the authoritative magazine about high fidelity

AUDIO

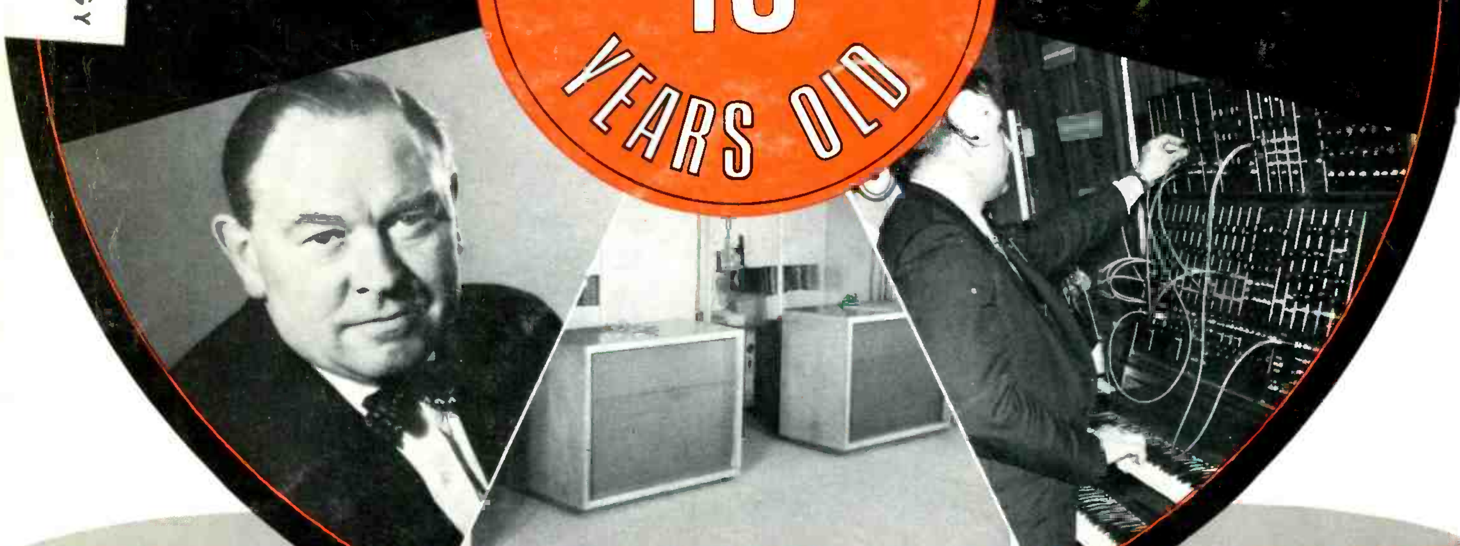
ON SALE JANUARY 1968 60¢

FURTHER ADVENTURES OF AN AUDIO PURIST

GERALD MOORE'S FAREWELL CONCERT

STEREO DISCS 10 YEARS OLD

THE AUDIO PROs AT SHOW TIME



ALSO: EQUIPMENT AND RECORD REVIEWS, TAPE GUIDE...AND MORE

New Scott 344C– more power, more features.

Scott's 344 series receivers have led the medium-price field in popularity since their introduction, and the all-new 344C is sure to be no exception! 90 Watts of usable power give exceptional performance from a whisper to a roar. The 344C even sounds better between stations . . . annoying hiss has been wiped out by Scott's muting control.

Want speakers in several rooms? It's a cinch with the 344C. You can even switch off all speakers and listen in privacy through stereo earphones. And the 344C's new pushbutton panel includes special controls so you can monitor off-the-air taping, with professional results.

If your listening isn't complete without AM, tune in with Scott's new 384 . . . basically a 344C in AM/FM form. Both the 384 and the 344C include Field-Effect Transistors, Integrated Circuits, and all-silicon output. Both offer you an entry into high-price features and performance . . . at medium price.

344C/384 Control Features Dual Bass, Treble, and Loudness controls; Volume compensation; Noise filter; Interstation muting; Tape monitor; Dual speaker switches; Front panel dual microphone inputs; Professional tuning meter; Front panel headphone output.

344C/384 Specifications Music Power Rating, 90 Watts @ 4 ohms; Harmonic distortion, 0.8%; Frequency response, 15-30,000 Hz ± 1 dB; Cross modulation rejection, 90 dB; Usable sensitivity, 1.9 μV; Selectivity, 46 dB; Tuner stereo separation, 36 dB; Capture ratio, 2.2 dB; Signal/Noise ratio, 65 dB;

Price: 344C, $399.95; 384, $439.95

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AUDIO

Successor to RADIO, Est. 1917

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JOSEPH GIOVANELLI
LEONARD FELDMAN
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Coming in February

Building a Three-Channel Electronic Crossover — C. G. McProud discusses some of the advantages attributed to the use of electronic crossover networks and provides details on how to construct a three-channel unit.

How Negative Feedback Influences Amplifier Performance — Norman Crowhurst recaps traditional methods of analyzing negative feedback in preparation for later articles on fallacies of the approach.

Microphones for Sound Reinforcement Systems, Part III This concluding article in the series by Arthur Davis and Don Davis draws upon their wealth of practical experience in solving some application hurdles.

Benny Goodman Rides Again — Bertram Stanleigh writes about B.G. Today.

EQUIPMENT PROFILES:
Shure M75E stereo phono cartridge

Telex Amplitwin and Serenata II headsets

Plus: ABZs of FM, Audioclinic, Tape Guide, Record Reviews, and more.

ABOUT THE COVER: January's cover celebrates the stereo disc's Tenth year, going on Eleven, as a commercial reality. In addition, photographs from various feature articles provide some hints on what's published in this issue.

AUDIOCLINIC

JOSEPH GIOVANELLI

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

Hum from a phonograph

Q. I would appreciate your advice. My equipment consists of a record changer, a receiver, two tape decks, and two speakers.

Frequently, when playing the phonograph, I hear a loud hum from one or both speakers. At first I thought that the hum might be caused by loose jacks. When I wiggled the jacks which lead into the turntable, the hum temporarily disappeared, but would soon return. I also noted that touching the jacks at the other end caused the hum to momentarily disappear.

I have tightened the ground connection from preamplifier to turntable, but to no avail.

What could cause this problem? Would it have anything to do with a ground?—Roy W. Hoffmann, N. Bergen, N. J.

A. I would say that "grounds" are the most likely cause of your hum trouble. If you are using commercially-made, molded cable, it is possible that the shield has come loose from the shell of the connector where it cannot be seen. Replace the entire cable or at the very least, replace the defective connector.

The typical connector used in home music systems employs an outer shell, or skirt, as a ground connection. It is designed to have a broad contact surface to ensure a good ground connection. However, it often happens that the shell expands, leading to poor contact with the shell of the female connector mounted on the equipment chassis. This poor contact can result in hum. Squeeze the shell of the male connector slightly with pliers until it fits snugly when re-inserted. This remedy should improve the situation.

It is also possible that one of the ground lugs in your phonograph cartridge has become loose. Remove the lug. Squeeze it lightly with pliers so that it fits over the cartridge clip more snugly.

In addition, hum can result if a ground connection made to the input connector inside your receiver is improperly soldered.

The same holds for the grounds inside your record changer.

Harpsichord effects from a piano

Q. Can you suggest some sort of equalization circuit to simulate the plucking of a guitar or the sound of a harpsichord, using the input from a piano?—Joseph C. Cavella, Hollywood. California

A. To achieve the effects which you are seeking, I think that you do not need an equalizer as much as you need some form of a square-wave generator.

The harpsichord is rich in harmonic content. Such harmonics can be produced by square-wave oscillators. Your problem is further complicated because you want to obtain your input from something other than pre-tuned oscillators which are always running or at least ready to run at a definite frequency. I believe you will have far less trouble if you change your approach from the use of a standard piano to the approach taken by electronic organ designers. If you continue to use the piano idea, you will then have to use some kind of limiting to drive a multi-viibrator whose frequency will be determined by the frequency generated by the piano. However, this would mean that only one tone at a time could be generated. Chords would represent a real problem. Further, I am not at all sure you could generate the transient wavefronts needed in order to simulate the harpsichord.

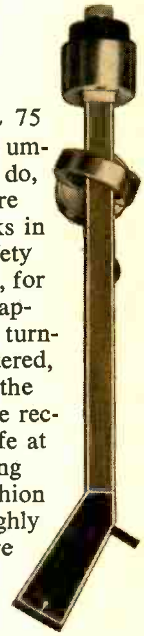
Therefore, I once again suggest that you follow electronic organ practice for the generation of percussive sounds. You will need to construct only those parts of the electronic organ circuit which would fit your particular requirements.

Circuits of the type under discussion can be found in texts dealing with the design philosophy of electronic musical instruments. I suggest that you consult such works because the subject is too complex to be dealt with here.

If you have some reason why it might be necessary for you to use your present piano keyboard, you possibly do exactly that if you are able to locate an Organo inside or outside "setup." What these units are is a bracket with rods protruding from it. Each rod, when the bracket is mounted properly, extends to touch a particular piano key. When the key is depressed, spring load-

(Continued on page 59)

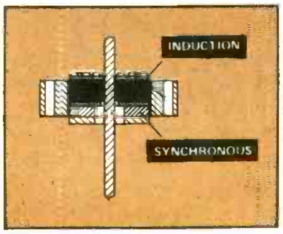
What we learned from the public at the high fidelity shows



Before we unveiled the new synchronous Garrards at the New York and Los Angeles High Fidelity Shows, there were certain considerations in our own minds. One was whether people would grasp the special importance of synchronous speed in automatic turntables... the improvement it can make in performance. Then, we wondered whether even the knowledgeable men and women who come to high fidelity shows would understand the new Synchro-Lab Motor™, which is not only synchronous, but has certain desirable features of the induction type, in addition. We also asked ourselves whether, in the big news about the motor, people might not overlook many other significant advancements incorporated in the new Synchro-Lab Series™. *We* knew that the Garrard models represented a major forward step in automatic turntable performance. Would visitors to the shows realize it?

We are happy to report that they did. We found they were quick to appreciate the advantages of a synchronous turntable motor that delivers a *guaranteed constant speed,* regardless of changes in voltage, record load, stylus pressure or temperature. Many of them were surprised, and expressed their pleasure, at learning that the new motor is available not only in our top model, but in a complete range of prices.

And their questions showed that they understood the admittedly technical features of the Synchro-Lab Motor, with its two rotor sections that combine true synchronous speed with high torque, instant power and freedom from rumble.



What about the other new features? Some were apparent at a glance—the highly refined, ultra-low mass tonearm on the SL 95, for example, with its Afrormosia wood inset, its gyroscopically gimballed needle pivots for minimal friction, its new anti-skating control with patented sliding weight design, its calibrated stylus pressure gauge with precision ¼ gram click settings.

Other features needed demonstration, which, we are pleased to say, drew favorable response from most. For instance, the new automatic spindle (based upon Garrard's traditional "pusher" principle) on the SL 95 and SL 75 which does what the inverted umbrella spindle was supposed to do, but does it better and far more safely. This new spindle works in combination with a record safety platform, and we showed how, for manual play, the platform disappears into the unit, leaving the turntable surface free and uncluttered, but ready to be released with the touch of a button. It holds the records absolutely steady and safe at two points, each record falling straight down on a micro-cushion of air. They liked the new highly simplified controls, and we learned that interest in cueing is still very high.

Incidentally, it seems worthwhile to mention that Garrard's cueing controls, on all its new models, can be used whether records are being played manually or automatically.

Were you at one of the Shows? If so, thank you for visiting us, and for your appreciation of the new units. For those who could not attend, we have the same 20-page full color Comparator Guide we gave visitors, illustrating the entire Garrard line from $37.50 to $129.50. For complimentary copy, write: Garrard, Dept. AA-1, Westbury, N.Y. 11590.

WHAT'S NEW IN AUDIO

Viking enters 8-trackers

Viking, a pioneer in the 4-track tape cartridge equipment field, has introduced three 8-track tape cartridge players for home use. All units have a low silhouette design. Model 811 is a table-top unit in a walnut case, incorporating playback preamplifiers for use with existing stereo equipment ($99.95). Model 811W ($149.95), also a table-top unit in a walnut case, has a built-in power amplifier, two speakers, and volume, tone, balance controls.

In addition, it has a speaker switch and stereo headphone jack. The third unit in the series, Model 811P ($149.95), is a portable version of the 811W. Its case has a two-tone vinyl finish.

All models in the series feature a frequency response of 40 to 15 kHz at its $3\frac{3}{4}$ ips speed, signal-to-noise ratio of 50 dB peak, and wow and flutter of 0.3% RMS, according to the manufacturer. Tape reproducers with self-contained power amplifiers feature 10 watts (IHF) total power output, and include two $5\frac{1}{4}$-in. high-compliance full-range speakers.

The players have pushbutton track selection and numerical track indicators. Check 95

Sansui "bookshelf-size" AM/FM stereo receiver

Sansui introduces a compact $16\frac{1}{2}$-in. wide x $12\frac{3}{16}$-in. deep x $5\frac{1}{8}$-in. high (excluding knobs and rubber stands) AM/FM stereo receiver, Model 400. The solid-state unit's amplifier section produces a total of 60 watts (IHF) at 4 ohms. Power bandwidth at 8 ohms is 20 to 50 kHz; frequency response, 20 to 30 kHz ±1 dB; harmonic distortion, under 1% at all power levels up to rated output. The FM tuner section features 2 microvolts IHF sensitivity, a signal-to-noise ratio of more than 60 dB, selectivity of more than 45 dB, stereo separation, better than 35 dB. AM sensitivity is 20 microvolts.

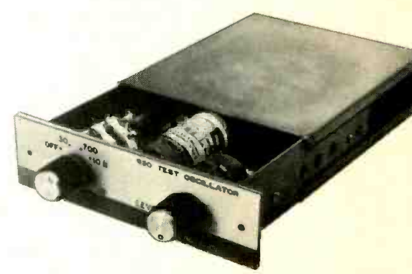
Switching from FM mono to FM stereo broadcasts is accomplished automatically. A stereo indicator changes in color if the dial pointer crosses a station broadcasting in FM stereo.

A combination of a silicon controlled rectifier and quick-acting fuses protects power transistors from damage due to short circuits.

In addition to the usual assortment of controls, the front panel has a speaker selector switch, loudness on-off switch, stereo headphone jack, noise filter switch, a tape monitor switch, and an FM tuning meter. The unit is priced at $239.95. Check 96

Battery-operated test oscillator

Model 930, a $1\frac{1}{2}$-in. x $5\frac{1}{2}$-in. x $5\frac{1}{4}$-in., battery-operated test oscillator from Universal Audio, N. Hollywood, Calif., has been introduced for use in recording, broadcast and motion picture sound facilities. The professional unit provides three fixed audio sine wave frequencies for setting program levels and for checking frequency response of equipment. Standard units produce 30 Hz, 700 Hz and 10 kHz signals, though other frequencies are available on special order.



The output is continuously variable from −60 dBm to 0 dBm into 600 ohms, unbalanced. It's powered by internal 12-volt batteries or an external 24 Vdc source. Frequency stability is ±5%. Distortion is said to be less than 1% at all frequencies. $87.00, less batteries. Check 97

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REVOLUTIONARY SELF-THREADING TAKE-UP REEL

Just drop the end of the tape over this reel, start your recorder, and watch it thread itself! Unique Scotch® process automatically threads up tape of any thickness, releases freely on rewind.

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THE ASSOCIATION INSIGHT OUT — 5370. Plus: We Love Us, Reputation, On A Quiet Night, etc.

FRANK SINATRA THAT'S LIFE — 3728. Also: The Impossible Dream, Give Her Love, etc.

RAY CONNIFF'S WORLD OF HITS — TWIN-PACK Counts As Only ONE Selection! 3335. This special Twin-Pack includes two great Ray Conniff albums. Counts as only one selection!

HOROWITZ IN CONCERT — 3767-3768. Twin-Pack Counts As Two Selections.

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MAGNIFICENT MARCHES EUGENE ORMANDY — 5373. March Of The Boyars, Wedding March, etc.

PERCY FAITH Today's Themes For Young Lovers — 5420. Plus: Mary In The Morning, Release Me, etc.

Russian Sailors' Dance LEONARD BERNSTEIN — 2875. Works by Grieg, Tchaikovsky, Dvorak, Copland, etc.

THE 4 SEASONS FRANKIE VALLI SOLO — 5430. Plus: Secret Love, The Trouble With Me, Ivy, etc.

PETER, PAUL and MARY ALBUM 1700 — 5509. Plus: If I Had Wings, Rolling Home, 12 in all

MAHLER: Symphony No. 8 LEONARD BERNSTEIN — 3764-3765. Twin-Pack counts as two selections

GERSHWIN RHAPSODY IN BLUE — TWIN-PACK Counts As Only ONE Selection! 3527. A bargain for lovers of light classics! This special Twin-Pack tape counts as only one selection!

JOHNNY CASH GREATEST HITS, Vol 1 — 5095. Plus: Orange Blossom Special; It Ain't Me, Babe; etc.

BILL COSBY SINGS "SILVER THROAT" — 5508. Meet Cosby as "Silver Throat" in this fun-filled album

PETULA CLARK These Are My Songs — 5487. Plus: I Will Wait For You, Lover Man, Groovin', etc.

BEETHOVEN Symphony No. 9 ("Choral") EUGENE ORMANDY — 5485. ". . . greatest virtuoso orch. of all time."—N. Y. Times

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THERE MUST BE A REASON WHY the famous Columbia Stereo Tape Club sells more pre-recorded 4-track stereo tapes than any store in the country! It's because so many thousands of tape recorder owners find Club membership the easy and economical way to get all the tapes they want! And to introduce you to the many benefits of membership, you may select any five of the stereo tapes shown here, and we'll send them to you FREE! That's right . . . 5 FREE STEREO TAPES, and all you need do is purchase one tape now at the regular Club price, and agree to purchase as few as five more tapes during the coming year. In short, at the end of a year, you'll have at least eleven brand-new stereo tapes, and you'll have paid for only six!

HOW THE CLUB OPERATES: Each month you'll receive your free copy of the Club's magazine which describes and displays tapes for many different listening interests and from many different manufacturers. You may accept the regular selection for the field of music in which you are primarily interested, or take any of the scores of other tapes offered you, or take no tape at all that month.

TAPES SENT ON CREDIT. Upon enrollment, the Club will open a charge account in your name...and that means that you'll pay for the tapes you want only after you've received them and are enjoying them. The tapes you want will be mailed and billed to you at the regular Club price of $7.95 (occasional Original Cast recordings somewhat higher), plus a small mailing and handling charge.

YOU GET MORE FREE TAPES! Once you've completed your enrollment agreement, you'll get a stereo tape of your choice FREE for every two tapes you purchase!

SEND NO MONEY NOW! Just fill in and mail the coupon today! Your five FREE tapes and your first selection will soon be in your home for you to enjoy for years to come!

Note: All tapes offered by the Club must be played back on 4-track stereo equipment.

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In addition to the first selection I am buying now, I agree to purchase five additional selections during the coming year . . . and I may cancel membership at any time thereafter. If I continue, I am to receive a stereo tape of my choice FREE for every two additional selections I accept.

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ALSO SEND THESE 5 TAPES — FREE!

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City.................State.................Zip Code............

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AUDIO NEWS

Allied Radio-LTV Ling Altec merger

LTV Ling Altec has acquired Allied Radio Corp., well-known Chicago-based electronic parts and equipment distributor and retailer. Allied will be continued under the same name and with substantially the. same management, it was reported. Other LTV Ling Altec subsidiaries in the audio field include Altec Lansing and University Sound.

"Dust Bug" inventor dies

Cecil Ernest Watts, who invented the Dust Bug and other record-cleaning devices used by so many audio buffs, passed away recently at the age of 71.

Industry awards

AUDIO Magazine received the 1967 Maker of the Microphone Award ". . . in recognition of its pioneering and leadership in the dissemination of technical information on audio products and engineering advances in the audio industry." AUDIO's publisher, C. G. McProud (right), accepts the award from Oliver Berliner, grandson of the inventor in whose name the award is given.

General Electric consultant, Antal Csicsatka, was the recipient of the fourth annual consumer electronics award from the Institute of Electrical and Electronics Engineers. He was cited for ". . . an outstanding engineering contribution in the FM stereo field." It was the first award for radio technology, previous awards being for magnetic tape and color television developments.

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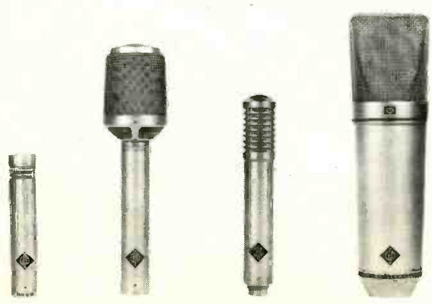

And that's not the only good news.

Now, it's easier than ever for you to own the world's finest microphone. Because we've reduced the price of the entire line—by as much as 30%.

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Performance? Identical to their tube predecessors. And that's the most exciting news of all.

