelity. He can, as many of the 10B owners are now doing, build a superb library of master-quality tapes, especially from live broadcasts.

New price: $600—no excise tax.

marantz

MARANTZ, INC. SUBSIDIARY OF SUPERSCOPE • INC.
25-14 BROADWAY, LONG ISLAND CITY, NEW YORK

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LETTERS

Authors Reply

SIR:

Our thanks to Mr. Villchur for this opportunity to elaborate on a few more of the details and benefits of the Bass Energizer; a device which we feel is an important contribution to the home music lover and the high-fidelity enthusiast. We will answer him point-for-point using the same numbering scheme.

1. Use of the 80-db Fletcher-Munson curve was intended to *illustrate graphically* the deficiency of the human ear and to emphasize the equalization offered by the Bass Energizer below 150 Hz. 80-db was selected arbitrarily because it is close to the typical levels used in living rooms for enjoying fine music reproduction.

2. No question about this point. The Bass Energizer is suitable for all speakers, large or small. Generally speaking, the little speaker requires more low-end assistance than does the large one.

3. The setting of the gain control of an amplifier certainly is not an infallible indication of the amplifier's capability or the speaker's efficiency. However, since amplifier manufacturers quite consistently scale equipment to perform properly with pickups of average output level. . . . and with speakers of average efficiency, it would seem apparent to the average user who is already operating his amplifier with the gain control near its maximum setting, that he has very little gain left with which to utilize the benefits of the Bass Energizer. Our remarks were labeled "not so technically" to provide the user with a quick, informal means of evaluating his system, and were preceded with a brief "technical" description of speaker efficiency.

4. The statement that a 35-watt speaker used with the Bass Energizer and connected to a 70-watt amplifier was presented basically as an additional benefit. Upon rechecking the article, we will agree that one word (absolute) could conceivably be misleading . . . IF the system was subject to tuner "pops" while the amplifier was operating at full output. On the other hand, the average volume level of music (as reported in the Bell Laboratories Record for June, 1934) is down 3 db at 150 Hz, and down 20 db at 50 Hz. The greatest energy concentrtaion of music is in the 200-600 Hz-range. Therefore, the insertion loss of the Bass Energizer should provide a 3 db safety margin on program material. *Within this range the* Bass Energizer obviously does provide some speaker protection, although this is not its primary function.

BILL YEAGER
ROGER HULL
464 N. James
Orange, California

Want Permanent Showrooms

SIR:

A permanent hi-fi showroom is a *must!* The consumer should enjoy the convenience of hearing any hi-fi speaker, big or small, coaxial or triaxial, without chasing around to various stores to hear them. I know of no store that has all the speakers of each manufacturer.

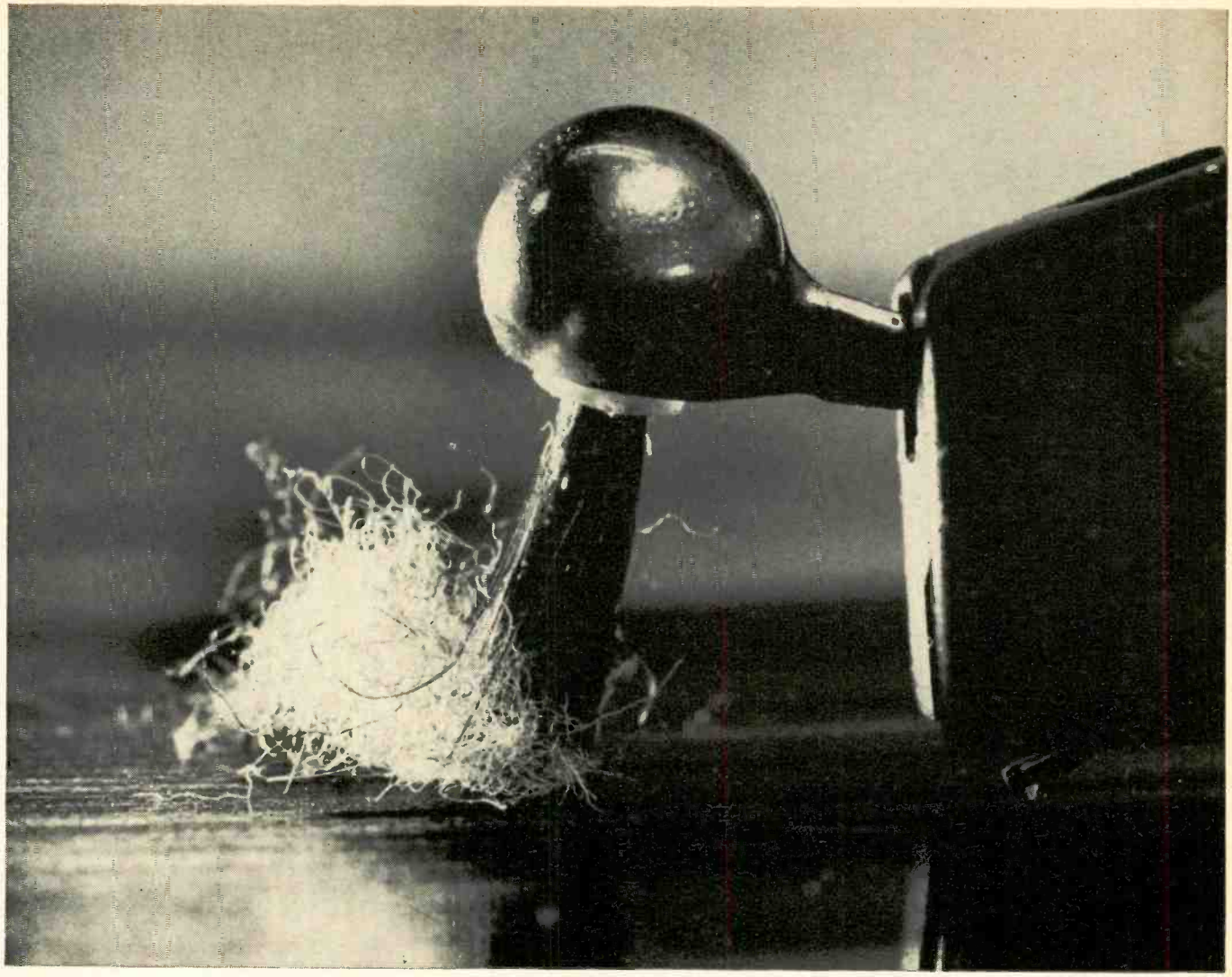
The hi-fi industry and the consumer would both benefit.

M. WALDER
70-20 Parsons Boulevard
Flushing 65, New York

SIR:

I am very much in favor of a permanent showroom for high fidelity equipment. Being one who lives a considerable distance from stores that handle high quality components, I find it very difficult—if not downright impossible—to audition the components in which I am interested. Even a trip to a large city doesn't fill the bill because it is necessary to drive all over the city to different dealers to hear everything. Time for doing this just isn't available. A permanent showroom would make it possible for me to listen critically to the components that interest me, and make it much easier for me to choose those

(*Continued on page 44*)



You are looking at the world's only true longhair cartridge.

In this unretouched photograph, the long, black hair of the brush built into the new Stanton 581 is shown in action on a rather dusty record. Note that all the loose lint, fuzz and dust are kept out of the groove and away from the stylus. That's why the Longhair is the ideal stereo cartridge for your Gesualdo madrigals and Frescobaldi toccatas. Its protective action is completely automatic, every time you play the record, without extra gadgets or accessories.

The stem of the brush is ingeniously hinged on an off-center pivot, so that, regardless of the stylus force, the bristles never exert a pressure greater than 1 gram and always stay the right number of grooves ahead of the stylus point. The bristles provide just the right amount of resistance to skating, too.

But even without the brush, the Stanton 581 Longhair is today's most desirable stereo cartridge. Like its predecessors in the Stanton Calibration Standard series, it is built to the uniquely stringent tolerances of Stanton professional audio products. Its amazingly small size and light weight (only 5 grams!) make it possible to take full advantage of the new low-mass tone arms. And its frequency response is factory calibrated within 1 db from 20 to 10,000 cps and within 2 db from 10,000 to 20,000 cps. Available with 0.5-mil diamond (581AA) or elliptical diamond (581EL); price $49.50.

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

Stanton

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LIGHT LISTENING

Chester Santon

Kismet (Original Cast of Lincoln Center Revival)

RCA Victor LSO 1112

Revivals, no matter where produced, have a way of coming in second (in more ways than one) to the original Broadway production. This situation sometimes improves on records, particularly where the original was taped in mono only and the revival can be produced with the obvious enhancements of stereo. The Music Theatre at Lincoln Center, through the courtesy of RCA Victor Records, has been giving some great shows of the past a new lease on life in the record catalogs. On average, the Lincoln Center revived original casts have not been strong enough to overshadow the casts first heard when these shows reached Broadway. This release of "Kismet" is a conspicuous exception to the rule that seems to have been holding sway uptown. Quite apart from the expected improvement in sound, we're presented with the original star of "Kismet", Alfred Drake, in better voice than ever before. (Or have mikes improved that much since the release of his old Columbia disc?) In the role of his stage daughter, the most prominent female part in the show, Lee Venora continues the favorable impression she made as Drake's leading lady in the recording of "Kean". Anne Jeffries and Richard Banke are heard as other major denizens of old Baghdad singing the tunes Robert Wright and George Forrest fashioned from themes by Alexander Borodin. Banke is no match for "original" original-cast Richard Kiley in *Stranger in Paradise* but all other facets of the production are in top order under the guidance of veteran conductor Franz Allers.

Carol Channing Entertains

Command Tape C 880

There are plenty of recordings that tend to disprove the fact but it is possible to title an album lavishly without resorting to exaggeration. Such a title has been affixed to one of the better albums to come out of the Command operation in many months. The extent of the coup pulled by Enoch Light will probably be appreciated in full detail only by rival record producers. I'm sure any label around these days would have been proud to play host to Carol Channing in the collection of songs she has recorded here. It must be known in every hamlet in the country by now that Miss Channing's "Hello, Dolly" has been the "hot ticket" on Broadway for some time. Perhaps the first surprise in this well-processed tape album is the fact that the producers and Miss Channing have had the will power to bypass the title tune of "Hello, Dolly". Lest the show be neglected entirely, they have included the song called *Elegance* which is handled in the Dolly production by Eileen Brennan, Charles Nelson Reilly and Sondra Lee. A good song can withstand an awful lot of transformation. It certainly suffers no harm whatsoever in this star treatment. If you listen carefully to the entire Dolly score and then turn to this tape, you may be surprised to discover how much more sheer entertainment value Miss Channing has available to her in the contents of this reel. Once you get past the title tune in Dolly, Carol has very little in the musical that can rank with the material Command has recorded. No one will argue whether *Baby, Won't You Please Come Home, Mean To Me,* etc. are classics of their type. They've now been polished to a faretheewell and thrown in with lesser-known items that were made to order for the Channing style. Who else could do as much for *Widow's Weeds* or the rapid patter of *I'll Die Happy*. One of my favorites in the collection is *Homesick Blues,* with lyrics that deliver a very vivid picture of a Broadway now almost forgotten. The chorus backing Miss Channing is there to provide the atmosphere of the '20's but the arrangement of *Ain't Misbehaving* has it sounding like something straight out of TV's "Hullabaloo." The miking received by the star is very closeup. Luckily her relaxed style was able to keep the VU meter comfortable even at very close range. This is a highly successful tape on all counts despite the fact that my copy has what seems to be an interminable length of dead tape before the start of the first selection.

Mucho Machucambos

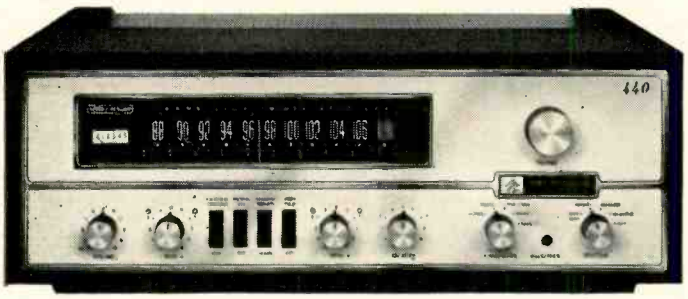
London Tape LPL 74055

How often do you find three Latin musicians as versatile as Los Machucambos? This may not be your first encounter with this exceptionally talented group. One of the most popular releases on London some three years ago when the label inaugurated its "Phase 4" stereo series was these artists' "Percussive Latin Trio". Their latest tape album can be recommended without reservation. There is as much entertainment packed into the two sides of this reel as you'll find in most Latin releases that feature a whole carload of musicians and singers. The Phase 4 process is put to busy use by London's engineers as the trio (two parts male and

(Continued on page 63)

Introducing the first solid-state stereo receiver of Fisher quality under $330.

It is not easy to make an all-in-one receiver that equals or surpasses the performance of comparable separate components. It is even more difficult to adapt the complex new technology of transistor circuits to simple, reliable, integrated stereo receiver design. But to do *both* at a truly moderate price takes almost occult powers. Or Fisher engineering.



It is with exceptional pride and an unprecedented sense of achievement that Fisher introduces the 440-T stereo receiver, a no-compromise, all-transistor instrument suitable for the most advanced audio systems and selling for only $329.50. (Cabinet, $24.95.)

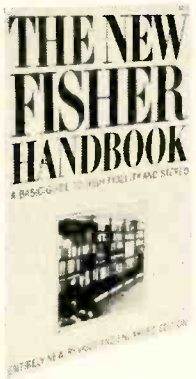
On a single, compact chassis only 11 inches deep and occupying only 16¾ inches of shelf space, the 440-T incorporates a superb, all-solid-state FM-multiplex tuner with automatic mono-stereo switching, an extremely versatile stereo control-preamplifier, and a heavy-duty, silicon-powered stereo amplifier. All the stereo electronics you are ever likely to need, all with Fisher reliability.

The Fisher 440-T fairly bristles with engineering innovations, convenience features and Fisher exclusives. Read the specifications on the right and convince yourself. Then ask your Fisher dealer for a demonstration. We predict you'll walk out with a 21-lb. package under your arm.

Features and Specifications

- *No output transformers—therefore no limitation of bass performance or of transient response because of transformer characteristics.*
- *Silicon output transistors for conservative operation at high power. Massive heat sink. Power output is 70 watts (IHF) at 4 ohms, 50 watts at 8 ohms.*
- *New all-transistor front end with 4-gang tuning condenser for highest sensitivity and lowest noise, plus overload rejection unexcelled by vacuum-tube front ends. Sensitivity is 2.0 μv (IHF); signal-to-noise ratio is 68 db at 100% modulation.*
- *Four wide-band IF stages and three limiters.*
- *Wide-band (one megacycle) ratio detector of highest linearity and lowest distortion, capable of unusually accurate detection of multiplex signals.*
- *Exclusive Fisher* STEREO BEACON* *for automatic switching between FM-mono and FM-stereo modes, and automatic visual indication of stereo broadcasts. No relays, no clicks.*
- *Professional d'Arsonval-type tuning meter.*
- *Highly effective muting between stations.*
- *Convenient speaker selector switch.*
- *Size: 16¾" wide, 5⅛" high, 11" deep (12⅜" overall, with knobs). Weight: 21 lbs.*

*PATENT PENDING



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AUDIO ETC.

Edward Tatnall Canby

VERY SOLID STATE

This last summer I had my first really extended experience with all-out, completely tubeless hi fi. I am solidly enthusiastic. And so this month I am moved to expound, not on the solid-state circuitry, which has been properly discussed these many years in our pages, but simply upon the sheer impact of this new home equipment on the home hi fi listener accustomed to years of tube equipment. It's a side of the business neglected among audio people—matter of not having time to see the forest for the trees.

The Revolution

The solid-state revolution, you see, is for most audio people very much a matter of electronics. Enough! It's a world in itself, complex, rapidly developing, a technical challenge to keep a man up to his ears in technical progress every single month. This has been an exciting and a tough decade, this last one, for those who were brought up on mere tubes.

Then for others in audio, differently oriented, this new solid state involves a major housing project, to put viable frames around the new circuitry, hook it up in electronically workable packages (which will, of course, work interchangeably with the old tube stuff). That, too, is an absorbing business in itself.

But the solid-state revolution goes a lot further out still. It has to be looked at from an outside point of view to be seen (and heard) in any sort of perspective.

It's a wider revolution, in the large, than the circuit people can hope to think about. These new transistors, tossing out a half century of tubed progress, have in turn provoked, and will further provoke, a major revolution in all the outward forms of hi fi, toppling traditions, customs, ideas, that go back to our own Very Beginning, around 1948.

What I mean is, the entire "face" of hi fi is now changing. The whole way it works, the sizes it comes in, the prices it asks, the divisions and categories into which it has for so long been fixed—all are up for complete overhaul and are well on the way to it already. The entire modelry—to coin a word—is under revision.

Even the basic relationships between component and "mass-produced" equipment, on which the very foundations of component existence have been built, are now all up in the air, and more so than ever before, as bigger and bigger performance, at less and less distortion and lower and lower current drain, goes into smaller and smaller places. I overheard a customer muttering, "Who wants a separate preamp and power amplifier, two units to buy, when, after all, each of them is almost as big as a cigarette lighter?" (And why don't they build the FM stereo tuner into the handle? It's only reasonable!)

Even now, in our present state, the current crop of hi fi equipment has a new and strangely unfamiliar "feel" to it as compared with the familiar hi fi equipment of a few years back, and back before that. Even our relatively large present solid-state units (as compared to matchbox and cigarette-lighter miniaturization, or missile stuff) give us a new kind of outward hi fi, as well as a new era in sound.

I'm speaking of things that hit the eye, that are touched by the hand; I'm concerned with ancillary solid-state characteristics like, say, *heatlessness*. What a new experience that is, for the hardened hi fi man! It's one of those things that counts *first*, even before sound itself.

Then take the new and different values as between sound and size, in the salesrooms and at home. They're startling.

You find, for instance, (if you haven't been shopping around lately) these little portable suitcase phonos which look very much like updated models of the old ones—until you discover that they have complete stereo hi fi systems built in, squeezed around the edges of the record changer. And big sound out of detachable stereo speakers. Then there are the modest little amplifiers that look like preamps and turn out to be big-watted enough to fill an auditorium. And the medium-sized power amps of major wattage that make you stagger when you pick them up—they're so light.

And there they all sit, these new models stone cold on the hottest days, and they don't do a thing (except amplify) no matter how long you leave that dim little pilot light ON. When these machines aren't working, they really rest. On *or* off. New! Brand new.

Silence

And there is the new silence—a thing I hadn't really thought about. It's golden for my jaundiced ear! Those new phono systems, for instance. You can leave them accidentally going for days, or even months, simply because when they are ON they sound as if they were OFF. By golly, they have amplifiers at last that sound like an amplifier should—dead quiet. I mean really SILENT. Not a trace of the old familiar faint hum, or that distant rhythmic rumble of a turning table, which for so many years warned us that we'd left the hi fi running. Now, you can't even tell.

And there are those dim little ON lights. They don't help much. Not very visible. You can overlook them easily enough, with all that utter silence. They have to be dim, of course, because they mustn't heat things up; but that's no sweat. ON or OFF, it's all pretty much the same. You can afford to leave the stuff ON because it doesn't draw enough current to measure, it won't get hotter and hotter, and it won't really deteriorate. Nothing really happens at all—until you get around to amplifying something. Then, out of the silence, POW! The big sound.

Sometimes the dim little lights aren't even ON lights. Who needs an ON light? Maybe they're just telling you that your tuner is soundlessly picking up a stereo station. Or some interchannel noise. They often go on and off by themselves, this kind. The light goes out and you go out. Sheer habit. Come back a week later and there's that little amber eye, cooly looking at you with its tenth watt or so of light-power, and the whole rig still in full operation, silent as the grave, and has been al week. Real weird. No harm done.

It's a fantastic new sort of efficiency, wonderfully adapted to the household-type human being. After all, don't people always tend to leave things ON? In the old days of constant-drain, high-heat, steady-deterioration tube equipment we had to be careful. Our pilot lights were brilliant little red and yellow and green jewels that you couldn't ignore, and shouldn't. Isn't it convenient, now, to be able to forget? Life is really different.

Hazards

I'd better repeat, hastily, that I'm still concerned with important *externals*—not inner elecronic values. I know all about the continuing excellence of tube design, as per, for instance, McIntosh, and I'm aware that plenty of us are still willing to bear the old fashioned disadvantages of tubes in order to reap the ever-increasing benefits. I'm just pointing out how Mr. Homebody feels, when he tries out the solid state. It's the way I feel myself, tubes or no.

Yes, I know (as who doesn't) that tubes can be quickly replaced when they blow or when they wear out; whereas solid state blows for good if it blows at all. Might as well toss the whole unit in the ash can, they keep telling me. And there are those dreadful things one can inadvertently do, like overheating the ultra-sensitive solidry, or crossing up those tricky grounds that *must* be kept apart and afloat separately. None of these problems with tubes. Real solid-state hazards.

Well, all I can say is—touch wood—no solid state has blown up for me yet. Not a thing has quit, or sizzled or smoked or popped. Touch wood again. And the longer this goes on, the more I get the feeling *—well, let it blow. I'm happy. I've got my money's worth already.* I've been convinced, and I'm getting more money's worth every day. By the time my solid state blows up on me, I'll be thinking it almost has a right

to. As far as I'm concerned, it has already proved itself reliable.

(Well, I may have to eat my words. I'll take the risk.)

Blinking Indicators

I mentioned last month those little KLH solid-state tuners two of which were involved with my stereo FM listening (FFFFFFFF, in the August issue). One of them, on its own, was the Model Eighteen, half a shoebox in size, an incredibly tiny and remarkably potent example of the new solid state exterior. Really a gadget! With that eerie (still, for me) instant warm-up (if this is the word for something that doesn't get warm) and that familiar faint yellow indicator light which, as any solid-stater can guess, isn't even an ON light at all; it's a stereo indicator. Who needs an ON light? If I didn't happen to have an over-all master switch for my equipment (relic of tube days) I'd just let the Model Eighteen run on forever. There it would sit, month after month, acting 24 hours a day like a big, whopping senior-model FM stereo tuner! Astonishing this transistor stuff.

The other KLH tuner, internally identical, was built into a few square inches of a Model Twenty, one of those portable phonos with a complete hi fi system installed down one side. It was this swanky unit that I left running by mistake time after time—for it was the most completely SILENT phonograph I'd ever "heard." In fact, for two nights in a row I slept within three feet of that machine without ever noticing that it was not only ON the entire time but with the turntable (Garrard) silently turning away, hour after hour, for days!

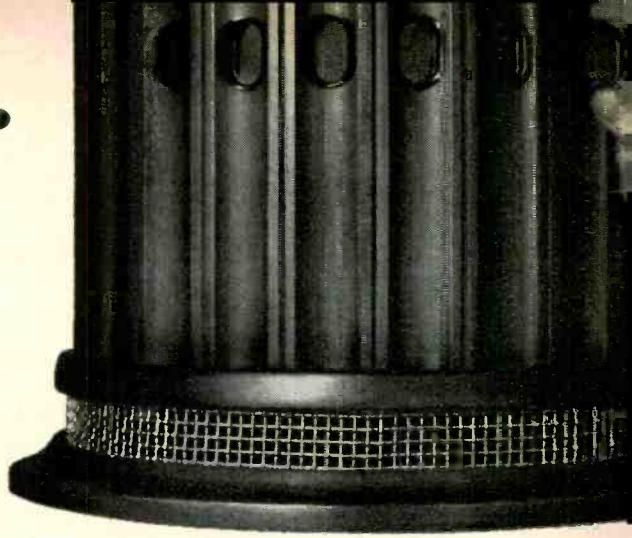
Now that, to me, is a major value though it may not seem impressive to the circuit people. I have always detested hum, even the slightest trace of it, *and* turntable noise, mechanical or in the form of induced signal. Very seldom have I ever heard equipment that didn't give itself away, even though faintly, when the switch was left ON. There is absolutely no trace of hum in this little phonograph, nor of motor noise. Quite seriously, that is the very finest compliment I can give it. I think you'll discover that the same applies rather typically to much of our new solid-state equipment and to the new and quiet turntables that go along with it.

Then there was the Scott almost-solid-state Model 312 stereo tuner. It had four Nuvistors, which rated it as semi-tube (supposed to be very sound practice in tuner design); but in outward functioning and looks it was very definitely in the solid-state camp—small, compact, cool-running, quick-warming and powerful as all get-out. At a higher price, it seemed to have the baby KLH beat by a small margin in sensitivity—not by much—and it had a batch of controls-in-detail of the sort appropriate on this type of model—but put all that aside: I have only one major observation to make on my reactions to its solid-state tuning, versus that of the KLH.

I can understand the thinking that prompted KLH to give the most it could in sheer reception for the money at the expense of a means for making the stereo

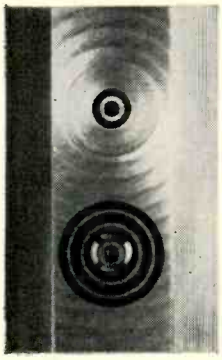
(*Continued on page 61*)

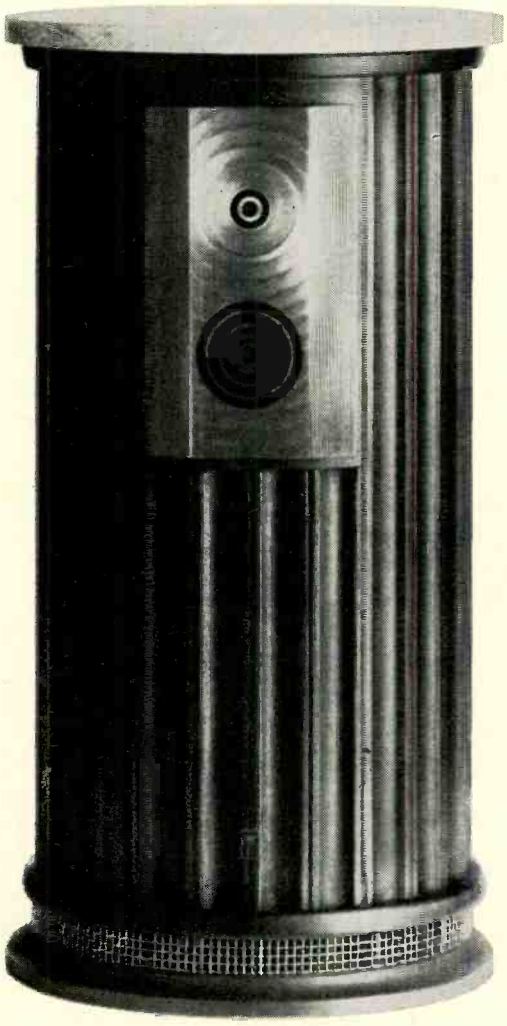
Feature by feature, the new Empire Grenadier 8000P is the most significant advance in stereophonic reproduction.



Empire's new Dynamic Reflex System allows you to adjust the bass and treble response of your Grenadier speaker system to suit your individual room acoustics. Your decor has no effect on the phenomenal stereo separation of the Grenadier 8000P

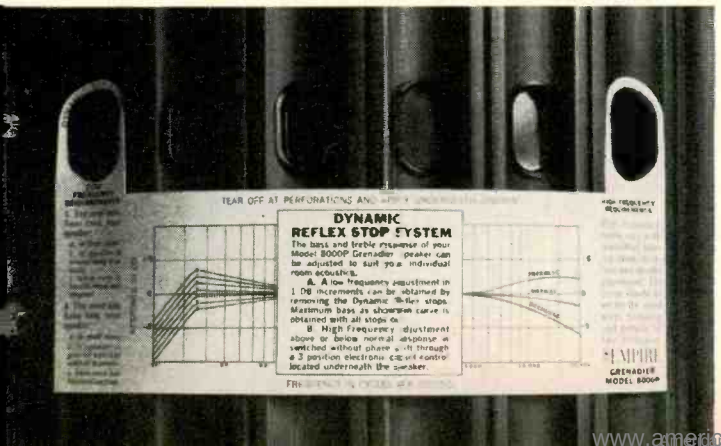
Empire's exclusive die cast divergent acoustic lens assures fuller frequency and separation plus broader sound propagation. Sit anywhere, hear everything. Speaker placement is non-critical.





Take a good look at the statuesque originality of this wide angle speaker system. Its hand rubbed walnut finish and imported marble top, in combination with its revolutionary achievement in sound reproduction, earmark the new Empire Grenadier 8000P as the most exciting speaker system in the Hi Fi industry today.

Your permanent guide to greater listening pleasure



EMPIRE

World's most perfect high fidelity components. For a sound demonstration go 'round to your HiFi dealer. Empire Scientific Corp., 845 Stewart Ave., Garden City, N.Y.; Export: EMEC, Plainview, N.Y.; Canada: Empire Scientific Corp. Ltd., 1476 Eglington W. Toronto

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HERMAN BURSTEIN

Send questions to:
Herman Burstein
280 Twin Lane E.
Wantagh, N. Y.
Include stamped, self-addressed envelope.

IN my writings here and elsewhere I have tried to make the point that one of the factors accounting for the higher price of better components is quality control. This applies not only to the manufacturer but also to the distributor and the retailer. When you shop for the lowest price you may be depriving yourself of the opportunity of getting the component in its best possible condition, so that it fully measures up to the potential afforded by its design and construction. The merchandiser (distributor or dealer) who takes high fidelity seriously will feel a sense of responsibility about the equipment he lets out the door. He will check it over before it goes out. But bear in mind that time spent checking a component, particularly a component as complex as a tape recorder, can represent an appreciable sum of money.

My point is illustrated by a recent visit to the distributing agency for a tape recorder that has gained a very fine reputation. This distributor takes nothing for granted but spends 20 minutes or more checking every tape recorder before it goes to the dealer. Altogether there are 70 items in the checklist, grouped into three categories: appearance, mechanical operation, and electrical operation. In connection with appearance, the distributor looks for such things as scratches, loose knobs, loose screws, cabinet chips, missing warranty card, and so on. In connection with mechanical operation he checks normal tape speed, rewind speed, fast-forward speed, take-up action, wow and flutter, tape guidance, belt noise, other levers and switches, pressure wheel alignment, whether the turntables are touching the top plate, whether tape touches the reel flange as it winds off the reel or onto the reel, whether the tape winds evenly, and the like. In connection with electrical operation he checks whether the machine records properly, whether it plays back properly, playback frequency response, record-playback frequency response, distortion, erasure, A-B comparison with a program source, output level, noise, tubes, gain, crosstalk, oscillation, and so on.

The distributor estimates that under 10 per cent of the tape recorders which come into his place have some kind of defect, and that as the result of his checking procedure more than 99 per cent reach the final customer in tip-top shape, meeting or exceeding the manufacturer's specifications. But, we must remind ourselves again, this kind of thing costs money.

Q. I will appreciate information about low-noise tape. What are some of the precautions one should use in obtaining optimum results with this kind of tape?

A. Data released in 1963 by the 3M Co. (makers of Scotch tape) indicate that its low-noise tape has the following characteristics compared with its standard 111 tape when used on a tape recorder properly adjusted (in terms of record drive, bias, and record equalization) for 111: (1) about 6 db less apparent noise; (2) about 2 db less output in the low and mid range; (3) greater high-frequency sensitivity, resulting in about 5 db rise in response (relative to 1000 Hz) in the region of 10,000 to 15,000 Hz; (4) more extended treble response prior to the sharp drop-off that occurs at the high end; (5) about 2 to 5 db greater output at tape saturation in the high end, resulting in improved dynamic range.