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TAPE GUIDE

HERMAN BURSTEIN

Tape copying

Q. In transcribing recorded tape and phono discs onto tape, would we be able to economize on tape by using an "extended range" tape at 3.75 ips without affecting quality? Or is 7.5 ips still the speed? To preserve the original quality of the recording over decades, would we do better with acetate base, 1½-mil polyester, 1-mil polyester, or 1-mil tensilized polyester? For cleanest recorded sound, is it necessary to use a bulk eraser to erase a previously recorded tape? If so, what criteria should we use in shopping for one?—Joe Horning, Kent, Ohio.

A. (1) Whether you can copy at 3.75 ips without significant loss of quality depends on the quality of the tape machine, of the copying tape, and of the recorded tape or phono disc. The only thing I can venture is that there is a reasonably good chance of success, considering strides in the state of the art over the past few years. The wisest thing is for you to try copying first at 3.75 ips, then at 7.5 ips, and compare each copy with the original on an A-B basis (2) For preservation of tape quality over a long period of time, including minimum print-through (which increases with time), 1½ mil polyester tape is generally preferred. (3) If a previously-recorded tape has been subjected to a high recording level, or if for some reason the previously-recorded tracks do not line up exactly with the recorded tracks of the machine you are now using, it is advisable to use a bulk eraser. I can't advise you on criteria for purchasing the eraser. I think that the price differences among erasers reflect convenience features and duty cycle (how long you can operate the eraser before you have to allow it to cool) more than quality of erasure.

Echo chambers

Q. I am ever fascinated by the different types of echo chambers used. Recently I spotted one that was rather long, wide, and narrow, made of beaverboard, I believe. I asked the engineer how it worked, and he said that one end houses a speaker, and the other a microphone. You just feed a signal through this device and voila!—echo! If this is true might I build such a unit at home? Do you know of any place that offers plans for such an echo device as I have described? Would it be possible to take one channel of a four-track machine, feed it through such an echo device, and get a signal complete with echo on the other channel? Would there be any power supplies or electronic devices to build for use in conjunction with the above mentioned structure? If so, what? How would I control the extent of the echo? Any answers you may be able to provide concerning a home-made echo chamber would be greatly appreciated.

A. I cannot claim expertise on acoustic echo chambers such as you describe, and cannot refer you to plans for such a device. It would seem you might try to copy the construction and dimensions of the one you saw. It appears that the type of echo device you describe would favor a certain range of frequencies, depending upon its dimensions. However, this is not necessarily detrimental to the effect you seek.

As you say, it would be possible to play one channel of a tape machine (assuming this machine can play one track while recording another), feed the signal through an echo chamber, and record the result on another channel. This signal would have to go through a power amplifier in order to power the speaker of the echo chamber. I think that the amount of power required is quite modest, so that a simple power amplifier capable of putting out a few clean watts (perhaps as low as 3 watts) would be sufficient. You can purchase such a power amplifier for a relatively small amount from one of the kit manufacturers. To control the amount of echo, it would be necessary to combine the output of the echo chamber (the microphone output) with the signal originally fed into the chamber.

In other words, the two signals would have to be combined in an electronic mixer. Accordingly, the playback channel of the tape machine would feed into two devices: (1) through a power amplifier into the echo chamber; (2) the electronic mixer. The microphone of the echo chamber would also feed into the mixer. The combined signals would go from the output of the mixer into the tape machine for recording on another channel. Depending on your tape machine, it could possibly be used as the mixer (that is, some tape machines permit mixing of low-level and high-level signals. Æ

Meet the "Copy Cat"

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

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

AMERICA'S FIRST CHOICE IN TAPE RECORDERS

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AUDIO, ETC.

EDWARD TATNALL CANBY

1. Chromed cassettes

Believe me, if you can possibly make it, go to the next AES convention—West Coast, East or wherever. If you are even slightly knowledgeable, you'll be fascinated, both by the audible "papers" (as they are so coyly entitled) and by the associated exhibits. If the annual Hi-Fi Shows give you a bird's-eye view of audio as it is, and will be for the next months, the AES meetings let you in on the future. At the New York meetings last fall I got enough ideas for a couple of years' worth of this department. One day, the talk didn't stop (except to listen) from 9:30 in the morning to 10:30 at night.

And if there's too much of a muchness, you can pick up "pre-prints" of just about everything and sometimes even more. (Most papers are too long and get cut in midstream when the warning gong goes off.)

All of which is merely prelude to things that will hopefully come later on in this department. I found that the most exciting characteristic of the AES subject matter is exactly its lack of *fait accompli*—for these are developments not so much completed as under way, inconclusive—if often loaded with audio high explosive. Frequently, indeed, one must read between the lines (and view between the exhibits); for our wary engineers quite rightly do not like to commit themselves about "commercial" prospects until those prospects are actually launched and under way.

Thus there were all sorts of interesting things persuasively set forth and demonstrated at AES which were invariably "purely experimental" — no particular future exploration contemplated. It's all, of course, just for the fun of it, we are supposed to understand. Well, maybe, maybe not.

Granted that many developments as presented in this preliminary stage do, in fact, veer off in other directions, never arriving on the commercial scene at all in the form we at AES see them. But, to use an old phrase, where there's smoke there's fire. And the wonderful fun at AES is to try to smoke out the fire, if you wish, by sheer gamesmanship.

Thus, just to name one item, we were introduced to what may be the biggest thing in tape for the future, a new *kind* of tape coating. No—it isn't even being contemplated for audio and consumer use—yet. It is in development for the much more important (yes, alas . . .) computer market, branching out from business into Defense and Space and all the rest. But there the tape was. And there was the Gauss Company, which makes fancy tape duplication systems for the trade, showing off a couple of cassettes full of the stuff, plus the results of their testing, comparisons of various parameters with the best standard (that is, ferrous or iron oxide) tape.

Available in cassettes? Oh, no-no. Gauss got a sample of the new tape in a computer formulation and size. Just for the fun of it (oh yeah?), they sliced it up into the 1/7-inch cassette width —by *razor blade,* mind you. Then they hand-wound the stuff into an empty cassette. Big apologies were made for finger prints, grossly enlarged in the photomicrographs — we laughed. Also for some edge distortion where the 4-track stereo ran into some of those hand razor-blade edges!

The producing company for this new tape was silent as the grave. (I was told they had representatives on hand, to listen.) They are not officially interested in consumer audio. Really, truly. Too busy elsewhere. They probably wished that we all would please look the other way and just concentrate upon the fabulously good ferrous tapes now being produced. Let well enough alone.

But they aren't going to have it that way, I suspect. Because right now we are in fact in a crisis and a bind, if I read all the signs right, precisely in this area—as the tiny slow-speed cassette takes over in miniature four-track stereo. Our tape isn't really quite up to it. Touch and go. Even the very best. The commercial tape people are singing out bravely and, in the end, their sing will be right. Stereo in cassettes, two-track each way, four tracks, and competitive as all get out. But the quality corner—again if I guess right—hasn't yet quite been turned. We desperately need a breakthrough, and a big one.

What just *might* do it would be a really different tape, one that could give that chrome-trimmed sound in stereo even at 1⅞ ips. Not just a further refinement, but something new.

This tape *is* new, if unrefined as yet. I need say no more, at this point, than this: it isn't ferrous, it's chrome—was it chromium dioxide? (They didn't pass out any literature or even a pre-print —the demonstration was thrown in at the last minute.) And, other things hopefully being equal, at 1⅞ ips in a cassette configuration this new tape added up its major performance parameters to match standard tape traveling *twice as fast.* Does that mean something, or doesn't it? We most certainly will be finding out.

Not much question about those micro-slides we saw. Finger prints aside, the oxide surface was astonishingly smoother and finer than any ferrous tape. That would do it.

Some snide Doubting Thomas whispered in my ear that chrome oxide was well known as an excellent abrasive. Could be. But I suspect our engineer brothers will figure out a way to take care of *that,* if they really have to. So — watch duPont, and chrome oxide tape. Maybe in a couple of years or so . . .

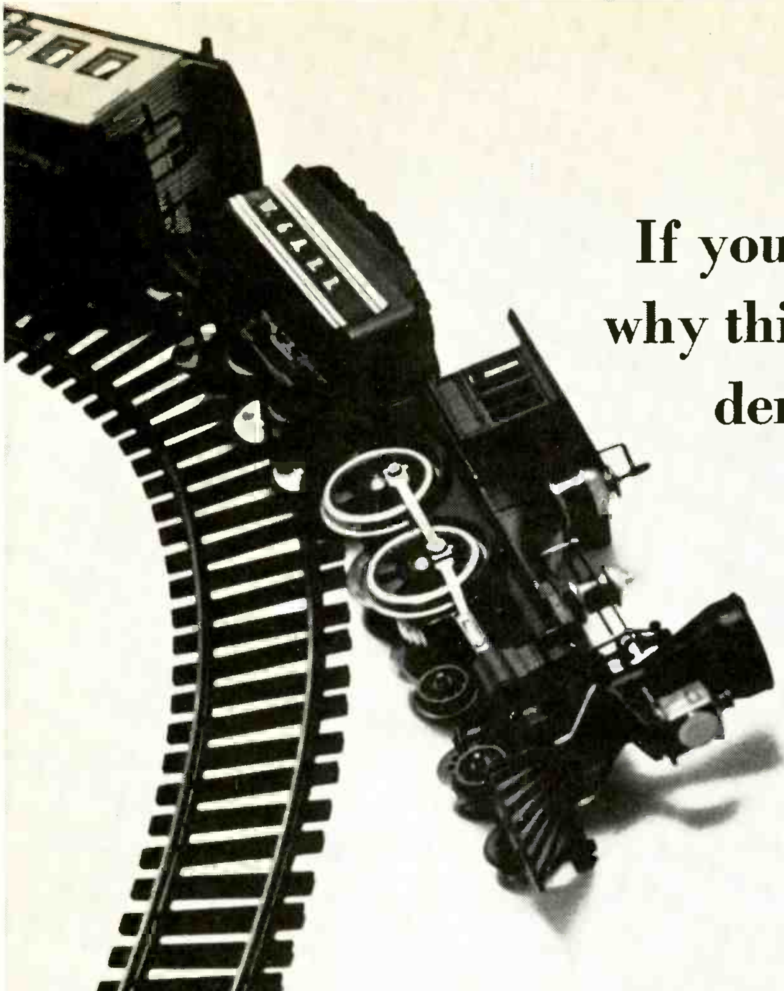
2. Pine needles

These days, audio seems to be everywhere in my thoughts. Even on weekends, and in the most unlikely situations. Like, say, raking up pine needles off my lawn.

Raking leaves takes a bit of planning —you advance across the lawn in a sort of ragged frontal progress, moving forward a few feet at a time, curving your "front" here and there so you won't get trapped in corners and behind trees, gracefully converging all your leafy lines until you break them up into piles and burn them or cart them away—assuming a windless state of the atmosphere, of course. Only fools try to rake leaves in a cross wind. (Haven't you?)

Pine needles are something else again. I have several gorgeous old white pines above my house and—in case you didn't know—they shed their old needles profusely each fall, right

(Continued on page 63)



If you understand why this model train derailed . . .

you'll understand the importance of high trackability in your phono cartridge

Breathes there a man who's never seen a model engine attempt to negotiate a too-sharp bend, too fast? The train derails. This is kid stuff when compared to the wildly undulating grooves that the phono cartridge stylus encounters in many modern recordings . . . especially if the recording is cut at a sufficiently high velocity to deliver precise and definitive intonation, full dynamic range, and optimum signal-to-noise ratio. Ordinary "good" quality cartridge styli invariably lose contact with these demanding high-velocity grooves . . . in effect, the stylus "derails". Increasing tracking weight to force the stylus to stay in the grooves will ruin the record. Only the Super Trackability Shure V-15 Type II Super-Track® cartridge will consistently and effectively track all the grooves in today's records at record-saving, less-than-one-gram force . . . even the cymbals, drums, orchestral bells, maracas and other difficult-to-track instruments. It will make all of your records, old and new, sound better. Independent experts who've tested the Super-Track agree.

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Letters from Readers

• In the November issue of AUDIO I note a letter concerning my recent article about a stereo limiter.

I appreciate the writer's comments concering separate limiting of stereo channels. It is true that separate limiting of stereo signals can lead to "wandering stereo images," particularly when the signals are continually "processed." Our design philosophy was given in a previous article (AUDIO, September 1965, p. 50) as follows:

"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 cannot always be accurately predicted. For this use, and for this use alone, this arrangement is recommended."

DR. WAYNE B. DENNY
Grinnell, Iowa

• I read with interest the article by Wayne B. Denny in your September issue. First, let me point out that in 1961 I built a similar device and applied for a patent. In 1965 patent #3185936 was issued covering the device. My device had an additional feature whereby the function of the unit could be reversed, thus allowing re-expansion of the compressed signal on playback.

The author describes the action of his device as symmetrical clipping; I hope this is not the case as this would introduce great amounts of distortion. I think the action is better described as an automatic gain control or volume compression. I would like also to point out that in his Fig. 4 the symbols he uses for the amplifier modules are backwards from the usual practice.

I think that the author greatly limited the usefulness of the device and gives the reader a few wrong impressions.

1. "The operator has no control over the signal level at which limiting will occur." This can be cured by placing gain controls between A_3 and A_5 and also between A_4 and A_6.

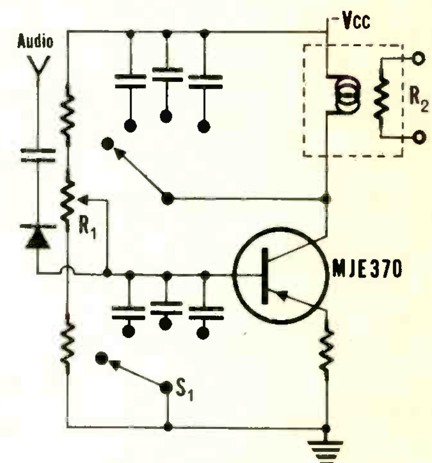
2. ". . . nor can he change attack and release times of the control circuits." ". . . but this would greatly complicate the circuit."

Mr. Denny also gives one the impression that "'RC' time constant" circuits are complex above the reader's comprehension. This is no more so than would be loudspeaker crossover networks.

The circuit for driving the lamp shown below overcomes all of these disadvantages and more.

In this configuration the use of the bias control R_1 and the elimination of the output transformer allow the lamp to be biased slightly on. This is adjusted so that the value of R_2 under no-signal conditions is somewhere between 1 meg and 500K ohms. This allows for a much faster attack time

(Continued on page 58)



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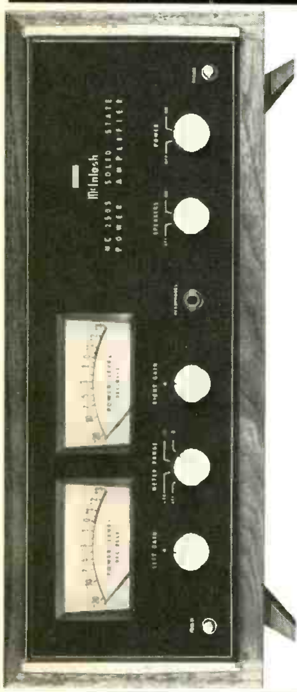


ABZ's of FM

LEONARD FELDMAN

Co-channel Interference

Examining the difference between the propagation of FM and AM broadcast signals, we see two outstanding advantages of wideband FM (as presently broadcast): outstanding fidelity and reduced interference. The term "interference" applies to more than merely "static." It covers any voltage arriving at the input of a receiver or created within the circuitry of the receiver itself which "interferes" with satisfactory reception of the desired station signal.

For a better understanding of FM, we shall therefore next examine the significant forms of interference prevalent in radio broadcasting and show why these forms of interference are less dominant in FM reception than in AM reception.

A frequent annoyance in AM listening (particularly at night, when reception range increases) is the piercing whistle heard when two stations are operating within the same channel. This whistle is produced whenever the frequency difference between the stations is equal to an audible frequency. In the case of adjacent channels (10 kHz apart), the whistle is often eliminated in quality AM receivers by the incorporation of a "10 kHz Whistle Filter." This circuit effectively suppresses all frequencies around 10 kHz without significantly attenuating desired frequencies (5 kHz and below, for AM).

In this instance, however, we are discussing Co-channel interference, where two stations (however distant from each other geographically) are occupying the same assigned channel but, because of permitted tolerances, may have carrier frequencies several hundred cycles apart. Since the two carriers are so close in frequency, both signals pass through the circuitry of the AM receiver until, at the second detector, the beat note appears. In typical AM situations, the interfering signal will be noticed when it is only $1/100$ as strong as the desired signal. Contrast this with the situation in FM, where, as we shall soon see, the desired signal need be only twice as strong as the interfering signal to *completely* over-ride it!

Fig. 1 represents two r.f. signals, differing slightly in frequency and considerably in amplitude. The resultant waveform (derived by algebraically adding the instantaneous amplitudes of each) is shown in the lower portion of the drawing. You will note that the resultant's amplitude varies at a rate equal to the difference between the two frequencies from which it is derived. If the two frequencies differ by, say, 400 Hz, the amplitude of the resultant will increase and decrease 400 times per second. This AM variation, applied to an AM receiver, would of course be detected in the course of the normal functioning of this type of receiver, producing the familiar "beat note" previously mentioned.

While the effect observed in Fig. 1 may be correctly termed a form of undesired "amplitude modulation," a second, less obvious form of modulation takes place in such situations—phase modulation. That is, with respect to the larger (desired) of the two signals shown in Fig. 1, the added resultant waveform alternately leads and lags by some finite number of degrees. The degree of phase lag or lead depends upon the relative amplitudes of the desired and undesired r.f. signals.

For illustrative purposes, let us suppose that the undesired waveform is $1/2$ as large as the desired signal. Under these circumstances, the phase shift (lag alternating with lead) will amount to 30 degrees. Now, phase modulation

(Continued on page 61)

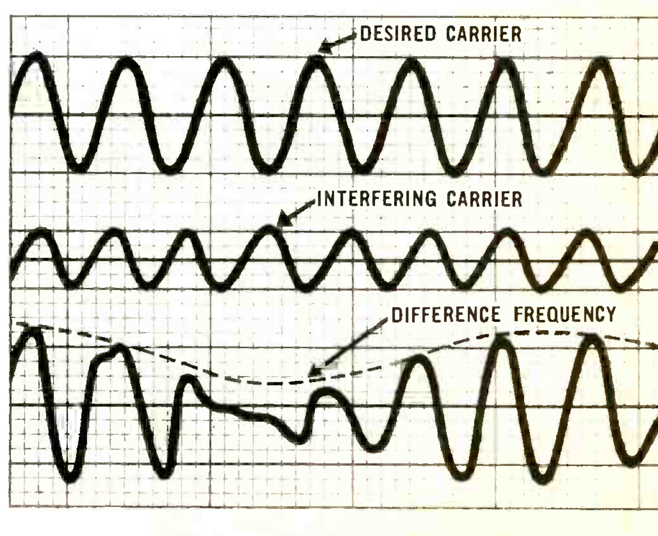
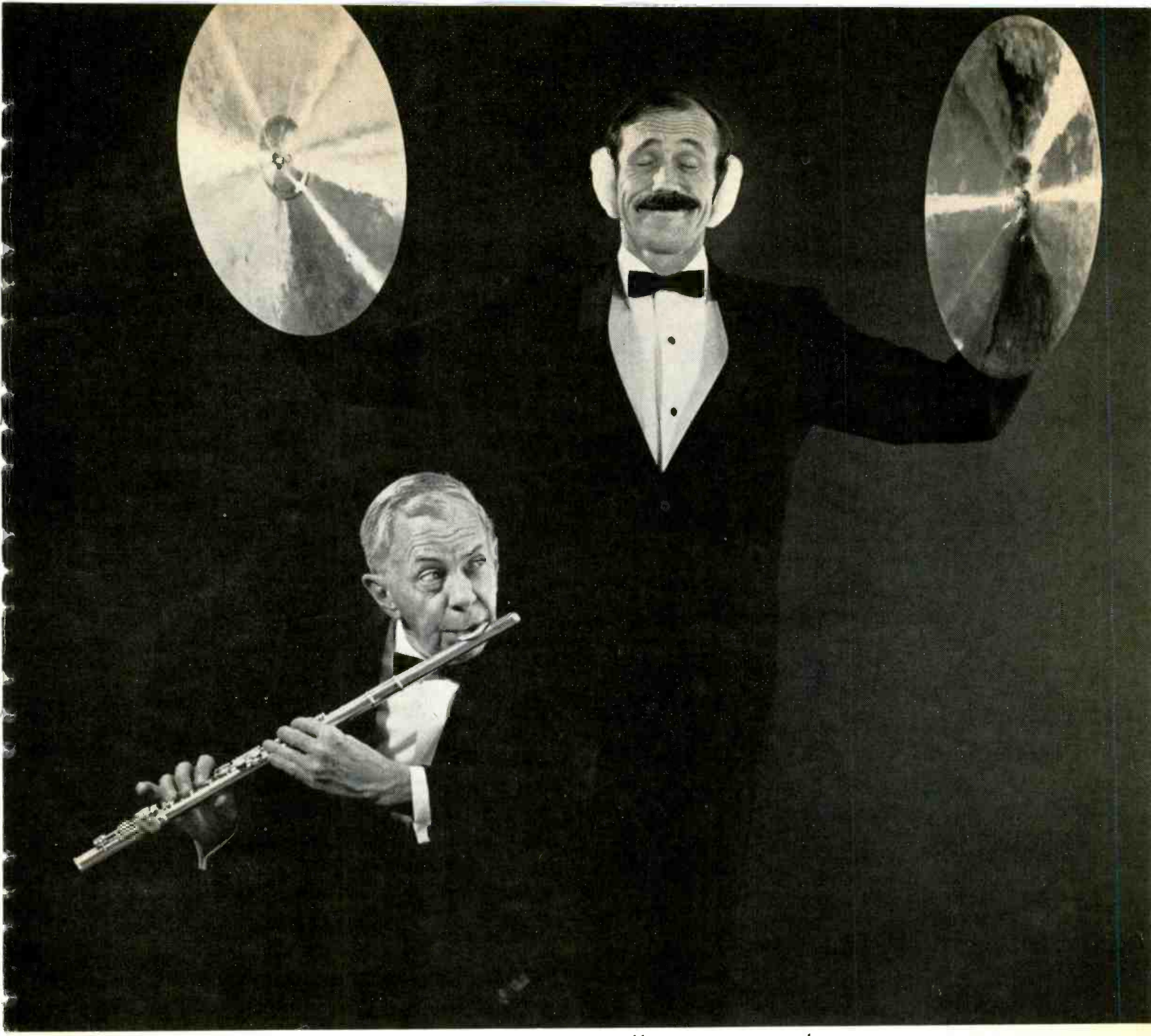


Fig. 1 — An interfering carrier added to a desired carrier of somewhat lower frequency results in the production (after detection) of a "beat" frequency.



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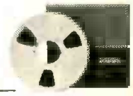

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EDITOR'S REVIEW

Equipment Review Credibility Gap

"Can a publication that accepts paid advertising evaluate advertisers' hi-fi equipment without prejudice?" is a composite question formed from a sizable number of reader comments. It deserves an answer in print because experience has proved that one reader letter often represents hundreds of readers' thoughts.

Examining AUDIO's Equipment Profiles over the past six months, we observe that significant shortcomings of equipment were noted in more than 20% of reviews, not to mention minor criticisms. This has elicited such comments as: ". . . Keep up the objective test reports."—Lester J. Mertz, Trenton, N. J. and ". . . Why did Equipment Profile 'butter up' [review] after discovering that the manufacturer overrated [specifications]." — Kenneth Doring, Tonawanda, N. Y.

Considering the latter comment, the reader was referring to our summation, which was laudatory with pointed reservations. There are three factors which must be considered here: evaluating specifications, listening/operating tests, and price.

Some of the specifications were not met, it is true. But being a shade off did not produce a discernible effect on performance during listening tests. One should recognize, too, that tuner alignment plays an important role in meeting a receiver's rated specifications. Two components may differ in performance. While one component may easily surpass its specifications, another unit, the same model, may fail to meet its specifications by a wide margin. So why fault a model that misses claims by a hair's breadth? The units that AUDIO examines are operating at or near optimum capability. Equally important, however, are the quality-control measures practiced by a manufacturer. Is he maintaining tight control over final inspection? If not, a unit capable of achieving an FM sensitivity of, say, 3 μV, may be passed with a 9 μV spec. AUDIO cannot answer this for you. No publication can.

None of the equipment reviewed in this six month period was deemed wholly unsatisfactory. Aha! a reader might exclaim. *Everything* can't be that good. And he would be correct. Some equipment does display inherent major faults that realignment, securing additional models for test purposes, and so on, will not overcome. The deficiencies are reported as they fall, so long as a unit can still qualify as high-quality merchandise. But when a unit turns out to be altogether second-rate, though we expected it to be a fine piece of equipment, AUDIO does *not* review it. Space limitations do not leave room to review all the excellent units on the market, let alone inferior ones.

In answer to the lead question, YES, we can and do publish unbiased equipment evaluations.

The Welte Piano Recordings

Many great pianists—Ravel, DeBussy, Mahler, de Falla, Richard Strauss, Saint Saens and Hoffman, among them—made recordings at the turn-of-the-century. Special piano rolls, invented by Edwin Welte, a German industrialist, made it possible.

The recording device was a special piano that was fitted with a carbon rod extending downward from each key. As a key was struck, a rod dipped into a tray of mercury, completing an electrical circuit. This activated a rubber wheel which was inked with graphite. Turning against a roll of aged, tissue-thin paper, the wheel marked the paper faintly if a key was struck softly or with stronger marks on fortissimos (where the carbon rod sank deeper into the mercury, increasing current flow).

A playback device, called the *Vorsetzer*, placed at the keyboard of any piano, plays back the rolls. It resembles an upright piano, but has 88 "fingers" extending from it. Sound reproduction is said to encompass every shade of dynamics of the original

The Welte Legacy series, first released on discs in 1963, and available through the Book-of-the-Month Club, will soon be available from Ampex Stereo Tapes on open reel magnetic tapes. *A.P.S.*

The highly-rated Sherwood S-8800 now features Field Effect Transistors (FET's) in the RF and Mixer stages to prevent multiple responses when used with strong FM signals. Among the Model S-8800's many useful features are two front-panel switches for independent or simultaneous operation of main and remote stereo speaker systems. Visit your Sherwood dealer now for a demonstration of those features which make Sherwood's new Model S-8800-FET receiver so outstanding. With Sherwood, you also get the industry's longest warranty—3 years, including transistors.

Compare these Model S-8800 specs: 140 watts music power (4 ohms) • Distortion: 0.1% (under 10W.) • FM sensitivity: 1.8 μv (IHF) • Cross-modulation rejection: -95db • FM hum & noise -70db.

Model S-8800 custom mounting $369.50
Walnut leatherette case $378.50
Hand-rubbed walnut cabinet $397.50

Sherwood

Sherwood Electronic Laboratories, Inc., 4300 North California Avenue, Chicago, Illinois 60618. Write Dept. A1

FURTHER ADVENTURES
OF AN
AUDIO PURIST

JOHN W. LINSLEY

Hi-fi enthusiast discusses results of his stereo equipment and installation experiments

Fig. 1—To minimize lateral and vertical pivot friction, the author's moving-pivot tone arm floats on distilled water.

THERE WAS A PLEASANT aftermath to my article, *A Purist Tackles Room Acoustics*, which appeared in the April 1964 issue of AUDIO. It put me in touch with audio purists all over the country. The result was like an audio buff's dream come true because I had an opportunity to exchange ideas and to listen to a wide variety of fine hi-fi stereo systems.

Spurred on by so many questions tossed at me about my practical experiences, I continued to search for ways to improve my system. Here are some of the results of my experiments in trying to improve my hi-fi system, as well as observations, if not conclusions, based on them.

I was reasonably satisfied with my own system after hearing many others, though I did admit the need for several immediate improvements. These included a better crossover for my Ionovac tweeters and a further improvement in a moving-pivot tone arm to reduce vertical and horizontal pivot friction. The arm's pivot now floats on distilled water, as shown in Fig. 1.

For some reason, such as the extreme variation in acoustics or just an inability to be completely unbiased, I found that my own horn-loaded speaker system offered *me* a most enjoyable compromise between four full-range electrostatic speakers, on one hand, and two infinite-baffle systems, on the other hand.

Now realize that I am just a dyed-in-the-wool purist who listens for subtle clues that might help me get just a little closer to the substantial feel and delicate clarity of live music. Conclusions on transducers have to be subjective, naturally. After all, I also heard some irritating sounds in the big horn systems, but I still feel that the horn approach offers me, personally, the best chance of achieving realistic sound.

My original hope was that these horns could be projected out on to my back porch with only the mouth and a coaxial mid-range set up so that they project into the listening room. With this in mind, I designed and built two straight exponential horns with a 75 Hz cut-off frequency, a 60 sq. in. throat area, and a 30-in. x 38-in. rectangular mouth (which is almost the 3 foot square theoretical minium recommended for use at 100 Hz). Such a horn doubles in cross-sectional area every 13 inches along its axis and comes out to an overall horn and chamber length of 5 feet 8 inches. (As you might suspect, these mouth dimensions were influenced by the width of my front door.) The completed horn, made out of 1 inch thick chip board, weighs about 125 lbs. See Figs. 2 and 3.

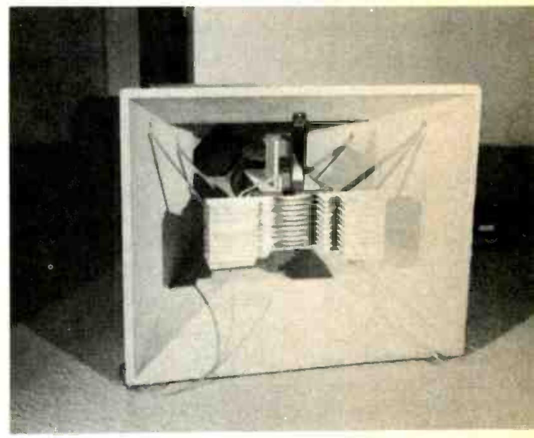
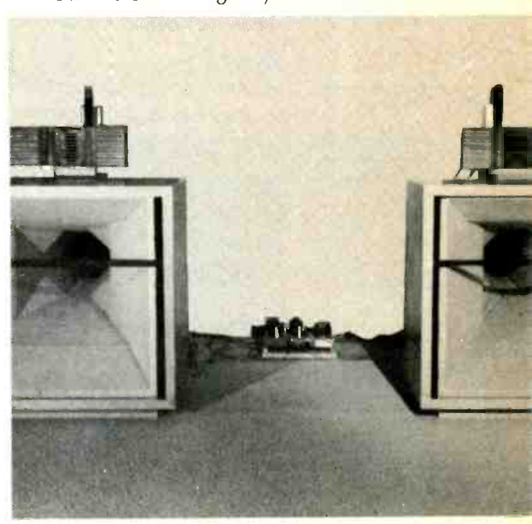


Fig. 2—Dropping a plan to use a coaxial mid-range and tweeter arrangement so that the bulk of each 100- to 500-Hz horn extends out from back-porch windows, the author placed all speaker diaphragms on the same vertical plane.

I had intended to stop at this point, but I was tempted to test the importance of placing all speaker diaphragms on the same vertical plane to minimize phase cancellation at the crossover points.

As it turned out, it was fortunate that I hesitated to fill my back yard with gigantic 30 Hz horns because the vertical alignment principle proved to be most significant; I would not have been able to locate my mid-range diaphragms over a woofer that was 20 feet out in the back yard. In fact, I am now convinced that this vertical alignment principle is one reason that the 30-Hz horn did not become too popular even in the monophonic era, when only one horn of this size was needed.

Fig. 3—The 100- to 500-Hz horns are made of one-inch thick chip board. Horn and speaker chamber totals 5 ft. 8 in. long; the mouth is 30-in. high by 38-in. wide.



Since all my listening efforts left me content with the horn approach, I decided to find out what would happen if I eliminated the common practice of compromising horn length, straightness, and mouth area below 500 Hz.

As I had no reason for dissatisfaction with the sound of my 15 inch K horn under 100 Hz, I decided to limit my experiment to horns that would be theoretically adequate for use between 100 and 500 Hz, with electronic crossovers at 100 Hz. This arrangement yielded a most natural-sounding bass when compared to the other systems so I decided to leave well enough alone until I had first explored the potential of larger horns in the 100 to 500 Hz range.

In a sense, the building of two straight experimental horns for use above 100 Hz was not too difficult, for a straight horn is rather simple compared to the complex construction required for a folded horn. The big problem was in finding enough space to house the horns.

So I moved the horns back into the living room, and placed the mid-range horns and tweeters in a vertical arrangement over the woofers. I noticed so much additional improvement that I simply could not give up the vertical diaphragm alignment, even though it makes my stereo setup almost eleven feet wide and six feet deep. See Fig. 4.

Now I fully realize that most people will think that I am just another far-out purist who has listened to so much music that he has started imagining differences that don't really exist. However, I assure you that there has been a good theoretical basis for everything I have heard in the past, only it took years to find the missing conditions that made the theories yield positive results.

For example, all theoretical logic indicates that front horn loading should yield a vast improvement in accuracy and power handling capability. Yet, from the beginning of my hi-fi experience I had heard a certain irritating quality in the big theater horns that initially led me to try cone-type mid-range speakers and, finally, run my Stephens theatre drivers at a lower level than most people would consider proper. I still liked the resultant sound better than any other I could hear, but I had to admit that the difference was not as great as theory indicated it should be.

At first I was tempted to blame my source material or the possibility that my compromised horns under 500 Hz were not providing a sufficiently solid foundation for such powerful mid-range horns. Of course, there was some truth in both of these, but my efforts to improve these factors weren't yielding much improvement until I attacked room acoustics.

The rough correction of my room acoustics (by shifting furniture, adding drapes, etc.) smoothed down those mid-range horns and seemed to improve the whole system's performance. I had achieved a most pleasant-sounding system, but it was obvious that I had done this by toning down a sound that still wasn't quite as smooth as it should have been.

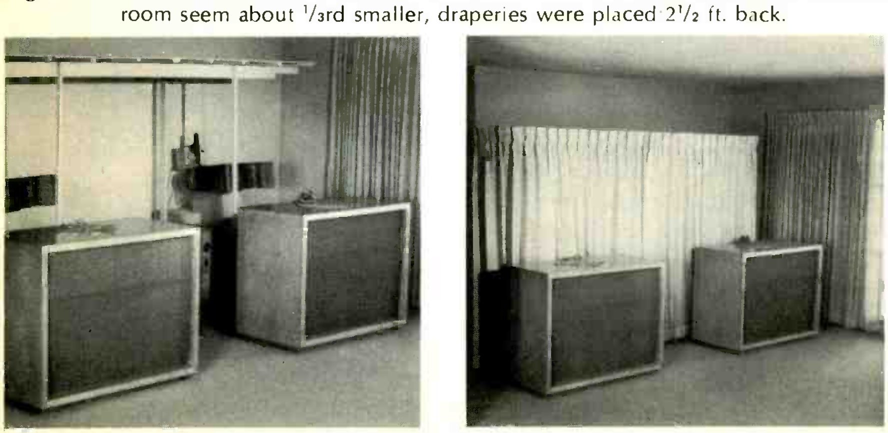
My first reaction was to try yet another improvement in the foundation under those big theatre-type mid-range horns. The net result appeared worthwhile at first. However, after a month of listening to those new 100 to 500 cycle horns, I finally had to admit that something was still wrong.

The new horns certainly gave the music a solid richness, but every once in a while I would hear an unnatural peak on a powerful horn passage or an irritating edge on the percussion sounds of instruments such as a vibraphone. Since these all seemed to occur around 500 Hz I thought that my home-made crossover networks were at fault and planned their early replacement. However, as indicated before, I finally decided to test the idea of lining up speaker diaphragms vertically, wherein I discovered that most of those irritating sounds had vanished. In addition, I was also pleasantly surprised to find that the absence of phase cancellation also filled in considerable detail around the 500 Hz range.

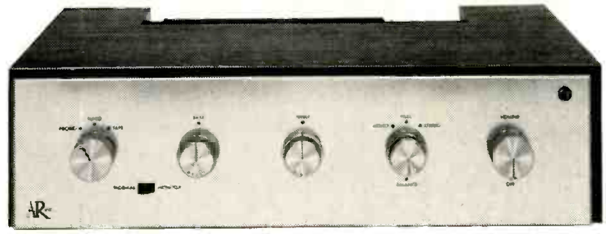
I eventually replaced my home-made crossover networks with J.B.L. N-500 professional networks just to see if such high-quality networks might yield a small but worthwhile improvement. They did yield a small but apparent improvement in clarity both above and below 500 Hz. Æ

Fig. 5—The author's present system includes the following components: ADC 10E stereo cartridge in a special moving-pivot tone arm; Thoren TD-124 manual turntable; Ampex 1260 4-track tape recorder; Marantz mono preamplifiers; Knight AM tuner; Fisher FM tuner; Marantz electronic crossovers at 100 Hz and 3500 Hz; JBL N-500 crossover networks at 500 Hz; Eico 28-watt dual basic amplifier above 3500 Hz; Marantz 40-watt basic amplifiers between 100 Hz and 3500 Hz. The latter drives JBL theatre woofers to 500 Hz and Stephens P-35 theatre drivers above 500 Hz. A Marantz 40-watt basic amplifier drives an Electro-Voice 15-in. "K" horn: Ionovac tweeters and JBL high-frequency lenses round out the system.

Fig. 4—Since it was impossible to conceal the big horns fully without making the listening room seem about 1/3rd smaller, draperies were placed 2½ ft. back.



AR INC. amplifier



Shown with optional oiled walnut wood cover.

Acoustic Research announces its first electronic product, *the AR amplifier,* an integrated stereo preamplifier/control and power amplifier, all silicon solid-state.

1. PERFORMANCE — The state of the art of electronic design has reached the point where it is possible to manufacture a nearly perfect amplifier. There are a few such now available. We believe the AR amplifier belongs in this select group.

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STEREO DISCS: 10 YEARS OLD

Stereo Disc Cutting

ALBERT B. GRUNDY

THE STEREOPHONIC RECORD WAS introduced over 10 years ago (at the October 1957 Audio Enginering Society Convention). Through these years, many articles were published about the method of obtaining two independent channels in one record groove. Nevertheless, many aspects of stereo groove cutting still remain a mystery to many audio buffs, including a host of recording engineers.

Disc cutting heads and cutting systems have an undeserved reputation of being the most temperamental part of any studio operation. Engineers often blame the system when results obtained at previous times cannot be repeated. More often than not, this is due to a misunderstanding of what happened the first time.

Tape recording has driven most "instantaneous" disc recording out of existence; the only commercial application left is cutting master records for disc production. In fact, today there are only two European firms (Ortofon and Neumann) and one American Company (Westrex) manufacturing mastering-quality mono and stereo dynamic cutter heads. One other mono cutting system, Grampian, is also used for mastering. It is a magnetic system as opposed to a dynamic system; that is, it has a stationary coil and a moving iron armature rather than a coil moving in a magnetic field.

It is of great benefit to understand how mono grooves are cut before tackling stereo grooves, so let us examine the earlier system first.

Monophonic grooves

Specifications for groove geometry and dimensions are given in great detail in the NAB and RIAA standards for disc recording and reproducing and are, in general, well known to most engineers. That is, static dimensions: depth, width, bottom radius and included angle. And professionals experience no difficulty with lead-ins, spirals, and lead-out grooves. But this is not always true of some of the groove's dynamic characteristics, such as, peak amplitude or velocity in centimeters per second. What happens during modulation is really what we want to know. Not only is the disc moving with turntable rotation, but the stylus is actually in motion perpendicular to the groove.

One other concept that should be clarified at this time is groove velocity or peripheral groove speed. The peripheral groove speed is the rate (usually in inches per second) at which the disc passes under the stylus. Since the rotational speed of the turntable is a constant 33⅓ rpm or 1.8 seconds per revolution, the length of groove passing the stylus in one revolution is a function of the instantaneous radius that is being cut.

As the stylus moves toward the center of the disc the radius becomes smaller. Consequently, the length of groove that passes the stylus in one

Fig. 1—Cross-section of 45°/45° stereophonic disc shows recording extremes.

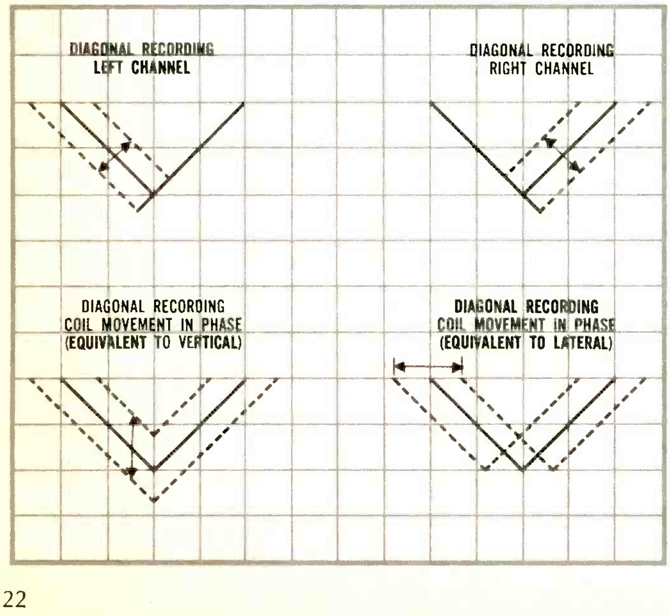
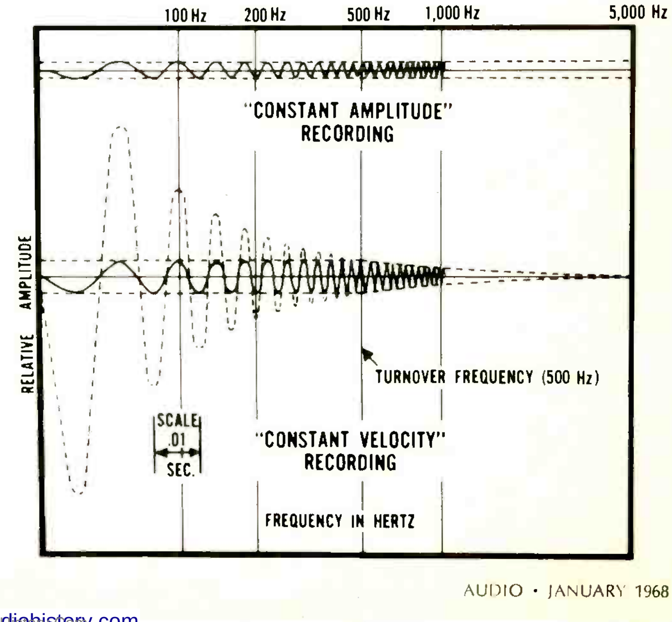


Fig. 2—Wave patterns of "constant amplitude" vs. "constant velocity" recording.