With proper adjustment of recording level, bias, and recording equalization, Scotch low-noise tape has the same output as Scotch 111 for a given distortion level; somewhat more extended treble response; equal flatness of response prior to treble drop-off; and less apparent noise. Scotch recommends about 2 db boost in record drive, about 15 per cent increase in bias, and about 3 db less record treble boost when using its low-noise tape, compared with optimum conditions for its 111.

*Q. I have a **** tape recorder and it has two outputs rated at 5 ohms for extension speakers. The two small speakers that came with the recorder sound like tin cans, so I have used my stereo speakers, which are rated at 8 ohms, and they sound fine. Is it necessary to match the 5-ohm output impedance of the recorder with 5-ohm speakers for best efficiency and sound? Is it better to use 3.2-ohm or 8-ohm speakers for the best match to the 5-ohm output? I tried a pair of 3.2-ohm speakers with the recorder and found that they sounded better than the speakers which came with the recorder.*

A. Impedance matching between the power amplifier and the speaker is an approximate process, inasmuch as the impedance of the speaker varies appreciably in different parts of the audio range. Thus it is found that a 1:2 mismatch or 2:1 mismatch is seldom of great consequence. Accordingly it appears that you would obtain about equally good results from either a 3.2-ohm speaker or an 8-ohm one when connected to a 5-ohm source. If you are trying for maximum power, the results may be better with a downward mismatch (speaker impedance lower than amplifier impedance).

Q. Is it common to run into dropouts that last for several feet of tape on a reel?

A. The only dropouts I have encountered have been those lasting a fraction of a second. Dropouts are more noticeable on quarter-track than half-track recording. And they are more noticeable as tape speed is reduced.

Q. I have been using "sandwich" tape and obtaining unsatisfactory results. I wonder if the problem is the tape or my recorder.

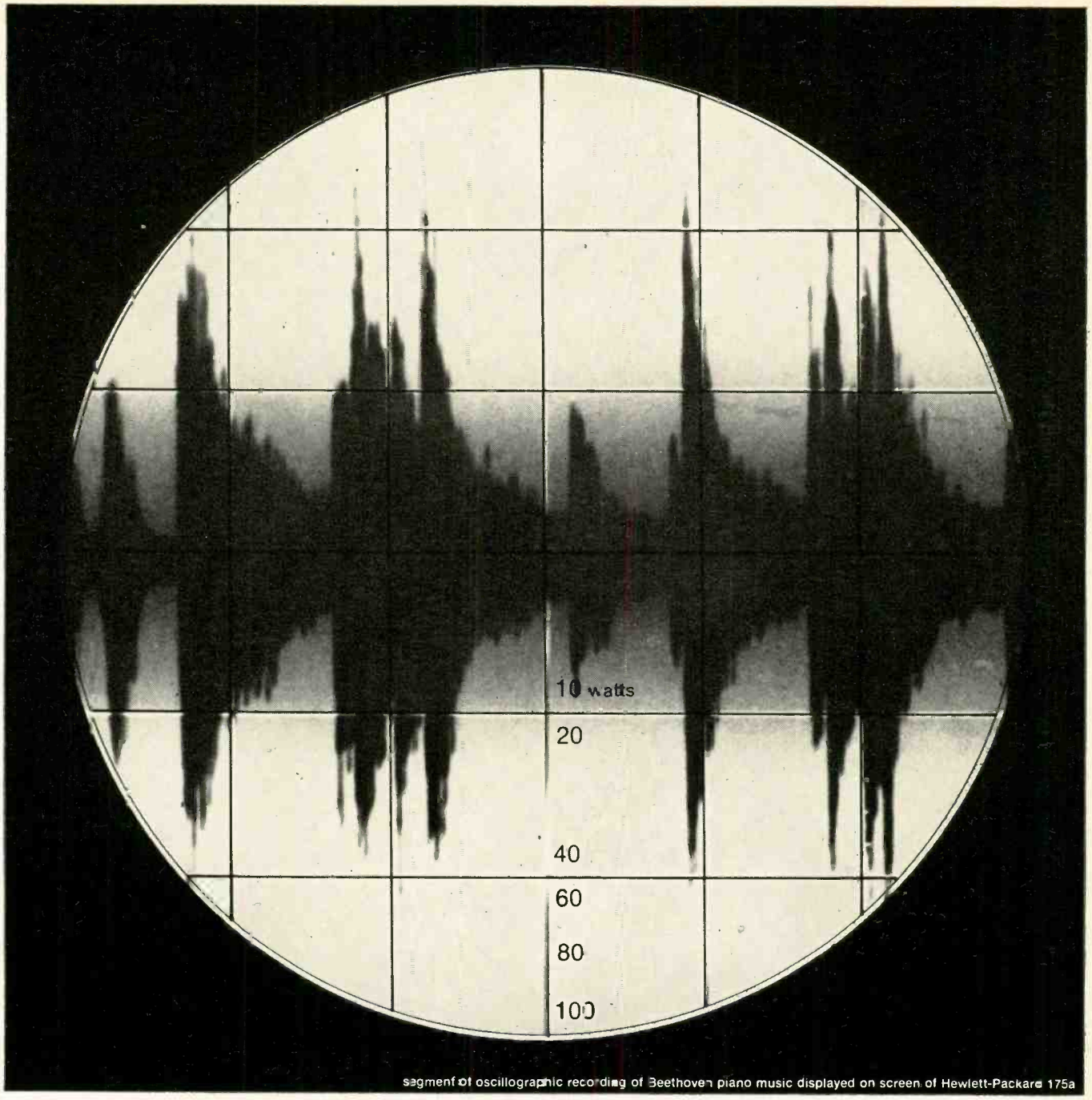
A. Sandwich tape is intended for special use, such as in a language lab, where the tape and the tape machine receive very intensive use. This tape has a fine plastic coating over the oxide, resulting in reduced friction between the head and the tape. Hence the sandwich tape lasts much longer than tape without protective coating; and the tape heads benefit similarly. However, the spacing between the tape oxide and the heads, owing to the plastic coating, results in treble loss. When bias is set for conventional tape, sandwich tape will result in about 4 db loss at 7500 Hz at 7.5 ips, and increased loss at higher frequencies. This may account for your unsatisfactory results.

Q. Mr. Pope's letter in the January, 1965, installment of the TAPE GUIDE, *referring to highs being lost on tapes stored for 3 to 5 years, has thrown a scare into me. I would appreciate your comments.*

A. I am inclined to believe that Mr. Pope's views tend toward the extreme side, although this does not mean that his statements are without foundation. In other words, I am trying to say that the phenomena Mr. Pope describes may not have a great practical effect. One must recognize that even if there is some loss of highs, one's sensitivity to high frequencies tends to diminish as one gets older, so that the loss is not so noticeable. Furthermore, there has been a definite improvement in the treble response of tape machines and tapes in the past few years, so that such losses as do occur are more likely then formerly to take place in a range above our hearing span. Thus a loss that used to take place between 10,000 and 15,000 Hz, where it would tend to have some audible effect, today might take place at 15,000 to 20,000 Hz, where it would have little or no audible effect.

Let me add that long-term storage is not the only reason for a tape recorder. There are many delightful things that I record which I play a few times in the following months but have no desire to preserve longer and therefore eventually erase.

(*Continued on page 46*)



segment of oscillographic recording of Beethoven piano music displayed on screen of Hewlett-Packard 175a

IS 100 WATTS PER CHANNEL NECESSARY?

Yes, and only the Mattes SSP/200 is guaranteed to deliver it.

The solid-state Mattes SSP/200 amplifier * was designed to reproduce music for serious listening, not just play at it; we therefore had to know how much power would be needed. The piano is one instrument we studied.
According to data taken at Bell Telephone Laboratories, piano reproduction should require at least 75 watts with modern, low-efficiency loudspeakers. We have confirmed this using the newest condenser microphones, mastering tape recorders and acoustic suspension loudspeaker systems: a medium-size Steinway required over 78 watts.
The SSP/200 delivers 100 watts per channel r.m.s. from 20 to 20,000 cps; IM distortion is about .07% at full output. These remarkable specs are only the beginning of the story of the Sharma Circuit™. Let your franchised Mattes dealer tell you the rest, or write us; there isn't another amplifier like it.

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MANUFACTURING ENGINEERS/SOLID STATE CIRCUITRY

*U. S. and Foreign Patents Pending

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EDITOR'S REVIEW

Hz, A NEWCOMER IN AUDIO

IN KEEPING WITH the rest of the world, and with a recent decision of the Standards Committee of the Institute of High Fidelity, AUDIO this month drops "cps" and substitutes the more universal "Hz" which, as everyone knows, is the abbreviation for Hertz, the discoverer of Hertzian Waves, apparently. In some ways this hurts, (what a lousy pun!) because it was so easy to change an author's manuscript from cycles or cycles per second to our previous abbreviation, cps. And we can only hope that we have caught all the seapeaesses in this issue and changed them to Hz's—at least, we caught most of them. And Hertz, by the way is pronounced "hairtz."

HI FI SHOWS AND OTHERS

We have quite a list of upcoming hi fi shows for the first half of 1966, not to mention the BIG one in New York this Fall—which occupies the N. Y. Trade Show Building from September 27 to October 3. This is followed by the Seventeenth Annual Convention of the Audio Engineering Society at Hotel Barbizon Plaza (don't omit the "Plaza"—the Barbizon is exclusively a hotel for girls) from October 11 through the 15th.

Then in February, 1966, there is the Philadelphia show at the Benjamin Franklin Hotel on the 18th, 19th, and 20th. The next jump is to Paris, for the Festival du Son, from March 10 to 15; back to the U.S. for the Los Angeles High Fidelity Music Show from March 27 to April 3, a two-week vacation (?) and the San Francisco High Fidelity Show from April 18 to April 25. Then, if you're so inclined, over the Pole to Hanover in West Germany for the collossal International Trade Fair, which they call the Messe, and hold it in a city which they spell Hannover, (pronounced Hahnnoaf'er). Since over a half million people are likely to attend that Fair, getting sleeping accommodations is the *mess*, usually— it is always useful to know the right people. Then there is a Trade Fair in Stockholm which will undoubtedly precede the Festival du Son by a few days, although the dates were not firmed by our closing time. Then, too, there is the International Audio Festival in London somewhere in the month of April—practically ensuring that no one of us will be able to attend them all. That won't keep us from trying.

But—first things first—we will definitely be at the New York High Fidelity Show—be the good Lord willing, as Arthur Godfrey always says. See you there?

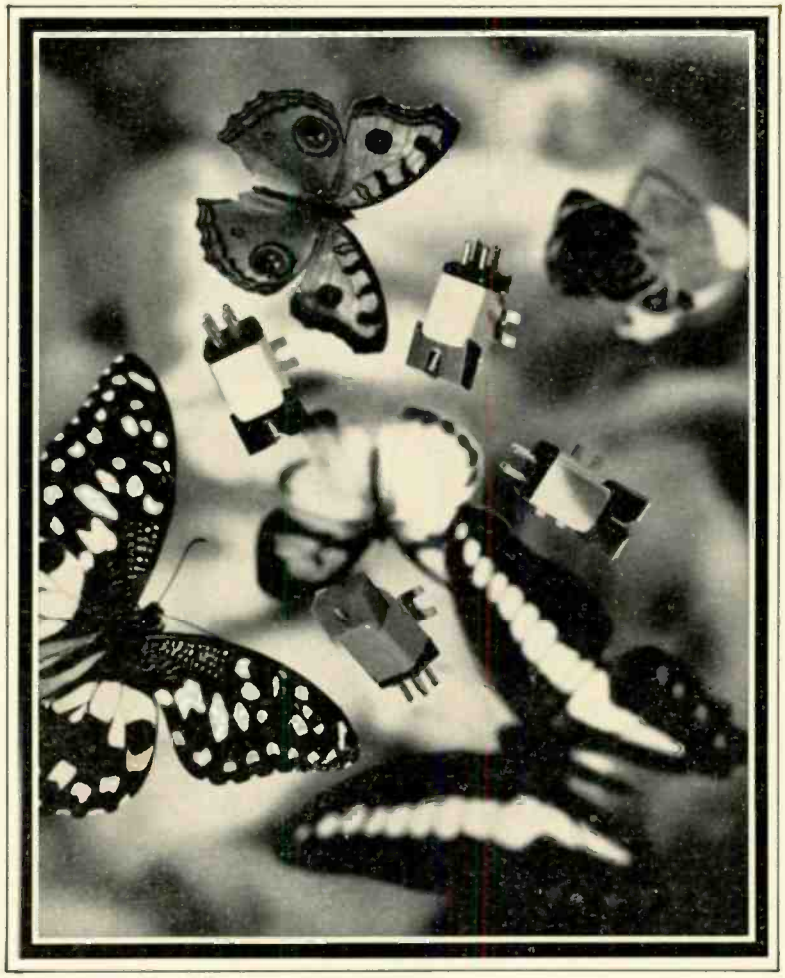
Incidentally, start making your plans to attend the AES Convention. The full program will be published in the October issue.

LOOKING FORWARD IN AUDIO

Sometimes, in order to force ourselves to adhere to a plan, we announce the content of future issues—and then strive to follow the plan zealously. In this instance, we signify our intention to cover tape recorders in depth in the December issue, and to follow in February with an issue slanted in the direction of test equipent. It has long been AUDIO's opinion that the serious hobbyist was not only interested in the highest possible (in terms of budget and the state of the art) reproduction of music, sound effects, and even some kinds of speech, but also in the proper maintenance of his equipment.

To this end, the knowledgeable audiofan—and if he reads AUDIO regularly, we contend that he *is* knowledgeable—may, and usually does, accumulate a bare minimum, at least, of test equipment. Not that he makes a gain run on his equipment every day, or checks distortion weekly, but that he does check tubes at intervals, investigates supply voltages, and at no less than semi-annual intervals actually checks frequency response, distortion, and power output. This may seem like a lot of work, and it is apparently less important with solid-state equipment, but one certainly gives his motor car regular preventive maintenance, so why not his music system? Not everyone needs a multiplex generator, even if he knew how to use it, but every audiofan does need a voltmeter, ohmmeter, and some means of measuring a.f. voltages over the audio spectrum. It's all part of the fun, and we hope to prove it—next February.

As for December, just preceding the Christmas buying season, a compilation of the various features of tape recorders will help you decide what you want your personal Santa Claus to drop down your chimney. Anyhow, a suitably marked copy of the December issue left around the house in a conspicuous place could prove influential. How much better a new tape recorder than a dozen typical Christmas ties!



Capture natural sound with Pickering.

From the softest flutter of the woodwinds to the floor-shaking boom of the bass drum, natural sound begins with Pickering. Right where the stylus meets the groove.

Any of the new Pickering V-15 stereo cartridges will reproduce the groove, the whole groove and nothing but the groove. That's why a Pickering can't *help* sounding natural if the record and the rest of the equipment are of equally high quality.

To assure compatibility with *your* stereo equipment, there are four different Pickering V-15 pickups, each designed for a specific application. The new V-15AC-2 is for conventional record changers where high output and heavier tracking forces are required. The new V-15AT-2 is for lighter tracking in high-quality automatic turntables. The even more compliant V-15AM-1 is ideal for professional-type manual turntables. And the V-15AME-1 with elliptical stylus is the choice of the technical sophisticate who demands the last word in tracking ability.

No other pickup design is quite like the Pickering V-15. The cartridge weighs next to nothing (5 grams) in order to take full advantage of low-mass tone arm systems. Pickering's exclusive Floating Stylus and patented replaceable V-Guard stylus assembly protect both the record and the diamond. But the final payoff is in the sound. You will *hear* the difference.

PICKERING—for those who can hear the difference.

Pickering & Co., Plainview, L.I., N.Y.

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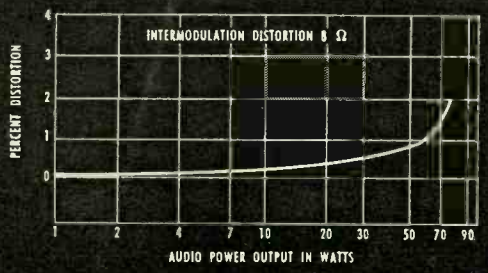
Compare these Sherwood S-9000 specs! Power output for both channels is 150 watts at ¾% I.M. distortion. Continuous sine-wave power output (two channels) is 100 watts at ¼% distortion. Power band width: 12-25,000 cps. at 1% distortion. Hum and noise: Phono—70db, Tuner—80db. Sensitivity: Phono 2.5 mv, Tuner 0.35v. Other Sherwood ALL-SILICON Solid-State amplifiers are the S-9900, 90-watts music power (features ctr. channel mono power) @ $229.50 and the S-9500, 50 watts music power @ $179.50.

0.1% distortion



. . . and *All-Silicon* too!

Chart reprinted from test lab report, May, 1965, High Fidelity.

Are you ready to step up to a Sherwood? You are, if what you seek is the "transparent", "life-like" reproduction resulting from 0.1% distortion previously obtainable only in bulkier, more-expensive basic amplifiers. And, did you know that *only* Sherwood features *ALL-SILICON* solid-state circuitry in every amplifier to earn the industry's most enviable reliability record? This is why experts confirm again-and-again . . . *Sherwood is the best!*

Paired in "Gemini" walnut cabinet @ $39.50 is Sherwood S-9000 Solid-State 150 watt amplifier, $299.50, and S-3000V FM Stereo tuner, $165.00.

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Development of a Pulse Modulated Audio Amplifier

In Four Parts, Part 1

NORMAN H. CROWHURST

The future of high-power transistorized amplifiers may just possibly lie in the "Class D" arrangement, as has been suggested in several previous articles, but still relatively unfamiliar to designers. This series should provide a workable starting point for practical circuitry—eliminating much of the fundamental drudgery.

THE FIRST ARTICLES calling attention to the possibility of doing something of the kind we are about to discuss used the expressions, "Two-State Modulation" and "Class-D"—the first from the academic basis for the way active elements are used in this new method, and the second because it was the next available class letter.

Basically, any system that switches between full conduction and non-conduction, without lingering in intermediate conditions—a method of operation particularly useful with transistors—can be described as two-state modulation. As Classes A, B and C have been known for years to audio and radio people, it was not illogical that application of this new mode to audio should be called Class D.

The experimentation described in these articles started with an effort to see what could be done with this mode, and finished up with a new mode that goes a step further than had previously been described. It fits neither the two-state nor the Class-D appellation precisely, and does considerably better.

Efficiency

The first concept of Class-D or two-state can be illustrated by means of a hypothetical single-ended push-pull output stage (*Fig.* 1). Without bothering to go into details about how the modulation might be achieved, a sinusoidal (or any other waveform) output is synthesized by switching the transistors at ultrasonic frequency, varying the "up" and "down" intervals (*Fig.* 2).

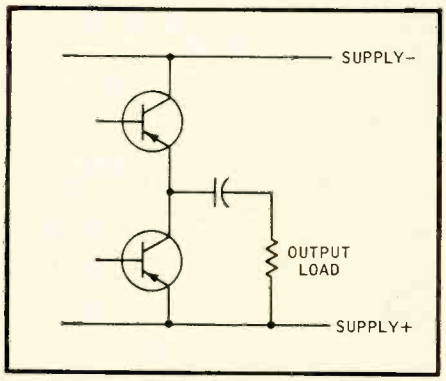

Fig. 1. A simple output circuit that can easily embody the Class-D or two-state modulation operation, used for considering what happens.

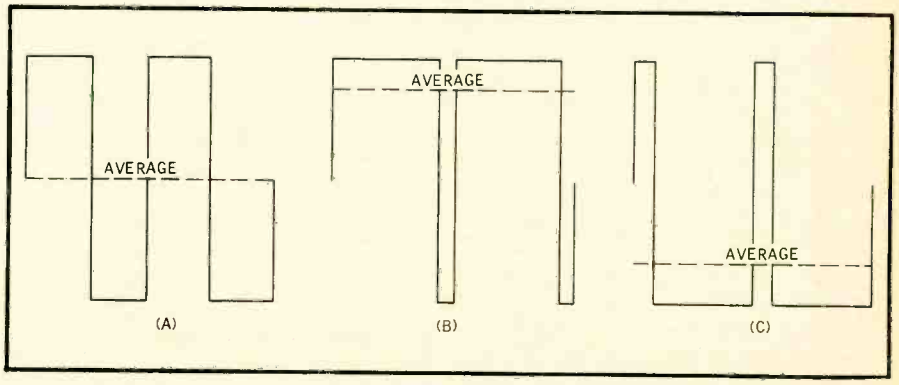

Fig. 2. Waveforms associated with using the output of *Fig.* 1 in two-state mode: (A) at quiescent, when average voltage is set at middle by equal "up" and "down" times; (B) longer duration of "up" yields a resultant average that is "up"; (C) similar for "down".

In the "up", the upper transistor is conducting and the lower one not, so the output terminal is momentarily "connected" to the upper supply terminal. In the "down", the lower transistor is conducting and the upper one is not, so the output terminal is momentarily "connected" to the lower supply terminal. By varying the intervals of "up" and "down", according to the instantaneous "audio" value of the waveform, any momentary output voltage can be simulated.

Merely by filtering off the ultrasonic switching frequency, the "average instantaneous" audio value appears. It is "average" in respect to the ultrasonic switching frequency and "instantaneous" in respect to the audio frequency being handled.

The advantage claimed for this circuit is that it enables the transistors to divide their time between fully conducting and non-conducting with no half-way points. As the dissipation of a transistor when either fully conducting (at almost zero volt drop) or non-conducting (zero current) is very small, this means all the supply energy is used in the output circuit, and very little in the transistors.

Where Does the Dissipation Go?

This sounds quite plausible, until we remember that one or other of the transistors is fully conducting all the time, allowing full current part of the way. And the supply voltage presumably retains its full value, regardless of signal. So where does the current and its attendant dissipation go? What really happens when there is no, or very little audio signal present? That's a good question.

If the output is connected directly to a resistance load, there will be full current at the ultrasonic frequency in alternate directions through the load. If filtering, with an inductance input filter, is used to prevent any current except audio from reaching the load (*Fig.* 3), then the current will only *start* to rise in a given direction when the transistors are switched in that direction. If the transistors spend equal time switched each way, as they should at zero signal (audio) then there will be little current either way.

But there is some current, as allowed by the input inductance of the filter. And this current, at the supply voltage, constitutes a loss that has to be dissipated somewhere, most likely in the filter, but possibly also in the transistors, in the form of transient conditions during the switching, which is never really instantaneous. Adding elements to the filter will prevent ultrasonic energy reaching the load, but the input inductance is the only element contributing effectively to "quenching" the ultrasonic energy. What it doesn't quench has to get dissipated somewhere.

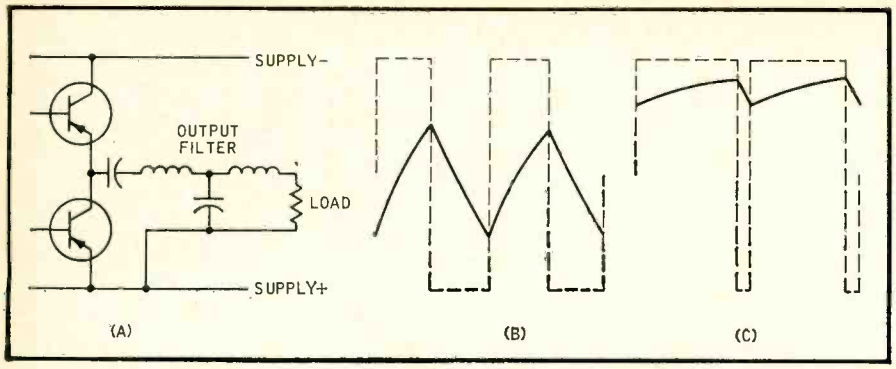

Fig. 3. Inserting a filter can prevent the ultrasonic part of the energy from reaching the load: (A) the same circuit with filter inserted; (B) voltage (dashed line) and current (solid line) at quiescent; (C) same at an instant when resultant audio is "up".

To summarize what Class-D achieves: in theory it enables the transistors to operate at close to 100 per cent efficiency, by merely switching; in a practical circuit, the efficiency is dependent on the efficiency with which the filter can separate the audio frequency from the ultrasonic switching frequency and, because the switching is not ideal, the theoretical transistor efficiency is not realized, though appreciably more than the circuit efficiency is.

Perhaps we should stress the distinction between efficiency of a component, such as the transistor, in handling power, and the over-all circuit efficiency. Even if the transistors dissipated no power at all, which would make them 100 per cent efficient, this is no guarantee that all the supply power is converted into audio. This relationship refers to another kind of efficiency—conversion efficiency. With this particular kind of circuit the loss occurs mainly at zero signal, low signals, and where large signals have an instantaneous value near zero.

A multistage filter is little help in improving this efficiency. However many reactance elements are used, the Q of the input inductance must be very high. And because of the fact that ultrasonic power, equal to the ultimate peak audio power, is *available*, the filter can only be of limited utility.

Improving Circuit and Conversion Efficiency

The first step to improve this basic situation seemed fairly obvious, although a search of the literature suggested that nobody had thought of it before. This was to switch only as much current as the signal of the moment demands, by using two transistors to switch current in opposite directions, not simultaneously, but in a sort of "Class B" mode (*Fig.* 4).

At quiescent, very small pulses are switched in alternate directions. As signal swings the required output to one polarity or the other, those pulses are enlarged, while the others disappear. A circuit to achieve this can best be visualized as using an output transformer (*Fig.* 5) although there are other ways that would do it equally well.

With the Class-D or two-state method, the switching could be self-initiating, reversal occurring whenever there has been "enough current pulse" in one direction. In short, a separate multivibrator to generate the ultrasonic frequency is not necessary; over-all feedback, with constants chosen so as to cause switching at ultrasonic speed, is all that is needed to make it work.

But the two-way, "Class-B" signal cannot so readily be based on such a self-generating action; some synchronizing signal must be provided that will pulse the transistors alternately and with uniform spacing. So the first requirement is a multivibrator that will generate overlapping "starter pulses". If the generator can have triangular, or sawtooth outputs, these can be combined with the audio signal at the base of transistors working so as to saturate quickly, to vary the relative period of "on" and "off".

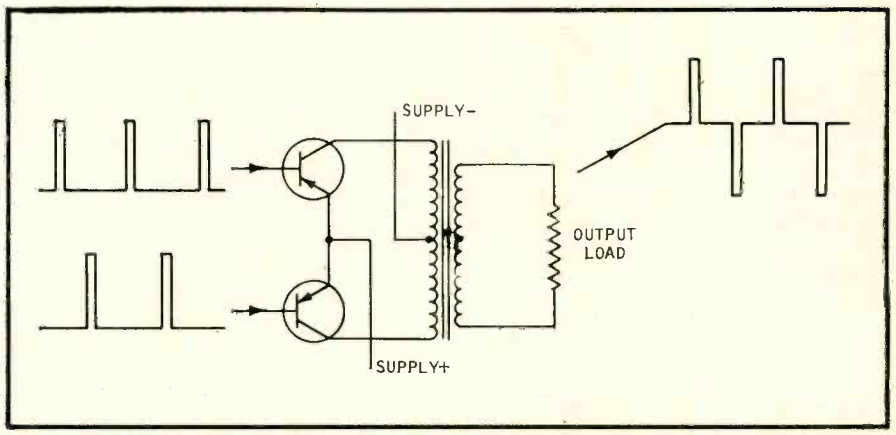

Fig. 5. A form of output transistor coupling that could use the signal form developed at *Fig.* 4. Note how interlacing of pulses on the output sides produces pulses alternating in opposite directions in the output itself.

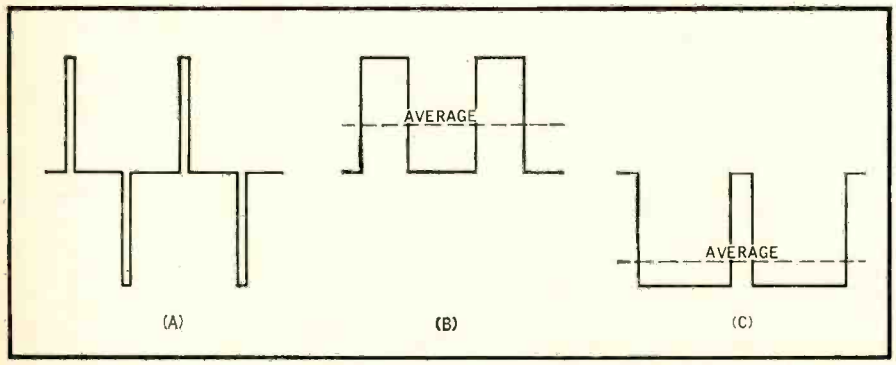

Fig. 4. The concept that started this experiment away from the basic Class-D concept: (A) quiescent waveform, at output, before filtering; (B) an "up" signal, less than half full magnitude; (C) a "down" signal, more than half full magnitude.

A multivibrator that produces overlapping sawtooth waveforms is shown at *Fig.* 6. Basically it generates square waves at the collectors. But at the bases, each has a half-period sawtooth, with zero voltage for the other half period. To make a complete sawtooth on each side, all that is needed is a diode and a capacitor with discharge resistor. A full-period sawtooth is necessary on each side, because we want to modulate current in either direction up to full time. Having only a half-period sawtooth would restrict the maximum "on" time of each transistor to half the ultrasonic

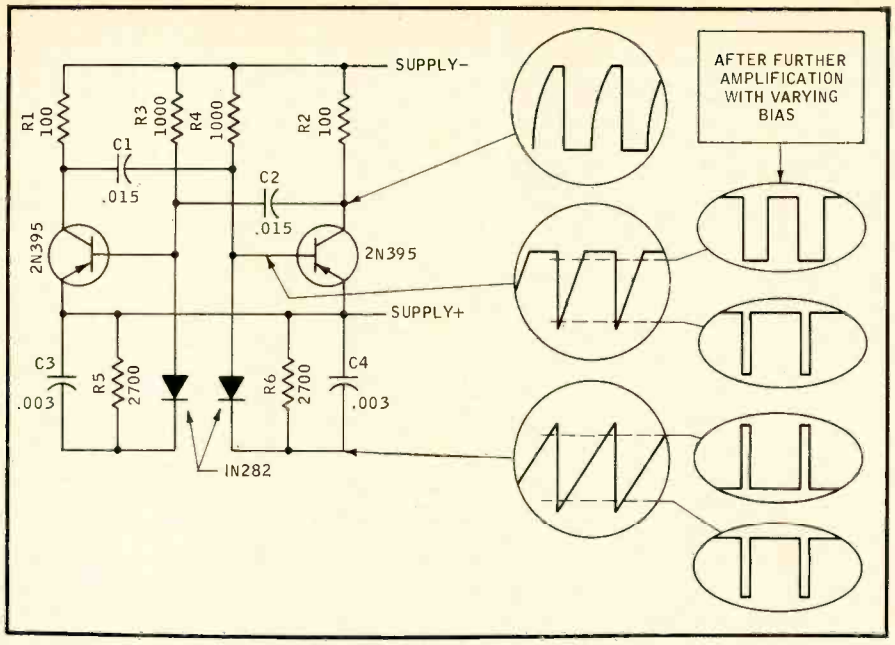

Fig. 6. A multivibrator circuit to produce the required interlaced sawteeth for generating variable duration pulses.

period, which would halve the available power from given output transistors.

The frequency of this kind of multivibrator is determined by the value of the base resistors in conjunction with the coupling capacitors. To give a reasonable output level, working from a 12-volt supply, this circuit used 100-ohm collector resistors and 1000-ohm base resistors. Almost any transistor will serve. The one actually used was 2N395. The frequency is arrived at as follows:

With capacitors C_1, C_2 and C_3, C_4 in a 5:1 ratio, the positive maximum voltage will be about 5/6 the supply voltage. So the switching action will be initiated, each way, when the capacitor discharge has progressed by the fraction 6/11 [from 10v/(12v + 10v)], or 0.55. Referred to the time constant, this is 0.6, because $e^{-0.6} = 0.55$. This translation can be made from tables or an exponential slide rule.

Assume we want a switching frequency of 60 kHz. Then 0.6 of the time constant must be 8.33 microseconds (half a period of 60 kHz). So the time constant should be 14 microseconds. With 1000 ohms, this requires C_1 and C_2 to be 0.014 μf. Using preferred values, C_1 and C_2 can be 0.015 μf, while C_3 and C_4 need to be 0.003 μf.

To get a good range of sawtooth voltage (and current) the discharge time constant for C_3, C_4 should be about half the period of the high frequency, or 8.33 microseconds, requiring R_5, R_6 to be about 2.7K. This allows discharge to about 0.136 (e^{-2}) of the full positive voltage, so the range of voltage on the positive sawtooth is from 10 to 1.36. Through the 2.7K resistance, this represents a current of 3.7 to 0.525 milliamps.

We have shown R_5, R_6 returned to supply +, because this is their effective termination, from the viewpoint of the multivibrator. Actually, they will return to supply + through the base/emitter of a transistor, as we will see in a moment.

A circuit to provide the necessary combination with audio components is shown at *Fig.* 7. It consists of a phase inverter coupled to a pair of direct-coupled stages, whose bias is chosen so that with no signal, the sawtooth only just fires the output transistor (not shown) by only just momentarily switching the last transistor in each side, shown here, off. At first, the notion was to make the stages following the phase inverter work near cut-off, because only the excursion in one direction was used to modulate that particular output transistor.

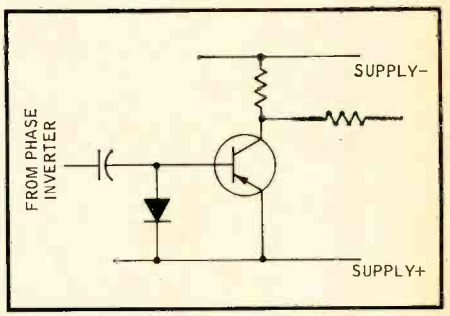

Fig. 8. Using a diode to overcome the rectifying action that prevented the circuit of *Fig.* 7 from working successfully.

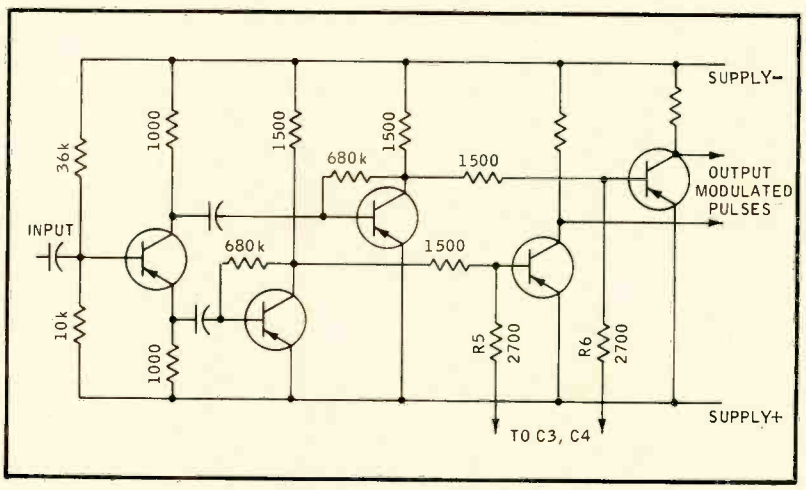

Fig. 7. A phase inverter, drive stage, and mixer stage, for producing the required modulation form for both sides of the output push-pull. See text for derivation of values.

Derivation of the phase-inverter bias is simple: the divider resistors are calculated to put the base, with a current of about 1/100 the collector current, at ¼ the supply voltage. With 1000-ohm emitter and collector resistors, working at 3v, 3mA, the base takes 30 microamps. Using 10k for the bottom resistor, resulting in 300 microamps, the top resistor must pass 330 microamps at 9 volts, requiring 36k.

For the drive stages, following the phase inverter, we need first to consider the bias current needed by the mixer stage that follows it, so that cut-off of this stage allows the pulses to be extinguished completely. The maximum pulse current is 3.7 mA, so we should

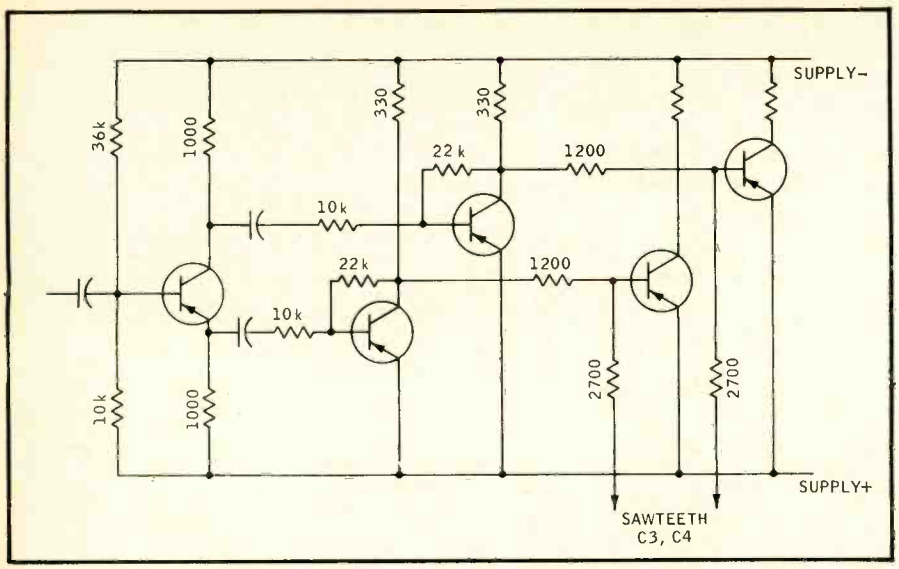

Fig. 9. Revised values for the circuit of *Fig.* 7, to work the drive stage in Class A. This circuit worked. See text for derivation of values.

provide at least 4 mA. From the 12-volt supply, this requires 3000 ohms, for the combined coupling resistor and collector resistor. Making each 1500 ohms seems convenient.

Now, to get minimum pulses at quiescent, the drive stage should take about 0.7 mA, so we pick bias resistors to pass about 7 microamps at about 4.8 volts (to deliver 3.2 mA through 1500 ohms to the mixer-stage base) requiring 680k. This is based on transistors with a current gain of 100.

To swing the pulse to full period, the collector voltage must drop so that the 1500-ohm coupling resistor passes only 0.5 mA, or about 0.75 volts. This means the collector resistor must drop 11.25 volts, by passing 7.5 mA, which will mean the collector passes 7 mA, requiring a base current of 70 microamps. As the phase inverter is working at 3 mA, this drive is well within its capability.

All the transistors in *Fig.* 7 can be 2N323's or a similar type. The problem found with these values was that the drive transistors, swinging widely into and out of cut-off, behave as rectifiers.

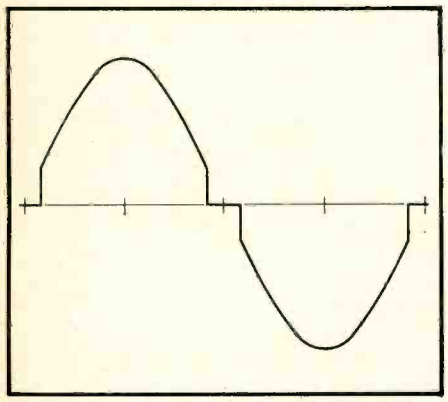

Fig. 10. The kind of crossover distortion that this kind of operation later showed, requiring a new approach.

For the benefit of the transistor's own operation, a diode to conduct in the opposite direction will maintain correct bias (*Fig.* 8). Unfortunately, it was found impossible to arrange the diode circuit so that (a) it maintains uniform loading on the phase inverter as output loads, at the same time as (b) it maintains a constant bias for the transistor, as signal increases. If the bias changes, a sudden stop in the signal will leave the output transistors either receiving no pulses at all, or receiving pulses that will allow excessive current.

The circuit of *Fig.* 7 then had its values changed so that the pair of transistors following the phase inverter operated strictly in Class A and the Class-B function was introduced by arranging that the d.c. coupling to the mixer stage caused pulses of minimum duration at no signal. Then quite a small signal in either direction would cause one output transistor to cease receiving any pulses at all, while the other would receive pulses of growing duration, until it remained switched on for the whole period, at full audio signal in that direction.

Making the collector resistors 330 ohms as a starting point, and considering the drive transistors cut off, at maximum swing into the off phase of this side, the coupling resistor will need to pass twice the bias current, or 7.5 mA, producing a 2.5 volt drop in 330 ohms. The coupling resistor needs to drop the remaining 9.5 volts at 7.5 mA, requiring 1200 ohms. Quiescent bias should pass 3.5 mA through the same 1200 ohms, requiring 4.2 volts at the collector.

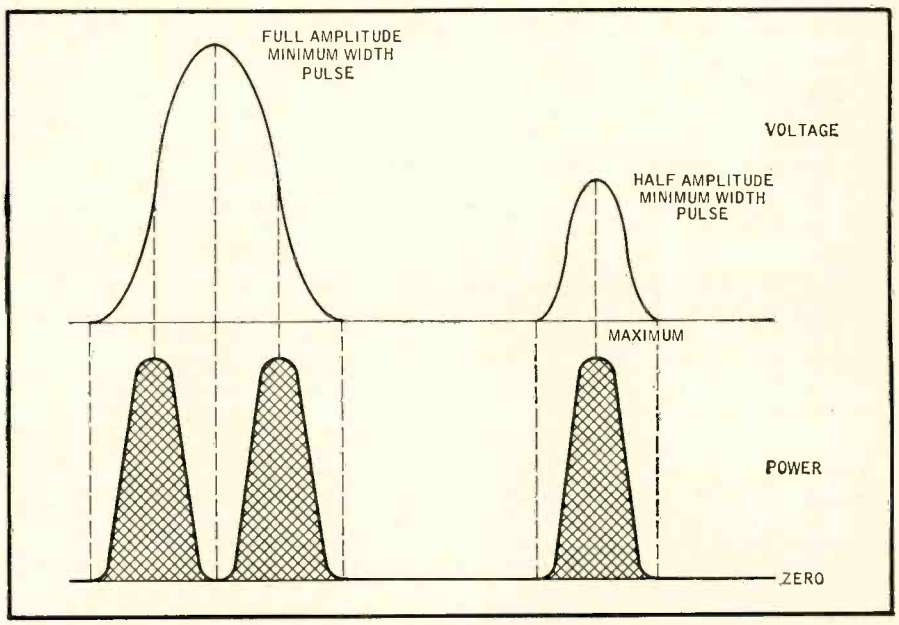

Fig. 11. One of the concepts on which amplitude modulation of minimum-duration pulses was based. Note that a full-amplitude minimum-duration pulse results in twice the transistor dissipation of a half-amplitude pulse.

To drop 7.8 volts, the 330-ohm resistor must pass 23.5 mA, of which 3.5 goes to the 1200-ohm resistor, so the collector must take 20 mA at quiescent. To make it do this, the bias needs to be 0.2 mA, with 4.2 volts from the collector. This requires 22k, instead of the previous 680k. To linearize the coupling from the phase inverter, the base input needs to be about 0.2 mA peak, to be derived from about 2 volts peak (allowing a margin under the 3 volts theoretically available), as 10k resistors can be inserted in series with the coupling capacitors. The revised circuit is shown at *Fig.* 9.

(Continued on page 50)

Loudspeaker Directional Characteristics

DAVID L. KLEPPER*

An exceedingly important parameter of loudspeakers used for sound reinforcement is the directional characteristic. This article discusses this property of cone loudspeakers and line sources (columns).

Following the basic choice between a central or a distributed loudspeaker system to solve a particular amplification or reinforcement problem, the sound system designer must select the appropriate loudspeakers and the location and orientation of each loudspeaker. Certainly frequency response, power-handling capacity, efficiency, and distortion will all play an important part in the selection. These four characteristics are adequately discussed in manufacturer's literature and have been frequently reviewed in technical journals. However, from the sound system designer's standpoint perhaps the most important property of a loudspeaker is its directional characteristic.

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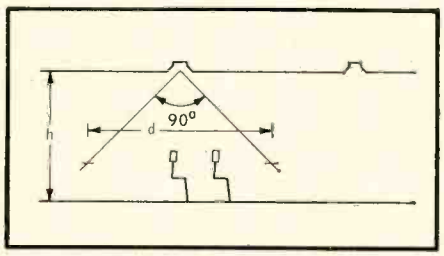

Fg. 2. 90-deg. spacing for a distributed loudspeaker system in elevation. Diameter of coverage for each loudspeaker equals twice the loudspeaker height minus ear height. For seated audience: D = 2 (H—3.33 ft.).

Manufacturer's literature is frequently vague about the directional characteristics of loudspeakers. Sometimes it is not discussed at all; occasionally, an almost meaningless single-number coverage angle is given for directional column and horn-type loudspeakers; some catalogues give information only on the vertical coverage angle, excluding the necessary information at other coverage angles of interest.

Much of the technical literature on acoustics simplifies the problem of sound radiators' directional characteristics by employing single numbers, either a *directivity index* or a *directivity factor*. These quantities are a measure of the ratio of the sound intensity at a given distance and at a given direction to the intensity that would be obtained at the same position from a completely omnidirectional sound source radiating the same total sound power.[1,2] Usually, the single number provided is the "on-axis" directivity index or directivity factor. Since loudspeakers with identical directivity indexes or directivity factors (at a particular frequency) can have, in fact, widely different directional characteristics, a single number is usually not too useful to the sound system designer.

More useful information for evaluation can be provided by a polar plot. This shows the variation in sound pressure level, usually with reference to that measured on axis, over 360 degrees at a particular frequency or averaged over a band of frequencies. Polar plots, if required, can be given in two planes, showing the horizontal and vertical characteristics.

However, even polar plots do not tell the complete story. It doesn't take much experience with loudspeaker design to realize that the directional characteristics of available loudspeakers vary markedly with respect to frequency. We can readily experience this by standing in front of any typical loudspeaker system, hearing the tape hiss or the record scratch and then moving quite far off axis where there is a marked lack of these effects. What we are hearing, of course, is a variation of frequency responses as we observe the loudspeaker from different directions. At the same time, we hear a clear variation in directional characteristics with frequency; the loudspeaker is more directional at high frequencies than it is at low frequencies. In one way or another, these variations in directional characteristics with frequency are true of every loudspeaker, whether

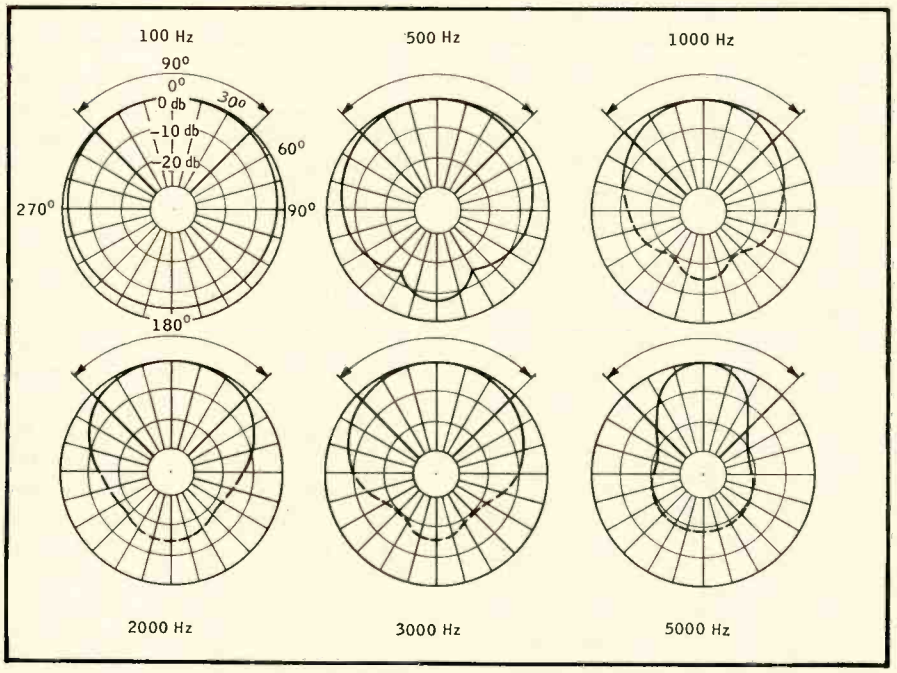

Fig. 1. Directional characteristics of the Western Electric 755A loudspeaker at several frequencies. The Altec Lansing 755C loudspeaker is similar.

[1] Harry F. Olson: *Acoustical Engineering*, D. Van Nostrand, Princeton, N.J., 1957, p.211.

[2] L. L. Beranek: *Acoustics*, McGraw-Hill, New York, 1954, p.109.

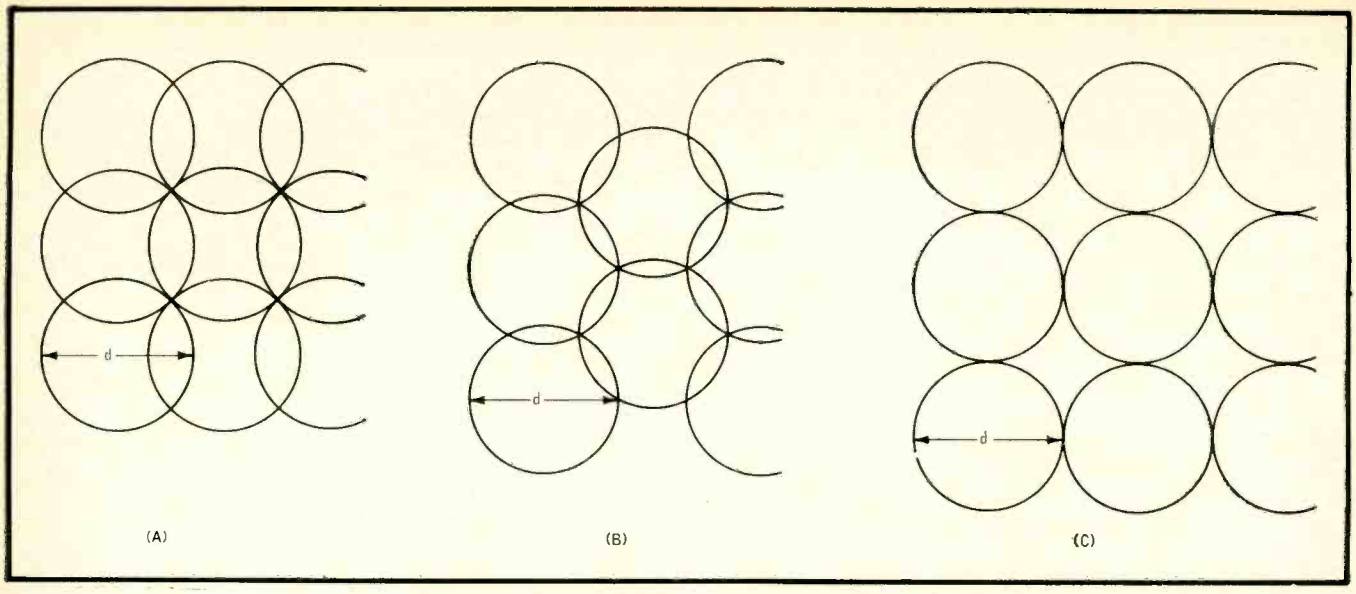

Fig. 3. Plan view of 90-deg. spacing for a distributed loudspeaker system. (A) and (B) are recommended; (C) is maximum compromise.

it be an ideal direct-radiator piston, any of the available cone-type direct-radiator loudspeakers, directional horns, or column loudspeakers with supposedly defined directional coverage patterns. Olson and Beranek both cover in detail the equations and methods for predicting coverage patterns of radiating areas of different sizes and shapes.[3, 4] This theoretical work will not be repeated in this article; but, instead, we will discuss in general the directional characteristics of a number of basic types of loudspeakers, their areas of application, and how the reader may avoid surprises by recognizing the variations of directional characteristics with frequency that can be expected.

1. Direct-Radiator Cone-Type Loudspeakers

The "ideal" cone-type loudspeaker is often thought of as a vibrating piston in which case the referenced equations and data may be used to derive the polar directivity patterns at various frequencies. However, to quote Dr. Olson, ". . . there is considerable deviation from piston action in a cone-type loudspeaker."[5] Factors that affect the directional characteristics of a cone-type loudspeaker of a given size and at a given frequency include: 1. The material of which the cone is made (affecting the speed of propagation of the sound wave within the cone outward from the voice coil); 2. the depth of the cone, or cone angle; and 3. particular details of the cone construction. Loudspeakers with deep cones usually are more directional than those having shallow cones. Cone materials producing a high sound-energy-propagation velocity generally have sharper directional characteristics than those with a lower sound-propagation velocity. Cone "break-up" at high frequency, which often causes peaks and dips in the frequency response of the loudspeaker, at the same time usually broadens the directional characteristics, because the loudspeaker becomes a series of small sound sources with a random phase relationship, rather than a single large sound source.

[3] Beranek, *op. cit.*, Chapter 4, "Radiation of Sound."

[4] Olson, *op. cit.*, Chapter 2, "Acoustical Radiating Systems."

[5] Olson, *op. cit.*, p. 153

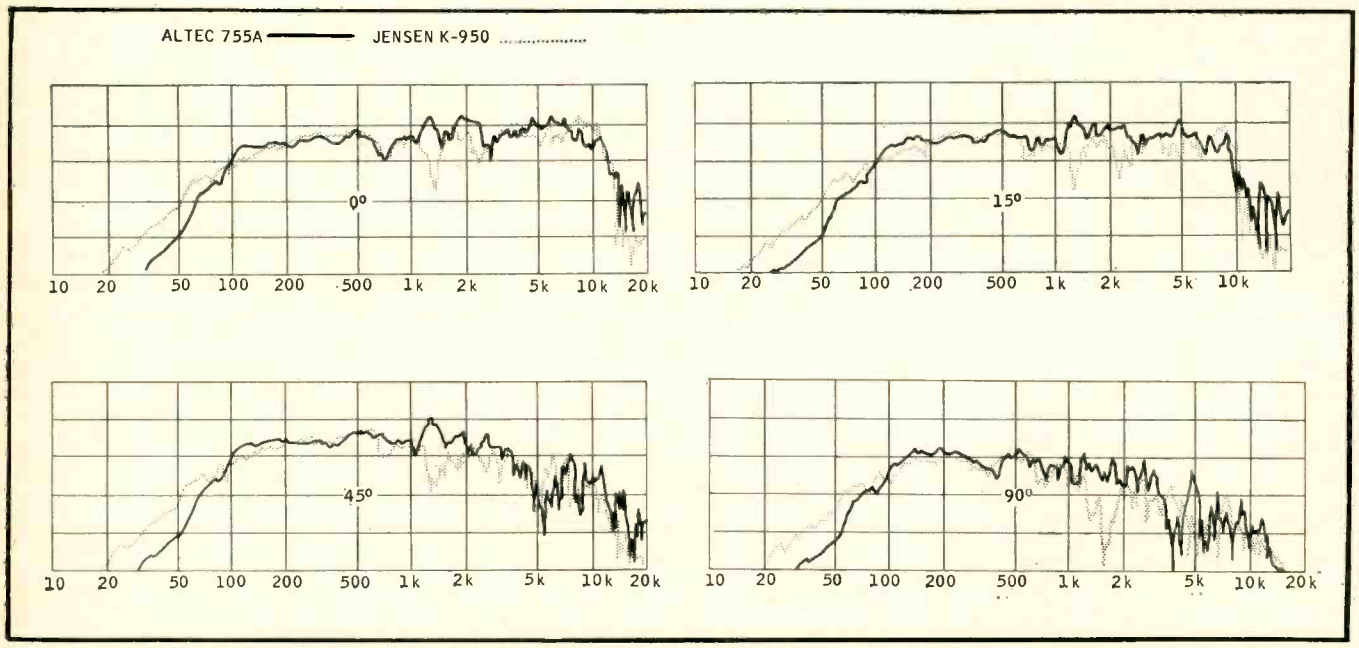

Fig. 4. A family of frequency response curves for the Western Electric or Altec Lansing 755 loudspeaker, at several angles, compared with similar curves for the Jensen K-950 8-in. coaxial loudspeaker.

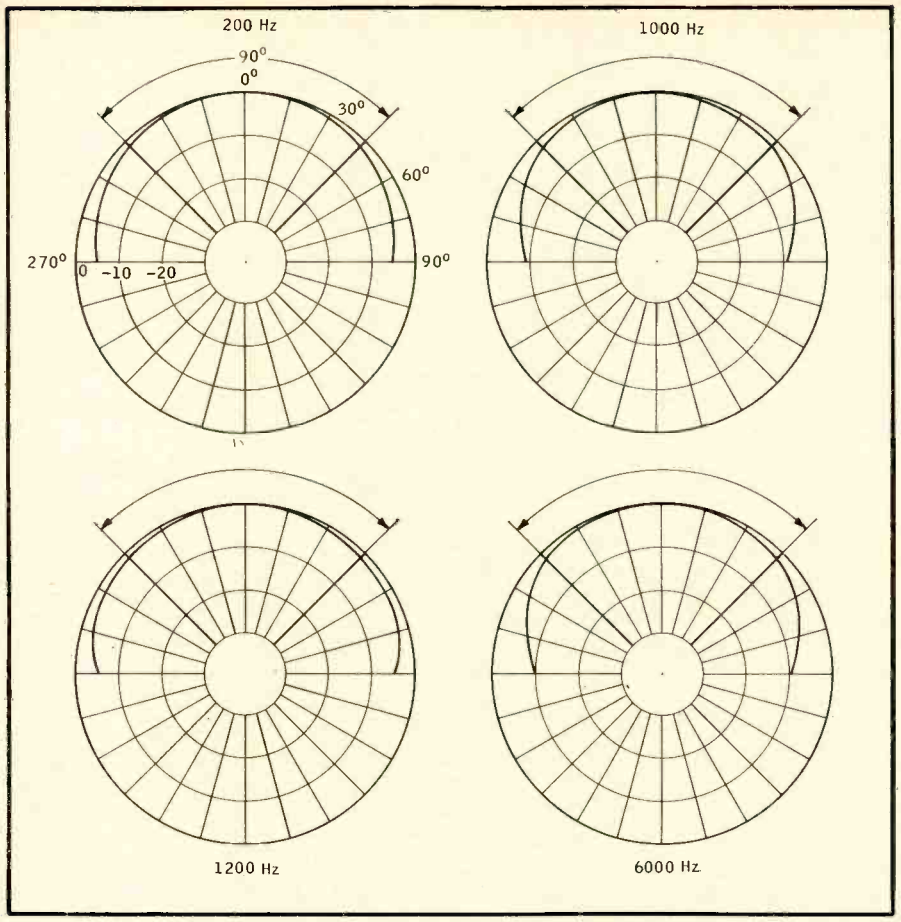

Fig. 5. Directional characteristics for a typical 15-in. coaxial loudspeaker at several frequencies.

Indeed, there are loudspeaker designs that deliberately "break up" the cone by inserting a mid-cone compliance element between the outside ring and the inside small cone. In such a loudspeaker, the small inner cone can move freely at high frequencies, while the entire cone moves together at low frequencies. A sound source of a smaller size will always have broader directional characteristics at a given frequency than a larger size sound source of the same shape; therefore, such a mid-cone compliance can serve to maintain a more uniform directional characteristic with respect to frequency, as well as improve the high-frequency response of a single-cone-type loudspeaker.

The first loudspeaker the author knows of which effectively employed a mid-cone compliance to improve both high-frequency response and high-frequency coverage was developed by Bell Laboratories roughly 20 years ago. This type of loudspeaker has been widely applied in many distributed loudspeaker systems, allowing loudspeakers to be spaced farther apart, and yet provide uniform speech intelligibility over the floor area. An early application of the Bell Laboratories loudspeaker to a distributed loudspeaker system was the fine public address system at Newark Airport. The directional characteristics of the loudspeaker are shown in *Fig.* 1, and guides for optimum spacing, considering both economy and uniformity of coverage, are shown in *Figs.* 2 and 3.

A loudspeaker that has directional characteristics that do not change greatly with respect to frequency will likewise have frequency-response characteristics that do not change greatly with respect to angle. A family of frequency-response curves for the Western Electric 755A loudspeaker shows unusual uniformity with respect to angle for a cone-type loudspeaker.[6] (See *Fig.* 4.)

Coaxial loudspeakers are finding increasing applications in distributed loudspeaker systems, because they also can provide quite broad directional characteristics at high frequencies. The spacing rule based on a 90-deg. cone of coverage, which has been used for many years as a general guide for the Western Electric 755A loudspeaker, is usually applicable to the layout of coaxial loudspeakers. There are two 8-in. co-axials on the market by different manufacturers that are practically identical in all performance characteristics — power handling capacity, frequency response, and directional characteristics. A family of frequency response curves for one of these units is illustrated in *Fig.* 4; note how similar it is to the Western Electric loudspeaker with mid-cone compliance discussed earlier. The fact that these loudspeakers are lower in cost, as well as available with identical performance from two manufacturers, makes them popular units in engineer's specifications. Systems employing them may be heard in the Washington, D.C. Dulles International Airport,[7] Chicago's O'Hare Airport,[8] and the Wold Chamberlain Field, in Minneapolis.

When even coverage is required from a distributed loudspeaker system and at the same time low-frequency response and power handling capacity beyond that available from 8″ cone

[6] The "successor" to this loudspeaker is currently manufactured by the Altec Lansing Corporation, Model 755C.

[7] Burns and McDonald, Kansas City, Engineers; Acoustical Consultants, BBN.

[8] Naess & Murphy, Architects and Engineers (including sound system).

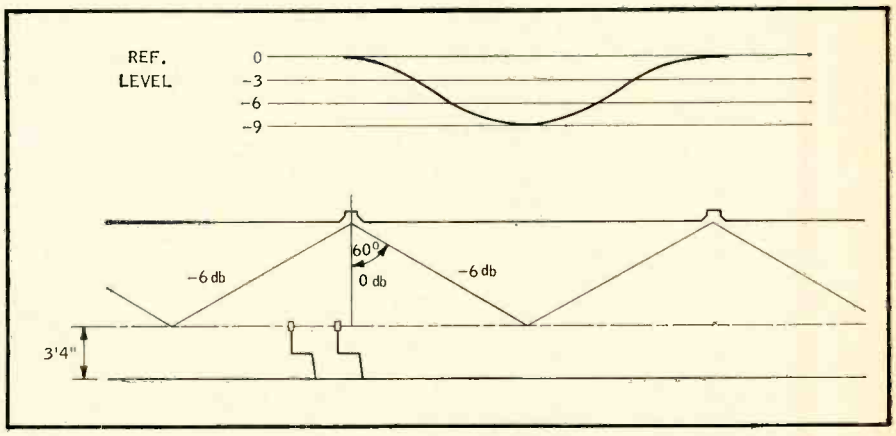

Fig. 6. Approximate variation in level using 120-degree loudspeakers spaced for 120-deg. coverage. The assumption is that loudspeaker's response is 6-db down 60-deg. off axis.