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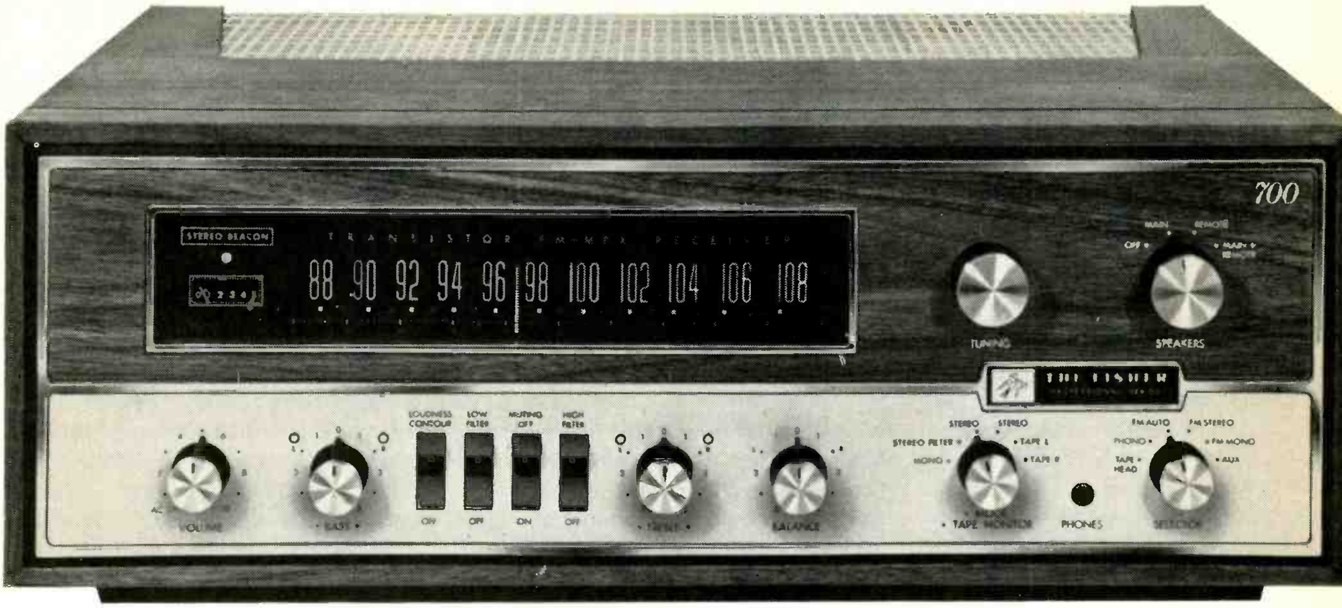

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revolution becomes progressively less. The circumference at the beginning diameter of a standard 12-in. LP is approximately 36 inches. Groove speed, based on the foregoing 1.8 seconds per revolution, is therefore 20 inches per second. By the same reasoning, groove speed at the RIAA minimum closing diameter is 8.3 inches per second. With modern cutting heads, this variation in groove speed has very little effect on the recording process. It simply means that the packing density of information is about 2.5 times as great as the inner diameter. Its effect really shows up in playback when we try to recover this information. A cutting stylus for monophonic records moves laterally with respect to the plane of the disc surface. In other words, it is actually on the disc radius and instantaneously perpendicular to the rotational motion of the groove.

The motion of the stylus and, therefore, the dynamic characteristic of the groove, is most easily examined with sine wave modulation. When the cutter head is driven by a sine wave, the stylus moves from side to side in a straight line. The stylus moves from its center rest position to one extreme, stops, reverses its direction, and moves back through the center position to the other extreme, stops, and repeats the pattern. When the disc is rotating, this motion is stretched out in the form of an undulating groove which has the appearance of a conventional sine wave. The distance that the stylus moves from the rest position to the extreme position (where it stops and reverses its direction) is called the peak amplitude; the distance between the two extremes, which is simply double the one-side distance, is called the peak-to-peak amplitude. This peak-to-peak amplitude actually determines the total over-all width of the groove. Since there must be some space between adjacent grooves, a certain land area must be allowed. The total space allowed for each groove must therefore be the sum of the peak-to-peak amplitude of the groove and the width of the land.

The stylus velocity is the rate at which the stylus moves back and forth in the groove. This can be either the cutting stylus or the playback stylus. All dynamic cutter heads and pickups are velocity-sensitive devices or transducers. The pickup transforms the mechanical motion of the groove into a voltage at its output terminals according to the general law: $E = BLV$

Fig. 3—Example of a disc mastering lathe, the Neumann AM-131, shown with a Neumann ES-59 mono dynamic feedback cutterhead mounted.

In this equation, the B is the magnetic field strength of the permanent magnets in the cutter head or pickup, and the L is the length of wire in the coil. For any pickup or cutter head, these two factors are fixed. Therefore, the equation can be simplified to: $E + KV$

The output voltage, E, of the pickup is directly proportional to the velocity, V, of the stylus and, in the cutter head, the stylus velocity is directly proportional to the driving voltage. (K is simply a constant.)

The stylus velocity will be a sinusoidal function if the cutter head's driving voltage is also a sine wave. The stylus moves from the center rest position to one extreme end. And it must slow down to zero velocity when it reaches this end to reverse its direction. It starts to move in the opposite direction, accelerating until it passes through the center position and then slowing down so that it stops and reverses again at the other extreme limit of motion.

It should be obvious from this that the stylus reaches its peak velocity at the moment it passes through the center position. Since the stylus has to stop and start in the opposite direction at each extreme limit of motion, its velocity is constantly changing. Accordingly, the expression "stylus velocity" must refer to some particular instantaneous velocity. This is, as mentioned before, the velocity of the stylus when it passes through the center position. It is at this position that the maximum driving voltage to the cutter head is required. And it's here that the pickup produces its maximum output voltage. From this it can be seen that stylus velocity is actually a measurement of the level on the disc. The higher the instantaneous stylus velocity, the higher will be the output from the disc.

The direct relationship between stylus velocity and stylus amplitude is really very simple. One other factor must be considered: the number of these back and forth motions that the stylus must make in any given amount of time. This is, naturally, the frequency of the signal being recorded. If we start with something simple like 1000 Hz, we know that the stylus must make 1000 of these back and forth trips in one second. How far it can go (amplitude) is a function of how fast it must go (velocity).

At a frequency of 1000 Hz, the stylus has .001 seconds to complete each trip. If we make it move faster it can go further in this amount of time than if it moves slowly. The amplitude is directly proportional to the velocity and indirectly proportional to the frequency. For example, at 100 Hz the stylus has .01 seconds to complete each trip. This is ten times as much time per trip. If it is to maintain the same velocity it must travel ten times farther per trip to use up the allotted time per trip.

If a simple constant-velocity cutter head is fed a constant voltage and the frequencies varied, the amplitude must vary from very high at low frequencies to very low at high frequencies, in accordance with the expression $A = V/2\pi f$.

The most important factor that determines just how much amplitude can be cut is the required playing time of the disc. If 12-inch LP's were cut to play only five or ten minutes, they could have big fat grooves with large amplitudes and, therefore, a very good signal-to-noise ratio. The only limiting factor would then become the size of the playback stylus. Since this is gener-

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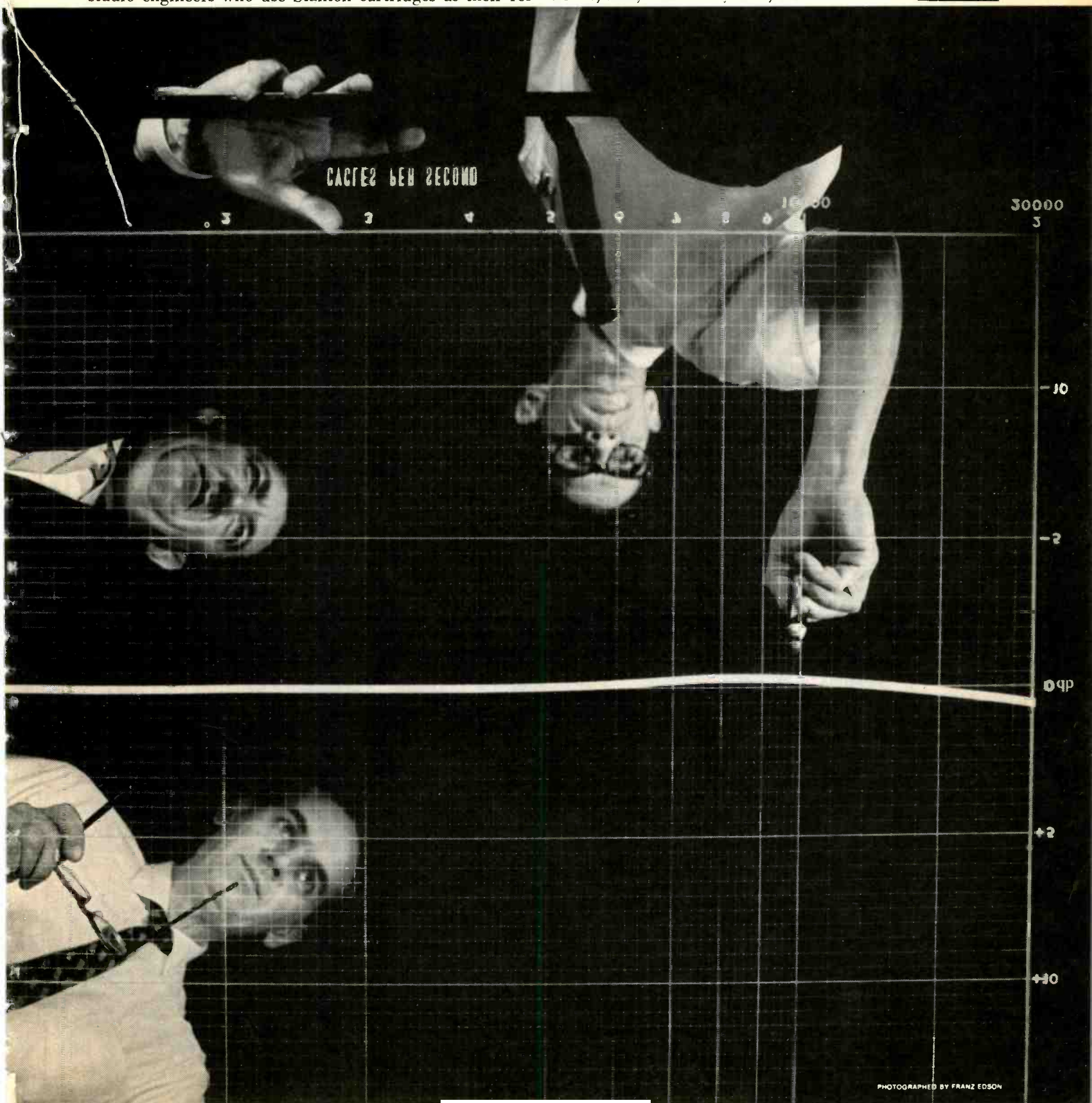

ally fixed, there is a limit to just how large the groove can be. As most LP's have twenty to thirty minutes of playing time, the available space on the disc itself limits the amplitude of the grooves.

For a 12-inch 33⅓ disc to play twenty-five minutes and stay within the standard maximum and minimum diameters, the pitch of such a disc must be 250 lines per inch. The reciprocal of the lines-per-inch figure is the number of inches per line (always a fraction). This is a measure of the total space available for the peak-to-peak groove amplitude and the land width. For a twenty-five minute disc this groove space is .004 inches.

That seems like an awful lot of space considering that, at the standard peak stylus velocity of seven centimeters/second at 1000 Hz, the peak-to-peak amplitude is only .0022 centimeters or .00087 inches. But the audio frequency spectrum is incredibly wide; the conventional range from 20 Hz to 20 kHz is about 10 octaves wide. Considering that constant-velocity devices—dynamic pickups and cutter heads—have an amplitude that's inversely proportional to frequency at a rate of 6 dB per octave (that is, if you halve the frequency, you double the amplitude), this would mean for the above-chosen 7 centimeters/second velocity at 1000 Hz and the resultant amplitude of .00087 inches, that the amplitude at 20 Hz would be .044 inches and .000044 inches at 20 kHz. Both these extremes are obviously impossible. Something's got to give! At the low end, the available groove space couldn't possibly accommodate such excursions. At the high end there is plenty of room available in the groove space for wider excursions, but noise is the limiting factor.

To overcome these limitations, we must modify the system to restrict the amplitude of excursion in the low-frequency part of the spectrum and to increase the amplitude at the high end. This is done by recording equalization. The amplitudes in the low end are limited by changing the cutter head's characteristic at 500 Hz from constant velocity to constant amplitude. This frequency is called the turnover point. The level of the voltage driving the cutting stylus, and therefore the cutting stylus velocity, is rolled off at a rate of 6 dB/octave. The normal rise in amplitude of 6 dB/octave with lowering frequency is thus exactly balanced and the amplitude remains constant. All this is shown graphically in Fig. 2.

Above the turnover point, the voltage driving the cutter head, therefore the stylus velocity, is increased with frequency. This produces an almost constant amplitude characteristic, as in the low end. This lifting of the level above the turnover is called pre-emphasis. The resulting recording characteristic is the exact inverse of the standard RIAA playback characteristic. (Actually, the recording characteristic is controlled by geometry, and the RIAA playback characteristic must compensate for it.)

There is a third section or time constant in the RIAA characteristic in addition to the high end pre-emphasis and low end constant amplitude time constants. This provides for a slight increase in the recorded level in the very low bass end so that turntable rumble will be somewhat reduced in playback.

Stereophonic grooves

Standard stereophonic grooves are cut with the 45-45 degree system originally described by Blumlein so many years ago, now called the Westrex system. The unmodulated grooves are identical to today's standard monophonic grooves. Because of the adoption of smaller-radius playback stylus tips (0.7 and, recently, 0.5 mil) for stereo cartridges, the minimum dimensions of stereo grooves can be somewhat smaller.

The left and the right channels are recorded each at 45 deg. to the surface of the disc. The motion of the cutting stylus for each channel is basically the same as that in mono recording. The stylus tip moves along a straight line at an angle of 45 deg. in mono recording; this straight line is parallel to the surface of the disc. When the stylus moves along this 45-deg. degree line, its movement is somewhat side to side and somewhat up and down. More technically speaking, there is both a lateral and a vertical component of stylus motion. The second channel is recorded in exactly the same way, except that the line of stylus motion is tilted at 45 deg. in the other direction, making an angle of 90 deg. between the two lines of motion. The resultant stereo groove is thus a combination of both lateral and vertical motion.

If the two channels of the cutter head are fed identical signals, the vertical components will add together and produce a vertical motion of the cutting stylus twice as great in amplitude as would be obtained by feeding one channel alone. The lateral components are also equal, but in opposite directions, so that they cancel one another. Obviously, there is no resultant lateral motion. In case the two channels are fed out of phase, just the opposite occurs—the vertical components cancel and a purely lateral or monophonic groove is cut. These relationships are shown graphically in Fig. 1.

In most stereo tapes, the bass frequencies (from approximately 200 Hz on down) are in phase. This is true of conventional recording techniques, but not necessarily true where extremes of separation are attempted. It is desirable to have this in-phase or mono information appear as lateral modulation, primarily because stereo records are sometimes played with a mono cartridge. To achieve this lateral motion for in-phase signals, one of the channels in the cutter head is reversed in phase by the manufacturer so that mono signals may be fed in phase to the cutting channels. From this it can be seen that, for composite stereo signals, all information that is in phase from the two channels appears as lateral modulation and all signals that are out of phase produce vertical modulation. The lateral modulation is produced by the sum of the right and the left channels, while the vertical modulation is produced by the difference between them. Another way of looking at the whole picture is that mono is merely a special case of stereo where the left and right channels are identical.

It is common practice today to cut mono records with stereo cutting systems. This requires top-quality stereo cutting systems in which no vertical modulation results from cutting channels being driven in phase. It is clear that it won't be long before strictly mono cutting systems become a thing of the past. Æ

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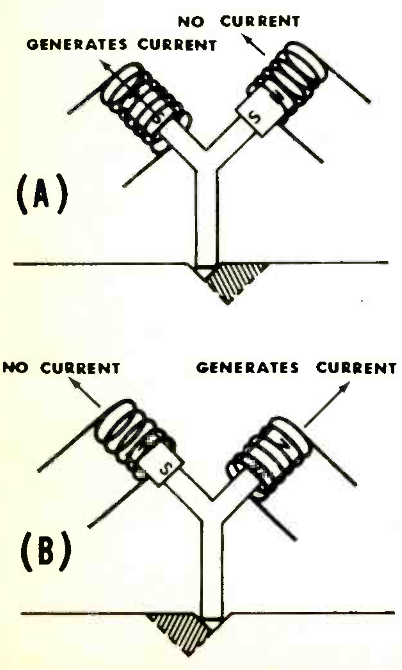
Stereo Disc Playback

CHARLES R. DOTY, Sr.

IT WAS JUST ABOUT this time ten years ago when stereo discs became a commercial reality. Amidst intra-industry wrangling about which system to adopt, a record company *(Audio Fidelity)* jumped the gun and produced a stereo record based on the Westrex 45°/45° system, as attendees of the New York high fidelity show at the end of '57 might recall. Shortly thereafter, the Westrex system was adopted by the Record Industry Association of America (RIAA), and the stereo disc and stereo disc playback equipment entered the main stream of America's home entertainment scene.

The single-groove stereo record spawned single-stylus phono cartridges with two internal elements. The playback system, as we know it today, is based on a stylus following the undulations of a record groove which is cut with groove walls at a 90° angle to each other, each 45° from the horizontal, as shown in Fig. 1. The motion that the stylus makes while in a stereo record groove is transformed into two distinct signals. Of course, it is impossible for a playback stylus to move in separate 45-deg. directions simultaneously. Actually, signals are generated according to the resultant of two vector forces, as illustrated in Fig. 2. So unlike mono records, which employ grooves that cause styli to move laterally, stereo records induce styli to move both laterally and vertically.

Fig. 1—Drawings show how movement of a stylus in a stereo record groove can cause an output in a phono cartridge's right channel (A) or left channel (B).



Some basic stereo system setup pointers are recapitulated here for new readers. Figure 3 shows the principle of stereo reproduction. In this mode of operation the sounds are picked up by a microphone on the left and a microphone on the right of the musicians. More than two microphones are often used to feature certain instruments, but the principle is the same. The violin on the left, marked X, is nearest to the left microphone. The left microphone will therefore pick up more sound energy from the violin than the right microphone. In the case of the drum, marked Y, equal sound intensity will be picked up by both the left and right microphones as it is located midway between them.

The sounds picked up by the left and right microphones are passed through separate amplifiers and recorded on magnetic tape. At a subsequent time the tape data is transferred to a master disc. By ingenious use of a combination of lateral and vertical motions, the master disc cutting stylus engraves both information channels in the side walls of a single V-shaped groove. Each groove wall is engraved at a 45 degree angle with respect to the disc surface.

When the finished records are played, the stereo cartridge stylus will respond by producing two independent outputs which are identical to the sounds heard by the left and right microphones during the recording session. These sounds are amplified (by separate amplifiers) and fed to left and right speaker systems, the combined output of which produces the stereo effect. Violin X will be heard on the left and drum Y will be heard midway between the two speakers. Other instruments will assume their relative positions due to the difference in sound intensities picked up by the left and right microphones during the recording session. The result will be a sound pattern emitted by speakers which is identical to the sound field picked up by the microphones.

The mere fact that a stereo record is being played on stereo equipment does not necessarily mean that one is getting the full impact of its potentialities. (Nor does it imply that it is high fidelity sound.) Certain rules must be followed to obtain the best reproduction, as follows:

Speakers are potentially one of the most important units in a high-fidelity stereo sound system. They must be installed properly if best results are to be obtained.

Before trying speakers in various positions in the room to determine the location where they sound best, they should be phased so that their cones will move in and out in unison. A good check on proper phase is to position the speakers a few feet apart, facing toward you, and play a passage from a mono organ record containing low pedal notes. Controls should be set to "MONO" or "A+B." Note the intensity of the low notes and then reverse the two connecting wires to one of the speak-

(Continued on page 60)

Fig. 2—A stereo cartridge's stylus cannot be in two places at the same moment, of course. The stylus makes one resultant motion. The drawing at left shows the sum of equal left and right signals as a vertical motion line; at right, a strong left signal added to a weak right signal produces a diagonal stylus motion.

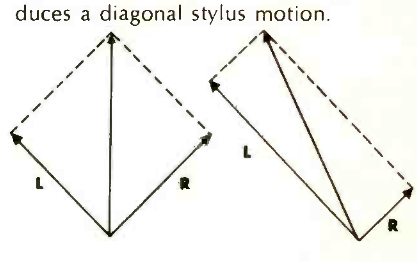
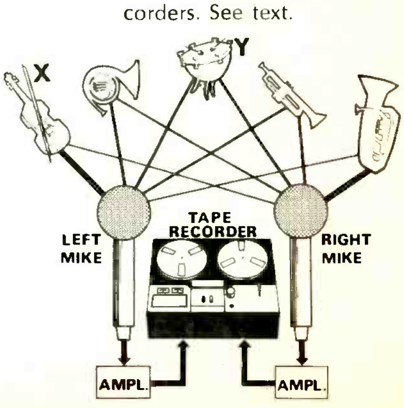


Fig. 3—Stereophonic recordings are initially made with multi-channel tape recorders. See text.



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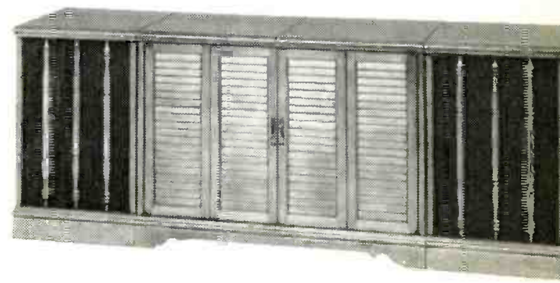

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Electro-Voice displayed its line of professional microphones as well as hi-fi stereo electronic components.

The 33rd Audio Engineering Society Convention in New York City was a smashing success. A large variety of technical papers were presented by their authors (see AUDIO, October 1967), with audience participation spicing discussions.

The exhibit of professional audio equipment, with over 35 manufacturers displaying their technical wares, garnered favorable comments from attendees. Aside from the interest generated by new products, exhibit booths were manned by truly knowledgeable representatives who did a splendid job fielding questions on products and applications.

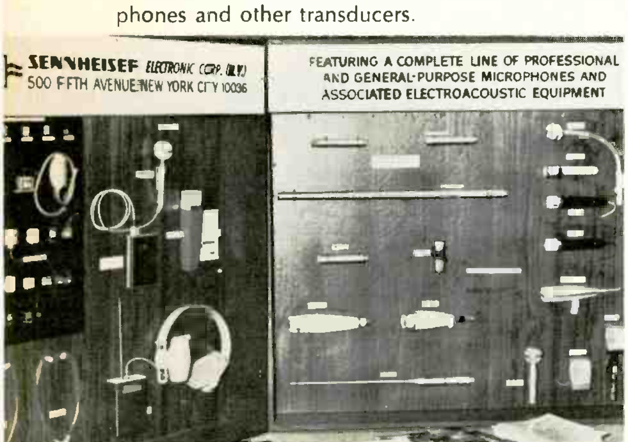
A number of exciting developments were shown at the exhibit. For example, *Dolby Laboratories* had a separate listening room where attendees were treated to playback of recorded tapes before and after they were "Dolbyized." Next door, *Gotham Audio* featured a great many new products, including: Neumann FET transistor microphones, an FM stereo monitoring receiver, miniature integrated amplifier/speaker system for monitoring purposes, and a direct-reading audio wattmeter.

Altec Lansing spotlighted a control console, "Voice of the Theatre" speaker systems, and other professional sound equipment.

Electrodyne featured its audio control console.

Gotham Audio's demonstrations of operating equipment attracted considerable attention. The company's EMT 930 Studio Turntable System is shown in the background. Dr. Neumann (left) and Stephen Temmer, president of Gotham Audio, are shown in inset.

Sennheiser exhibited its complete line of microphones and other transducers.

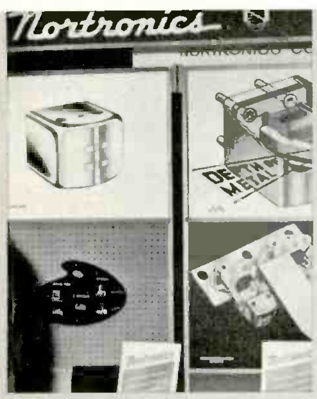


Show Time

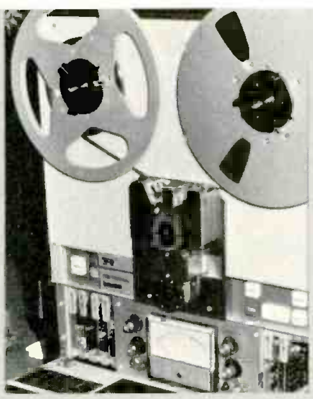
Among other interesting developments shown at the AES show were: *Altec Lansing's* solid-state condenser microphone system; *Ampex'* 24-track, 1-in. tape recorder; *Bozak's* line of commercial amplifiers; *Capps'* models of styli, 50X normal size; *Computron's* (BASF) impressive display of different magnetic tape formulations; *Crown's* new computer logic control tape transport; *Gauss'* 120 ips (who says tape speed is getting slower?) tape machine for duplicating purposes; *Electro-Voice's* long line of microphones, including "shotgun" types; *Fairchild Recording's* thin-line series of speech input equipment; *Lang's* custom studio equipment; *Nagra's* miniature, portable, battery-operated tape recorders; *Norelco's* line of AKG microphones; *Nortronic's* broad line of magnetic tape recorder heads; *Phase III's* electronic music equipment, with Robert Moog showing 'em how; *Scully's* new professional tape recorders; *Sennheiser's* wall of mikes of various types; *3M's* "Isoloop" tape machine, as well as its magnetic recording tape and "tape-on" speaker wiring system; *Universal Audio* debuted its battery-operated, three-frequency test generator; *Vega* exhibited its wireless microphone system.

Shown here are some exhibit scenes captured at the show.

Dr. Ray Dolby demonstrates how his audio noise reduction system operates. He A-B'd recorded tapes, made with and without the Dolby system. Other components used here included Scully tape equipment, an Altec Lansing audio amplifier, and giant Tannoy speaker systems.



Nortronics displayed its magnetic tape heads.



The 3M Co.'s "Isoloop" professional tape recorder with front panel removable printed circuit boards.

Ampex's professional audio equipment.

Computron's BASF magnetic recording tape line.

◀ Crown displayed its new computer logic control tape machines.

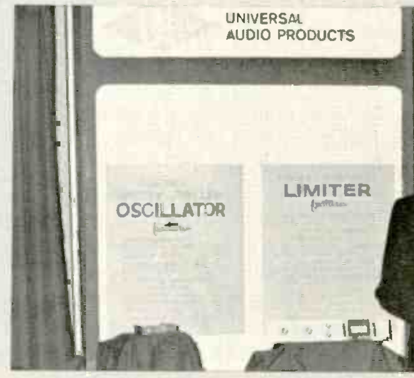
Scully exhibited a broad line of tape equipment. ▶

The Audio PROs at Show Time
(Continued)

Lang shows line of recording and broadcast equipment, including a new compact mixer and tape playback amplifier.

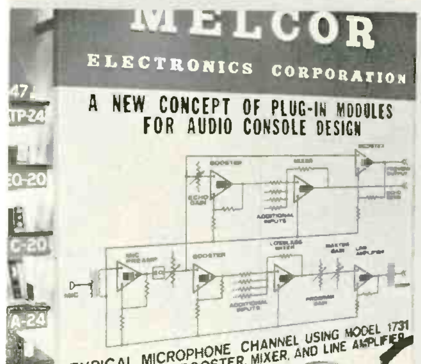
AES Convention attendees prove that pro's and consumers share some things in common. That's AUDIO's Ed Canby in the background.

Fairchild Recording's in-depth line of professional components.



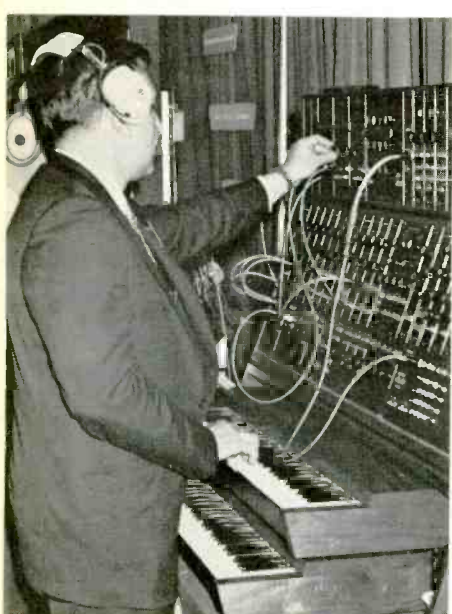
Universal Audio featured an FET limiter and test oscillator.

Melcor displayed plug-in modules.



Langevin showcased its mixers and power amplifiers.

Do-it-yourself composition of electronic music at Phase III's booth.



Bruel & Kjaer exhibited test instruments, including a new tape recorder for lab measurements. General Radio showed how its Strobotac (electronic stroboscope) stopped motion of a speaker's vibrating cone so that its movements can be analyzed.

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Features: Out of intensive research comes the Marantz "passive RF section" a revolutionary new development which advances the state of art and eliminates the overloading problems commonly encountered in strong signal areas . . . Four I.F. stages assure maximum phase linearity and maximum separation . . . an integral Oscilloscope, a Marantz hallmark, provides absolute tuning accuracy and permits elimination of multipath . . . Gyrotouch tuning provides a new experience in quick, silky-smooth station selection and precise tuning. **Amplifiers:** Solid-state throughout with a massive power output of 40 watts continuous rms per channel, from 20 Hz to 20k Hz, nearly three times the output of many receivers rated at 60 "music power" watts . . . Direct coupled design for instantaneous recovery from overload . . . Automatic protector circuits for amplifier and speaker systems eliminate program interruptions . . . Total distortion from antenna input to speaker output is less than 0.2 per cent at rated output . . . and substantially less at listening level. Flawless performance was the design objective. Flawless performance has been achieved.

Specifications: **Tuner Section:** Signal-to-Noise Ratio — 70 DB; Harmonic Distortion at 400 Hz, 100% modulation — 0.15%; Frequency Response, 75 microsecond de-emphasis — ±0.5 DB; Multiplex Separation, 20 Hz — 43 DB, 1000 Hz — 45 DB, 10k Hz — 35 DB, 15k Hz — 30 DB. **Amplifier Section:** Power, 40 rms watts per channel at 4 and 8 ohms, 20 Hz to 20k Hz; Distortion, 0.2% THD; Frequency Response, 15 Hz to 30k Hz, ±0.5 DB. **Dimensions:** 18¼″ wide x 16″ deep x 6″ high.

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Microphones for Sound Reinforcement Systems Part 2

ARTHUR C. DAVIS & DON DAVIS

Microphone sensitivity, do-it-yourself sensitivity measurement, and directionality are discussed in this installment

THE FIRST ARTICLE IN this series discussed reinforcement microphones in general and looked into some of the specific characteristics of the moving-coil method of acoustic-to-electric transduction. Going again to characteristics of microphones, in general, we next need to consider the amount of electrical signal the microphone actually generates by means of the acoustic wave.

Microphone sensitivity

Microphone sensitivity, both actual and apparent, can be discussed at this point. Moving-coil microphones, properly designed, can exhibit excellent sensitivity.

Actual sensitivity can be best visualized by recognizing the following: Some sounds can have such a low SPL at the frequency at which they occur that the pressure exerted on the microphone diaphragm does not create sufficient voltage to override the voltage generated by the internal impedance of the microphone itself. (This "self noise" is the reason carbon microphones aren't used in reinforcement work.)

In other words, one microphone's "self noise" may be great enough to mask a signal that is clearly reproduced by a second microphone with a lower "self noise" threshold. From this consideration, coupled with the level at which the diaphragm and/or voltage-generating mechanism overloads (due to excessive acoustic pressure), the dynamic range of the microphone can be calculated.

Here is a common misconception regarding microphones: If you connect two microphones into a mixer amplifier, whichever mixer control is set lowest for the same SPL at the microphones indicates the most sensitive of the microphones. This is not entirely true. While it is an indication of the effective output of the microphone, and as such aids in designing input amplifiers, among other circuits, it does not tell the operator which microphone will pick up and reproduce weak sounds with the least noise.

Factors to be considered in evaluating "self noise" in microphone systems is shown in Fig. 1. When extremely quiet studios are used, all of these factors become almost equal in value if all design parameters are maximized. (Barkhausen noise is an exception to this. It is usually much lower in level than the other noise sources.)

Apparent Sensitivity. Apparent sensitivity is another matter. Conversion charts in Fig. 2 allow quick

USING THE MICROPHONE SENSITIVITY CONVERSION CHART

Microphone sensitivity can be specified by several different methods. To properly compare the rated sensitivity of two different microphones, their sensitivity ratings must be converted to the same method. The nomograph in Fig. 2 gives the relationship between:

1. The open circuit voltage (S_v). This is normally specified as dB above or below 1 volt if a sound pressure level of 1 microbar drives the microphone diaphragm.
2. The open circuit power (S_p). This is normally specified as dB above or below 1 milliwatt if a sound pressure level of 10 microbars drives the microphone diaphragm.
3. The RETMA sensitivity rating (G_m). This is normally specified as dB below 1 milliwatt if a sound pressure level of 0.0002 microbars drives the microphone diaphragm.

Finding the RETMA Impedance Rating (R_{mr})

To find (R_{mr}) locate the impedance on the Nominal Impedance in ohms scale. These values appear along the base of a triangle which has for a peak the (R_{mr}) values (left hand side of scale). For any nominal impedance along the base of a triangle use the value given at the peak of that triangle. (RETMA impedance ratings do not extend below 19 ohms.)

Example of Chart Use

Have: A microphone with an open-circuit voltage rating of 1 millivolt (−60 dB) and a nominal impedance of 15,000 ohms.

Find: 1. Power level sensitivity
2. RETMA sensitivity rating

Solution: 1. Connect (S_v) to nominal impedance in ohms with a straight line (solid line on chart in Fig. 2). Read power level sensitivity from (S_p) scale (−58 dB)

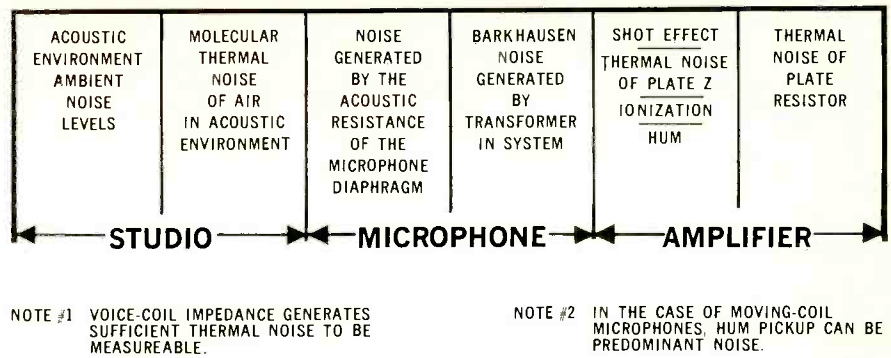
2. To find the RETMA sensitivity rating, locate the RETMA impedance rating. Looking to the left of 15,000 ohms on the nominal impedance scale, we see that 15,000 ohms is along the base of the triangle with 9600 ohms as its peak. Connect 9600 ohms to the open-circuit voltage on the (S_v) scale (−60 dB), the dotted line on chart, and read the RETMA sensitivity rating on the (G_m) scale (−150 dB)

Finding Open-Circuit Voltage Sensitivity of Microphones Undergoing Impedance Transformation

1. First find the power sensitivity (S_p) rating of the microphone at its original impedance. Using the (S_p) reading as a pivot point, realign with the new impedance rating. The open-circuit voltage may then be read on the (S_v) scale.

References: RETMA Standard SE-105
"Microphones for Sound Equipment"—ASA Standard 224.I
"Acoustical Terminology"

Fig. 1—Sources of self-noise in microphone systems.



conversion of a manufacturer's microphone ratings. The number of conversions that the chart and data sheet supplies indicates the complexity, confusion and consternation that microphone users face when approaching a strange manufacturer's new offering for connection to an existing sound system. The illustrations also allow a quick calculation of the point where microphone output drops below the sound system's electronic "equivalent input noise" (EIN) figure.

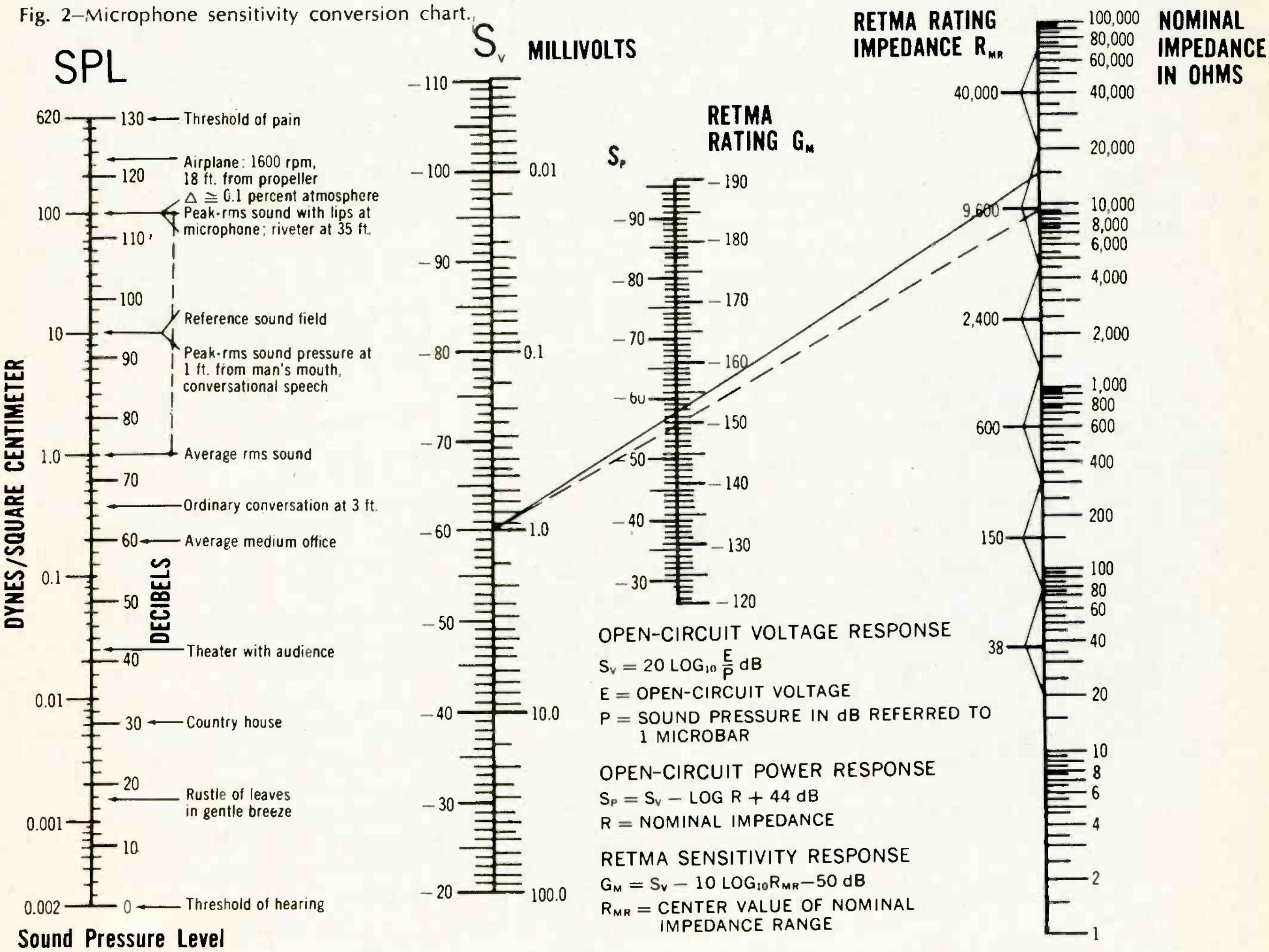
In using microphones in professional sound system work, every effort should be taken to obtain accurate, reliable threshold figures from the microphone manufacturer being specified.

Do-It-Yourself Measurement. In designing a control console for a sound reinforcement system in which a microphone you are not completely familiar with (and in many cases, those you think you are familiar with) is to be used, the following test is invaluable:

(1) Set up a test speaker in the manner shown last month (first article in the series) for measuring acoustic gain.

(2) Place this test speaker two

Fig. 2—Microphone sensitivity conversion chart.



feet in front of a sound level meter (SLM) and right on its most sensitive axis (0° incidence).

(3) Using the SLM in the exact position the microphone to be tested will occupy, set the test loudspeaker (using random noise for a source) to a reading on the SLM of 100 dB SPL. (This is the typical SPL generated if the lips are pressed against the microphone while talking.)