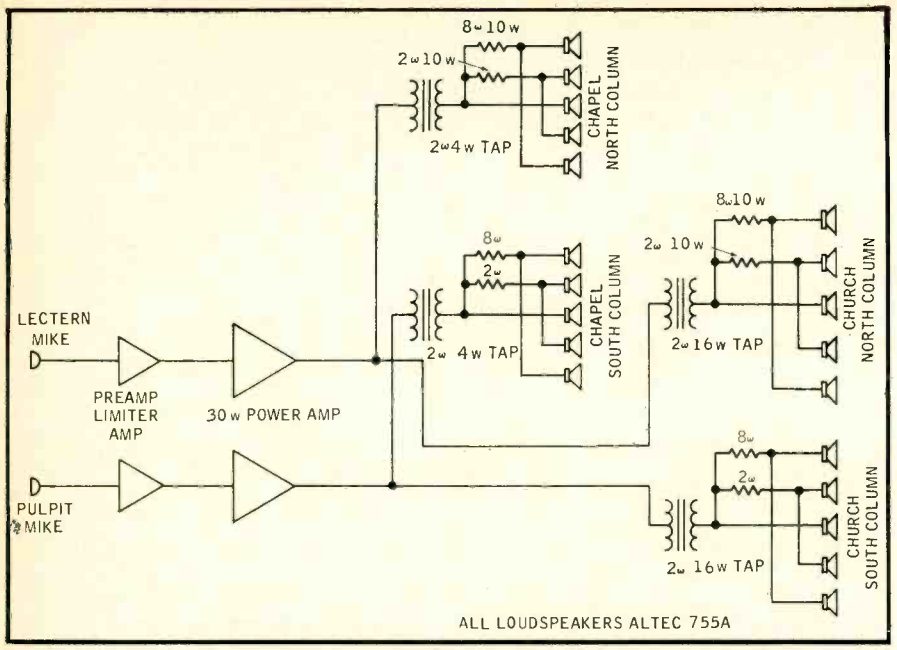

Fig. 7. Line-source loudspeaker setup for Harvard University's Memorial Church, using level tapering.

loudspeakers, then the larger co-axial loudspeaker is the obvious choice. The Olson-designed LC-1A has been used for very-high-quality distributed loudspeaker systems.[9] A recent alternate that appears similar in performance characteristics, although greatly different in construction, is the James B. Lansing LE14C. Typical directional characteristics for such loudspeakers are shown in *Fig.* 5.

Coaxial loudspeakers that employ horn tweeters with direct-radiator low-frequency units can often give the designer of a distributed loudspeaker system some difficulty because their directional characteristics are usually different in the vertical and horizontal planes. With loudspeakers pointing straight down, this difference in coverage angle rules out a regular square grid of loudspeakers. Many of the units with high-frequency horns attempt to get wide high-frequency dispersion in *one* direction, greater than 90-deg. Usually, the sound system designer cannot take advantage of this wider dispersion, because if he does, inverse-square law alone (without consideration of the directional characteristics of the loudspeaker, i.e., assuming the loudspeaker is omnidirectional) will result in wide variations in the sound pressure level over the area covered. (Refer to *Fig.* 6.)

Unfortunately, many distributed loudspeaker systems are not designed either with the relatively close on-center spacing determined by the 90-degree criterion, or with loudspeakers that employ means for reducing excessive high-frequency directivity. Very low cost ($1 or $2) loudspeakers are the ruin of many systems. Sometimes the designer attempts to overcome inadequacies of a loudspeaker type by distributing the high frequencies with metal diffusing devices or scatterers *underneath* the loudspeaker. The author has even heard of a system with the loudspeakers installed upside-down with a whopping electrical boost to the high frequencies! Any of these approaches will usually create a peaky high-frequency response and, all too often, zones of unintelligibility.

Admittedly, for some types of paging systems, the 90-deg. criterion may be relaxed. For example, in a long corridor or concourse, the designer can expect some reinforcement from floor and wall surfaces (but then let us hope the space isn't too reverberant!). In some applications, depending on the importance of the space, he may simply accept the fact that a listener will walk from dead spot into a zone of coverage to hear the announcement, but such systems cannot be considered models of good design. On the other hand, there are sound system designers that consider even 90-deg. spacing for distributed loudspeaker systems not stringent enough and use as a criterion for good design the listeners' inability to hear changes in level or lack of awareness of the location of loudspeakers when he walks about under the distributed loudspeaker system.

At the Dulles International Airport there are low-ceilinged areas where the architects, Eero Saarinen and Associates, for design reasons did not desire the use of conventional 8-in. loudspeakers. The solution to this problem was the use of a KLH 6.5 4-in. speaker, whose directional characteristics are illustrated in *Fig.* 9. Uniform coverage can be obtained in relatively inexpensive distributed loudspeaker systems by the use of smaller than usual loudspeakers, still adhering to the 90-deg. on-center-spacing criterion. Naturally, the designer must consider the loss in low-frequency response, reduced efficiency

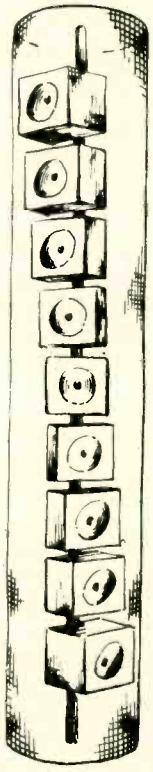

Fig. 8. "Barber Pole" line source. The length of the line is shortened by the increasing directivity of the individual cone loudspeakers at higher frequencies.

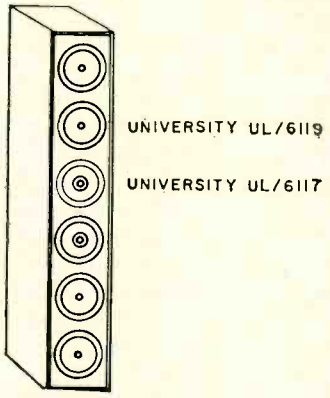

Fig. 9. Line-source loudspeaker system with high-frequency radiators omitted in outer loudspeakers (University UCS-6).

[9]Olson, *op. cit.*, p. 139-147. Good examples of distributed loudspeaker systems employing the RCA LC-1A loudspeaker are in the Ballroom of the Will Rogers Hotel, Fort Worth, and the Civic Auditorium in Austin, Texas. Both systems were designed by Dr. C. P. Boner, Austin, Texas.

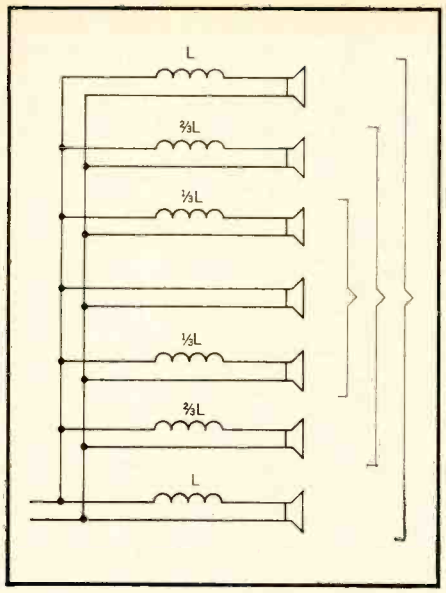

Fig. 10. Custom line-source loudspeaker system using KLH 12.5 loudspeakers and frequency tapering. Special inductors may be required.

and reduced power-handling capacity inherent in the use of many types of small loudspeakers.

Although distributed loudspeaker systems represent the most frequent application of cone direct radiators for sound reinforcement, they have been used also for central systems. The simplest central loudspeaker system would be a single cone loudspeaker above the proscenium of a small auditorium or lecture room. If the system is necessary for speech reinforcement, the broad coverage angle can put loudspeakers of this type at an extreme disadvantage; too much sound energy may go towards the microphone as compared with the amount of energy directed towards the audience.

A coaxial loudspeaker used for a central system may be more directional at high frequencies, but usually will continue to direct a good proportion of low-frequency energy at the stage. Also the high-frequency coverage of the audience may not be sufficiently uniform. There is a range of application for coaxial loudspeakers; usually either one or two loudspeakers in a single enclosure, above the center of the proscenium stage in a small auditorium. Such systems are often recommended for playback of motion picture sound and in small (60-200) seat auditoriums, primarily where the last row is less than 60 feet from the front of the stage. If the auditorium is well-designed acoustically, electronic speech reinforcement should rarely be necessary; but the system can be used for speech reinforcement to provide a few db gain for particularly weak-voiced guest speakers or inexperienced speakers.

Naturally, even when laying out such simple central loudspeaker systems, the directional characteristics of the loudspeaker should be carefully studied in relation to the geometry of the room, the audience area to be covered, and the location and orientation of any hard, sound-reflecting surfaces in the room which can either reinforce sound or produce echoes, depending on their location. Without careful loudspeaker placement and orientation, even the few db of reinforcement required in such spaces will not be achieved, and the reinforcement system will have "negative gain." Use of advanced techniques, such as feedback-stabilizer frequency shifter recently developed by Manfred Schroeder of Bell Laboratories or the narrowband equalization techniques widely applied by Dr. Paul C. Boner of Austin, Texas, can improve the feedback stability of any system, even the simplest direct-radiator central loudspeaker system.

Cone loudspeakers sometimes are employed in central reinforcement systems in large rooms usually by combining several of them into one or more line-source or "column" arrays to improve directional control.

2. Line-Source or "Column" Loudspeaker Systems

To quote Dr. D. Kleis of Philips: "It is well-known that a beam of sound having a large horizontal and small vertical radiating angle can be obtained by means of a loudspeaker column or "sound column," consisting of several loudspeakers mounted one above the other and all operating in phase."[10] A number of manufacturers furnish packaged "column" loudspeakers, usually employing between three and 15 direct-radiator cone loudspeakers, usually with all loudspeakers operating (more or less) in phase with series-power connections. All line-source or column loudspeakers have directional characteristics that vary with frequency. Dr. Kleis points out that a "column" two meters in length has a coverage angle of 68-deg. (in the vertical plane) at 300 cps but only 6.4-deg. at 3000 cps. In the horizontal plane, the directional characteristics would be the same as for a single loudspeaker of the type making up the complete line source.

Directivity patterns for continuous straight-line sources are indicated by Olson for various ratios of wave length to length of source.[11] However, a typical column loudspeaker is not a continuous straight-line source; its directional characteristics over its operating frequency range will vary between the characteristics of the continous straight-line source and a series of point sources.

Obviously, the smaller the loudspeakers and the greater the number used in a line-source of given length, the better will be the approximation to a continuous line source. The advantages of this better approximation are: 1. Fewer side lobes; and 2. No major side lobes at all up to the frequency which has a wave length identical with the on-center spacing of the loudspeakers. Beaminess at high frequencies can be reduced by padding down the level of the outer loudspeakers. This technique does *not* reduce the variation in directional characteristics with frequency, but instead reduces slightly the directi-

[10] D. Kleis, "Modern Acoustical Engineering," *Philips Technical Review*, Vol. 20, No. 11 (Eindhoven, Holland).

[11] Olson, *op. cit.*, p. 36.

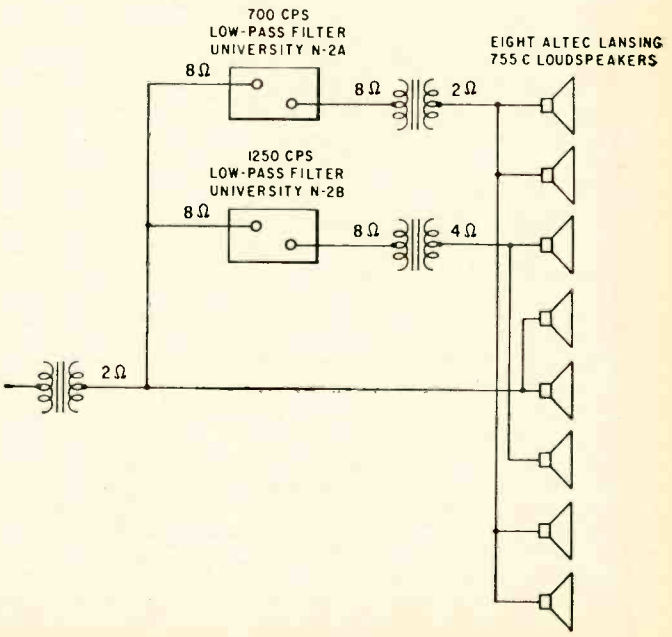

Fig. 11. Compromise frequency tapering.

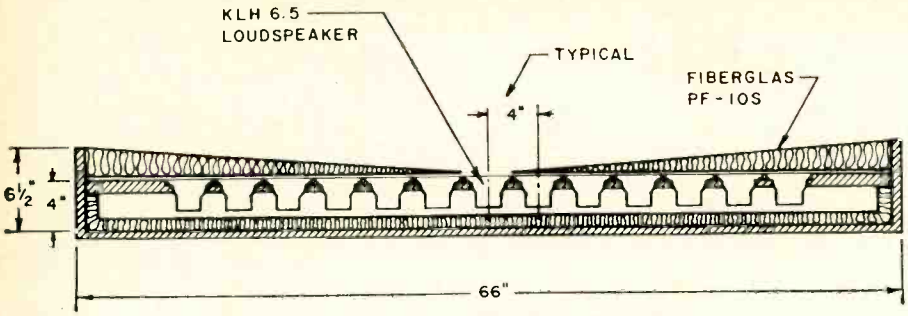

Fig. 12. Line-source loudspeaker with acoustical low-pass filters in front of loudspeakers in the form of PF-105 Fiberglass.

vity at all frequencies, and smooths the frequency response off axis. It is a useful technique for less critical applications. A sound system employing this technique is illustrated in *Fig.* 7.

In the opinion of the author, there are several disadvantages to a large number of commercial "column loudspeakers" that limit their application to *designed* sound systems. "Off-the-shelf" units that employ a number of identical loudspeakers while in a series-parallel configuration, with all loudspeakers receiving identical power, often show the following undesirable characteristics: 1. Peaky frequency response, and lack of control of directional characteristics at high frequencies due to phase differences between individual loudspeakers, in turn caused by cone breakup and often emphasized by the series connections used; 2. Strong, minor or off-axis lobes (or side lobes) at high-frequencies which is characteristic of columns behaving more as a series of point sources rather than as a continuous line source (some sound system people have referred to the existence of strong side lobes as a "skating effect"); 3. Peaks in the off-axis high-frequency response are a direct result of the previous two factors. These defects have not precluded the application of column loudspeakers to many sound system problems. Often they can be overcome when the installer is given a free hand to experiment with a number of different locations and orientations for his "column," but the system designer who is attempting to help an architect plan a building having satisfactory acoustics cannot usually indulge in such experimentation. In any case, the careful sound system designer may often wish to reduce or eliminate these effects, as well as to improve the uniformity of the main-lobe coverage angle with respect to frequency, beyond that given by the theoretical continuous line source. The results of such improvement may include increased feedback rejection with a predicted microphone and loudspeaker location, more uniform coverage of the audience area, the greater proportion of direct-to-reverberant sound energy with resulting higher intelligibility, and smoother frequency response in the audience area.

There have been many attempts to produce line-source loudspeakers that have less variation in directional characteristics as a function of frequency. All approaches attempt to decrease the length of the line at higher frequencies and increase it at lower frequencies. (This is often called "frequency tapering.") Indeed, if we could develop loudspeakers with dimensions of radiating surfaces that varied *directly* proportional to wave lengths, we would then have loudspeakers with constant directional characteristics. (Whether their frequency response and power handling characteristics would be suitable for reinforcement applications is another question, of course!)

Dr. Kleis has described the "barber pole" technique, which uses the directional characteristics of the individual cone loudspeakers themselves to decrease the length of line at high frequencies. Simple cone loudspeakers that become more directional at high frequencies are "skewed" along the length of the line, with no two loudspeakers pointing in the same direction.[12] (See *Fig.* 8.)

At any given direction in the horizontal plane, energy is radiated from only a few loudspeakers at high frequencies; however, since the individual loudspeakers are omnidirectional at low frequencies, the entire line source radiates throughout all horizontal directions. Effectively, the length of the line source is decreased at higher frequencies, and the directional characteristics are more constant than if all loudspeakers were pointing in the same direction.

Of course, the system designer is forced to use whatever amount of "frequency tapering" results from the increasing directivity at high frequencies of the particular cone loudspeakers employed. One advantage of this technique is the lack of falling efficiency and sloping frequency response at high frequencies, usually requiring electrical compensation, inherent in other forms of frequency tapering.

A second method of frequency tapering is the use of loudspeakers with different frequency-response charateristics. Sometimes, a manufacturer will omit the tweeter on the outer loudspeakers of a line source (see *Fig.* 9), or else employ a small high-frequency line source within the same package as a larger low-frequency line source, both driven through an electrical crossover network. Such systems provide a narrowing beam width at low frequencies, which widens out again at the crossover frequency, and then narrows at higher frequencies. With the frequency range divided into two, over all variations in directional characteristic can be held within tolerable limits for many applications.

There are two methods for continuously tapering a line-source loudspeaker system (on a loudspeaker-by-loudspeaker basis); one is electrical, at the input to the loudspeakers, and the other is acoustical, at the output.

A continuously electrically tapered line source is shown in *Fig.* 10 while *Fig.* 11 shows a "compromise" solution, using off-the-shelf components. For applications where less variation in directional characteristics is important, loudspeaker-by-loudspeaker tapering should be used, and custom-built inductors are then required.

(*continued on page 59*)

[12] Kleis, *op. cit.*, p. 11. The Palais Chaillot system in Paris is an illustration of this technique.

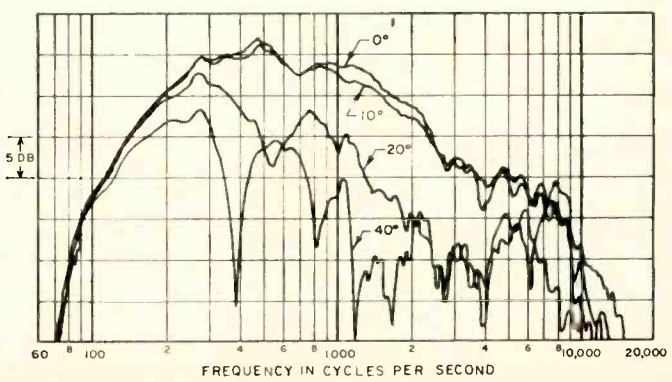

Fig. 13. Family of unequalized frequency response curves for line-source loudspeaker illustrated in Fig. 12. A 6-db-octave rising characteristic should be employed with this system.

The Improbable Optical Microphone

VIRGINIA RETTINGER*

Unlikely as it may seem to the casual observer, the idea of the use of a reflected light beam has been suggested for a number of applications as transducers. The author shows the fallacies of the proposal with respect to microphones, at least.

Knowledge of microphones, their principle and operation, may well include information about devices which do not stand the acid test of workability, patent descriptions to the contrary. One such transducer is the "so-called" optical microphone, whereby the modulation of a light beam reflected from a vibrating diaphragm is amplified in one manner or another to obtain a vibration of sufficient amplitude which can be employed usefully. In practice such devices leave a great deal to be desired, which is one reason why they are not on the market. It is the purpose of this article to describe the reason for this unacceptability.

Of all the various types of vibrating element in a microphone, the one which has by far the largest amplitude is the ribbon in a so-called velocity microphone. Its amplitude approaches within a few per cent the amplitude of a vibrating air particle, and the deflection, d, is given by the equation:

$$d = \frac{e \cdot 10^8}{LB2\pi f}$$

where e = open-circuit ribbon voltage, volts
L = ribbon length, cm
B = flux density in air-gap, gauss
f = frequency

For $L = 5$ cm, $B = 10{,}000$ gauss, $f = 1000$ Hz, and $e = 0.001$ volt for an input sound pressure of 1 microbar, $d = 0.00000318$ cm $= 0.0000012$ in., or 1.2 micro-inches. For higher frequencies this amplitude will be smaller, and for lower frequencies greater. *Figure 1* shows the amplitude of a vibrating air particle, and it is seen that its maximum deflection comes close to that of a ribbon, for the same frequency and sound pressure. One may well consider this figure a little closer, to learn of the enormous range of vibration amplitudes involved in the propogation of sound in air. Thus, for a frequency of 10,000 Hz and a sound pressure of 0.01 microbar, the air particle amplitude is 0.0015 micro-inches; for a frequency of 100 Hz and a sound pressure of 100 microbars, this amplitude is 1500 micro-inches, or a million times larger. The equation for the air particle amplitude is given by

$$D = \frac{P}{2\pi fcd}\text{(cm)} = \frac{.0015P}{f}\text{(inches)}$$

where P = sound pressure in microbars
c = velocity of sound = 34,400 cm/sec
d = density of air = .0012 g/cm³
(cd = specific acoustic resistance = 41.4 g/sec/cm²)

What is usually attempted[1] in optical microphone construction is to direct a fine beam of light against a vibrating diaphragm fitted with a grating of some kind. The vibrating grating is meant to intercept the light, that is, to modulate it, after which the light is intended to be amplified. But is this possible?

Figure 2 shows why the scheme fails.

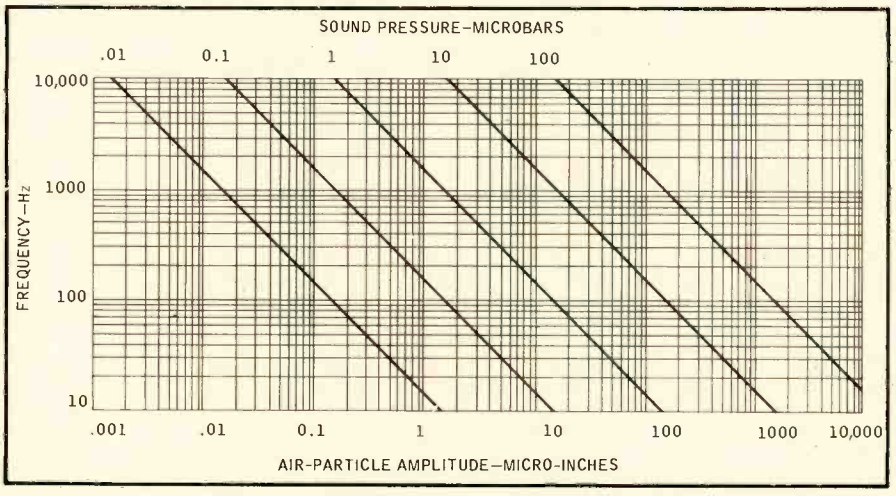

Fig. 1. The amplitude of a vibrating air particle.

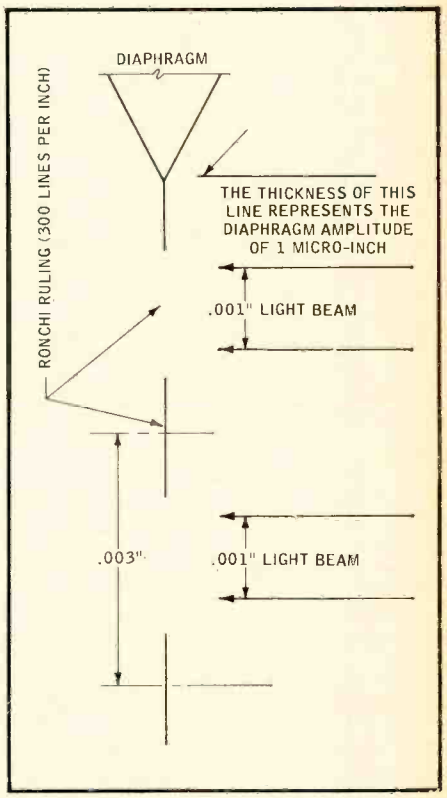

Fig. 2. The grating method of light modulation.

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[1]See, for instance, U. S. Patent No. 2,666,650, and 2,259,511.

(Continued on page 59)

Solid-State Limiter for Tape Recording

JAMES YOUNG* and WAYNE B. DENNY**

A device for use in recording to prevent a "peak" from driving amplifier or tape into distortion.

IN MAKING TAPE RECORDINGS of live performances it is generally preferable to make the recording at the highest possible level. In recording at such high levels "accidents" may occur which will drive either amplifiers or tape into distortion. A device which would prevent this overdriving on peaks while still preserving the major portion of the dynamic range without modification would be desirable. The solid-state limiter described below will perform this function. The device makes use of the Raytheon "Rayistor" which is basically a light source and a photo-resistive element combined in a transistor-sized capsule. The more current through the light source the lower the resistance of the photo-sensitive element.

A preliminary stereophonic arrangement employed a single side-amplifier as driver for two Rayistors, one for each channel. A sum-signal was used to drive the side amplifier. The intention was to prevent wandering stereo-images by using identical gain reductions in both channels. This did not work out very satisfactorily in practice: proper adjustment was very difficult to obtain. Despite the added complexity it was decided to provide two identical limiters, each with its own side amplifier.

Separate limiters for each channel can result in wandering stereo-images which could be serious in a *volume compressor* where compression occurs at nearly all signal levels. The device described here is intended only to catch those momentary peaks, which, it is hoped, will occur infrequently. During these infrequent and short intervals the wandering-image problem should not be serious: in any case it will not be as serious as the occasional overload we desire to prevent.

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***Physics Department, Grinnell College, Grinnell, Iowa*

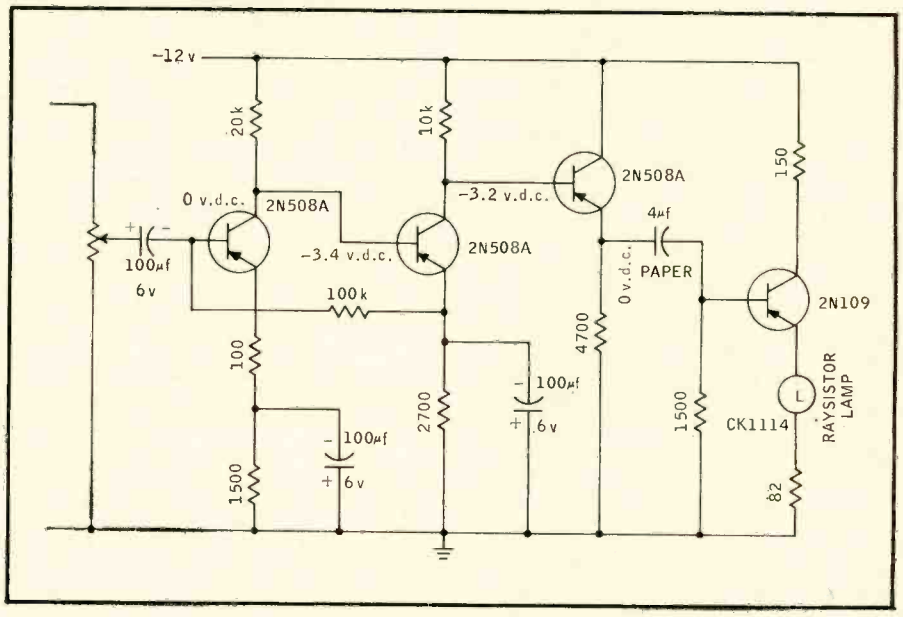

Fig. 2. Solid-state side amplifier.

The general arrangement of the limiter is shown in *Fig.* 1. Gain reduction occurs whenever the resistance of the Raysistor falls appreciably below that of R_2. Gain control R_3 is adjusted until limiting occurs at the desired level. The signal used to drive the side-amplifier can be obtained at any convenient point in the amplifier following the point where limiting is introduced. If the impedance to ground is high it may be necessary to employ isolating resistors to prevent shunting by the relatively low input impedance of A_2. A suitable side-amplifier circuit is shown in *Fig.* 2. It is based on a preamplifier suggested in the General Electric Transistor Manual. The final transistor (2N109) operates essentially Class B

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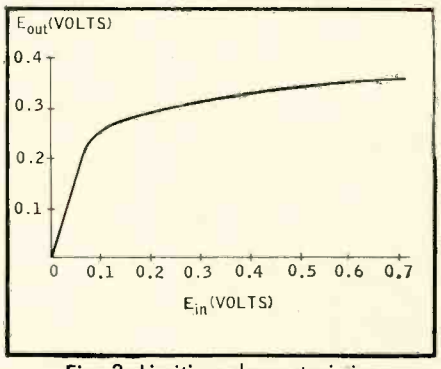


Fig. 3. Limiting characteristics.

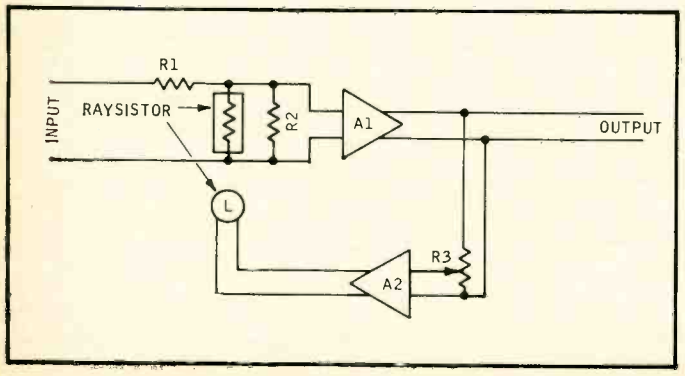


Fig. 1. General setup of limiter.

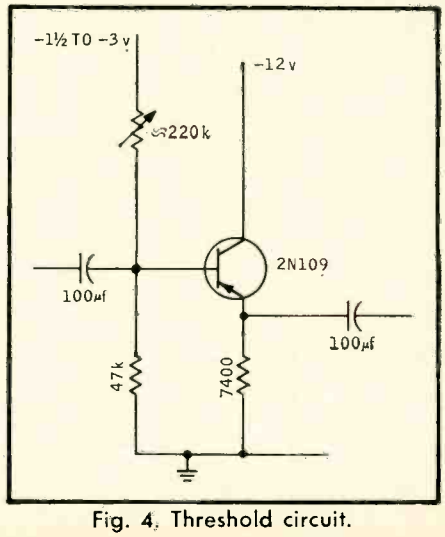
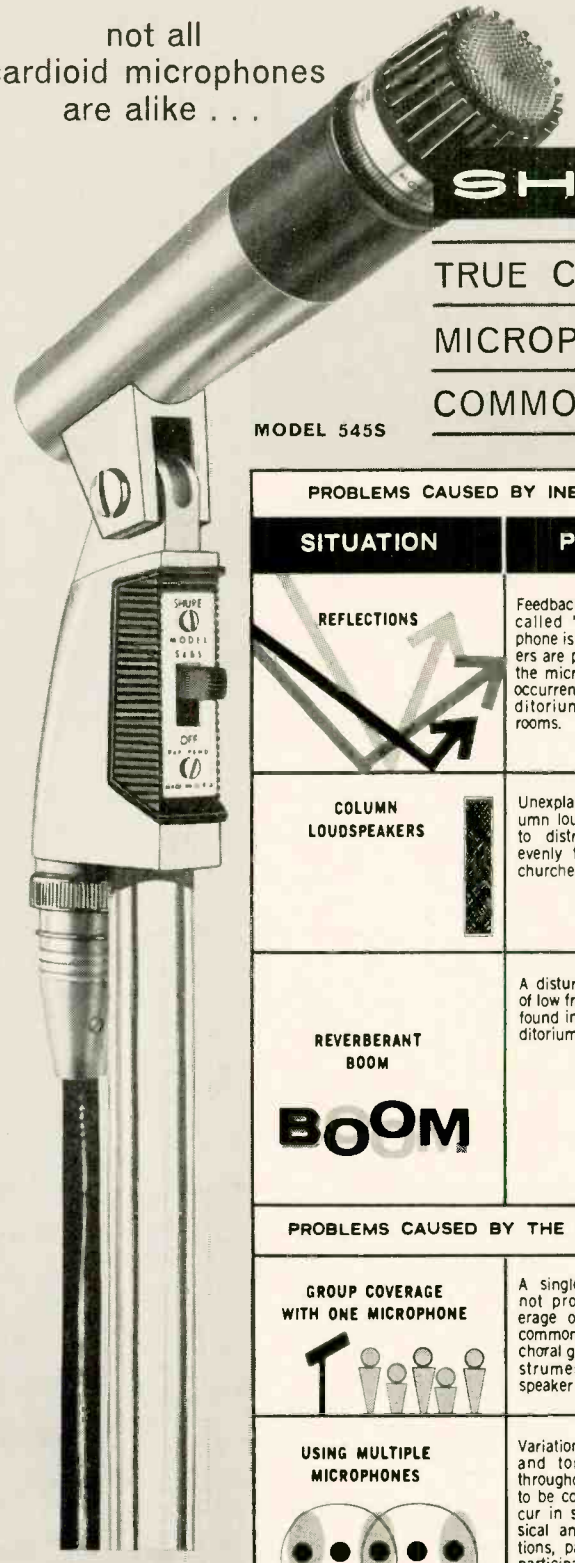


Fig. 4. Threshold circuit.

not all cardioid microphones are alike . . .

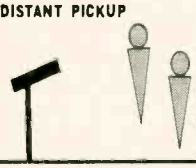


only the

SHURE UNIDYNE III

TRUE CARDIOID UNIDIRECTIONAL DYNAMIC MICROPHONE SOLVES ALL THESE COMMON MICROPHONE PROBLEMS!

MODEL 545S

SITUATION	PROBLEM	CAUSES	SOLUTION
PROBLEMS CAUSED BY INEFFICIENT REJECTION OF UNWANTED SOUNDS BY THE MICROPHONE			
REFLECTIONS	Feedback occurs where a so-called "cardioid" microphone is used and the speakers are placed to the rear of the microphone. A common occurrence in churches, auditoriums, and meeting rooms.	Sound bounces off hard surfaces on the walls, floor and ceiling, in and around the audience area and the microphone used is not effective in rejecting these sounds at all frequencies, and in all planes about its axis.	The Unidyne III eliminates this problem because of effective rejection of sound at the rear of the microphone with uniformity at all frequencies. Sounds bouncing off the floor or other reflective surfaces that reach the rear of the Unidyne III are rejected.
COLUMN LOUDSPEAKERS	Unexplained feedback. Column loudspeakers are used to distribute sound more evenly to the audience in churches and auditoriums.	While column speakers direct the sound toward the audience, they also have side and rear sound lobes which may reach the microphone. Feedback occurs when the rear and side sound lobes of the speakers coincide with the rear and side lobes of a so-called "cardioid" microphone.	The Unidyne III solves this problem because it has no rear or side lobes. Thus it rejects the side and rear lobes of the sound column speakers.
REVERBERANT BOOM	A disturbing, echoing effect of low frequency sound often found in churches, large auditoriums, and arenas.	The particular "cardioid" microphone used fails to retain its unidirectional characteristics with low frequencies. In addition, its front response tends to accent low frequencies of the desired sounds. These factors result in pickup and reinforcement of the low frequency reverberation and boominess characteristic of many halls.	Using the Unidyne III Microphone will solve the problem because it maintains a uniform pattern of sound rejection in all frequencies, even as low as 70 cps. The frequency response also has a controlled roll-off of the low end. This prevents reinforcement of the low frequency reverberation and diminishes the effect of a boomy hall.
PROBLEMS CAUSED BY THE MICROPHONE'S INEFFECTIVENESS IN PICKING UP THE DESIRED SOUND			
GROUP COVERAGE WITH ONE MICROPHONE	A single microphone does not provide uniform coverage of a group. This is commonly experienced with choral groups, quartettes, instrumental combos, and speaker panels.	The particular "cardioid" microphone used lacks a uniform pickup pattern, so that persons in different positions within the general pickup area of the microphone are heard with varying tonal quality and volume.	The Unidyne III affords uniform pickup of the group with a resulting consistency in volume and sound quality among the members of the group.
USING MULTIPLE MICROPHONES	Variation in the pickup level and tonal quality exists throughout the broad area to be covered. This may occur in stage pickup of musical and dramatic productions, panels and audience participation events.	The pickup pattern of the microphones used is too narrow, causing "holes" and "hot spots". The off-axis frequency response of the microphones also varies.	The Unidyne III permits a smoothness in pickup as the true cardioid pattern gives broad coverage with uniformity throughout the coverage area. This eliminates "holes", "hot spots", and the variations in sound quality and permits blending many microphones with ease.
DISTANT PICKUP 	Too much background noise or feedback results when working with microphone at desired distance from sound source.	So-called "cardioid" and particularly long range microphones being used are less directional with lower frequencies. In addition, they have lobes or hot spots that pick up sound at the rear, resulting in the background noise or feedback problem.	Use the Unidyne III to gain relatively long range with effective rejection of sound at all frequencies at the rear of the microphone.

SHURE BROTHERS, INC.
222 Hartrey Ave.
Evanston, Illinois

U.S. Patent D190,864; other patents pending.

Circle 131 on Reader Service Card

The Languad Expert Goes Solid State

GEORGE L. AUGSPURGER

Solid state is here. The ultimate system is within sight. Sound is beyond audibility.

AFTER MOVING to the West Coast several years ago, I lost track of my old friend George Anthrubus, the languad expert. Perhaps I had better explain that "languad" is George's own term for the kind of language that ad writers use. George firmly believes that the real literary achievement of our age lies not in Broadway plays or quasi-obscene novels, but in advertising nomenclature. To quote George, "'Real gusto from a great light beer!' will be remembered long after the allusive images of John Updike have crumbled to nothingness." That's how strongly he feels about it.

As I said, I had been out of touch with George, and it was a pleasant surprise to hear his voice on the telephone a few weeks ago. It developed that he had set up his own consulting business in Los Angeles, and was eager to show me his new office.

"Not only is the decor designed to enhance the prestige of the firm's image," George told me, "but we have incorporated a large multi-purpose area for maximum utilization of chargeable space. It is in this acoustically agreeable environment that I have installed my completely new custom stereo installation."

I should have mentioned that George was one of the original hi-fi enthusiasts, long before 100-watt amplifiers, or stereo, or transistors, or any of the things we take for granted today. The prospect of being able to examine and hear his latest assortment of sound-reproducing apparatus made the invitation doubly attractive. I promised to drop by the following week.

The address George had given me turned out to be a former slot-car and karate studio on Santa Monica Boulevard. A tasteful brass nameplate read simply, "G. Pointdexter Anthrubus & Associates." Inside, the decor was every bit as impressive as George had promised. And when he himself appeared, his new aspect was equally arresting. In place of the former shapeless tweed suit and conservative tie, George now was attired in Hollywood street clothes: bulky Cardigan sweater over turtleneck T-shirt, stretch trousers, suede flamenco boots, and wrap-around dark glasses.

He noticed my surprise and coughed modestly. "An elegant aura of casual accomplishment is essential to the executive who wants to stand out in any group." said George. "But enough of that. I am more interested in your reaction to my new stereo system."

"I thought that your previous set-up was one of the best I ever heard." I said. "Do you really think there is an improvement?"

As Implacable System

George nodded. "Yes indeed. *This* is a system designed for the connoisseur of sound, the collector with tastes and demands above the ordinary . . . precision built for the talented listener who is implacably determined to own the finest!"

He ushered me into a handsomely decorated studio-like room. There was a large conference table, a projection screen, several comfortable looking Danish modern chairs, and a fantastic piece of sculpture dangling from the high ceiling. A long counter at the far side of the room was covered with a mass of electronic equipment . . . oscilloscopes, meters, power supplies and so on. George waved me to a chair and waited expectantly.

"I see the installation still is in the breadboard stage." I observed.

"Oh, no." said George. "That's just my test gear for making adjustments and evaluating results. As it turns out, I really have no use for it because the literature which came with the components I selected assures me that distortion is lower than the inherent noise level of the finest test records and laboratory measurement instruments."

"Have you been working on it long?" I asked.

"Yes," indeed, Achieving this rare combination of top performance and top value took many long months of painstaking research and around-the-clock work from the most!" declaimed George, running out of breath.

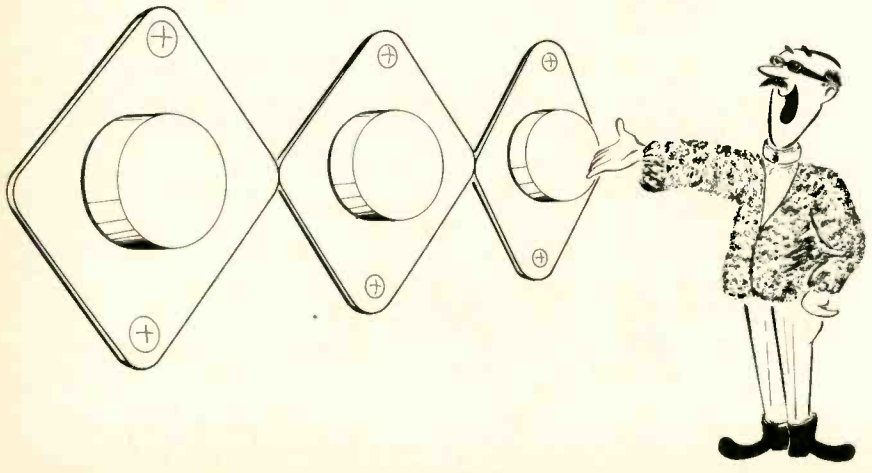
I blinked. "The most what?" I asked.

"The most imaginative engineering minds in high fidelity, of course," said George. "It is a magical new music experience. Unhindered, totally freed. . . . Totally freed from what, do you suppose?"

George really had gotten into the full swing of his languad quotes by now, and he caught me unawares. "Totally freed from government intervention" was the only way I could think of to end the sentence, and I was sure that wasn't right.

After an awkward pause, George cleared his throat and murmured, "You do read the ads in AUDIO, do you not?"

(*Continued on page 52*)

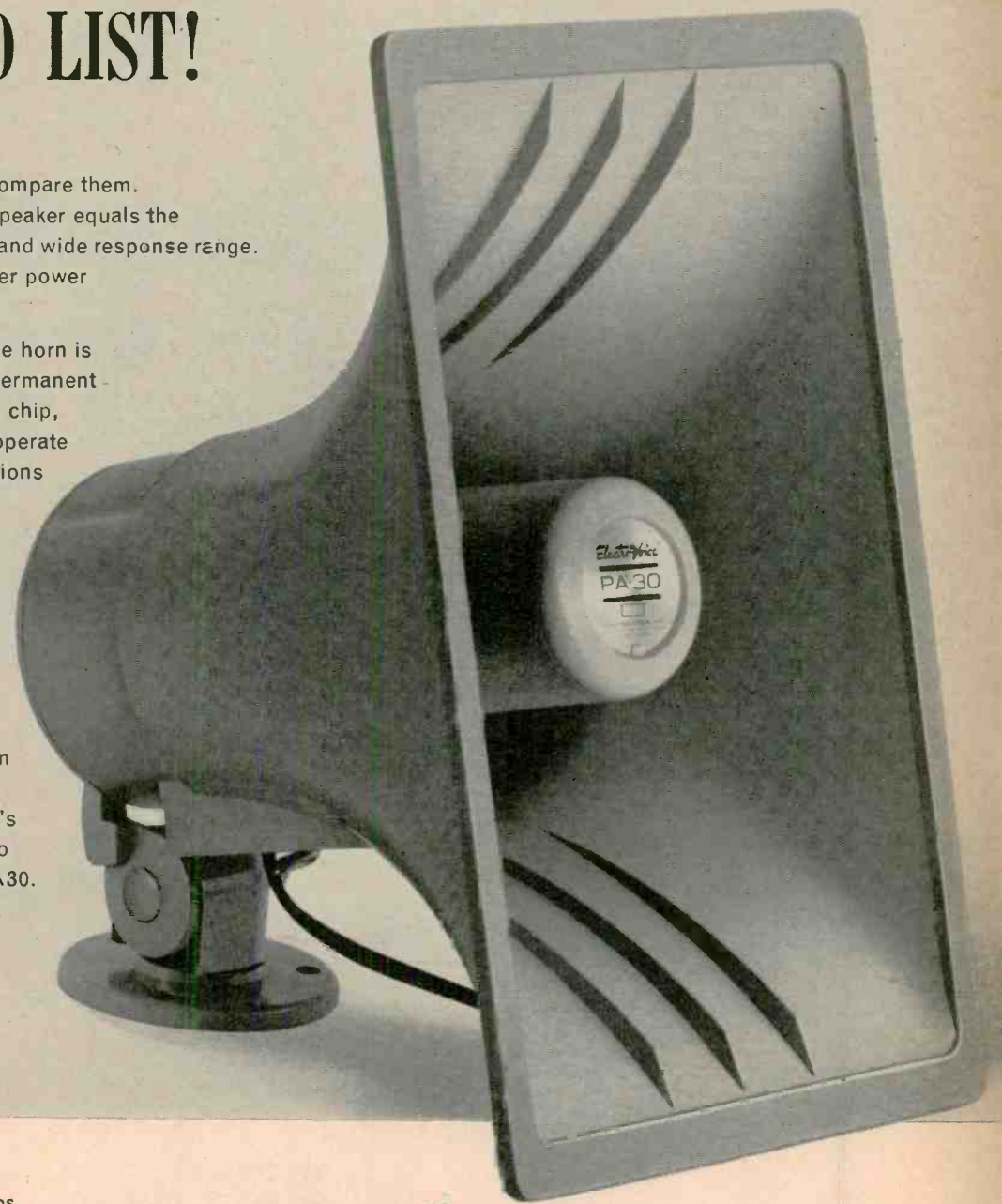


If you could combine the best features of every competitive paging speaker — YOU STILL WOULDN'T EQUAL THE NEW ELECTRO-VOICE PA30 FOR JUST $34.50 LIST!

Study the specifications. Compare them. You'll find that no other paging speaker equals the new PA30 in both high efficiency and wide response range. And none in its class offers higher power handling or wider coverage.

Now look at the PA30 itself. The horn is molded of modern "*Implex*" for permanent strength and beauty. It can't rust, chip, fade, or peel. Check the easy-to-operate swivel mount. One wing nut positions the PA30 securely at any angle. And you can also rotate the horn from vertical to horizontal for precise coverage control.

What you can't see—inside—is a husky new ceramic magnetic structure that gives the PA30 its muscle and high efficiency. There's an entirely new diaphragm and voice coil assembly, too. You can't see it, but you *can* hear it. It's the reason why there's no equal to the powerful sound of the new PA30. Prove it to yourself with your next paging installation.



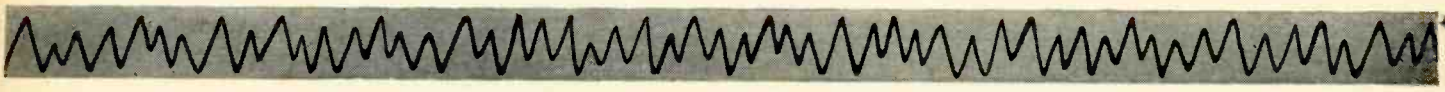
SPECIFICATIONS

Frequency Response	250-14,000 cps
Power Handling Capacity:	
Program Material	30 watts
Peak	60 watts
Impedance	8 ohms (45 ohms available, Model PA30-45)
Dispersion	90° x 120°
Sound Pressure Level	125 db (@ 4 ft. on axis with 30 watts input)
EIA Sensitivity Rating	59 db
Mounting	Universal swivel bracket
Dimensions	11 in. high, 6½ in. wide, 8½ in. deep
Net Weight	5 lbs. 9 oz.
Accessories	Model TR3 integral line matching transformer mounts directly to PA30. No exposed wiring. Slip-on connectors. Available for 70.7 or 25 volt lines. $15.00 list.

Model PA30 with TR3 Transformer installed

ELECTRO-VOICE, INC.
Dept. 956A, Buchanan, Michigan 49107

Electro-Voice®
SETTING NEW STANDARDS IN SOUND



Now, there's a tape that lets you

Protecting Loudspeakers Against Overload

K. F. RUSSELL*

This letter from the Technical Manager of Wharfedale was prompted by a question in Mr. Giovanelli's "Audioclinic" earlier this year. Due to the importance of the subject, and the length of the letter, we are presenting it as a brief article. Mr. Russell's proposed protective circuit for loudspeakers could be very valuable to audiofans. It may stimulate others to solve the problem in other ways.

THE correspondence under the heading "Speaker Overload" in June "AUDIOCLINIC" raises interesting issues for the loudspeaker manufacturer and the loudspeaker user. Like your correspondent Mr. Aharonian, the user will want to ensure that he does not damage his speaker by driving it too hard, while the manufacturer will want to put a realistic rating on the speaker as a guide to its true power-handling capacity.

A question which frequently occurs is this: "I have a 50-watt amplifier, but none of your speakers is rated at over 20 watts. Does this mean that none of them is suitable for use with my amplifier?" or "I have a 25-watt amplifier, and I would like to use your Super 8/RS/DD speaker. However, I see that this is rated at only 8 watts. Will it be safe to use this with my amplifier?".

The difficulties for manufacturer and user are really the same, and the vital questions are, "what sort of signals will damage this loudspeaker?" and "what dangerous signals is this amplifier capable of delivering?". In a recent series of tests made at Wharfedale to determine the power-handling capacity of a new speaker system, our various measurements suggested a modest rating of 10 watts rms. One of the measurements we made was a peak voltage measurement using an oscilloscope as suggested by Mr. Giovanelli in his reply. On a music program with a wide dynamic range, the 15-watts rms amplifier we were using delivered peaks of 75 watts into our 10-watt speaker, without apparent distress either to the amplifier or the speaker. On this basis, one might suppose that the speaker rating ought to have been raised, but in fact, the speaker would only stand these very high peaks of power for a few milliseconds. The particular music program did not include any sustained power levels above a few watts, so that the actual average power level in the music, even in the loud passages, would not be more than about 7 or 8 watts in spite of the 75-watt peaks. The fact that our modestly rated amplifier was capable of producing these peaks arouses interesting thoughts on the potential peak outputs of amplifiers rated at 50 and 100 watts!

What sort of power will damage a loudspeaker? The answer is that there are three types of signal which are most dangerous. Probably the most common form of speaker damage is overload of a tweeter by applying a sustained note at high frequencies. Because of the low conversion rate in a loudspeaker of electrical to audio energy, most of the power is converted into heat in the loudspeaker coil. In a loudspeaker which handles frequencies below 400 cps, there is usually sufficient movement of the coil, when reproducing a complex wave form, to circulate some air over the coil, thereby dissipating the heat. Above about 400 cps the self-cooling action of the voice coil is much reduced, and a sustained input near the upper end of the audible frequency range produces heat which is dissipated only very slowly. Many tweeter units will thus burn out in a few seconds when subjected to a comparatively small power input at a single frequency. Because an average music program contains only a very small proportion of its power in the tweeter range, a tweeter unit is not likely to be damaged by a music program, even if its average power is much in excess of the single-frequency power which would destroy it. In general, it is safe for the manufacturer to rate the tweeter as though it were capable of handling the over-all power of the music program, because this figure can then be used as a guide when matching the tweeter to suitable bass and mid-range units.

It is also possible to damage full-range speakers with a sustained high frequency note, and for this reason it is always inadvisable for the amateur to test loudspeakers with an oscillator. However, low-frequency units normally have voice coils wound with a heavier gauge wire than full-range and tweeter units, and there is much less likelihood of damage to these speakers if they are subjected to a sustained high-frequency signal. The most usual form of damage in bass units is due to the voice coil being subjected to a greater displacement than the design allows for. This type of damage is more likely in expensive bass units where the permissable excursion of the cone is comparatively large. Bass units with a cone excursion of less than half an inch overall are less easily damaged, although occasionally a very large signal at low frequencies can cause the cone to split at the edge, or the neck of the cone to buckle.

Bass units fitted with long-throw voice coils can be damaged in two ways by excessive inputs at low frequencies. In one case the edge of the coil strikes the bottom of the magnet gap, causing damage to the coil former, and possibly to the end turns of the

*Technical Manager, Wharfedale Wireless Works Ltd., Idle-Bradford, Yorkshire, England.

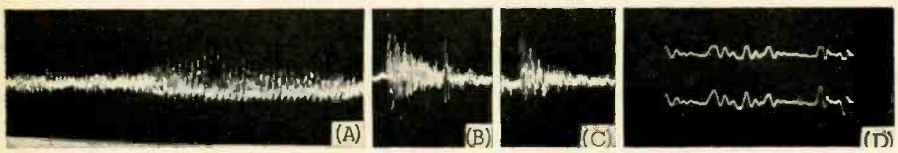


Fig. 1. Oscilloscope photos of various transients and effects of clipping: (A) Transient power peaks in musical passage; (B) and (C) examples of strong starting transients; (D) effect of clipping due to use of zener-diode limiter.

coil. On subsequent excursions, the damaged part of the coil will then interfere with the gap in the magnet, producing severe distortion of the sound. This type of damage can be caused by playing a music program at too high power, by applying too great an input from an oscillator, and occasionally by accidentally feeding a signal of power line frequency into the loudspeaker with the amplifier at high gain, for example because of ineffective grounding or an open-circuited input condition. A likely cause of this type of damage today arises from the use of electronic organs, many of which are capable of producing a sustained note with a frequency below 40 cps at relatively high power.

The second type of damage which is not uncommon in bass units occurs when the voice coil achieves such velocity that it leaves the magnet gap altogether, and either remains outside the gap or is so damaged in returning that it becomes locked in the magnet assembly. This type of damage is characteristically caused by high-power starting transients of a low-frequency note, for example the transient caused on striking the open E string of an electric guitar.

The problem facing the manufacturer is that of giving a realistic power rating to a loudspeaker system, which will give sufficient guidance to the user to avoid damage in these three ways, while at the same time enabling him to enjoy the full potentialities of the speaker in handling regular music programs at relatively high power. Because a loudspeaker does not always give warning of impending failure through overload, the user will want some guidance on what can be safely fed into the speaker without causing damage. It is not a complete answer for the manufacturer to give a conservative rating for the speaker, nor even to specify peak input signals, since the amount of damage caused by these will depend upon their duration and frequency. In some cases it may be possible to overcome the problem by telling the user that the speaker may be used with any power amplifier for domestic listening to speech and music, on the assumption that damage is not likely to occur at the sort of power input which the listener can stand without discomfort. However, this does not take into account electronic organs or the amplification of other instruments with potentially dangerous outputs.

A solution which naturally suggests itself is the use of a fuse, as discussed in the correspondence. If any reader wishes to waste a certain amount of time and money in an interesting way, he might like to do an investigation on the actual rupturing conditions for a random batch of fuses. A few minutes work will immediately suggest that their consistency as circuit breakers leaves something to be desired. Their real disadvantage, however, lies in their inability to protect the speaker against damaging starting transients at low frequencies, and damage caused by comparatively modest inputs at single frequencies in the upper range of audibility. If a low-rated value is chosen for the fuse, it may do a satisfactory job for most types of music, but whether it ruptures or fails to rupture on any given power peak is determined partly by its temperature before the peak occurs, and partly on the duration of the power peak itself. Thus an isolated peak of power may fail to rupture the fuse, whereas a much lower peak, occurring in a comparatively noisy passage may cause the circuit to open.

The use of zener diodes also suggests itself, and appears at first sight to be a possible solution. Our experience with these devices in the loudspeaker circuit confirms their effectiveness as a protection for the loudspeaker, and it is also possible to obtain zener diodes with power handling capacities of 50 watts or more, which suggests that they are not likely to be severely damaged themselves. The over-riding disadvantage of zener diodes as signal limiters is that the point at which clipping occurs is immediately audible, and if the zener voltage is chosen to conform with the highest sustained voltage that the speaker will handle without damage, all power peaks above this will be clipped. Such peaks occur in music with great frequency, and normally do no damage to the speaker, but the distortion caused by the clipping is audibly very distressing.

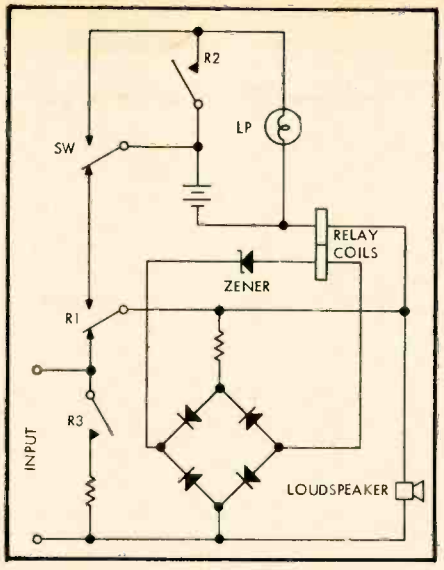


Fig. 2. Speaker protection circuit. When the zener breakdown voltage is exceeded, there is a current in one winding of the relay (which operates on very little current), causing R_1 to close, allowing the battery to energize the second winding, closing contacts R_2 and R_3. R_1 may have to be of the "make-before-break" type. R_2 completes the circuit to the pilot lamp and R_3 provides a dummy load for the amplifier. Switch, SW, is flipped to reset the circuit, and also allows the battery and lamp to be tested.

An alternative which works well under laboratory conditions involves the use of a sensitive high-speed relay in conjunction with a zener diode. In this circuit, the zener diode is fed with rectified signal, but does not limit the signal applied to the speaker because of the use of a buffer resistor. The relay is operated by a pre-determined overvoltage, and locks itself in the "on" condition in a secondary circuit powered by a dry cell. With the relay operated, the speaker is disconnected and if required, a resistive load can be offered to the amplifier and an indicator lamp illuminated. The circuit can be restored to the working condition with a pushbutton switch. This circuit works well enough to avoid damage to the speaker under most conditions, and if a very fast relay is selected, it is capable of preventing damage to a loudspeaker which is accidentally connected directly to the power line. There is, however, the problem of protection against single notes at very high frequencies, which would normally not operate the relay.

Manufacturers are naturally shy of marketing such devices, as they appear to give an unconditional guarantee to their products against misuse. They nevertheless offer useful protection to the loudspeaker user, and are only limited in their effectiveness by the reliability which the home constructor can build into them. A useful alternative to the protection device is a warning display, which will give some indication to the user when potentially dangerous voltages are present. A circuit of this sort is readily arranged, consisting merely of a neon tube with a series limiting resistor, the tube being arranged to fire at the appearance of an overload voltage. A tube would be selected with a very low burning current, say 1 mA, and a transformer introduced into the circuit which would step up the selected overload voltage to the firing voltage of the tube. This might be, say, 25 volts stepped up to 90 volts. Provided the transformer offers a very high impedance to the signal circuit, its introduction will have no audible effect. It might also be possible, with some ingenuity, to make up a display with more than one diode, making these frequencies selective, and also having different sensitives. Æ

Sound and Sight

Harold D. Weiler

From Fairchild Camera and Instrument Corp. of Plainview N.Y. comes another interesting industrial application for 8-mm sound-color film. Commercial airline pilots train themselves in complex flight, landing, and safety procedures.

The film showing the correct procedures is contained in a MoviePak cartridge which can provide up to twenty-two minutes of Audio-Visual information. The pilot, after checking out of Flight Dispatch, merely selects the cartridge pertaining to his next destination—inserts it into a Fairchild Mark IV rear-screen projector and obtains the desired flight and landing information. Since the film, in the cartridge, is in the form of an endless loop it is always ready for the next presentation.

Single-concept films of this type, produced for Audio-Visual instruction, have many applications in science, industry and education. Complicated industrial assembly procedures can now be easily taught. "Slow" pupils, in schools, may be provided with individual instruction which can be repeated until they "understand." Any film can be shown anywhere, in broad daylight, at any time. The projector is completely self-contained and portable. It weighs only twenty pounds.

• • •

Little did we realize, at the time of its writing, how prophetic and timely the closing remark of our first column would be. We wrote, "It is also interesting to note that many of the methods and techniques which will be provided are equally applicable to motion-picture or video tape recording, another field which we feel will open new horizons to the readers of AUDIO.

A short time after the column was written, we received a simple invitation to a press showing of a video tape recorder. Previous showings we had attended were of units ranging in price from three thousand to thirty thousand dollars. Hardly home recorders! This showing was different, the recorder was priced under one thousand dollars. As soon as we saw it we asked Mr. Morita, President of Sony Corporation of America to have his engineering staff provide us with complete information on its design, operation, and various applications. This information will appear in a forthcoming article.

Before our readers get the wrong impression, we hasten to say it will be a few years before the video tape recorder replaces the movie camera for audio-visual or home entertainment purposes. The video camera, which is slightly larger than a 16-mm motion picture camera must be used in conjunction with a video recorder which weighs about sixty-five pounds, not exactly portable. However, the SONY video recorder has many other applications which we feel will be of interest to our readers.

The similarity between the methods employed for picking up sound and sight for motion pictures and for video recording is most interesting. The process of recording sound is exactly the same, from microphone to tape, for motion pictures or for video recording. For motion pictures the sound is recorded on a magnetic stripe coated on the film. For video recording the sound is recorded on the same magnetic tape that carries the images.

The images to be recorded are picked up by a lens which is identical in both media. With motion pictures the image picked up is transmitted through the lens and impressed on a light-sensitive emulsion on the film. In video recording the image picked up is transmitted through the lens to a light sensitive Vidicon tube and through it is impressed on the tape. While this is an over-simplification of both media it will suffice for the moment. It is because of this similarity in the pick-up of both sound and sight between the two media that the information we will provide on filming for the Audio-Visual field is also applicable to video recording.

Before discussing the actual aural and visual techniques employed in motion picture and video production it would be well to explain something of their background and history. How and when they were developed and why and the purpose they serve. It is the application of these techniques which transforms the camera and microphone from mere electro-mechanical recording instruments into extensions of the beholder's senses, capable of transporting him through time and space.