(4) Now substitute the microphone to be tested in place of the SLM. The output of this microphone will be led to the input of the microphone preamplifier used in the console; output impedance of the microphone should match the nominal source impedance of the microphone preamplifier. (Since microphones are not normally terminated at the input of the microphone preamplifier, and the actual input impedance of the preamplifier is usually many times that of the nominal source impedance rating; measurements of the microphone output alone does not tell the whole story.)

Terminate the output of the microphone preamplifier in its rated load, read the output level in dBM and examine the waveform with an oscilloscope. Many times at this point, it will be discovered that the microphone preamplifier is being grossly overdriven. Therefore, an input loss pad ahead of the preamplifier would be required (or else a less sensitive microphone).

It is not unheard of to encounter output levels from microphones that exceed −15 dBm in actual service (for example, a trumpet blown into it at 130 dB SPL). In the case of a typical high-quality preamplifier with a gain of 51 dB, the output level would have to be +36 dBm. (In this case, the actual maximum output level for rated distortion of this amplifier is +27 dBm.)

The natural solution is to insert at least a 20 dB loss pad ahead of the preamplifier. (A bridging-type pad is often used to avoid loading the input of the preamplifier.) Overdriving the very first amplifier stage is more common that is ordinarily realized. Most sound engineers don't believe it until they try this test on one of their own sound systems.

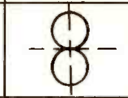
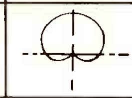
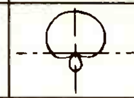
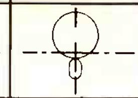
MICROPHONE	OMNIDIRECTIONAL	BIDIRECTIONAL	DIRECTIONAL	'SUPER-CARDIOID'	'HYPER-CARDIOID'
DIRECTIONAL RESPONSE CHARACTERISTIC					
RANDOM ENERGY EFFICIENCY (%)	100	33	33	27	25
FRONT RESPONSE / BACK RESPONSE	1	1	∞	3.8	2
FRONT RANDOM RESPONSE / TOTAL RANDOM RESPONSE	0.5	0.5	0.67	0.93	0.87
FRONT RANDOM RESPONSE / BACK RANDOM RESPONSE	1	1	7	14	7
EQUIVALENT DISTANCE	1	1.7	1.7	1.9	2
PICK-UP ANGLE (2θ) FOR 3 dB ATTENUATION		90°	130°	116°	100°
PICK-UP ANGLE (2θ) FOR 6 dB ATTENUATION		120°	180°	156°	140°

Fig. 4—Directional response characteristics of microphones.

Microphone directionality

The first carbon microphones made were of the pressure type and exhibited essentially omnidirectional response. These were followed by the early condenser microphones developed by Wente and Thuras of Bell Telphone Laboratories.

Ribbon Microphones. The development of directional microphones began with the ribbon microphone. The ideal ribbon microphone presents a ridged surface supported by corrugated suspension at each end, allowing the working length of the ribbon (the part that cuts the magnetic field of force) to move as an unflexed plane through the magnetic lines of force.

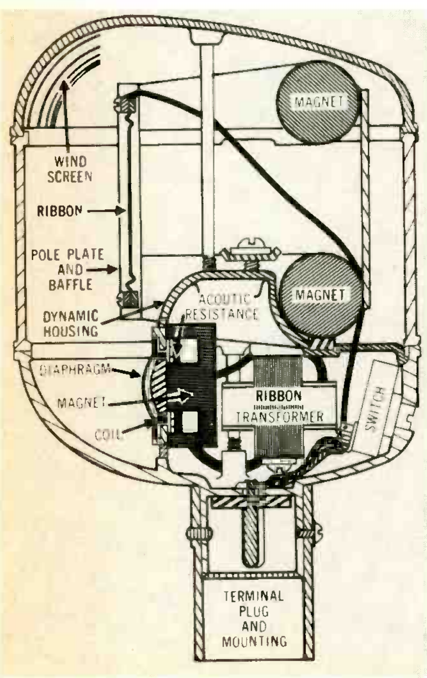
This metallic ribbon is suspended in the magnetic field and is freely accessible to air vibrations from both sides. The ribbon responds to the difference in pressure between the front and the back surface. In other words, it responds to the pressure gradient or the particle velocity. The electrical output waveform of a ribbon microphone follows the same rules as does the moving-coil microphone. While the ribbon responds directly to the particle velocity of the sound wave, it generates its voltage proportionally to the velocity of the ribbon in the magnetic field. (See Fig. 3, where a ribbon and a moving-coil microphone share the same case.)

If a wave in a far field approaches the ribbon at 90° to the front axis the result is *no pressure gradient* between the front and back of the ribbon; therefore, no movement of the ribbon. This makes the ribbon microphone a highly efficient bi-directional microphone. (See Fig. 4.) In studio usage this directional pattern can be useful in discriminating against unavoidable ambient noise.

The ribbon microphone suffers three handicaps to widespread use in reinforcement systems, though careful professional users do achieve exceptional results with them (even outdoors) if their limitations are thoroughly understood and compensated for:

1. The ribbon is fragile, easily damaged by wind. (Also, it is easily

Fig. 3 – Ribbon and moving-coil microphone share the same case.



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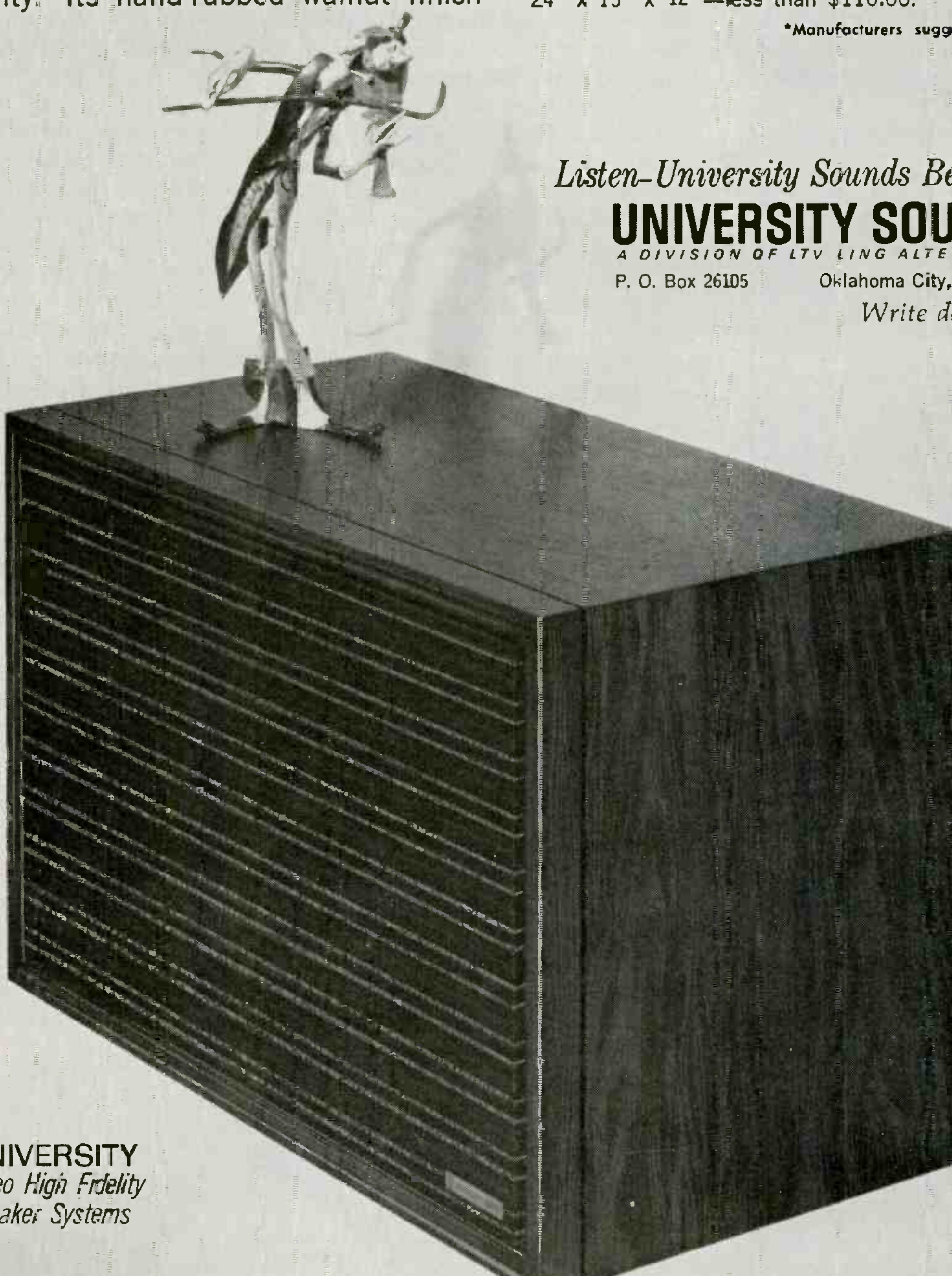
SPECIFICATIONS: 12" woofer—8" mid-range—patented Sphericon tweeter —30-30,000 Hz —35 watts Music Power — continuously variable Brilliance control — 24" x 15" x 12"—less than $110.00.*

*Manufacturers suggested resale price.



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damaged by being knocked down or dropped.) Thus performers should not (as they often do) test the microphone by blowing into it. When it can be shielded from the wind (such as in a wind-free theater in a protected ravine), or mounted where the performer cannot get closer than 6 feet from it (overhead or the far side of the footlights), damage can be minimized. To meet a psychological need, the performer can be given an empty case to carry in his hand while the pickup is made from overhead.

2. The ribbon microphone should not be used where it must be mounted near a large surface. Ribbon microphones placed against a wall lose sensitivity, for example. (The sound wave reflects off the

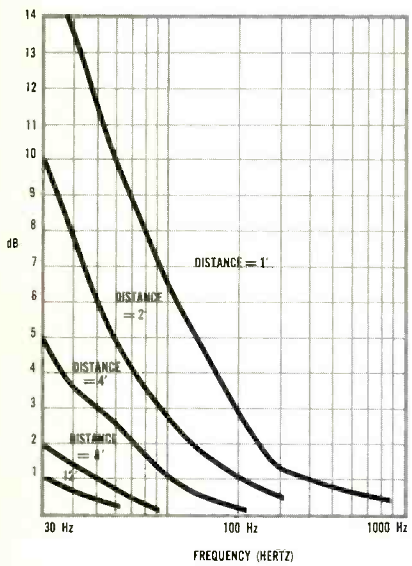


Fig. 5—The low-frequency response of a velocity microphone changes as it is approached due to a proximity effect.

wall to the rear of the ribbon, destroying the pressure gradient. The maximum response of a ribbon microphone will occur $2N - 1\lambda/4$* from the wall. In the case of the moving-coil pressure-type microphone, the greatst output will occur if it is placed next to the wall since its maximum response occurs at the surface of the wall and at intervals of $2N\ \lambda/4$ from the wall.

3. As a ribbon microphone is approached, its low frequency *changes*. This proximity effect is charted in Fig. 5. There is a real necessity to keep performers away from this microphone for best results. The ribbon microphone makes an excellent narration microphone in studios but is usually misused by being placed on the table in front of the narrator rather than on a boom over his head. It should be mentioned that some performers have used the proximity effect to generate special tonal characteristics. In cases of this type, the microphone is used as a generating rather than as a reproducing instrument, and fidelity is dispensed with.

Cardioid Microphones. Cardioid means heart-shaped, and refers to the plane view of the polar pattern. Once the moving-coil pressure microphone and the ribbon velocity microphone were on hand, mathematically-minded people quickly saw an advantageous summation of their voltage outputs. Fig. 6 illustrates the results of such a combintion—the cardioid microphone.

It is necessary to remember, in both the case of the cardioid and the velocity microphone, that the polar patterns, while illustrated in two dimensions, exist in three dimensions. That is, an omnidirectional microphone polar pattern is not a circle, but a sphere. The polar response of a bi-directional microphone resembles two spheres, and a cardioid's response resembles a pumpkin, with the microphone located at the stem position.

In well-designed microphones, the vertical polar response will closely approximate the horizontal response. (Many mysterious problems have been solved by discovering that, in "bargain microphones," the horizontal and vertical polar characteristics were not the same.

The ability to vary the rear lobe on a directional microphone is the best known method of picking up both a weak voice and a strong voice in the same area. Placing the strong voice on the rear side of the microphone

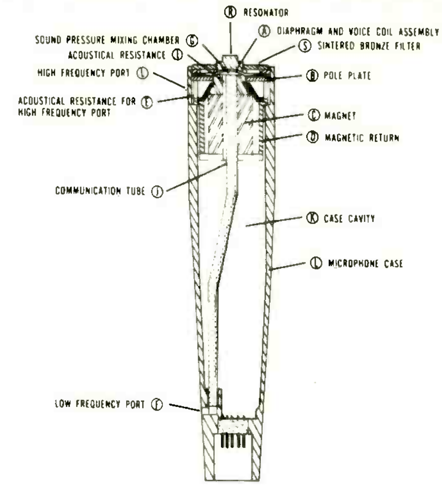


Fig. 6—Cross-section of a typical cardioid microphone.

allows you to attenuate it (relative to the weak voice). The cardioid pattern can also be obtained from the moving-coil microphone alone if access to the rear of the diaphragm by the sound wave is carefully planned in relation to phase.

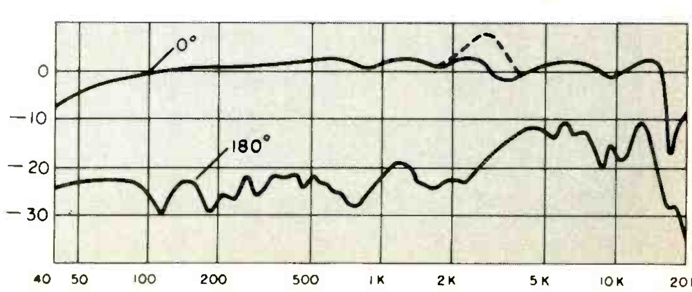
Figure 6 shows the internal construction of such a microphone, with its rear ports for high and low frequencies and the necessary communication tubes.

Fig. 7 details the frequency response taken first on the 0° axis, then on the 180° axis. Sound reinforcement engineers must be careful to avoid microphones whose 180° response introduces detrimental amplitude or phase changes, thereby triggering premature feedback problems. Recording and broadcast engineers, however, can safely ignore such details. (Where a Radio-TV show includes sound reinforcement to a live audience, an acoustical engineer is a worthwhile consultant to have available.)

Condenser-type Microphones. The condenser-type microphone comes closer to the perfect transducer than any other practical microphone in

(Continued on page 58)

Fig. 7 — Frequency response on 0° axis and 180° axis.



N = an integer, λ = wavelength

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The AM section of the Five-Thirty employs a MOSFET front-end and separate AM board with its own I.F. strip. The result is a radically new sound in AM—an AM radio that serious music listeners can take seriously.

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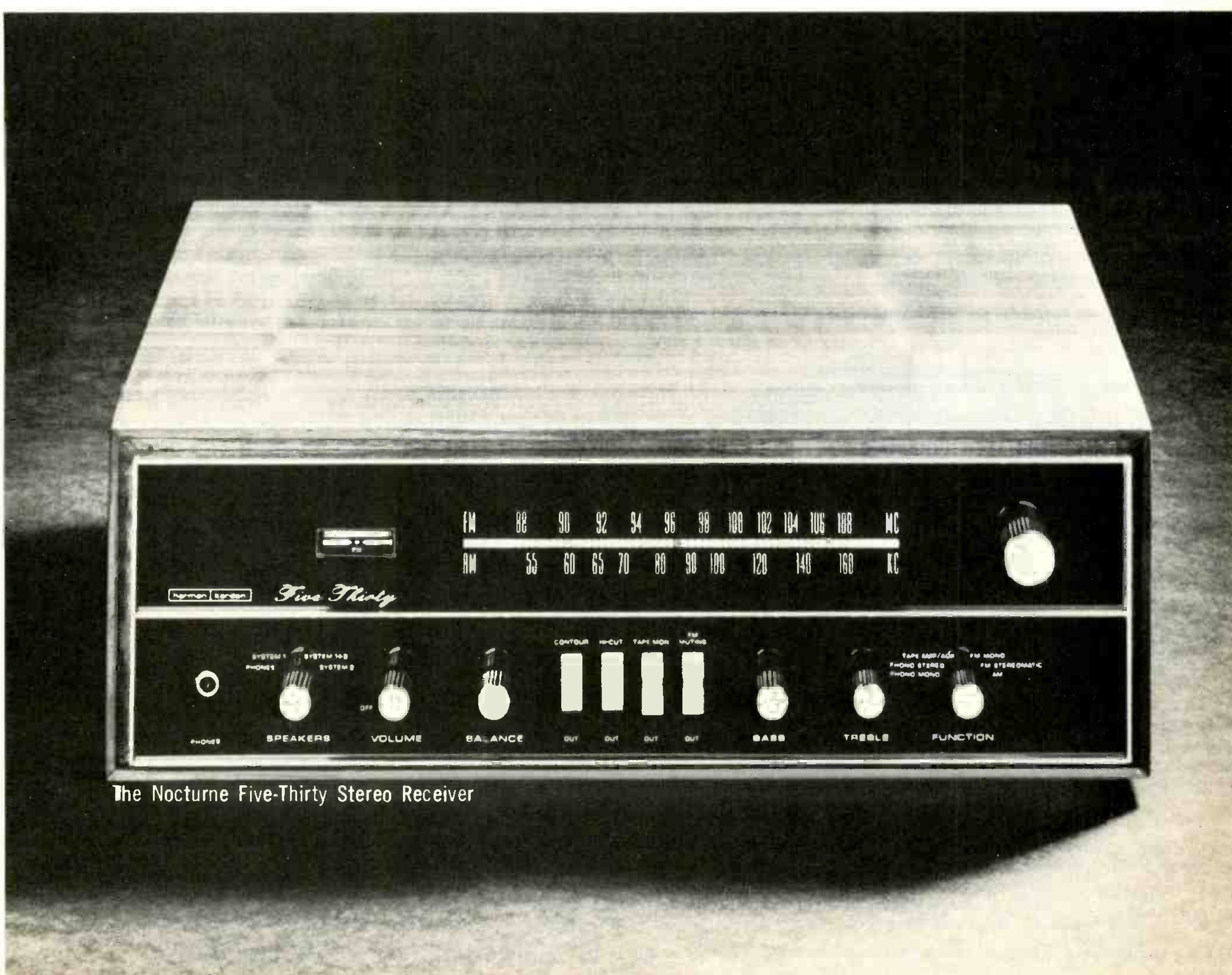

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EQUIPMENT PROFILES

University Sound "Studio Pro 120" FM Stereo Receiver

MANUFACTURER'S SPECIFICATIONS—Total Music Power (IHF): 120 watts at 4 ohms, at 0.8% THD. Continuous Power (RMS): 30 watts per channel at 8 ohms, 0.3% THD. Power Bandwidth: 10 Hz to 40 kHz, at 0.3% THD. IM Distortion: Less than 0.5% to rated output. Frequency Response, 1 Watt: 10 Hz to 100 kHz +0, −3 dB. Noise and Hum: Tape monitor, −83 dB; AUX, −80 dB; Phono, −60 dB; Tape Head, −63 dB; all below full output. Input Sensitivities: Tape Monitor and AUX, 0.4 volts; Tape Head, 1 mV; Phono, 4 mV. Damping Factor: 50:1. FM Sensitivity (IHF): 2.3 microvolts. IF Image Rejection 90 dB. Alt. Channel Selectivity: 55 dB. FM Frequency Response: 20 Hz to 20,000 Hz ± 0.5 dB. FM Stereo Separation: 40 dB at 1 kHz. FM Distortion: Less than 0.5% for 75 kHz deviation. Dimensions: 16⅜-in. x 4½-in. x 12-in. deep. Weight: 17 lbs.

University Sound has been quietly engaged in manufacturing of electronic equipment for military purposes for some years now, but has restricted its consumer activities to transducers—until now! With the introduction of its "Studio Pro 120" FM stereo solid-state receiver, the company embarks on a new road.

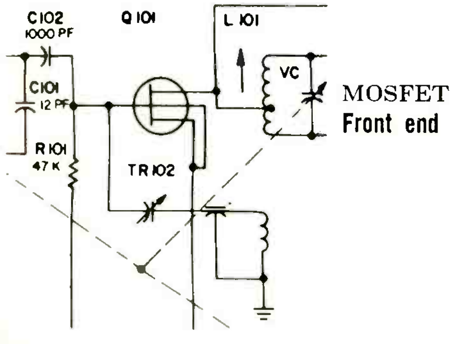
It has done so with a receiver which, through its excellent performance, functional design, company wherewithall, and price ($379.50), is destined to be a formidable competitor to other receivers.

The Studio Pro 120 does not feature any design breakthroughs in the sense of a radically new device or circuit. Rather, it incorporates good design philosophy that takes advantage of the state-of-the-art devices and circuits available to engineers. The unit includes 31 silicon transistors (including a front-end MOSFET), 21 diodes, and two of the latest integrated circuits, for example. And starting from scratch, the company was not locked into designs that would be costly to change in one fell swoop. The result is a sensibly arranged front and rear panel layout, a refreshingly handsome appearance, and some extra comforts that will be noted later.