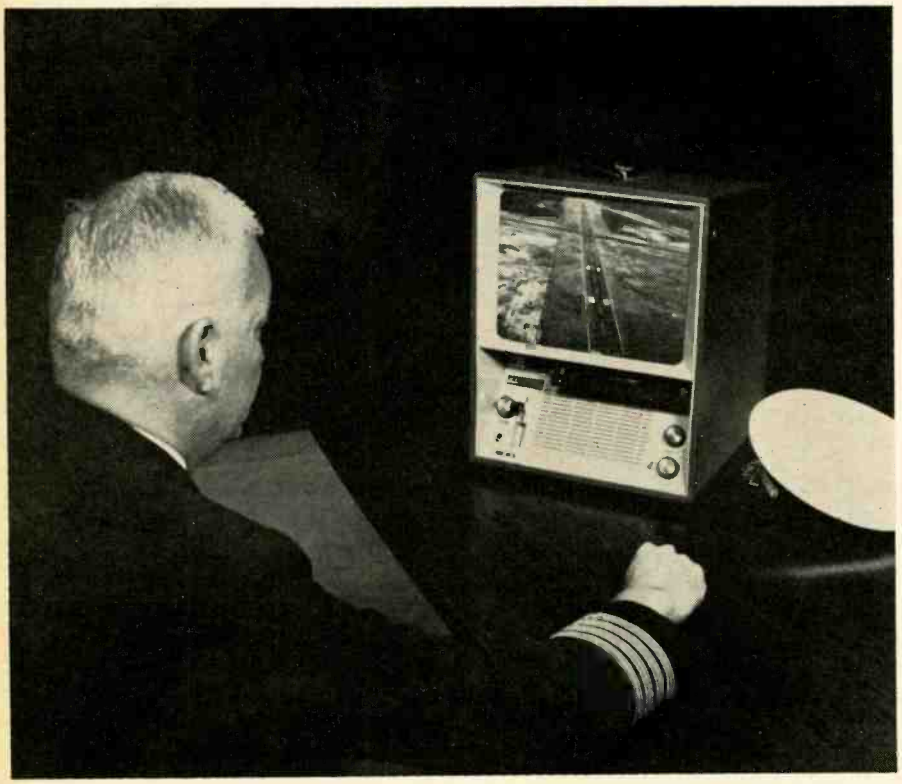
At the beginning of the twentieth century, George Melies, one of the pioneers of the motion picture industry, discovered nearly all of the basic visual techniques which today form an important part of motion picture and video recording technology. He was the first to discover slow- and fast-motion filming, through which the camera can be made to compress and expand time.

Through the use of the slow-motion technique an incident or event which occure in micro seconds can be extended to minutes, on the screen, thus expanding time. This technique permits the detailed study of analysis of operations or events which occur too rapidly for the eye to follow when observed directly. Conversely, fast-motion techniques permit the filming of an event which takes minutes in real life, to be shown in seconds, compressing time, so that the movement of an individual operator or a group of people or vehicles can be analyzed.

It was this basic discovery, later brought to perfection by Walt Disney and utilized so effectively in his "Nature Series," which made it possible to film an event which took months—the process of seeds germinating, the plants growing and coming to blossom—and see the entire life cycle screened in only a few minutes. Time-lapse photography, as it is called, has become one of the most valuable techniques ever developed for science, industry, and medicine.

Melies evidently also had a knowledge of the physiological aspects of sight far beyond his time. He must have known something of how our eyes perceive an object, how the received information is transferred to the brain, and how it is then

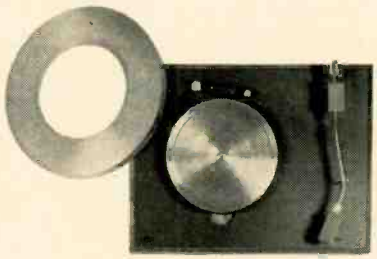
(*Continued on page 44*)



Packaged cartridge of 8-mm sound film provides airline pilot with a preview in color of his next airport destination.

The American Record Guide has published test reports on 16 turntables. The AR had the lowest rumble; wow and flutter were reported below the bottom accuracy limit of the meter.*

*Through January 1965; includes 6 record changers.
AR turntable reported on December 1964.



Radio-TV Experimenter published the most recent test report (February 1965) on the AR turntable. This is the opening paragraph:

RADIO-TV EXPERIMENTER LAB CHECK

ACOUSTIC RESEARCH XA
Two-Speed/Manual
Stereo Turntable

Take a few minutes and add up the cost of your amplifier, speakers and record collection. Even if you've only got a hundred or so records the investment is somewhere between $500 and $1000. So what's it worth to you to hear the music *exactly* as it was recorded? How much is a turntable worth which adds no coloration of its own —no wow, no rumble, no hum, no pitch changes. Better yet, what's it worth for a turntable which exceeds the stability of the best broadcast turntables; one that will keep the needle in the groove even when a bunch of teenagers use the music room for a dance hall. Is it worth $200 or $300? Maybe it is, but all it will cost you is $78, the price of AR's Model XA turntable.

The XA turntable is actually a "player" ... ced motor ...

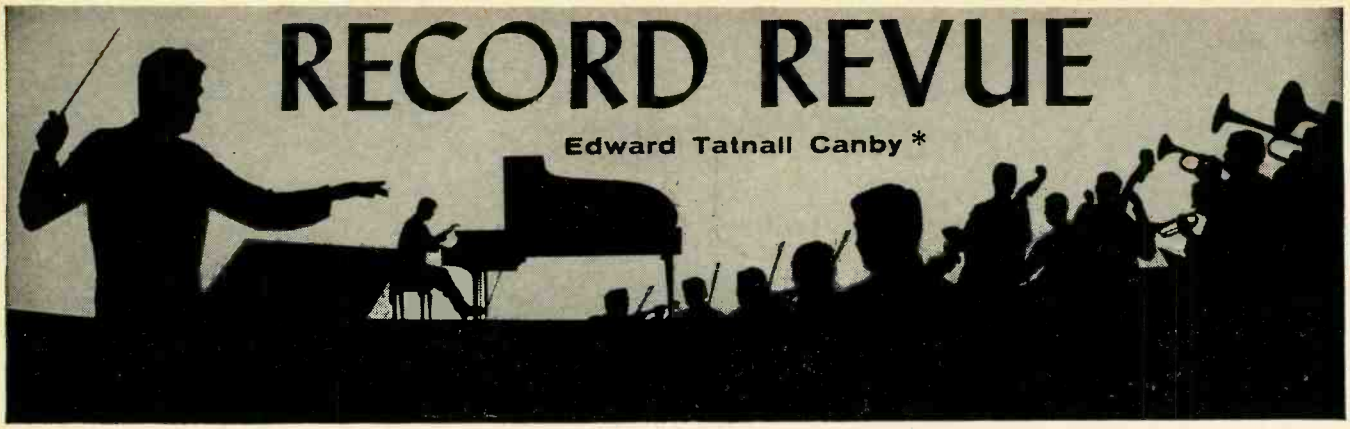
Literature on AR turntables and AR speakers is available on request.

$78.00 complete with arm, oiled walnut base, and dust cover, but less cartridge, 33⅓ and 45 rpm

5% higher in the West and Deep South

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

Circle 136 on Reader Service Card



RECORD REVUE

Edward Tatnall Canby*

A Look at RCA

Brahms: Symphony No. 2. Boston Symphony, Leinsdorf.

RCA Victor LSC 2809 stereo

Brahms: Symphony No. 1. Boston Symphony, Leinsdorf.

RCA Victor LSC 2711 stereo

Van Cliburn Brahms Concerto No. 1 Boston Symphony, Leinsdorf.

RCA Victor LSC 2724 stereo

Beethoven: "Emperor" Concerto. Artur Rubinstein; Boston Symphony, Leinsdorf.

RCA Victor LSC 2733 stereo

A good musical picture comes out of these Boston-Leinsdorf discs released over more than a year's time—though I'm not able to focus my ears hard enough to distinguish between "early Dynagroove" and the presumably later variety. They all seem to have that peculiar wooden sound, the dullness in the highs, . . . but one does get used to that, and in other respects the recordings are very much worthwhile.

Leinsdorf has emerged as a curiously modern Germanic conductor, more at ease with the big old pieces than either Munch or Koussevitsky, his predecessors, evoking a naturalness and enthusiasm for this music that neither of the others ever managed. But he is also far more modern; his tempi are of the quick, latter-day sort, minimizing the "old fashioned" aspect of the Romantic music. A good combination, decidedly; for Leinsdorf does not force the issue into hard-toned harshness, as some younger conductors do. His Brahms still melts engagingly, though economically. And his Beethoven expands beautifully.

The two Brahms symphonies, released a year apart, are perhaps definitive for this modern-yet-natural approach to Brahms. The second is somewhat brighter in sound (modified Dynagroove??), but both are impressive. The two piano concerti are splendid in the orchestra—and curiously, their two pianos are quite different in sound in accordance with their players' respective generations. (Is it the pianos themselves and/or the microphone technique?) Cliburn's piano is typically bright, metallic, a bit hard. Whereas Rubinstein's is much more mellow, even in the loudest passages. Now don't go telling me it's the *playing*. . . .

Cliburn is really proving himself as the younger generation's specialist in big, old-fashioned Romantic music. He is good in this difficult Brahms, eloquent, accurate, authoritative and fluent. He must have worked hard. As for Rubinstein, he is utterly a past master of the Beethoven, to perfection—the wisdom of age and, still, the fingers of youth. Amazing. He doesn't even sound tired, playing this concerto for the nth time, as well he might after so many years of concertizing.

Organ Music of the Bach Family. Carl Weinrich, Organ of the Gen. Seminary Chapel, New York.

RCA Victor LSC 2793 stereo

This is a fine organ record, partly thanks to an excellent new organ in a splendid stone-and-wood chapel, partly due to the sheer variety of music turned out by no less than six members of the Bach tribe, both before and after the great J. S. Bach himself. Three earlier Johanns are represented—J. Bernhard (Bach's second cousin, slightly older), J. Michael and J. Christoph, and two of the "Bach sons", Carl Philipp Emanuel and Wilhelm Friedemann. It is all sturdy music and wonderfully suited to the organ—even the more *galant* music of Carl Philipp Emanuel, well on the way to Mozart and Haydn.

Mr. Weinrich's phrasing still tends to be haphazardly *staccato* (a leftover from the old days of blurry organs) but the big liveness and the circumspectly distant RCA mikes combine to minimize the trouble. The sound seems to me excellent (with very good organ bass)—and on good equipment, at that. The label carries the Dynagroove designation.

Monteverdi: The Sixth Book of Madrigals. Polyphonic Ensemble of Rome, Antonelli.

RCA Victor LSC 7035 (2) stereo

This somewhat surprising (for RCA) two-disc album takes Dynagroove to Italy, somehow or other. Main effect, for my ear, is to dull the sound. Just turn the tone control up and it sounds better.

The Sixth Book of Monteverdi madrigals is a collection of works, already astonishingly varied, most of them soloistic and with instrumental accompaniment. Two famous "madrigal cycles" are included, the *Lamento d'Arianna* (adapted from an earlier opera, music for solo voice) and the "Tears of a Lover", *Lagrime d'amante al sopolcro dell'amata.*

I wish I could enthuse over the performances—for the project is tremendously valuable and, I think, unique. But when you go to Rome, you get Italian opera—Caruso-style. That's what we have here. Huge, cavernous, wobbly basses. Enormous, throaty, wobbly sopranos. Super-Romantic sighing and dying-away, abysmally slow tempi—a positively elephantine procession of heavyweight presentations (though, to be sure, these elephants are sincere and musical in their own manner).

Nobody knows, of course, precisely how these works really sounded. As for me, I know how they surely did *not* sound—like this. Caruso & Co. hadn't been born yet, by some two centuries. The internal evidence of the music itself (I've sung and conducted a good deal of it) indicates that the singers must have had small, very intense, bright and *accurate* voices, without more than a trace of vibrato, "blending" together, a bit like our own barber shop or pops-commercial vocal blends, or the blending of good country-style folk singers. (Not the same music—just a similar blend.)

If you don't mind vocal elephants, plunge into this. The music is certainly worth it.

Telemann & Co.

Court Dances of Medieval France—The Arbeau "Orchésographie". Telemann Society

Turnabout (Vox) TV 34008S stereo

All In A Garden Green (English Dance and Ensemble Music). Telemann Society.

Counterpoint/Esoteric 5616 stereo

The Telemann Society of New York, run by Richard and Theodore Schulze, seems out to beat the N.Y. Pro Musica in mass production of old music. The Society "team" quickly becomes familiar, in these and many another disc. Its product varies from energetic-and-good to energetic-and-downright-awful. It is *always* energetic! And often irritatingly insensitive. There are many really excellent individual items, taking by themselves; but in the long pull the Society shows a determined sort of semi-fanaticism that quickly wears the patience thin. Curious—for they are musical people and full of verve. If they'd only stop long enough to let the music

(*Continued on page 54*)

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Enjoy it — *the lively sound.* Put it anywhere — everywhere! No matter where, the Ultra-D fits!

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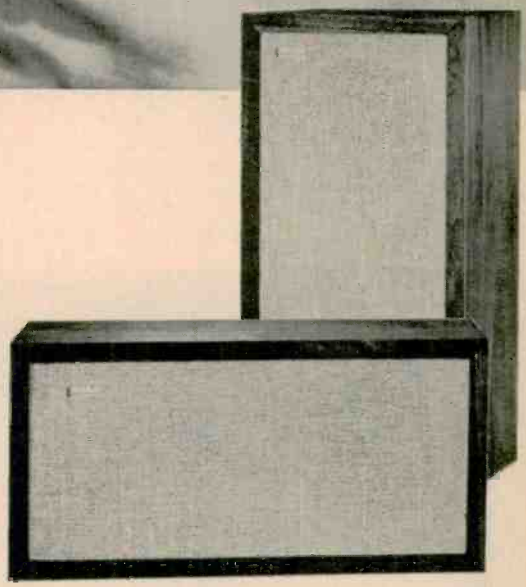

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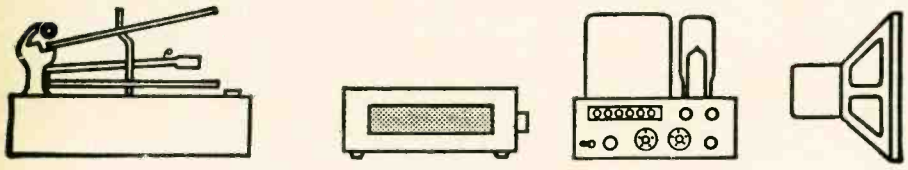
ULTRA-D SPECIFICATIONS: *Components — 10" ultra-linear high compliance woofer, 4" direct radiator mid-range, 3½" direct radiator tweeter.* ***Response—35 to 19,000*** *cps. Size— 23 13/16" h. x 11⅞" w. x 9¾" d.* ***Finish Oiled walnut.*** *Selling Price — $87.25*

Circle 137 on Reader Service Card

EQUIPMENT PROFILE



SHERWOOD S-9900.

Virtually all of the new amplifiers coming our way are of solid-state design. Whether this is the sounding of the death knell off vacuum tubes is still too early to say. The fact is that tubes *are* bowing out in the amplifier field. This new product from Sherwood is a good example of just why the demise of tubes is no loss at all.

Clean, uncluttered design has always been a hallmark of the Sherwood product line. This latest item is not a departure. Six knobs and four slide switches are set off in a balanced design, against a white background. Everything is functional. Sherwood has joined that growing group of manufacturers believing (as we do when used with identical speakers) that a modern stereo control center does not need separate bass and treble controls for each channel. So, combined channel function is provided for upper and lower tone shaping.

There are the usual selector, mode, volume, and balance controls. There are also switches for tape monitor, hifilter, loudness compensation, and speaker on-off. Finally there is a front-panel stereo headphone jack. In addition to all this, there is a small phono input level-control pot located in the lower left corner of the face plate.

The rear panel is also uncluttered. There are the speaker outputs—two widely spaced screws for each channel. A single a.c. outlet is provided. There are also the inevitable fuses, one in the a.c. primary and one each in the supply to the output transistors.

Physical dimensions are 14 x 10½ x 4 inches high. Shipping weight is 22 pounds.

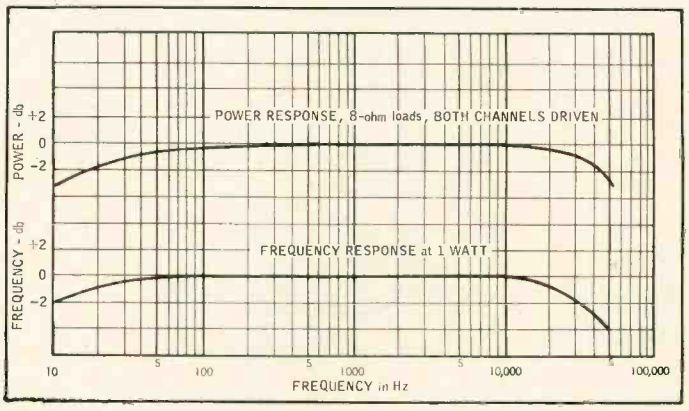


Fig. 2. Frequency- and power - response curves for the Sherwood S-9900 solid-state amplifier.

Measurements.

Frequency response and power response are shown in the accompanying Fig. 2. Power response was taken into an 8-ohm load. It would be higher for 4 ohms; lower for 16 ohms.

Square-wave observations were impressive. There was no evidence of ringing even with capacitive-type loads. The S-9900 should be able to handle electrostatics well within its stride.

IM distortion curves were the best we have yet seen for a solid-state amplifier. There were no evidences of the typical camelback curve usually found.

1 watt (equiv)	.05%	25 watts	0.49%
5 watts	0.10	30 watts	0.54
10 watts	0.32	32 watts	0.90
20 watts	0.48	33 watts	9.0

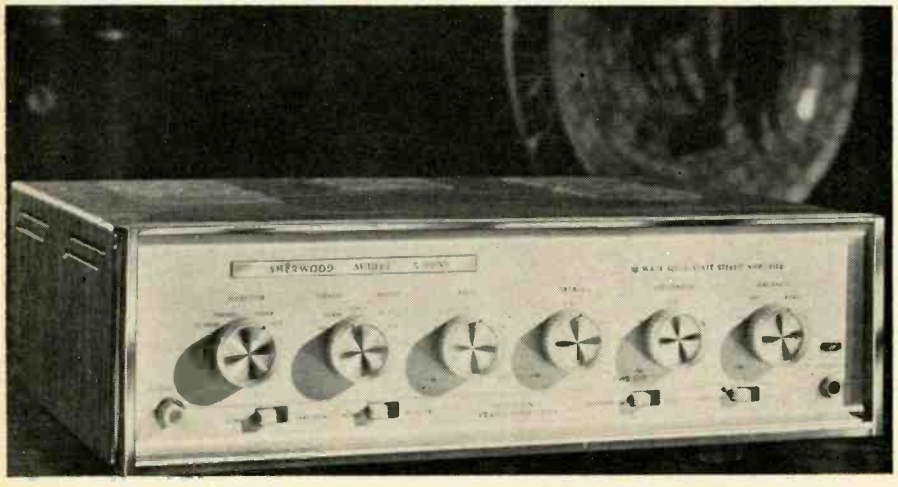


Fig. 1. Sherwood S-9900 90-watt Solid-State Amplifier.

Phono equalization, sensitivity and overload characteristic were checked. Sensitivity was good. 3.2 mv at one kc will drive the amplifier to full output. RIAA equalization was on the button over the high end; it was equally accurate to below 100 Hz. At 50 Hz, equalization was 2 db down. Below that frequency there was increasing loss. These are fine figures. Few preamplifiers in any categories, much less lower priced integrated units, show accurate equalization to below 50 Hz. Furthermore, the differences are only audible on the finest systems. So, do not count this as a strike against Sherwood.

What should be counted down is the poor overload characteristic. We mentioned that there is a front panel phono input level. With this control manipulated for best position, the best overload figures was 38 mv. With the pot full open the overload point was 30 mv. This will cause no problems with low output magnetics such as the Grado A, but an Ortofon SPU severely overloaded on musical peaks. The result is that there is a potential problem here of cartridge-amplifier compatibility.

This is a very quiet amplifier. Total noise was well below 90 db on high-level inputs. Noise was 48 db below a 2.8 mv input in phono. These are indeed excellent figures.

Finally, we checked the hi-cut filter operation. It begins its rolloff at 5 kHz, is 9.2 db down at 7.5 kHz, and down 15 db at 10 kHz.

With cartridges that did not overload the phono inputs, this proved to be one of the cleanest sounding and most listenable solid-state amplifiers it has been our pleasure to investigate. Much of this can be traced to the low-distortion characteristics of the unit. This S-9900 is cool-running, compact, and seemingly reliable. Sherwood should sell a lot of these to satisfied users.

Circle 175

NEUMANN MODEL U-64 MINIATURE CONDENSER MICROPHONE

Some forty-five years ago, there was a radio product on the U.S. market which was called "Multum-in-Parvo," translated hy its promoters as, roughly, "a lot in a little space." Since we haven't heard anything of that product for nearly that many years, we could suggest the application of the same title to the Neumann U-64, for

it certainly offers a lot of microphone in a little package. The unit proper, shown in Fig. 3, measures only ⅞" in diameter by 4" long, made possible partially by the use of a low-noise Nuvistor as the cathode-follower tube in the microphone unit. Its power supply measures 4" x 4" x 8¾"—although the dual power supply which will accommodate two U-64's is the same size. If you use a complete complement of U-64's, you would probably use the rack-mounting model which will power six microphones, and which measures 19"x3½".

No condenser microphone is inexpensive, but the U-64 offers one feature which we believe is unique in the condenser microphone field—that of a uniform cardioid pattern over the entire frequency range. Most cardioid microphones exhibit considerable directionality at the high frequencies, but much less on the low end. The U-64, on the other hand, has practically the same directional pattern at *all* frequencies. Frequency response curves taken at ±135 deg. from the axis run nearly parallel, and the attenuation at this angle is ±15 db throughout the range from 100 to 18,000 Hz, which is remarkable. For extremely close recording, where high levels could become objectionable, there is a switchable 14-db attenuator between the microphone capsule and the Nuvistor.

Another unusual feature of the U-64 is the presence in the microphone body itself of the output coupling transformer which provides output impedances of 50 and 200 ohms, both ungrounded. In many condenser microphone combinations in which a separate power supply is employed, the output transformer is usually located in the power supply package, with the attendant possibility of hum pick-up from the power transformer or from nearby high-current lighting circuits (in the case of TV and motion picture applications).

Specifications

For a maximum distortion of 0.5 per cent, allowable sound pressure is 200 microbars in the normal condition, but with overload protection switched in, the maximum allowable sound pressure is 800 microbars.

Output level measures just under 1 mv per microbar into a 1000-ohm load. Response is essentially flat, with a slight droop below 40 Hz to compensate for the bass rise at close range, and a rise of about 2 db at the high-frequency end of the spectrum.

The diagram of the U-64 is of polyester, vacuum gold plated and temperature stabilized. The unit requires a supply of 6 volts at a current drain of approximately 120 ma for the heater, and a plate and polarizing supply of 120 volts at less than 1 ma.

The N6u power supply provides the required voltages, employing Zener-diode stabilization of the heater supply. The N62u supply is a dual unit (although the same size as the single unit) capable of feeding two U-64 microphone units. Furnished with the U-64 is an acoustic foam anti-pop filter which is also an effective wind screen. The unit is available in matte satin chrome or in non-reflecting dark gray.

Circle 176

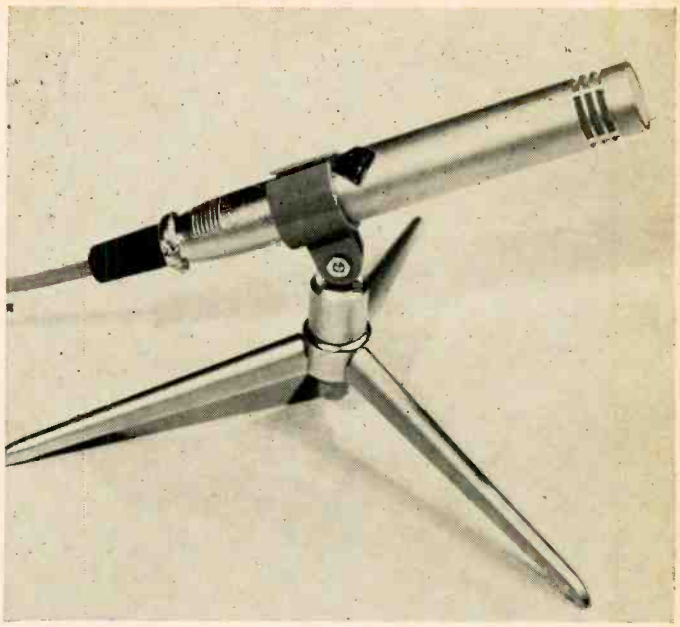


Fig. 3. Neumann U-64 Condenser Microphone.

SHURE "SOLO-PHONE" HEADPHONE AMPLIFIER

That there is some demand for private listening is attested to by the almost universal presence of headphone jacks on most modern amplifiers, if not by the number of headphones on the market and their popularity.

But the presence of the headphone jack on the amplifier does not completely solve the problem. Granted that the person who wishes to listen without disturbing others may be considerate enough to do so, but he may also be depriving others of *their* listening while he is indulging in *his*.

The Shure Solo-Phone is the solution. Not only can the one who wishes to do his listening in private do so without disturbing the remainder of the family, but they can listen to their program at the same time.

The Solo-Phone is a small transistorized amplifier designed to drive headphones only, and providing sufficient gain to operate from a magnetic cartridge. A front-panel switch activates a low gain input which permits its use with tuners or tape recorders equipped with only an "amplifier" output, but not equipped to accommodate headphones.

It employs four transistors in each channel, with a complementary pair in the output stage so arranged as to provide adequate output into a pair of conventional low-impedance phones. In the phono position, more than enough volume is provided by an input of only 1 mv from the cartridge, and since the volume control precedes the amplifier, the problem of cartridge overload is not encountered. What overloading that does occur is the result of attempting to obtain too much output—the maximum is of the order of three volts. Up to the overload point, the distortion measures in the vicinity of 0.3 per cent. Feedback around the first two transistors provides the required equalization for phono reproduction, while in the low-gain position of the switch, the amplifier is "de-equalized" to accommodate flat signal sources, such as a tuner or the amplifier output from a tape recorder.

A dual volume control is provided, with a friction clutch between the two knobs so that both will normally turn together, but can be set to different positions to allow for variations in hearing sensitivity of the two ears, or for correcting program material, or simply because you like it that way.

The power switch on the front panel also activates the a.c. convenience outlet on the rear, and the ON condition is indicated by a pilot lamp.

Circle 178

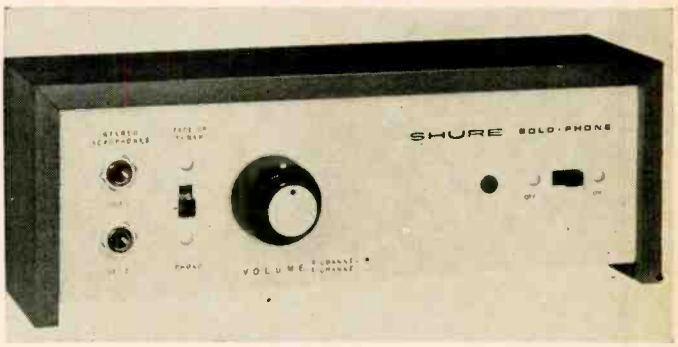


Fig. 5. Shure "Solo-Phone" a transistorized headphone amplifier

SOUND AND SIGHT

(*from page 38*)

converted into mental impressions. He also discovered the techniques of fade-in, fade-out, and dissolve. When these techniques are substituted for our normal visual experiences, they are able to suggest the passage or lapse of time rather than record it in its entirety, and they permit a change from one location to another, on the screen, without actually filming the transition.

Melies last and perhaps greatest contribution to the art was his most famous picture, "A Trip to the Moon," made in 1902, which was to eventually become responsible for the creation of the motion picture industry as we know it today. It was the first film ever made to tell a complete story in pictures.

It seems strange today that Melies, having gone so far did not continue and investigate the effects of moving and changing the placement of his camera. During this period the camera was fixed in one position to encompass the entire scene, all subjects were filmed from one angle and at eye level. This created an effect similar to that of watching a stage play from the center of the orchestra.

At this time all motion pictures, with the one abovementioned exception, consisted of short, single-scene, newsreel-type films only a few minutes long, similar to today's average amateur home movie. They were usually photographed outdoors and consisted of individual incidents, a parade, a scene in a garden. The titles are self-explanatory, "Racecourse Scene," "Babies Playing," "Arrival of a Train." The public eventually grew tired of this simple novelty. The vaudeville theatres showing these films dropped them from the program. Sales fell off!

Edwin S. Porter, an assistant to Thomas A. Edison, thought pictures which told a story like, Melies' "A Trip to the Moon" might provide the solution and woo the customers back.

In Porter's files there was a film of the type which had lost favor with the audiences—a simple film showing the routine of firemen answering an alarm, complete with burning buildings and racing fire-engines. He decided to use it as the basis for a little story. He shot some additional scenes of a heroic fire-chief rescuing a mother and child from a burning building and simply combined them with his stock fire scenes. The picture, "The Life of an American Fireman," is famous today as a primitive classic.

The film opened with the fire-chief asleep, at the station, dreaming of a woman and child in danger of being burned alive. The next scene was made with the camera close to a fire alarm box and showed only a hand pulling the alarm—the first dramatic close-up in screen history. The ringing of the alarm bell at the fire-house awakened the sleeping fire-chief. This brought in the stock shots Porter had at hand, such as the firemen sliding down the pole, the engines turning out to answer the call, the engines dashing wildly through the streets. Here Porter employed, again for the first time in the movies, the technique known today as parallel action, which is used to intensify suspense. This technique shows two different sequences of action, happening in different locations but cross-cut so that they are depicted as occurring at the same time. Porter intercut the rushing fire-engines with a shot of the mother and child in the burning building. Then back to the engines again—would they arrive in time? The eventual arrival of the engines and the climax, the dramatic rescue, ended the picture.

What appeared on the screen was a series of individual separate shots combined and edited in such a manner that the suspense and action were greatly intensified. The picture was exciting—it built up to a climax. The result was startling in its realism, the barrier between the screen and the audience was broken, they became participants in the action! Porter had stumbled onto something new! The camera had at last abandoned its passive role and the audience loved it!

Porter's next picture, "The Great Train Robbery," employing the same formula which had been so successful with the "Fireman," enabled him to make more subtle use of the techniques with which he had experimented earlier and to use once more the dramatic close-up. This time the picture closed with a startling head-and-shoulder view of a bandit firing his gun point-blank at the audience. It was an even greater success than the "Fireman." However, with the exception of the one close-up, the camera remained at eye level and the picture was shot at a comparatively long distance from the camera.

These few simple visual techniques developed by Melies and Porter are the fundamental basis of all motion picture and video filming today. It remained however, for one other man to combine the techniques of Melies and Porter and improve each in the process of fusing them into a complete whole. More about him next month. *Æ*

LETTERS

(*from page 6*)

that are best for me in my situation. This could be worked into one trip to the 'big city'.

The thought strikes me that such a showroom would even be beneficial to manufacturers for testing out the public's reaction to experimental equipment.

I just hope that such showrooms won't be found only in the New York area. I would like to see them scattered across the country. As implied earlier, I feel that this would be the best way to get a product before the greatest numbers of interested people in a favorable situation.

The Rev. L. W. Russ
Bluff Springs, Illinois 62622

Do Eggs Square?

Sir:

I have just read the article by Mr. Butterly in the June issue. I am rather disturbed that Mr. Butterly after *Eq.* (2) refers to eggs squared over two. This, of course, should be either eggs half-squared or half-eggs squared, and in either instance had to accept because eggs are mightly hard to square, even when whole. The rest of the article is mighty *rigorous*, one might even say *mortis*.

Charles M. Davenport
567 Howard Street
Whittier, California

Power Ratings: Average-to-Peak

Sir:

In the July 1965 issue of Audio appears a letter from Victor Campos in which he discusses the ratio of peak to average power in a KLH Model 16 amplifier. As I read Mr. Campos' statement, the conventional IHF rating of the amplifier, both sides driving 4-ohm loads, is 15 watts; but the peak power under the same condition is 150 watts.

I am curious as to how Mr. Campos arrives at this 150-watt rating. If this is a so-called "music power" rating, then the amplifier can deliver 150 watts if its supply voltages are maintained; but when these supply voltages decrease under continuous drive condition, the rating falls to 15 watts. This 10-to-1 power range, which Mr. Campos lauds as an asset, would seem to indicate that the supply voltages drop to about one-third of the quiescient condition. This represents a condition of very poor power supply regulation; and should it happen, there would be such shifts of operating conditions that linearity could not be maintained over the dynamic range.

If there is some other definition of "peak" power which gives Mr. Campos' amplifier an advantage over othr designs, then I think description of this and explanation of how it can be measured would be of considerable interest to all of us.

David Hafler
President, Dynaco Inc.

Vintage Theater Amplifier

Sir:

I thought that you and your readers might be interested in a real vintage amplifier which has been in my possession since about 1950.

The amplifier is a Western Electric 7A Amplifier "Licensed For Use Only As A Part Of The Western Electric Loud Speaking Telephone Outfit" as the name plate warns. The tubes in this unit are Western Electric 216A Triodes with four-pin keyed bases.

This amplifier was originally installed as

Fig. 1. Vintage amplifier.

300 Years ago they'd have burned us as witches. We make little things perform miracles.

Like the KLH Model Eighteen.

It's a solid state FM stereo tuner.

Sopping wet, in its handsome oiled walnut enclosure, it weighs less than four pounds. And it measures just 9" wide x 4¼" high x 5⅜" deep.

Can something like that perform miracles?

We have witnesses.

"The design philosophy of the Model Eighteen is definitely rooted in the KLH tradition of making as much as they can themselves to insure quality . . . In the case of the Model Eighteen they have gone to the trouble of making their own i.f. transformers . . . the payoff is in performance . . . the most remarkable specification of the KLH is its price $116.95. At that price and with the performance it provides, the KLH is a remarkable tuner buy." AUDIO MAGAZINE.

"The Eighteen is engineered to produce maximum performance with minimum complexity . . . (It) is an exceptional value, and is, in fact, one of the better FM tuners I have seen regardless of price." JULIAN HIRSCH, HI FI/STEREO REVIEW.

"Its clear open sound and sensitivity to stations all the way up and down the dial qualify it unquestionably for use as a tuner in the finest of playback systems." HIGH FIDELITY.

"The audio purist who spends his entire life looking for better sound would find no fault with the Model Eighteen." RADIO-TV EXPERIMENTER MAGAZINE.

"The KLH Model Eighteen in normal use should never need realignment or servicing for the life of the unit."

Who said that? We did.

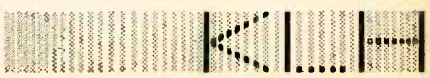
Is that witchcraft?

Not really. We did it all with our own hands, our own parts, our own imagination. The way we do everything. The KLH way. It guarantees miracles.

And those rumors of ladies in pointed hats prowling the moonscapes of Cambridge, Mass., are completely unfounded.

We'll bet our broomstick on it.

For more complete information on all our miracles, write The KLH People, 30 Cross Street, Cambridge, Mass., Dept. 102.



30 Cross Street, Cambridge, Mass.

Circle 139 on Reader Service Card

the audio amplifier in the Orpheum Theatre in Hillsboro, Illinois, which is my home town. I was an usher at the theatre when I acquired possession of the amplifier from the then owner of the theatre.

The filaments of all three tubes are still intact and light when connected to a 6-volt battery. In fact the amplifier appears to be in its original condition except for new wires from the input terminals to the input transformer which were replaced prior to the time that I acquired it. I have also resoldered a lead from the single capacitor which was almost broken off.

I have no idea how old this amplifier is but the last patent date on both the tubes and the amplifier name plate is 1920.

DONOVAN MERRY
510 Southland Circle Drive
Tuscola, Illinois 61953

TAPE GUIDE

(from page 14)

Q. I have two reels of °°°° triple-play tape on which I have recorded over $100 worth of records. I no longer possess the records so the tapes are very valuable to me. For several months I had no trouble when I played these tapes. But now when I play them I get the most horrible, though occasional, squealing sound. Most of it is mechanical, but sometimes it can also be heard through the speakers. As far as I can determine, the squeal occurs when the tape passes over what I call a tension bar on its way to the heads. I notice that these tapes squeak when I draw them through my fingers, while my regular tapes do not. I wrote to the tape manufacturer, and all he told me was to keep the tape recorder parts clean, but I had already done this. Do you have any suggestions?

A. The following steps might help: (1) Restore moisture to the tapes by enclosing them in a container along with a moist sponge for about 24 hours. (2) Apply a special lubricant, sold for this purpose by audio salons and mail order houses, to the tape heads and tape guides. (3) Apply special lubricant to the tape. (4) Have the tape tension and pressure pad (if any) tension checked.

Q. I desire to buy a tape deck in about the $200 category, and all those I have seen around this price, with one exception, have just a single motor. The exception uses three motors. The question in my mind is whether I am getting more for my money if I buy the 3-motor deck.

A. Certainly you will be getting more motors, but not necessarily better performance. Generally you get performance commensurate with the price, regardless of whether the tape machine has one, two, or three motors. Thus an Ampex or Tandberg with one motor will outperform a number of less expensive machines with two or three motors.

Q. My bother is in Japan and can get me a tape recorder there at a very good price. Is there any reason not to take advantage of this opportunity?

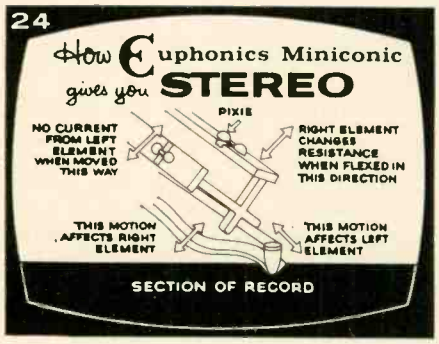
A. A tape machine is quite a complex article, with quite a variation not only in price but also in features, flexibility, and performance. Of all audio components, it is probably the one—after the speaker—which is the most desirable to buy in person rather than on a sight-unseen basis.

Q. I would like to add a tape deck to my audio system and have tried to make a reasonable selection, but the more I look the more I realize I need expert advice. Within my budget I have found a group of machines that have the features and functions I want. These are (listing omitted here). Can you tell me which of these are compatible with my Fisher 500-B and which are the top three of this group?

A. As I have tried a number of times to make clear in this column, the TAPE GUIDE cannot make recommendations as to specific brands of equipment. I don't think you will have a problem of compatibility when using your Fisher with any of the tape machines you have in mind. The principal potential problem is multiplex squeal, and a good tuner minimizes this danger.

NEW LITERATURE

● **Phono System Analysis.** This new 8-page, 4-color 11 x 17 inch brochure offers a "definitive analysis . . . of the role of a phono cartridge and tone arm in the reproduction of music from modern stereo records." The title is "The Story of Euphonics Miniconic." Subjects covered include: increased dynamic range and how to achieve it; constant-amplitude *versus* constant-velocity recording; modulation noise resulting from loss of stylus-groove contact and how to eliminate it; genesis of the RIAA recording characteristic; role of the bi-radial (elliptical) stylus in reducing shock noise; factors governing optimum compliance; inertial mass and its effect



on good reproduction; the benefits of very low effective tip mass, how it promotes 50-kHz tracking, essential for full-fidelity. One entire section is devoted to how the right and left stereo sounds are generated with only one stylus tip tracing a single groove. 36 picture frames with text comprise six of the eight pages. The back cover is a catalog of the Euphonics line. The brochure is free. Circle 210.

● **Tape Recorder Catalog.** "Sound Begins and Ends with a Uher Tape Recorder" is the self-explanatory title of a new 16-page free booklet. It is, in fact, a comprehensive catalog of the entire Uher line covering each product complete with uses, specifications and a photograph. It also contains a background on the company and a complete listing of all Uher tape reording accessories. Circle 211.

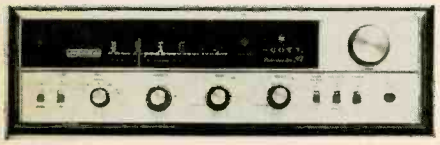
● **School Sound Systems List.** This new free catalog describes the new Rauland Deluxe line of solid-state school sound systems. Dual-channel and three-channel systems are offered in console, desk-top and rack-mount styles. Scores of basic systems are available with many flexible variations to meet every school need for intercom and program distribution. The fully illustrated four-page catalog is punched for insertion into standard three-hole binders. Circle 212.

● **Condensed Tube Catalog.** This newest guide from Amperex Electronic Corporation is intended to serve as a quick reference for designers of new equipment as well as for replacement tubes. A numerical index, descriptions, and basic specifications of the Amperex tube line are all provided. Included for the first time in this manual are descriptions of the cathode ray and vidicon tube lines. The full line as listed in the table of contents consists of: Power Tubes; Thyratrons; Subminiature Tubes; Premium Quality Tubes; 10,000 Hour Tubes; UHF Special Purpose Tubes; Rectifiers-Diodes; Counting, Selecting, and Indicating Tubes; Cathode Ray Tubes; Ignitrons, Voltage-Reference and Regulator Tubes; Vidicon Tubes. There is no charge for this 26 page catalog but it must be requested on company stationery. Write to: Amperex Electronic Corporation, Advertising Department, Hicksville, Long Island, New York 11802. Circle 213.

● **EICO Catalog.** New products and a new format from last year are featured in the 1965 EICO products catalog. Revised in style for greater readability, this 36-page catalog contains the latest products, described in depth, of this manufacturer of kits and wired electronic equipment. Well over 200 products including hi-fi/stereo components, test and measurement equipment, CB transceivers, ham gear, and educational training aids. Each piece of equipment is included in this full-line catalog. All important details of the unit are pin-pointed for at-a-glance identification and photographs are used to illustrate every item. There is no charge for the catalog. Circle 214.

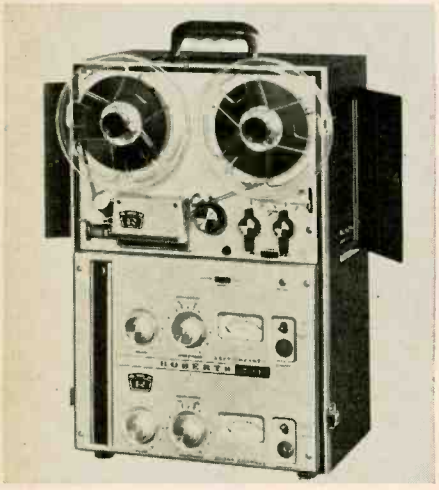
NEW PRODUCTS

● **Solid-State Amplifier Kit.** Interesting and unique circuitry has been incorporated into this new H. H. Scott LK-60 kit to protect the builder against loss of expensive output devices due to faulty wiring of the kit. If a wiring error has been made, the circuit, which uses an ordinary light bulb, absorbs excess power the moment the amplifier is turned on. This causes the bulb to glow, providing a dramatic visual signal for the builder to recheck his wiring. Other special features include a circuit



monitor that allows balance and bias of the output stage to be set for minimum distortion; front-panel stereo headset jack; tape recorder input and output facilities; and a speaker on/off switch. Steady-state power output is 30 watts per channel. Harmonic distortion is less than 0.8 per cent. Frequency response is given as 10-40,000 Hz. Price is less than $190.00. Circle 200.

● **Four-Track Stereo Recorder.** The model 721 is the latest addition to the Roberts line. Full-stereo record and play features, with separate channel VU-type meters being provided. The unit will also record sound-with-sound and channel transfer or recorded sound. 3¾ and 7½ ips speeds are standard; an accessory item is available to add 15 ips to the transport. Frequency response at 7½ is given as ± 3.5 db

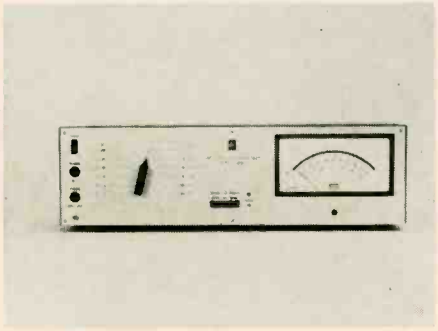


from 40-17,000 Hz; S/N is 45 db; wow and flutter (at 7½) is less than 0.2 per cent. There are built-in amplifiers and speakers. Power is specified as 12 watts peak (combined). A microswitch shutoff is provided in case of accidental tape breakage or runout. Size of the unit is 20½" h x 13¾" w x 11" d. Weight in its carrying case is 49 pounds. Price is $359.95 including two microphones. Circle 201.

● **Tape Head Series.** Nortronics has just announced a series of tape heads and adapters specifically made to complement the Ampex professional recorders. This is accomplished with the QK-76 kit. It allows the Nortronics heads to fit the shield cups of the Ampex head nests

directly and quickly. Once installed, the kit allows for rapid changeover of track styles and permits quick and easy installation of the various Nortronics units for record, playback, and erase on Ampex models 300, 350, 351, 400, 3000 and 3200. Circle 202.

● **Audio Frequency Millivoltmeter.** This latest product of West Germany's EMT Wilhelm Franz, GmbH, has been designed specifically for the audio measurements field. Twelve ranges are provided from 1 mv. full scale to 300 volts (−60 to +52 db). Indications are accurate to 1.5 per cent and are switchable to RMS or peak values. Bandpass is also switchable to either 200 kHz or 20 kHz with a 17 db/ octave filter slope. There is an internal precision reference

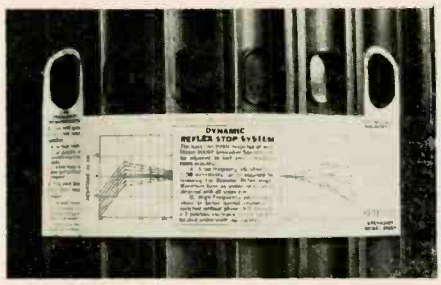


voltage for self calibration. Input impedance is 1 megohm shunted by 30 pf and is unbalanced. Coax connectors that will accept standard banana plugs are supplied. The meter, designated model EMT-125, will operate from a 95 to 266 volt, 50/60 Hz supply. Dimensions are 17" x 5¼" x 9" deep and weight is 13 pounds. Price is $325.00. Circle 203.

● **Professional Tape Recorders.** Ampex has just introduced a new series of audio recorder/reproducers, all with solid-state electronics, to the broadcast and recording industries. The AG-350 is the designation for this first all-transistor unit to be built around the renowned 351 series decks. New features added to this system include automatic equalization switching with a change in speed; a wider-opening head gate for easier threading and editing; a redesigned control panel; locking level controls; and improved

ferrite-type erase heads. The system may be had mounted in a console or in portable cases, or, if so desired, completely unmounted. Typical 7½ ips specifications include +2, −4 db 30-15,000 Hz frequency response over-all, signal to noise (two-track) of 55 db unweighted, and flutter of 0.14 per cent. Prices range from $1750 for an unmounted full-track (mono) system to $2670 for a stereo console. There is also a playback-only version, the full-track model of which lists at $1325. Circle 204.

● **Bass Tunable Speaker.** This is the latest in a series of pedestal-type speakers from Empire Scientific. Designated the 8000P, the column has removable stops (shown) that allow the bass response to be shaped to the individual users needs and preferences. Each stop removal en-



hances bass response by one db. Thus, maximum bass is to be had with all the stops out. The higher frequencies can also be affected by a three-position switch located on the underside of the speaker. In this way, the over-all response of the system can be tailored to its acoustical environment. In this Empire system, a downward-facing woofer, close to the reflecting floor surface, feeds through a front-loaded horn with a full-circle-aperture mouth. A midrange direct radiator and a high-frequency dome feed into the room through a wide-angle acoustic lens. An over-all response of 25-20,000 Hz is claimed. Nominal impedance is 8 ohms and maximum music power is 100 watts. Diameter is 16 inches; height, 29 inches; and weight, 85 lbs. The system is only available in a satin-walnut finish. Price is $235.00. Circle 205.

● **Solid-State Tuner.** Latest all-solid-state product from Harman-Kardon is the Model ST-2000 AM-FM-Stereo FM tuner. The manufacturer claims that the all-transistor front end is able to handle strong input signals, without overload or cross-talk. They also state that the use of transistors obviates the need for frequent tuner realignments. Flywheel tuning is provided with a d'Arsonval tuning meter. Three front-panel switches provide the AM-FM stereo/mono, and on/off functions. Other features include a stereo indicator

light and rear-panel convenience outlet. Sensitivity figures for the tuner are 2.9 μv IHF for FM and 50 μv per meter for AM. FM-if. rejection is better than 55 db, with image rejection at 45 db or more. Spurious response is given as in excess of 60 db rejection. Dimensions are 13¼-in. wide by 4⅜-in. high and 10½-in. deep. Shipping weight is 9 pounds. List price is $199.00. Circle 206.

● **Compact Speaker System.** High power capabilities and wide frequency range are two advantages claimed by University for their new ULTR A-S three-way speaker system. A high-compliance woofer is matched by a direct-radiator midrange and a special tweeter by a 6-db-per-octave L-C crossover network. A tandem control permits adjustment of high and mid-range drivers to suit room acoustics. Overall response

is claimed at 35 to 19,000 ps with crossover points at 1 and 5 kc. Impedance is 8 ohms. The enclosure is constructed of ¾-in. furniture woods with hand-rubbed oil walnut veneers. All four sides are finished. Dimensions are 23¾-in. high by 11⅞-in. wide, and 9¾-in. deep. Suggested retail is $54.40. Circle 207.

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Circle 141 on Reader Service Card

S/S LIMITER

(*from page 30*)

so that its emitter current is proportional to the signal level.

Figure 3 shows the kind of limiting which can be expected from the arrangement as described. It must be admitted that limiting is *not* instantaneous but it is quicker than manual "gain riding" and, with proper adjustment, likely to be less noticeable.

An alternate arrangement for determining the threshold of limiting employs a Class-C emitter-follower to drive the side-amplifier. In this case R_2 (*Fig.* 1) is omitted and limiting occurs as soon as the signal is high enough to overcome the base-bias of the Class-C emitter-follower. A suitable circuit is shown in *Fig.* 4. Results with this arrangement are similar to those using R_2 without the Class-C stage.

It should be emphasized that this device is not intended for use as an automatic gain-riding circuit in stereophonic applications. It was designed solely to eliminate or to reduce occasional overloading during the recording of amateur performers whose decibel output cannot always be accurately predicted. For this use, and this use alone, this arrangement is recommended. Æ

AUDIO AMP

(*from page 22*)

This circuit worked fine, and would be the basis of a wonderful d.c. to a.c. converter, except that the complicated push-pull circuit is hardly necessary for so simple a purpose. The two-state Class-D would serve quite well for converting a maximum continuous signal. We wanted to improve efficiency at low signals, and there this circuit showed a defect that proved impossible to resolve by simple circuit adjustment.

After adding suitable coupling to drive the output stage, it was found that for each output transistor, there is a discontinuity between passing a pulse of minimum duration, and not passing any pulse at all.

This means the output waveform, when properly filtered, looks somewhat like crossover distortion, only possibly worse (*Fig.* 10). Changing bias (of the drive stage following the phase inverter) does not remove this, because always there is an abrupt change from no pulse at all to a minimum pulse, and vice versa. How can this difficulty be circumvented?

Another Form of Modulation

So far we have been sticking to the two-state modulation concept. But transistors are not really two-state devices. They can be switched from on to off and vice versa in a certain minimum time, during which time there is a minute dissipation. It was this fact that spoiled the ideal characteristics of the original Class-D circuit, when operated with a filter that prevented the power going to the load.

Further, in the free-running Class-D circuit, zero signal speeds up the rate of switching, raising the ultrasonic frequency, and thus making the transistors spend a larger proportion of their time going back and forth, thus increasing dissipation.

Now, let's assume we can find a way of amplitude modulating the minimum pulse, until it reaches full amplitude, so it can be width modulated from there on. if each output transistor is pulsed at half amplitude in the quiescent condition, the maximum power dissipation will be half that for a full-amplitude minimum-duration pulse (*Fig.* 11). The instantaneous energy dissipated in the transistor goes once to its maximum (at half on, half off) and returns to zero, instead of making two such trips in immediate succession, as it does for the full-amplitude pulse.

The method of doing this proves to be simple (as soon as we have that spark of "genius" that shows us the way!): we apply negative feedback that only works on initial pulses, by allowing it to saturate for full-amplitude pulses. *Figure* 12 shows a circuit that will do this. The series transistor is in the supply feed to the modulating transistors (following the phase inverter) and is normally non-conducting, so the resistor between its emitter and collector carries the whole current, producing a small voltage drop.

When a pulse comes along, the transistor is switched on by a positive-going pulse fed back to its base, raising the supply voltage to the modulating transistors and thus reversing the switching action, unless the current value momentarily going to the mixing transistors is sufficient to switch the output chain on, in spite of this small reverse action from this series transistor, in which case the circuit reverts to simple duration modulation.

This circuit yields a bonus: not only does it enable continuous modulation right down to zero signal; it also enables the output transistors to have their quiescent pulse amplitude accurately controlled, so they operate at maximum efficiency and with extremely small dissipation at quiescent. What we have invented is substantially an ultrasonic way of controlling Class-B bias of a pair of output transistors.

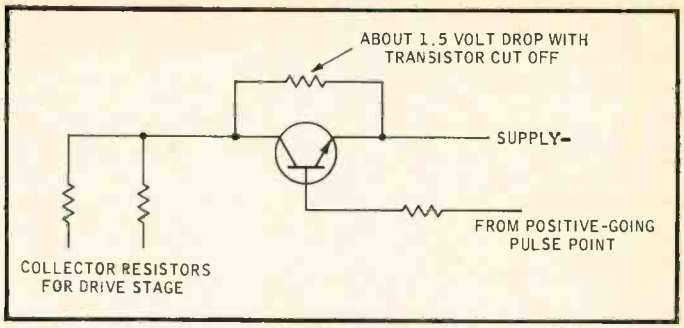


Fig. 12. Basic revision to circuit to introduce amplitude modulation of minimum-duration pulses.

Optimizing It

So far, so good. The circuit works. But when one comes to "optimize" a circuit for specific transistors, or starts looking for the best transistors to use for this kind of output circuit, one finds that transistors have more variables that

we ever knew about. In a following article, we will discuss these parameters and how to deal with them in arriving at a suitable design. And after we get through that, we will find that over-all negative feedback is possible, to make the waveform as good as may be desired, just as in any earlier variety of amplifier. The frequency parameters in the ultrasonic modulated part may not be as simple to assess as in simple amplifiers, but their behavior in an over-all loop is essentially the same as their simpler, earlier counterparts.

TO BE CONTINUED

LANGUAD EXPERT

(*from page 32*)

In spite of this gentle tone, the rebuke hit home. And then, in a sudden burst of inspiration, I remembered the entire phrase. "Totally freed from the last restraints to complete aural hedonism!" I cried.

George and I smiled warmly at each other, but I was determined to change the subject before he could catch me again. "I assume that all of the components are transistorized."

At the word "transistorized", George flinched. He removed his dark glasses and fixed me with a baleful stare. "Solid state," he said pointedly. "This system delivers the full promise of modern solid-state circuitry . . . the transient peak power performance and the trouble-free dependability that are now possible with the development of sophisticated solid-state devices."

In spite of George's assurance, I was a bit skeptical and said as much.

"Transistors have come of age," insisted George. "This system will perform almost indefinitely at its original performance level. There is absolutely no distortion, no coloration up to 40,000 Hz."

I started to ask what happened *above* 40,000 Hz, but George waved a finger under my nose and went right on. "It captures the sweet airy quality achieved with extremely low distortion and extended frequency response. It has complete stability regardless of the load, and virtually non-measurable distortion right up to the clipping point."

"Even if its response covers the full audible range," I began. But George interjected, "Response above and beyond audibility." "All right. Above and beyond audibility. Even so, do you really think there is such a thing as 'transistor sound'?"

George nodded emphatically. "Certainly. No-compromise big sound . . .

pure sound undefied by rumble or resonance. You will be immediately aware of its clearer delineation of the subtlest orchestral nuances. The transparent highs, the outstanding transient response, and the unbelievably low distortion now allow you to hear a new world of recorded definition and dimension. Crystal clear brilliance of each and every instrument and voice . . . in vibrant harmony and dramatic color; realistic dimensions in panoramic breadth and profound depth. This is truly reproduction for the audio perfectionist. It will not satisfy, but excel your fondest musical expectations."

Intuitive Response

I looked around the room, but still could see no sign of any sound installation other than the test instruments on the counter. "Uh, where are the controls?" I finally asked.

"There are no controls." said George. "This stereo system is a true product of the computer age, designed for instant, intuitive reaction to your thought."

"You mean . . .?"

"That is correct. The system automatically adjusts itself to suit your every listening mood. It is a real conversation piece for music lovers and electronics enthusiasts alike. Here is more than just 'super specifications' and spectacularly clean-textured sound. Here are components engineered only for those who expect the big, full sound of quality, demand superior performance and reliability and prefer all those special features."

"Where?" I asked.

"Where what?"

"Where are the components you are talking about?"

"Right in the chair you're sitting on." replied George. "There are circuit boards in the chairs, power transformers in the lighting fixtures, and the genuine Calder mobile hanging above your head is actually a special cast aluminum heat sink for the output transistors."

I suggested that George's novel arrangement, while certainly ingenious, might be somewhat impractical.

"Nonsense!" he snorted. "Solid-state circuitry now frees us from hidebound tradition and old-fashioned design. Each sub-assembly is long-lived, resin-sealed, and shock resistant. In your chair, for example, are three encapsulated, epoxy-covered circuit modules and five stable circuit boards."

Unfortunately, I could not restrain the impulse to add, "And how many *unstable* circuit boards?" George's withering look made me wish I had been more discreet.

"I'm sorry." I said. "It was only a feeble joke. I am convinced that you have incorporated a host of engineering subtleties that will delight the technically sophisticated."

George seemed somewhat mollified. "You are correct," he said. "The system features exceptional attack time, infallible stereo program indication, and its peak power capabilities approach one-hundred watts."

I thought this over for a moment. Then I said, "Those specifications certainly sound impressive, but they don't actually *say* much, do they."

"Really," said George sadly. "I am disappointed in you. If they *said* anything, they obviously would not be languad."

Too late, I realized his irrefutable logic. To cover my chagrin, I asked if the system could be demonstrated. George brightened up immediately.

"I want you to note the sparkling, transparent, transistor sound," he said. "You will hear a complete absence of restraint. This is clean power . . . a brilliance of performance never before expected in recorded music."

I looked about the room. "Where are the speakers?"

"Where?" repeated George with a sly smile. "Where indeed. We are *in* the speakers!" And with this he flipped a concealed switch at his elbow. The lights dimmed automatically, there was a brief warning of background noise, and that is the last that I remember.

After only a short stay in the sanitorium, and a vacation in the Arctic which my doctor recommended, I had a chance to talk again with George about that ill-fated afternoon. As much as it hurts to admit, the only answer seems to be that I simply am not a truly talented listener. I am not ready for no-compromise big sound, my ear is not the most discriminating, and what I really want is a music installation which will satisfy, but *not* excel my fondest music expectations.

From time to time as I listen to my own relatively modest $3000 system, I think of George Anthrubus with a touch of envy. He *knew* that he had incorporated every refinement which could possibly contribute to the experience of total listening enjoyment. And secure in his knowledge, George did not take the risk of actually listening. (I later learned that he wore ear defenders, and satisfied himself that the installation was operating by observing a permanently-connected oscilloscope.)

Whether there exists an audiofan with sufficient stamina to absorb the full aural impact of George's "ultimate" installation, I do not know. But I can testify that he has indeed achieved the full potential of solid-state circuitry, with response above and *beyond* audibility. Æ

RECORDS

(*from page 40*)

speak for itself, with a bit of inner contemplation! As it is, everything sounds determinedly alike, and determinedly Telemann Society.

The Society's dance playing is familiar on Vox's earlier "English Country Dancing Master" series. The dozens of short dances—both English and French—are set off by an occasional Baroque trio sonata or set of variations; the harmonizations are all by the indefatigible Richard Schulze, who plays recorders and plays them very well, if a bit dogmatically. The best music here is that arranged for various recorder combos, high, middle and low. Theodora S. plays a wiry and sometimes badly tuned oboe, which can (like so much else here) be expressive or downright annoying by turns. The harpsichord accompaniments, mainly by Dorothy Walters and Kenneth Weaver, are pounded out unmercifully, in triphammer style, with never a trace of variety or imagination. In the French recording an extra innovation is that once-popular instrument, the krummhorn, which sounds like a cross between a loud kazoo and a crow call. It *can* be played quite musically. Here, it just squawks. Like an aimable crow.

The French tunes are from a famous 16th century collection, with instructions and comment in dialog form. Harmonizations by Schulze. The English tunes are the "country dance" tunes that have fascinated amateur dancers for fifty years, since Cecil Sharpe first brought them back out of limbo.

P.S. These discs are part of the commercial "answer" to the challenge of the $2.50 Nonesuch label. Both Esoteric/Counterpoint and Turnabout deliberately imitate the Nonesuch covers, even to the same surfaces and the enclosing white line. OK, boys, fight it out! Content is what matters, remember.

Heinrich Schütz—Motets and Other Sacred Works. Telemann Society Chorus, with instrs.
Counterpoint/Esoteric 5619 stereo

Another mixed bill of goods. The Telemann Society (the two Schulzes) have hired some New York vocal professionals and named them a chorus, as is the way in the Big City. If all these people would listen to an occasional import from elsewhere—Europe, Canada—they might discover that there is more to choral singing, and even solo singing, than just assembling a batch of pros.

Three soloists. The high countertenor John Ferrante sings eloquently but often somewhat out of tune and his German is odd. Kitty Ferguson, soprano, is well-meaning—I couldn't say much more. Her sense of pitch is minimal and her vibrato monumental. John Dennison is an excellent big baritone, a bit too big for Schütz but expressive and earnest. In all of these solo works (from the *Symphonia Sacra* and *Cantiones Sacrae* series) Kenneth Weaver pounds a dogmatic organ and the two Schulzes chime in with energetic recorder obbligati.

As for the motets, they sound the way motets always do when you hire a batch of New York City professional singers and set them to sight reading old music. Huge, unblended vibratos, no ensemble whatsoever and a metrical "beat" that is wholly wrong for the music. Again—just try a few German imports if you want to hear how Schütz can sound!

Telemann: Instrumental Music. The Telemann Society.
Counterpoint/Esoteric 5617 stereo

Now here are the three prime movers in this Society—Richard and Theodora Schulze, Dorothy Walters—in their best form, playing Baroque instrumental music by their name-composer, Telemann, for recorders, or recorder and oboe, with harpsichord continuo (one excellent duet for two recorders alone). The Schulzes play the recorder and oboe melody lines generally very nicely—they can play well when the material is right. Walters pounds away on the harpsichord, but the material is more grateful for her and the pounding less evident than in the dance discs. This one is well worth investigating.

Madrigals and Instrumental Music (English). The Telemann Society Chorus and Instrumental Ensemble.

Counterpoint/Esoteric 5617 stereo

Both good and terrible. The English dances are nice—energetic as always and not too many of them to seem dogmatic. The little harpsichord (virginals) pieces and the several sets of variations are pleasantly enough set forth. But the madrigals are simply *awful*.