Operated by gold anodized, solid aluminum knobs, primary control functions include the usual selector switch, dual bass and dual treble controls (clutch operated for individual settings of left and right tonal response), balance control, gain control and tuning control. The smooth mechanical action of all of these, including the flywheel action of the station selector, rivals that found in some professional equipment. The front itself is a tasteful, gold anodized, brushed aluminum panel, complemented by a matching anodized dust cover (supplied at no additional cost). As shown in Fig. 1, two walnut side panels (optional at extra cost) may be affixed to "dress up" the unit for open-shelf installation.

Secondary controls are actuated by eight "rocker" switches. These include a speaker-remote switch, MPX, high frequency and low frequency filters, tape monitor switch, loudness contour switch, stereo mono switch, and FM mute switch. All of these switches are arranged so that, in their often-used position, they are similarly depressed. A stereo headphone jack completes the front panel layout.

The softly illuminated tuning dial area includes a positive-acting FM



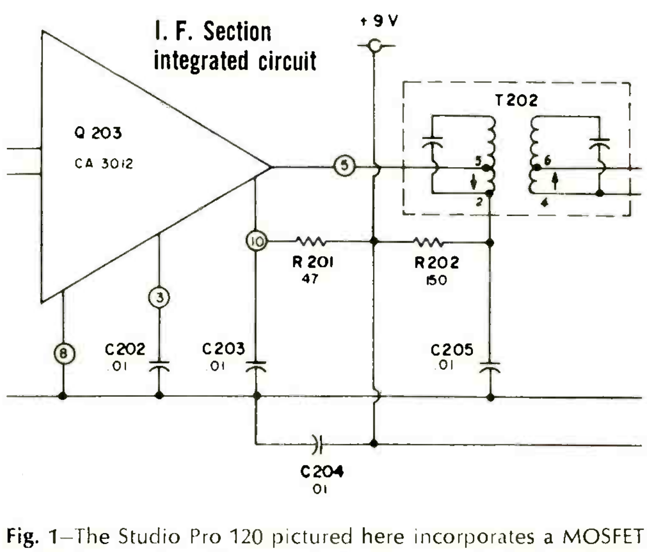


Fig. 1—The Studio Pro 120 pictured here incorporates a MOSFET in the front end and integrated circuits (one of which is shown here as Q203).

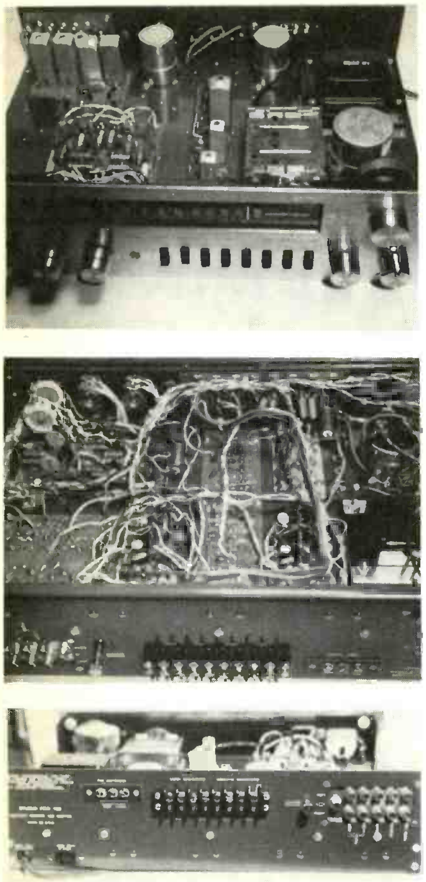


Fig. 2—Silver-plated etched circuit boards, interwired by harnessed wiring, contribute to the Studio Pro 120's professional appearance with the case removed. Neat rear panel layout includes a chassis ground binding post for connection to a turntable's chassis.

Stereo indicator light (which during all tests, instrument and listening, was *never* triggered by interstation noise or any other form of non-stereo interference). An illuminated center-of-channel tuning meter, found to be precisely aligned for perfect tuning, is also located on the front panel.

The rear panel, fully as large as the front panel, serves a dual function. It acts as a massive heat-sink for the four power output transistors (which are mounted on the inaccessible side) and provides a mounting surface for an 8-terminal barrier speaker strip, the inputs and tape outputs, a mixed-channel (L + R) output for use with a third-channel power amplifier, a convenience a.c. outlet, and FM antenna terminals. The " local " connection on the antenna strip was found to be superfluous since, in the case of this receiver, 200,000 microvolts of r.f. input applied to the "distant" antenna terminals did not cause even a trace of overload.

The Studio Pro has some welcome conveniences, including three 1 ampere circuit breakers which re-set automatically (two for the speaker channels and one for the power line) and a thumbscrew binding post for connection of a ground lead (for hum reduction) from a turntable base plate.

Circuitry

The completely shielded r.f. section of the receiver consists of a MOSFET r.f. amplifier, followed by a second bipolar transistor r.f. amplifier, a separate converter and a local oscillator, both of which are also silicon units. The FM i.f. section is comprised of two new RCA CA-3012 integrated circuits (each of which does the job of 10 transistors, and a variety of diodes and resistors). A conventional ratio-detector circuit completes the i.f. chain. Multiplex decoder circuitry includes five silicon transistors (one of which is used to actuate the stereo indicator light), two 1N87 diodes in a 38 kHz doubler circuit and four balanced 1N542 diodes in the demodulator bridge circuit.

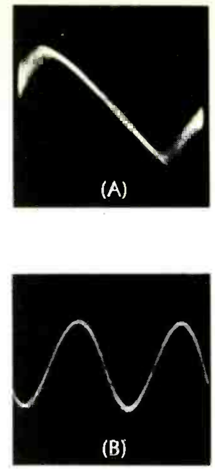


Fig. 3—At only 5μV r.f. input, sweep alignment response at the tuner's output exhibits linear trace (A) of over 300 kHz. This accounts for absence of bandwidth distortion in equivalent resultant sine wave output (B), taken at 75 kHz deviation. Note that only a trace of noise is evident at this low level. Quieting is 48 dB at this signal input strength.

Fig. 4 — Detector output at 25 μV input and sweep of $\pm$400 kHz is almost perfectly linear, resulting in a distortion figure for FM of only 0.5% for 75 kHz deviation.

All low-level audio stages feature 2N2712 silicon transistors. A total of sixteen are used for dual preamplifiers, tone control stages (feedback or Baxandall circuit), and low-level amplifying stages. Complementary driver stages for each channel consist of a 2N3053 (NPN) and a 2N4037 (PNP) combination which drives the 2N5037 output pair for each channel. Neither driver transformers nor output transformers are therefore required, resulting in a circuit which was found to be stable at all conditions of loading from open circuit to a 0.1-μF capacitor across speaker output terminals.

The bridge rectifier power supply

Fig. 5—FM characteristic of the Studio Pro 120 is exceptionally good, requiring a scale shift to begin at 0.1 μV instead of 1 μV.

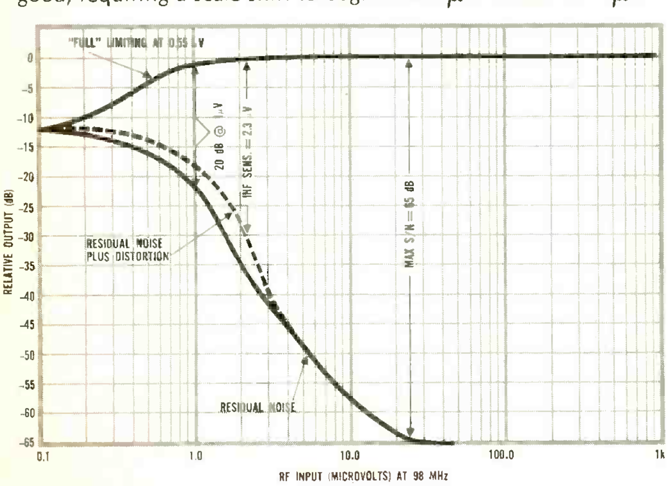
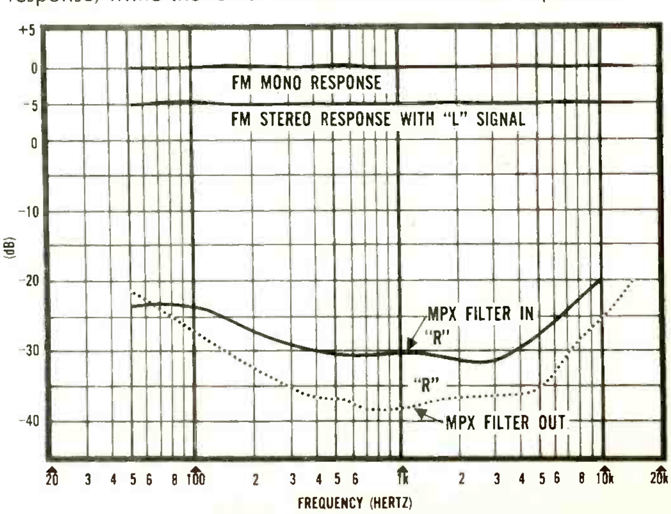


Fig. 6—The upper graph shows the Pro 120's FM mono and stereo response, while the lower curves illustrate channel separation.



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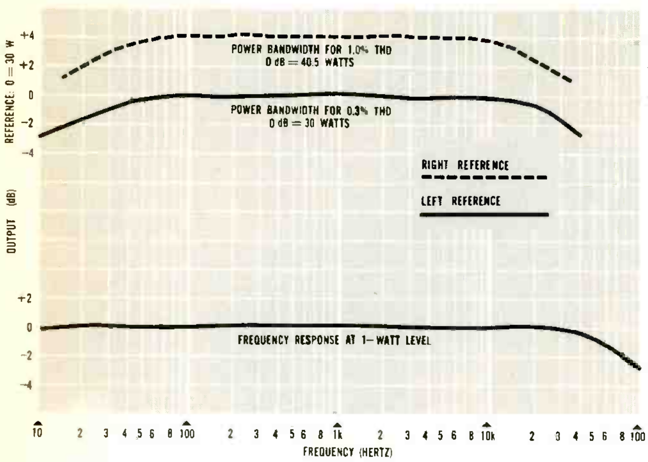


Fig. 7—Power bandwidth and frequency response characteristics.

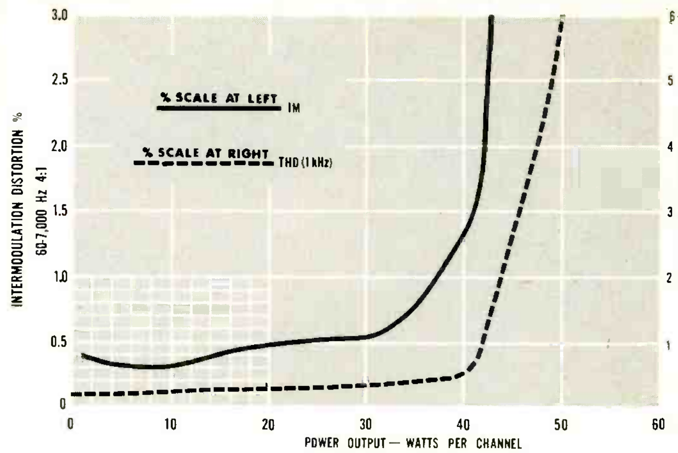


Fig. 8—Intermodulation and total harmonic distortion curves.

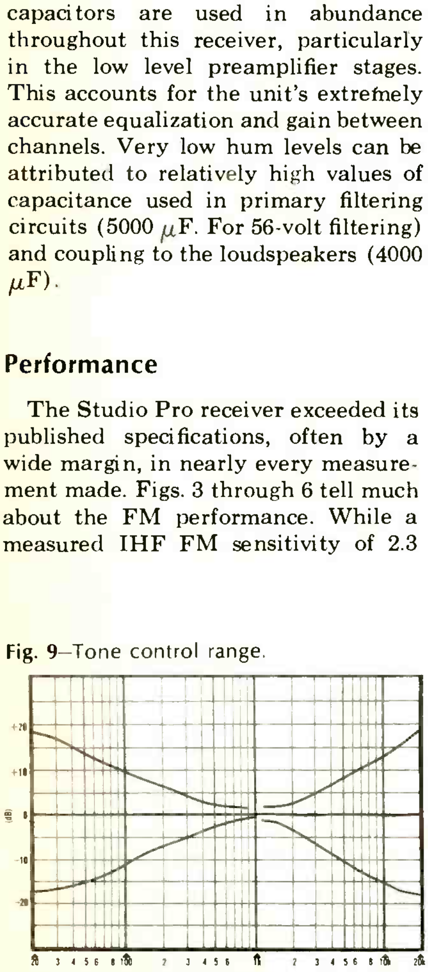
makes available voltages ranging from +56 volts (for the power output transistors) all the way down to +9 and −9 volts. The latter two voltages are zener regulated and are used to power the r.f. section and the i.f. strip.

Five-per cent tolerance resistors and capacitors are used in abundance throughout this receiver, particularly in the low level preamplifier stages. This accounts for the unit's extremely accurate equalization and gain between channels. Very low hum levels can be attributed to relatively high values of capacitance used in primary filtering circuits (5000 μF. For 56-volt filtering) and coupling to the loudspeakers (4000 μF).

Performance

The Studio Pro receiver exceeded its published specifications, often by a wide margin, in nearly every measurement made. Figs. 3 through 6 tell much about the FM performance. While a measured IHF FM sensitivity of 2.3 μV (exactly equal to the manufacturer's rating) tells part of the story, one should recognize that this rating encompasses both residual noise and distortion. As the Studio Pro's r.f. input signal was increased to 5 microvolts or so, however, the FM detector's linear response proved to be so good (Fig. 3A) and so broad (over 400 kHz even at this low signal input) that the recovered audio tone (Fig. 3B), representing full modulation at 400 Hz, exhibited just a touch of residual noise, but virtually no distortion. This is far better (from a listening point of view), than so many cases in which the residual "3%" (or −30 dB) component of the IHF sensitivity measurement consists primarily of distortion. As for "limiting," the receiver may be said to limit on incoming noise, since "full" (3 dB) limiting is achieved at an incredibly low input of only 0.55 μV!

Fig. 9—Tone control range.



The muting circuit does an effective job on muting interstation noise. At the same time, signal inputs as low as 3 microvolts overcome the muting feature.

It should be noted (From Fig. 5) that ordinary 20 dB quieting (without regard to the newer IHF specification) is achieved with an input of 1.0 microvolt (bettering the 1.6 microvolts claimed by University Sound). Total harmonic distortion for 75 kHz modulation is less than 0.5%, at all signal levels exceeding 25 microvolts, thanks in part to a wide-band detector response (shown in Fig. 4) which is almost perfectly linear for about 800 kHz.

As for FM stereo separation, the unit tested missed the 40 dB spec by only 2 dB, but this is a moot point. More important than this reading, which in itself is excellent, is the fact that at least 25 dB of separation is maintained at all frequencies from 20 to 10,000 Hz (see curve of Fig. 6).

Mono and stereo FM frequency response held to the 0.5 dB claimed by the manufacturer.

In high quality FM stereo units, circuit design to reduce reception of SCA broadcasts (background music via multiplex, on a station simultaneously engaged in stereo transmission) often leads to some degradation of separation capability, particularly at high frequencies. University Sound has wisely elected to reject SCA minimally, under normal conditions, since only a few stations engage in this additional, private subscriber service. When a station broadcasting SCA is encountered, however, some interference is noted. But this can then be attenuated by activating the MPX filter mentioned earlier. In this way, optimum separation is maintained for all stations broadcasting only stereo, while minimal reduction in separation is introduced by the filter to reject SCA interference properly for the few stations engaged in this form of broadcasting.

Additional FM specifications that were confirmed by measurement include a capture ratio of 1 dB and an alternate channel selectivity of 58 dB (the manufacturer boasts only 55 db) and FM cross-modulation rejection of better than 95 dB.

Curves and measurements tell much about equipment, but for the ever-growing number of FM-DX'ers, suffice to say that the Studio Pro 120 pulled in 38 perfectly listenable FM stations in the New York City area (of which 13 were broadcasting in FM stereo) on

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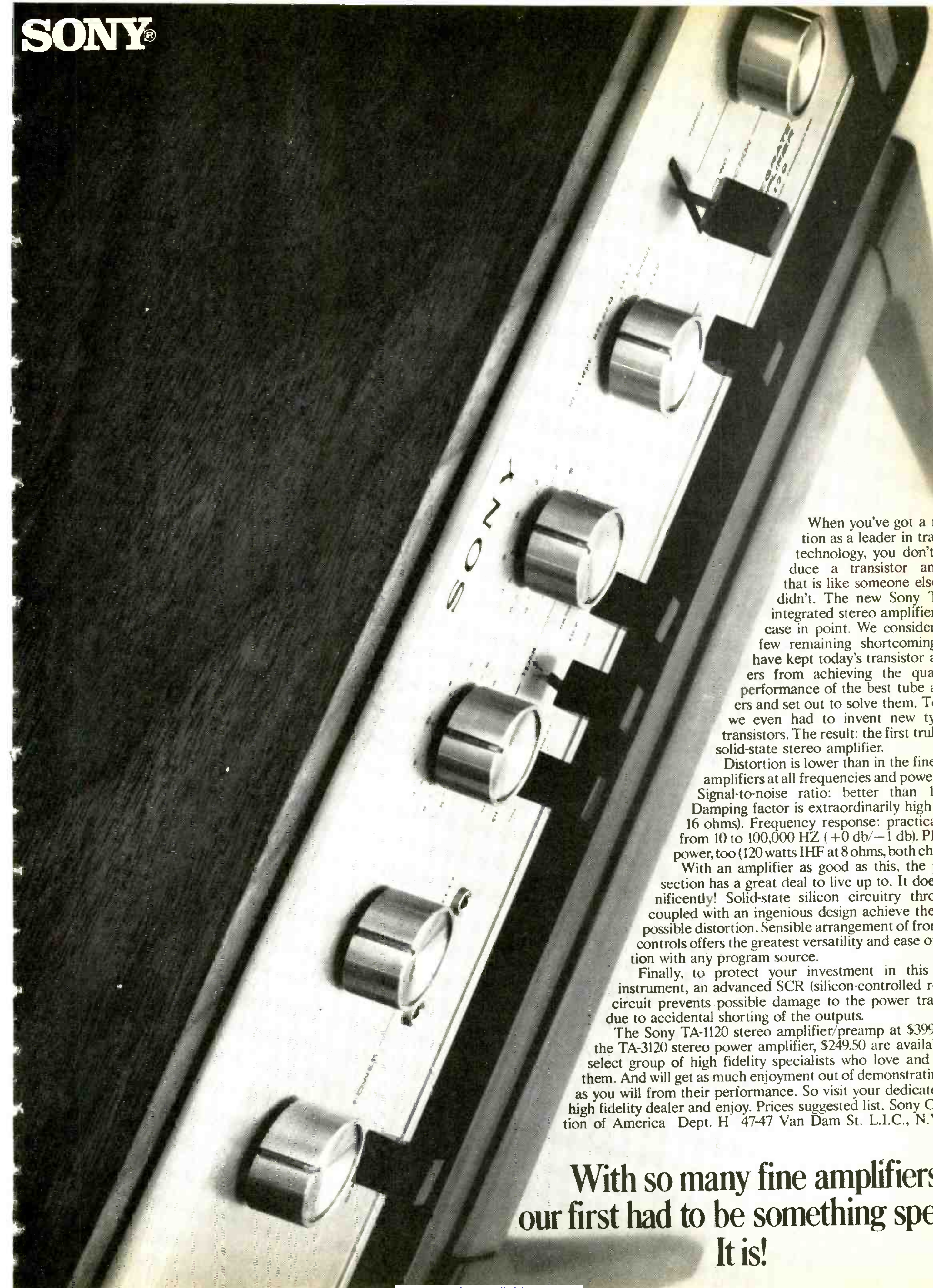

When you've got a reputation as a leader in transistor technology, you don't introduce a transistor amplifier that is like someone else's. We didn't. The new Sony TA-1120 integrated stereo amplifier is the case in point. We considered the few remaining shortcomings that have kept today's transistor amplifiers from achieving the quality of performance of the best tube amplifiers and set out to solve them. To do it, we even had to invent new types of transistors. The result: the first truly great solid-state stereo amplifier.

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With an amplifier as good as this, the preamp section has a great deal to live up to. It does, magnificently! Solid-state silicon circuitry throughout coupled with an ingenious design achieve the lowest possible distortion. Sensible arrangement of front panel controls offers the greatest versatility and ease of operation with any program source.

Finally, to protect your investment in this superb instrument, an advanced SCR (silicon-controlled rectifier) circuit prevents possible damage to the power transistors due to accidental shorting of the outputs.