It is hard to believe that any group of trained professional singers could think an English madrigal should sound like *this*—elephantine, wobbly, horribly unblended, dogmatically metrical and wholly unintelligible! Sort of half-speed singing-commercial style.

New—from The Forties

Serkin Toscanini Beethoven Piano Concerto No. 4. NBC Sympony Orch. (Nov. 26, 1944)

RCA Victor LM 2797 mono

Toscanini Berlioz Romeo and Juliet. Swarthout, Garris, Moscana, chorus; NBC Symphony. (Feb. 1947)

RCA Victor LM 7034 (2) mono

Toscanini Conducts Overtures. NBC Symphony. (1943-1953)

RCA Victor LM 7026 (2) mono

It is a very good thing to have these NBC Symphony broadcasts in LP form, even if Toscanini didn't exactly authorize their release from the grave. (He let very few recordings get by, in his last years.) They are now valuable and entertaining documents. And it is good that RCA has done a minimum of "modernizing"—and in particular has apparently refrained from the most obvious correction, the adding of synthetic liveness. For these famous broadcasts document a phase of the microphone art that it is well never to forget. *Dead—incredibly dead!* Closet-like. And close-sounding, too. This was the day of close-up everything, unrelieved by surrounding "spatial" liveness. With few high tones to define tone color and presence, the "dead" close-up was an aesthetic necessity, a compensation. It worked pretty well; but it sounds funny now.

The musical performances, of course, are documents too, though perhaps not quite in the way the press releases would make them. Here you will find that incredible Toscanini drive, the heightened tension, the hepped up tempi, the sense of controlled hysteria, that kept two generations of music listeners fascinated. It's still there. And here, too, is the marvelously exact phrasing and shaping—along with a surprising number of bloopers and out-of-time-bad-ensemble passages of the sort that we always seemed to find in the Toscanini high-voltage playing atmosphere. Today, they would be edited out, or replaced via re-takes. Then, they were inescapable and unrepairable, and that was that. A kind of recording honesty that is rather nice to experience now.

The overture album runs through Mozart, Brahms, Rossini and a brace of

the typical Toscanini "unknowns"—three overtures by Cherubini and two by Cimarosa. The earlier recordings are dead as only studio 8H could be dead—unbelievable. The last ones have a glimmer of liveness—still far short of "normal" by today's standards. Carnegie Hall—with audience? If I remember rightly. The Serkin performance of the Beethoven Fourth is scintillating in the piano (which recorded beautifully under 1944 conditions) and unusually expansive for Toscanini, with a minimum of over-tense hysteria. The Berlioz, two complete broadcasts, is absolutely superb, though the sound is closet-like beyond belief and the solo voices breathe uncomfortably down your neck. Even so—Berlioz, the highest-tensioned composer of the 19th century, is perfect for Toscanini, the super-tension 20th-century conductor.

The sound of all these is far better than most of us ever heard at the time and wholly acceptable for normal listening—acoustics and microphoning aside. It is the acoustical situation that seems immediately strange, not the recording. True, the highs are a bit dim and grainy (but there is an all-important mid-range definition, up to perhaps 6000 Hz, which helps a lot) and the loud passages show the typical uncompliant distortion that we took for granted (and which we may ascribe to cold styli and massive disc cutters). But there is very little harshness nor any unpleasant "surface noise." A few of the later overtures may date from the early tape era. The rest are discs, perhaps the once-familiar 16-inch air-checks.

A Sonata Recital by Joseph Szigeti and Béla Bartók (Beethoven, Debussy, Bartók) Recorded in the Library of Congress, Apr. 13, 1940.

Vanguard VRS 1130/1 (2) mono

Bartók in person, at the piano! If that means nothing much for you (it will thrill a lot of people)—you may still find his playing of Beethoven quite astonishing; for it is "old-fashioned", very noticeably so, and typical of his generation of pianists. Today, after all, Bartok if he were alive would be 85 years old, which would put him among the very oldest living performers. And since he died in 1945 he didn't have the chance to "evolve" a more modern style, as some of the present old men of the piano have been able to do.

Bartók and Szigeti here play the "Kreutzer" Sonata of Beethoven, the Debussy Sonata and two works by Bartók himself, the Second Sonata and the Rhapsody No. 1. The Debussy is squarely in Bartók's own period, oddly enough; it sounds modern and "right". (It was one of the last Debussy works, just before the end of World War I.) The Bartók, of course, sounds like Bartók, though perhaps more furiously dissonant than it would seem in a present-day performance, where this music is already moderately taken-for-granted. It wasn't in 1940!

The recording is of that dismally familiar pre-war sort, swathed in a stifling 4000-Hz cut-off. No highs, very little sense of presence, not even any liveness. Like listening through a sofa pillow. Too bad—but, even so, one can infer the excitement of the performance. Luckily, the acetate discs were quiet and there is no unpleasant harshness in the sound, though the piano resonates in wooden fashion thanks to some mid-range peak, perhaps in the cutter. It's a valuable document, highs or no highs. I enjoyed every bit of it.

Miscellany

Liszt: Four Hungarian Rhapsodies (Nos. 1-4). Vienna State Opera Orch. Fistoulari.

Vanguard SRV 164 SD

Enesco: Roumainian Rhapsodies Nos. 1, 2; Liszt: Hungarian Rhapsodies Nos. 5, 6. Vienna State Opera Orch., Golschmann, Fistoulari.

Vanguard SRV 160 SD

In the Everyman series, six Hungarian Rhapsodies (with Fistoulari) and two Roumanian (with Golschmann) are collected out of authentic Vienna on these two discs. The Enesco Rhapsodies are such watery-thin stuff you can scarcely keep your attention on them. But the Liszt Rhapsodies are always attention-compelling—whether to please or annoy.

Like much of the more popular Liszt fare, they combine outrageously banal show-off with a solid core of real musical value. You can't put any of them aside as mere bombast. The Viennese orchestras, knowing them best, can make the most of their musical values, given half a chance; and they do here, in very pleasing big-style fi.

Yale Collection of Musical Instruments, Vol. 1. (Froberger, Bach, Couperin). Robert Conant, harpsichord.
Yale Coll, YCMI 1 (comp. stereo)
(15 Hillhouse Av. New Haven, Ct.)

This is the first in a projected series of recordings: a fine harpsichord disc, ably performed and beautifully taped in stereo by Overtone Records (Richard C. Burns) of New Haven.

One of the big 18th century harpsichords is German, the other French; there is enough tone-color difference between them to make a meaningful sonic contrast—and Mr. Conant's program is ingeniously chosen to match each instrument's background, with a multiple set of tie-ins between the two.

The German instrument, a huge monster with 2-foot, 4-, 8-, and 16-foot stops, plays J. J. Froberger, his Toccata XVI, and a big Bach Toccata to match. The French instrument plays French music by two Couperins and—a further tie-in—a piece by Froberger written in French style at Paris; it is a "Tombeau," a piece in memory of a certain M. de Blancrocher ("White Rock") and, to cap the ingenuity, one of the Couperin pieces is also a Tombeau for the same man. . . . It all sounds a bit complicated here, but the music flows most ingratiatingly, both French and German, the French being particularly nice in the leisurely, legato sonorities and the well-managed ornamentation.

Excellent harsichord recording and interesting in that, as always, the recording engineer has the aesthetic problem of microphoning for best documentary effect. How much of the sound we hear is microphoning technique? The French Taskin harpsichord, for instance, is supposed to have a splendid big bass—and in fact it *is* startling on the record. But this *could* be managed by adroit mike trickery, like the old business of placing a mike underneath a piano to bring out a big bass. Only a "live" listening session could furnish answers; therefore we really depend on the recording engineer here. My guess is that he has done very well, both in the documentary sense and in pure recording technique, i.e., bringing us a useful and fine-sounding harpsichord tone in terms of the recorded medium. Æ

THIS MONTH'S COVER

From reader Gary Gottlieb of Chicago, comes this month's cover pictures, along with his own description, as follows: "This is a three-way system utilizing six basic amplifiers—bass, midrange, and treble—on each stereo channel. The 90-watt amplifiers (three on a chassis and featuring a 26-lb output transformer—no additional heat necessary in the living room) and transistorized preamp (which functions as a six-way electronic crossover) feed four 12-in. suspension woofers, two 12-in. mid-range drivers, and two electrostatic tweeters housed in 225-lb. reflex enclosures. All of these components — i.e., amplifiers, preamplifier, speakers, and enclosures were manufactured *entirely* by Sound Sales, Ltd., of Surrey, England, and sold as a complete unit under the trade name "Sound Sales Stereo Tri-Channel." Since all of the parts were designed for and optimally matched to each other, they were not available separately. Your only choice was either a mahogany or blond finish on the speaker cabinet.

"The balance of the system is comprised of:

Thorens TD-124 turntable
SME-II tone arm
Grado Model A cartridge
Ortofon SPE-GT and SPE-T cartridges
Dual 1009 record changer (in lower right compartment)
Fisher MF-300 Motorized (signal-seeking) FM tuner
Fisher RK-20 wirless remote control
Chapman S6E World-Wide tuner with AM and seven short-wave bands (Made in England)
Tapesonic Professional 70-DSF 3-speed tape recorder
Patch panel
Automatic time clock for the tape recorder

"Pilot lights indicate at a glance what components are in operation.

"Encompassing all of this is a 7-foot walnut cabinet of my own design (got it through the living-room door with ⅛ in. to spare) and custom-built by the Workbench of Chicago. The amplifiers glide out on platforms, and are well ventilated by Rotron Whisper Fans mounted at the rear of each compartment. There is also a bin for tape and records, and two concealed drawers accommodate tools and miscellaneous supplies. All mounting boards are removable, and rest on foam cushions."

Mr. Gottlieb concludes "The over-all project (or maybe "obsession" would be the better word) not only represents a $5000 investment but over five years of dreaming, planning, designing, saving, redesigning, purchasing, selling, as well as wiring, rewiring, shorting, shocking (literally), cursing, and crying. This extended period of "Blood, Sweat and Tears" has, however, resulted in a system which I feel more than justifies the effort, both esthetically and acoustically. At least, that's what I keep telling myself.

And besides that, it can also be used as an emergency shelter in the event of a nuclear attack!"

We think you have set a good example, Mr. Gottlieb, and hope many others will follow it up. More power to you—as if you needed it. Æ

JAZZ and all that

Bertram Stanleigh

Moiseyev Dance Ensemble Orchestra
Monitor Mono MF 451

No one who has ever viewed the fantastic performances of the Moiseyev Dance Ensemble will have the slightest difficulty in recapturing the color, movement, and excitement of this greatest of all folk dance groups when they hear these fresh, idiomatic performances by the group's own orchestra. The platter contains folk music from Byelorussia, the Ukraine, Estonia, and Moldavia, each performed with the subtle nuances characteristic of the region, combined with the high polish of a first class, thoroughly rehearsed instrumental group. No American or Western European orchestra, regularly playing for dancers, has ever performed with such ensemble precision, such balance and elan. The recording, made in the Soviet Union by Mezhniga, the government recording monopoly, is, alas, not on the same high order as the performances. It is nonetheless a substantial improvement on Soviet recording technique of a few years back. Sound is clear and low in distortion with none of those peaked, glassy highs that were once so common on Russian waxings, and the tape hiss that such recordings used to have is completely absent. Tape to disc transfer was accomplished in the United States and is of excellent quality. But the dynamic and frequency ranges of the recording are narrower than what we now expect on high grade Western recordings, and the somewhat distant miking and short reverberation period rob this disc of some of the sonic excitement that such colorful music should provide.

Paul Bryant Quartet: Groove Time
Fantasy Mono 3363

Organist Paul Bryant merges effectively with Plas Johnson, tenor, Gene Edwards, guitar, and Johnny Kirkwood, drums, in some of the most briskly sophisticated modern swing. From start to finish, the pace of this bright sounding platter is fast and crisp. A full measure of harmonic and melodic ideas is displayed in rapid succession with a very high level of instrumental competence and the sort of emotional abandon that a group only achieves when each member is enjoying himself and making a worthwhile contribution. This platter may not surge with deep-seated passion, but it rocks along in a most agreeable manner with plenty of style and swagger. Of the seven tunes on this disc, five are by members of the group: *Walrus Whiskers* and *My Three* by Paul Bryant, *Evol* by Johnny Kirkwood, *Two Mirrors* by Gene Edwards, and *Funky Mountain* by Plas Johnson.

Rural Rhythm Masters
Repeat Stereo 300-4

Like the other Repeat disc reviewed this month, this recording is made without the use of microphones, and it contains all of the remarkable technical features that make this new label's product so fascinating. In this well-performed collection of country music favorites, Ted Nash is heard once more, this time playing a fife that had been owned and played by one of the Army troopers who served under General Custer at the Battle of Little Big Horn. To my ears, this particular instrument sounds much like any other fife. However, Mr. Nash is clearly an uncommonly adept fife player. The fife has never presented any engineering problems in recording. Its range is limited, it has few overtones, and its dynamics are more than adequately encompassed by quite primitive equipment. So it is hardly a matter of earth shaking importance to note that there can be no doubt but that the sound of the fife has never been captured more successfully than on the present disc. It is the balance of the group that really counts, and the sound of the remaining instruments is close up and very realistic. Norman Whistler, fiddle, Dee Ford, guitar, Carl Scroggins, bass, and Frank Flynn, percussion, round out this very accomplished country group. Each musician's contribution comes across with maximum clarity, and the crisp detail in the bottom bull fiddle notes is a particular delight. Selections include *Orange Blossom Special, Mississippi Sawyer, Lost Indian, Pop Goes the Weasel, Soldier's Joy, Devil's Dream, Eighth of January, Listen to the Mocking Bird, Cotton Eyed Joe, Arkansas Traveler, Old Joe Clark, Turkey in the Straw,* and *Chicken Reel.* No matter how often you've encountered these tunes on discs, the present recording is so exceptional and the performances are so good that it shouldn't be overlooked. After several listenings, I compared the sound of this recording with half a dozen country music records that I think are among the top sonic products of studios in Nashville, New York, and Hollywood. Not one of them had the clarity of detail or the deep, clean bass of this new release, and the comparison of this "Polymax" surface with conventional pressings was most revealing. I don't think I've ever experienced such quiet surfaces before. Owners of wide-range systems and equipment dealers will want to use this record for demonstration purposes, and square dance fans will be delighted with the fresh spirit in these performances. Æ

OPTICAL MIKE

(*from page 29*)

A so-called Ronchi ruling with 330 lines per inch is fastened to a diaphragm, and 1-mil-wide light beams are directed against the ruling, in the hope that the alternate opaque and light-transmissive parts of the vibrating ruling will modulate the light passing through it. But look at the diaphragm amplitude of 1 micro-inch given to scale by the fine line in the figure. How can such a small vibration amplitude modulate such light beams? The answer is that it cannot. Hence the scheme fails.

The top part of *Fig.* 3 shows another "possible" scheme. Here a fine beam of light is reflected from a shiny diaphragm in the hope that the displacement of the reflected beam can be amplified and made use of. However, on the bottom of *Fig.* 3 we see more nearly the true spatial relationship of the parts involved. The displacement of the reflected light beam, for a 45-deg. angle of incidence, can be no more than 1.4 times the diaphragm amplitude. Hence, the reflected light beam displacement is 1.4 micro-inches for a frequency of 1600 Hz and a sound pressure of 1 microbar. Even so, we assume the diaphragm to be a ribbon-like structure, for maximum deflection. In order to obtain optical stability, the diaphragm should be a stretched membrane. For such a vibrating member the corresponding amplitude will be but a hundreth that of a ribbon, which results in still smaller reflected light beam displacements. Hence, this scheme fails also.

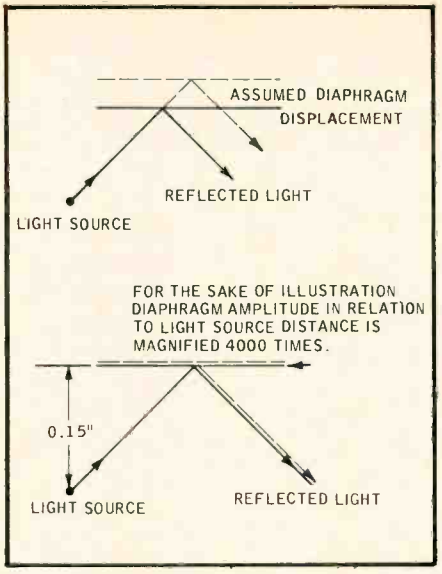


Fig. 3. Light being reflected from shiny diaphragm.

We have, therefore, to come to the sorry conclusion that optical microphones may be long, long in coming. Æ

LOUDSPEAKER

(*from page 28*)

Continuous frequency tapering by acoustical means has been discussed in a paper presented by the author and Douglas Steele at the 1962 meeting of the Audio Engineering Society.[13] *Figure* 12 shown a line-source loudspeaker using glass-fiber acoustical "low-pass-filters" in front of thirteen KLH 6.5 loudspeakers. This loudspeaker system provides a fairly constant 22 deg. vertical coverage pattern from 850 Hz through 4800 Hz, but requires a 6-db-per-octave compensating network to insure flat frequency response above 1000 Hz. The on-axis and 10-deg. off-axis response curves are within 2 db up to 6000 Hz, except for one "notch" at 4000 Hz. This loudspeaker is now employed in a speech reinforcement system in Boston's Tremont Baptist Temple. The technique appears a good low-cost alternate to continuous electrical tapering, especially where the loss of additional high-frequency power is not important.

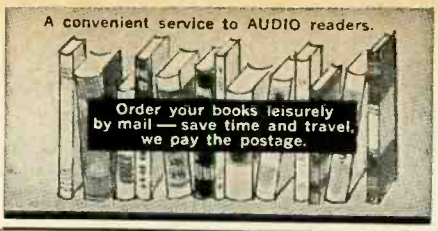
In custom designing a tapered line-source of any type, for any application, the first step is always to select the *lowest* frequency above which a broadening of the beam width cannot be tolerated. The maximum beamwidth and the lowest frequency can be employed to determine the length of the line source using the appropriate equations from Olson.[14] The *highest* frequency below which narrowing of the beam width cannot be tolerated and the beamwidth at that frequency will determine the length of the line (or the number of loudspeakers) that receive a full-frequency range signal. Between these two extremes filtering should be done on a geometric basis, at least as a first approximation. See *Fig.* 14.

However, there is a side effect to frequency tapering that must be remembered: phase shift of tapered loudspeakers usually occurs at the filter cut-off frequencies.[14] This phase shift occurs with both electrical and acoustical filtering, and the author finds experimenting with the taper filters in the laboratory (sometimes on a model when the full-size loudspeaker is too unwieldy) preferable to calculations.

[13] D. Klepper and D. Steele, "Constant Directional Characteristics from a Line Source Array," *Journal* of the Audio Engineering Society, July 1963, Vol. 11, No. 3, p. 198-202.

[14] Olson, *op. cit.*, p. 36.

A future article will include curved line-source loudspeakers, and horn loudspeakers of various types. Æ



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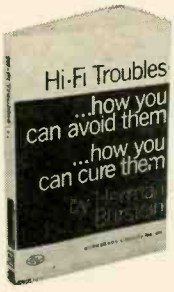

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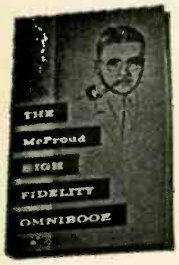

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AUDIO ETC.

(*from page 12*)

indicator light show *only* stereo. It works faithfully enough. It spots all the stereo stations. But it also spots every last bit of inter-channel noise. That means that in many locations and times of the day or night it is glowing most of the time, blinking away right across the dial. This constant and jittery on and off action is confusing and tiring—with, say twenty spots of useless interchannel noise to every true stereo station. It works—but *you* have to work too.

Myself, I'd pay KLH a bit of extra cash just to get rid of this effect, so the little light would light up ONLY when a stereo station was hanging around, ready for listening.

The Scott 312, in a different bracket, does have that very feature, a "threshold" control that you turn down until the indicator light just goes out on interchannel noise. Once it is set, the light goes on *only* for stereo. Seems like a petty difference, but it made a LOT of difference in my listening ease.

As for KLH's Model Sixteen (I got a batch of this company's equipment, all in a handful of little packing boxes) I've asked the company to allow me to keep it forever. I just can't get along without it. This one is a superb little "complete" amplifier-preamp, nominally medium-power (35-35, if I remember) but with some rather startlingly huge transient power capabilities. With transistors you never can tell. Please note the letter in our July issue which says this baby can give out momentarily with *150 watts per channel* of transient-power into a 4-ohm speaker system.

I've been using the Sixteen in two typically opposite ways, almost unthinkable in a comparable tube device. First, I carried it effortlessly (it is as light as a feather, speaking rhetorically) to a recording session, where it produced big-volume stereo playback of just-recorded material before twenty or thirty people in a large room. There was volume and to spare. In the old days, I would have hauled along maybe thirty pounds of tube amplifier to do the job.

Then, in contrast, I took the Sixteen to my office (in a shopping bag) and set it up on my desk for—of all things—earphone use. Miniscule power requirement! And there it sits, feeding a Jensen Bauer Circuit and a set of Sharpe phones without producing enough heat to notice, only a foot or two away from my face. A perfect desk amplifier. And again, that little amber light! Time after time I have it on by mistake all night and for hours during the day. No heat, no noise, no trouble.

100-100

Having read about that 150 watts per channel at 4 ohms, I intend to try blowing my roof off with the Sixteen one of these days via my home speakers—which is *à propos* of another piece of solid statery,

my final item, a thing called the Mattes SSP 200 solid-state power amplifier—and what a model! This one does what was supposed to be impossible. It boasts a conservative steady-state output of 100-100 watts. The makers don't offer "music power" nor "peak" ratings; but if they did (they tell us) there'd be 160 watts of "music power" for each channel.

Just imagine it. I've been using this lightweight affair—it is exactly that—for a month or more as my main power amp, replacing a reliable tube heavyweight that has always been quite able to blow me out of my room.

The Mattes amp is a lot more powerful in its output. I could tell that right away, even with my primarily music-minded ears. The bass had definitely a bigger whomp and it was cleaner, too. The rest of the sound just glittered and shone, real chrome-plate. Yet this darned machine can be carried on one hand, and when it is ON, but at rest (and SILENT) it draws the munificent sum of 25 or 30 watts of power out of your house socket. I tend to leave it going all day long. At rest, it doesn't ever get warmer than lukewarm on the top of the cage. The sides stay stone cold. (The old amp would scorch paper on top and often did.)

No criticism of the old tube-type amp, which merely acted as tube amplifiers must act if they're any good and powerful too. Just the normal difference between tubes and transistors (once the circuit problems are nicely solved)—so striking to somebody like me.

Sharma Circuit

All this spectacular performance in the Mattes SSP 200 is thanks to something called the Sharma circuit, patented, which neatly removes the bias current from the output transistors, allowing them to whale away at an enormous power output, yet preventing oscillations *and* providing low distortion. And safety. You can short the Mattes speaker connections at full volume, or leave them open. No damage.

In fact the only serious danger with a power amplifier of this whopping sort is not to itself but to the associated equipment that might get in the way. You can vaporize a speaker easily enough, or pop

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a set of earphones in an instant! So on the production models of the Mattes (mine is a semi-prototype) there's a neat and ingeniously simple safety gadget. Flip a TEST switch and your amplifier suddenly is 12-12 watts. Plenty for hooking up and testing and even playing a bit, with absolutely no danger to anything. When you're all ready, flip it back and—WHAM. The big noise again.

(You're safe enough in any case if you just remember to keep the dual volume controls at OFF while you're hooking up. Boy *did* I remember!)

For you who are circuit bugs, this Sharma circuit works "by connecting the output of the driver amplifier directly to the loudspeaker, as well as to the transformer," thereby allowing the big output stage to whomp it up to huge power. Normally there would be violent oscillation; but "special circuit techniques, in combination with a unique latching circuit, stabilizes the entire system. In the complete amplifier the output stage functions in much the same way as a tunnel diode or other negative impedance, which the stage is intended to simulate." That's what they say and so there you have it.

So far, the Mattes SSP 200 has been completely reliable and foolproof in use for me. And I continue to enjoy it thoroughly. Can I ever go back to less than 100-100?? I'm beginning to wonder.

My most graphic description of this power pack, already circulating around the hi fi boondocks, is that though at rest it just sits there drawing 30 watts and saying nothing at all, if I tickle my phono stylus with the end of my finger, at normal playing volume, *the house lights jiggle and go dim*. Amazing. The speakers, of course, give out a simultaneous thump that shakes the whole building. That's how much current this thing draws when it gives out full power in the low-frequency range.

I tried, just once, to see how much volume I would get at maximum. I turned it up and up, until my ears began to pop and my head spin. *Enough*! Once was plenty for *that* experiment. My ambitious assistant, though, is all for gathering together four big speaker systems and setting them up outdoors, to see whether we can carry across the valley five miles or so. Might play that Monitor record of Union Pacific diesels hauling freight upgrade in the big California mountains. Wouldn't *that* confuse my Connecticut neighbors, now?

So you see, I really do like solid state. Æ

LIGHT LISTENING

(*from page 8*)

one very female) is shifted about from Channel to channel to give the effect of a stageful of people. The Machucambos are off to a very promising start in a briskly uptempo version of *Cachita*. This pulsing display piece immediately establishes their virtuosity in Latin percussion. Particularly heartening to the experienced ear is the exceptionally transparent sound London and Ampex give us in the upper register of the percussion. Voices are equally crisp and clean as the trio lavishes its convincing talents on a smartly-paced roster of tunes that includes some familiar favorites. The weakest link in the lineup is a rather lachrymose translation of *Good Night Irene*, but everything else is bright and fresh in concept and execution. The real test of the trio's ability comes in the program's most often played items such as *El Rancho Grande*, *Yours*, *Maria Elena* and *Green Eyes*. Any group able to hold my attention in those Latin-style chestnuts really has to be first rate. An added touch of piquancy is a smoothly-played Mexican harp, putting just the right frosting on a tempting album.

Liza Minelli: It Amazes Me
Capitol ST 2271

There are weeks when a reviewer's sample recordings seem to arrive in cycles that have nothing to do with frequency response. Part of a month can go by and all one has for turntable fodder is a batch of releases that seem to insist on running to a single subject. There are weeks when the popular record industry appears to have its collective mind set on nothing but movie music. Another period finds them running to male vocalists as a main source of revenue. At the time this column is being assembled, female vocalists are all over the place, some of them heard in releases that actually merit a fair share of attention. (My general assumption, no matter how releases happen to run during any given month, is that female vocalists are more apt to arouse interest among AUDIO readers than male ones.) This recording happens to be the first I've heard by Liza Minelli that gives her a chance to show what she can do with a real song. (The tunes in her present Broadway show, "Flora, the Red Menace" can hardly be considered a challenge to any singer.) With Peter Matz in charge of the orchestra and the arrangements, Liza turns to Gershwin, Porter, Harburg, Rodgers, and Arlen for unhackneyed material and takes command of it on the best of professional terms. Her treatment of one song alone in this list should settle any doubts about the scope of repertory she's going to be able to handle from now on. In the show, "House of Flowers", seen on Broadway some years ago, Harold Arlen has a song called *I Never Have Seen Snow*. You seldom hear it nowadays because it requires mature skill coupled with a genuinely young voice. Miss Minelli has both attributes for use with almost equal effect in the album's other tunes that also require pathos, some sense of drama and a bit of adult humor. The latter certainly comes in handy in Gershwin's almost-forgotten *Lorelei*. The only reservation that may arise in anyone's assessment of the album is in the sound department. Capitol's latest recording process, whatever its merits in the reproduction of instrumental sound, unnecessarily burdens Miss Minelli in every word with a prominent sibilant sound. Æ

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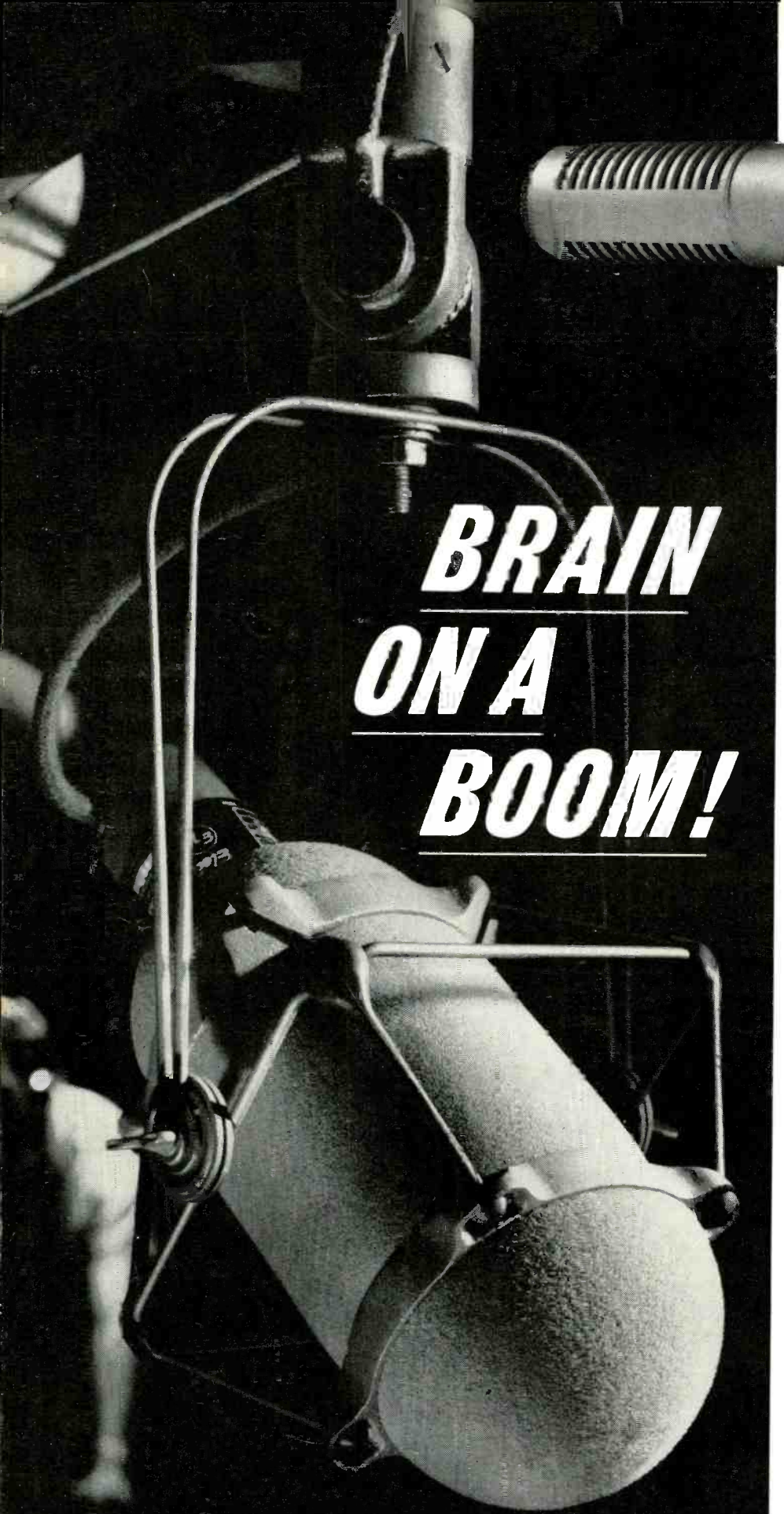

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