The Sony TA-1120 stereo amplifier/preamp at $399.50 and the TA-3120 stereo power amplifier, $249.50 are available at a select group of high fidelity specialists who love and cherish them. And will get as much enjoyment out of demonstrating them as you will from their performance. So visit your dedicated Sony high fidelity dealer and enjoy. Prices suggested list. Sony Corporation of America Dept. H 47-47 Van Dam St. L.I.C., N.Y. 11101

With so many fine amplifiers our first had to be something special. It is!

a simple, home-made dipole antenna tossed casually behind the receiver. This means that many of the stations were separated by only one channel-width (200 kHz); yet there was no difficulty in isolating one station from the next, nor was there the slightest audible evidence of co-channel interference.

Amplifier measurements

Though University Sound rates the continuous power per channel at 30 watts and 0.3% distortion, instrument readings obtained were 30 watts at 0.2% THD into an 8-ohm load. Not surprising, the stereo amplifier section is capable of a good deal more power out, so in plotting power bandwidth (Fig. 7), two curves are given. The lower curve is taken for 0.3% THD and corresponds almost precisely with the specifications listed earlier. Since less-conservative manufacturers usually specify a 1.0% THD figure, a second bandwidth plot was made based on this higher distortion figure. The results indicate a power bandwidth of 15 to 35,000 Hz, at 40.5 watts per channel. Curves of IM distortion and THD (for 1 kHz) are shown in Fig. 8.

Tone control range is shown in Fig. 9. Mechanical centering of the tone controls corresponded accurately with uniform or flat electrical response. Loudness compensation is so arranged that, with the loudness circuit in, a boost of approximately 10 dB at 100 Hz is provided at ¼ rotation, whereas at ½ rotation of the gain control, compensation is about 6 dB at 100 Hz. Under actual listening conditions, the loudness action here seemed a bit exaggerated. But many listeners do like enhanced bass and, in the final analysis, the loudness control can be turned off and the individual bass controls used for any degree of compensation.

Using a medium-output phono cartridge to check phonograph performance, levels corresponded nicely with the internal FM audio output, obviating the need to juggle the gain control every time the selector is switched from one mode to the other. As for phono and tape equalization, a plot was taken for comparison with RIAA and NAB (7½-in.) equalization standards, but since deviation never exceeded 0.2 dB, the "curves" appeared as a straight line! Phono hum and noise was less than that specified, measuring 68 dB below full output, referenced to a 5 millivolt input signal at 1 kHz. AUX hum and noise measured 90 dB below full output, a parameter normally associated with separate power amplifiers rather than all-in-one receivers.

Conclusion

Instrument readings never tell the whole story, of course, even with electronic componentry. There are still intangibles for which measurements have not yet been devised. Further, when dealing with readings in the vicinity of 0.1 and 0.2, tolerances of test instruments become significant factors. Consequently, one must live with a product under normal listening conditions for a while. This was done, some for sheer pleasure rather than pure evaluation.

The Studio Pro 120 handled all forms of source material effortlessly in a medium-large living room that has a fairly nice acoustic setting. Using a pair of highly respected, low efficiency speaker systems, the hi-fi stereo system (incorporating the Studio Pro 120) reproduced sound with matchless clarity. Percussion attack was beautiful to hear: crisp, sharp, absolutely clean, no muddiness—take your choice of adjectives.

There is no doubt that this receiver has a superlative audio amplifier. In fact, it's the peer of many separate amplifiers in performance quality. Coupled with an excellent FM tuner, and priced at $379.50, University Sound has made an auspicious entry to the component receiver field. Considering its performance, compact size, and cost, and ignoring the absence of some professional features such as step-type tone controls, output level adjustments for each input, etc., the Studio Pro 120 certainly lives up to its name. Check 98

HAMMOND M-100 CONDENSER MICROPHONES

MANUFACTURER'S SPECIFICATIONS— Omnidirectional condenser microphone with Nuvistor preamplifier. Frequency Response: 20 Hz to 22 kHz, ±3 dB. Sensitivity, 2 mV/μbar. Output impedence, 60 ohms. Power supply operates from 117-V. a.c. line. Microphone size, 13⁄16-in. dia. x 4-in. long. Power supply/carrying case, 4-in. x 4-in. x 12-in.

Fig. 10 – Microsound's Hammond M-100 condenser microphones.

Here is a condenser microphone at a price which makes it possible for the average individual to own one, not just the professionals. Or even to own two, since the price of a pair of Hammond M-100's, together with the power supply, is $229.50. Single, the microphone costs $149.50 with the power supply.

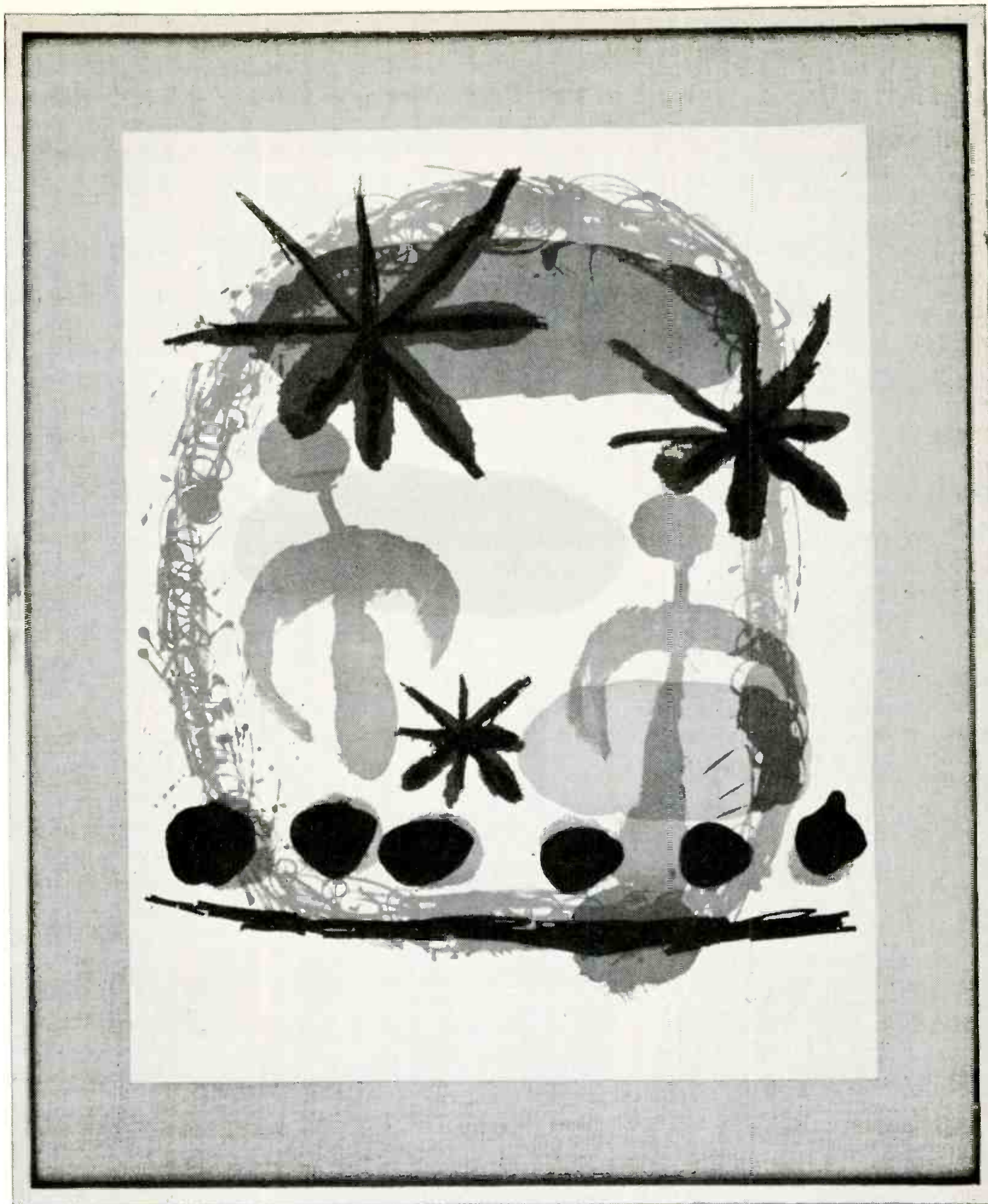
Considering the relatively low price of these microphones, one might be doubtful of the quality. But an inspection should relieve that doubt. The microphones are small and neat, and attach to their Cannon connectors with hardly any noticeable difference in diameter. (Now if the plugs were only black. . . .) The grille is a part of a machined aluminum housing, with the slots covered by a mesh to keep dust out of the diaphragm area. The power supply is built into the carrying case, and all cables can be accommodated in spaces at the ends of the case. These cables consist of two 15-ft. microphone cables, two 9-ft. shielded audio output cables, and the a.c. line cord, also 9 ft. long. The case is a single piece of aluminum bent in the form of a U, with the housing for the power supply in another U which occupies the center portion of the case. Two aluminum tubes are attached to the second U to hold the microphone bodies, thus serving to protect them, store them, or to provide a carrying compartment for them when going out in the "field" for a recording session.

We ran our usual comparison tests with a calibrated condenser mike of another make to determine the frequency response, and found it to be very close to the specifications—as close as such measurements can usually produce in other than an anechoic chamber. The comparative curves are shown in Figs. 1 and 2, the latter being the polar characteristic.

Aside from the human voice, crackling cellophane, jingling keys, and such other "live" sounds, we were not able to do much live recording with the M-100's. However, using reproduced music over a good system, we found that they would take a 95 dB SPL without overloading, and upon playing back, the reproduction was scarcely indistinguishable from the source. Putting the microphones outdoors simply brought the outside sounds right into the house, with birds and automobiles flying by right in the living room. Children playing on the street might as well have been inside as far as the sound was concerned.

The power supply is neatly made, employing a sturdy transformer, three transistors, and a VR tube on a gener-

(Continued on page 60)



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CLASSICAL RECORD REVIEW

EDWARD TATNALL CANBY

The Cat's Meow

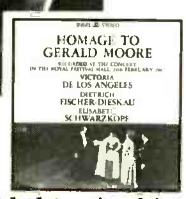
After some forty years of electrical recording, we are at last beginning to understand, most of us, that a recording *is* a recording. Not a concert on records. The two are separate media with values, principles, procedures, customs, and techniques remarkably unlike each other. Unlike but *equal*—that is the toughest thought for many of us to absorb, especially musicians! After these forty years, a lot of us still go around thinking that "live" music is naturally better than recorded.

Why, sure! Of course, it is. In its own way, in the right places, within its special limitations. We might also suggest that the "live" stage is similarly better than the recorded film, if you want an argument. Definitely—within *its* special limitations. In both cases, the live art is not exactly adaptable to the family living room. But there's a lot more to it than that. These media are *different*. Why compare?

If we will just quietly forget about live music being either better *or* worse than recorded, if we will just admit that recordings exist and are useful in their own terms (just as movies are), if we can understand that recordings and actual concerts share only two elements, performers and musical scores, all else being fundamentally unrelated—then (to come to the point) we can really enjoy Angel's recent album, *Homage to Gerald Moore*. Because it *is* a recording of an actual concert. And it is a remarkably successful one, only equalled in my memory by another Angel effort, the famed series of humorous *Hoffnung* concert albums of some years ago.

Gerald Moore is—was—one of the finest piano accompanists (classical division) who ever effaced himself behind some famous singer. He was tops, incredible, wonderful, ranking among the very few of the sort, such as Paul Ulanowsky, Coenraad V. Bos. Like others in this league, his specialty centered about the standard Romantic and semi-modern song literature from Beethoven and Schubert—vast quantities of Schubert and never so perfectly played—on into Fauré and Debussy. Like others of his sort, he played the piano parts with unbelievable suppleness, exquite phrasing and touch, perfect timing, absolutely right emotion; he powerfully sustained and often guided the great singers from his piano, while appearing to be no more than a mousy little man off in the background. That's the tradition.

Gerald Moore decided to retire—early. His hair isn't even gray. Walter Legge, genius of British musical production, decided to give him a public blast, which for once would feature the accompanist in the spotlight, to the tune of no less than three celebrated song-makers: Elizabeth Schwarzkopf, Victoria De Los Angeles and Dietrich Fischer-Dieskau. They all sang, together and in solo groupings. And Gerald Moore, mousy as ever, played for all of them.



But the audience at this concert, decidedly hep (not hip), cheered and bravo'd and shouted its delight, and its sorrow, especially for Gerald Moore's last appearance, the pianistic mouse about to retire. It was a tremendous occasion, and the better because it was humorous as well as sad. Under the impetus, a rare communication built up like an electric charge; everyone let go, bars went down, audience and performers were as one. Was "live" music ever so uniquely *itself?* Was nott his the essence of the living concert?

And Angel took it all down in stereo! Now it is released; not on one, but on two fat LP discs. The works.

What makes this rare recording of an actual concert unique is its astonishing honesty to the live medium. Too often, concert recordings are misguidedly compromised. Applause is hastily faded out, as though it were an embarrassment, the carefully casual tempo of the occasion is edited away, the feeling of being *there* is deliberately minimized, making a good live performance into a poor studio job. Not here! Angel had the sense (or the luck) not to try for sonic perfection, to let things happen as they would, let the sounds fall as they might. Thus the very imperfection of the mike pickup, the un-ideal acoustics, the erratic balances, the un-cued interruptions, the bursts of laughter (we must guess what caused them), even the obvious "projection" efforts of close-to singers trying to fill a very large hall, add up to a kind of realism, a sense of presence, that carries us along with with a grand documentary sweep. It has seldom been done as well on records—indeed, it defies the very medium itself. That takes real art.

'Course you have to know a bit of what all this music is about; Schubert, Wolf, Brahms, Verdi, Mendelssohn. Not much, if you are open minded. But if you do get bored, then skip quickly to the incredible Verdi duet between two lady cats—De Los Angeles and Schwarzkopf—all one burst of hilarious meows. That'll break you down.

Homage to Gerald Moore
Angel SB 3697(2) stereo ($11.58)

Performance: A — *Sound:* B+

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CLASSICAL RECORD REVIEW

EDWARD TATNALL CANBY
MARVIN ROTBARD

The Russians are coming

Polovetsian Mussorgsky: Night on Bald Mountain
Dances Ippjolitov-Ivanov: Two Caucasian Sketches
Leonard Bernstein Borodin: Polovetsian Dances
The New York Glinka: Russlan and Ludmilla Overture
Philharmonic Mussorgsky: Khovantchina Prelude.

Columbia MS 7014 stereo ($5.79)

. . . Well, you get the idea. The above is copied *exactly* from the album's cover. Read *down*, as well as across. Get it??

Good stuff! It's been awhile since I've played a Leonard Bernstein chestnut-war horse potboiler, and I am impressed. Don't know how he does it.

Not only is the sound immediately alive in impact, with a wide, deep sense of real space and lots of clean attack, but the performances are remarkably alive, well phased and communicative—as if these slightly faded show pieces of the later Nineteenth century were quite new. Amazing. But that's Bernstein. Under other conductors these pieces tend to be either noisy, or slickly suave, or just plain dull. E.T.C.

Performance: A— *Sound:* A—

Tchaikowsky: Symphony No. 4. Hamburg Philharmonic, Mackerras.

Checkmate C 76004 stereo only

I find the musical interpretation much less satisfactory than that in the releases reviewed last month.

Tchaikowsky is never easy to project and nowhere more difficult than in this Fourth Symphony. There are, admittedly, many possible approaches to its high-tension music. My preference is for tension via the built-in architectural strength of the work (emphasized in my annotations for this album). Mackerras gives us instead a juicy, uneven flow of music, overdoing some parts, de-emphasizing the sense of continuity. Not to my taste, though it may be to yours. E.T.C.

Performance: C+ *Sound:* B+

Tchaikowsky: Swan Lake—complete sound track. (Fonteyn-Nureyev). Vienna Symphony, Lanchbery.

Angel B 3706 (2) stereo ($11.58)

This is a typical anomaly of our day—a movie-ballet sound track, minus the movie and minus the dancers! All that is left, of course, is the original music just as it was in the first place, more or less. A mixed-media presentation de-mixed.

Nice cover, good write-up and all that. But the music itself is all that really counts. I found the recording minimally effective in stereo and somewhat on the dull side as compared to normal Angel jobs. (This even though it surely came from the original master tapes.) Musically, the playing—without the accompanying dance—seems often logy and heavy.

If you're going to do ballet music for the ears alone, then it should be tailored for listening. Not watching. E.T.C.

Performance: C *Sound:* C

Prokofiev: Oratorio "Ivan The Terrible" (from the Eisenstein films). Valentina Levko, mezzo; A. Estrin, narr., Moscow State Chorus, U.S.R.R. Symphony Stasevich.

Melodiya-Angel RB 4103(2) stereo ($5.79 ea.)

This big cantata-like piece is a close relative of the now familiar *Alexander Nevsky*. Both works are concert pieces derived from the music for the films of the same name (not sound-track recordings but new performances), the music arranged in concert form. Both shoot the musical works—huge orchestra, soloists, large chorus, sound effects, Russian bells in the fanciest Russian manner.

I found the piece really exciting, whether with the accompanying translation (and the Russian text, too), or just via plain listening as music. Either way it is highly dramatic and beautifully performed. Prokofiev was a master of dramatics and a composer who could write in "popular" film style without degrading his expression. It's an impressive work, if on the traditional side in respect to musical idiom, as might be expected; and in this all-Russian performance, even the narrator speaking in Russian, there is a rightness that would be missing, say, in an English-language performance with the Philadelphia Orchestra. E.T.C.

Performance: A *Sound:* B+

Prokofieff: Concerto No. 2 in G. Minor. Sibelius: Concerto in D Minor. Itzhak Perlman, violinist with Boston Symphony Orchestra, Erich Leinsdorf, cond.

RCA Victor LSC-2962 stereo ($5.79)

Here is a good example of competent engineering ideas coupled to the sort of music they suit well. Where the Prokofiev Violin Concerto is brittle and brilliant with sharply etched color against a constantly varying background, the Sibelius is richly romantic, fully integrated in its sound with a close support of the soloist provided by the orchestra.

Thus RCA has recorded the Prokofiev with excellent hall feel. Mr. Perlman stands well away from the orchestra, stereo spread is broad, and miking is placed to produce a bright sound that separates each instrument from that next to it.

In the Sibelius, distance is still held, but the tone is distinctly warmer, as if different microphones were used. The soloist is closer to the orchestra, occasionally being slightly swallowed by it.

Each technique is suited to the music, but Prokofiv comes off somewhat better than the Sibelius. Perhaps this is because I prefer the exciting Prokofiev to the popular Sibelius. As a demonstration showcase of equipment, the Prokofiev also has more to offer due to profusion of solo instrument displays. The final movement offers a series of chords accented with kettledrum beats that are guaranteed to shake your floor.

Itzhak Perlman makes his recording debut here. This 21-year-old Israeli shows every evidence of maturing into a truly major artist. His technique now is strong and exceptionally pure.

So you will want this disc because it represents an auspicious debut. And, it presents two important, and totally different examples of the violin literature. Add RCA's quiet grooves and you come up with an impressive package. M.R.

Performance: (Prokofiev) A (Sibelius) B+ *Sound:* A

(Reviews continued on page 52)

One-finger exercise for the music lover

Audio magazine captured the true spirit of the Elac/Miracord 50H in its September 1967 review: "...an outstanding performer...its automatic features make it a pleasure to use." What was *Audio* talking about?

The 50H has four pushbuttons: a "stop" reject button and three operating ones, each programed for another record size. The gentlest touch is all that's needed to put the 50H into automatic play: single records, once over or continuously, or stacks of up to 10 in automatic sequence. Or you can ignore the buttons, and play single records manually by simply placing the arm on the record. That's how easy it is to operate the 50H and enjoy the many performance qualities it has to offer.

Other features of the 50H include: Papst hysteresis motor; leadscrew adjustment of stylus overhang; cueing facilities; anti-skate compensation and direct-dialing stylus force adjustment to as low as ½ gram.

At $149.50 less cartridge and base, the Miracord 50H is probably the most expensive in the field. It is also the finest. See it at your high fidelity dealer or write for descriptive literature: Benjamin Electronic Sound Corp., Farmingdale, New York 11735

Miracord
the light touch

Lieder Music

Hanne-Lore Kuhse—A Lieder Recital (Schubert, Wolf, Brahms, Dvorak) with Takikiro Ilmori, pianist.
RCA Victor LCS 2967 stereo ($5.79)

For those who "dig" German Lieder this is an attractive record and an easy one for anyone's listening. The East-German soprano has a big voice (she sings Isolde in *Tristan*) but it is beautifully controlled and most intelligently used in these relatively small-scale songs with piano. She is modest, thoughtful, earnest and—best of all—she has an impeccably accurate sense of pitch. Does *that* make a difference! Wouldn't it be nice if all big-name singers sang in tune.

The accompanist is typical of today's international music-making. He comes from Manchuria, via study in Tokyo. He is good, though not in the league of the great European Lied accompanists. E.T.C.

Performance: B+ *Sound:* B

Post-modern music

The New Music. (Stockhausen, Penderecki, Earl Brown, Pousseur). Rome Symphony, Daderna.
RCA Victrola VIC(S) 1239 stereo ($2.50)

Theoretically, this record of very new music—"new music" is that which has come after "modern music", now old fashioned—should be 'way over your head, and mine too. If you read the scholarly accompanying annotations, it get worse and worse (though the notes in themselves make interesting reading).

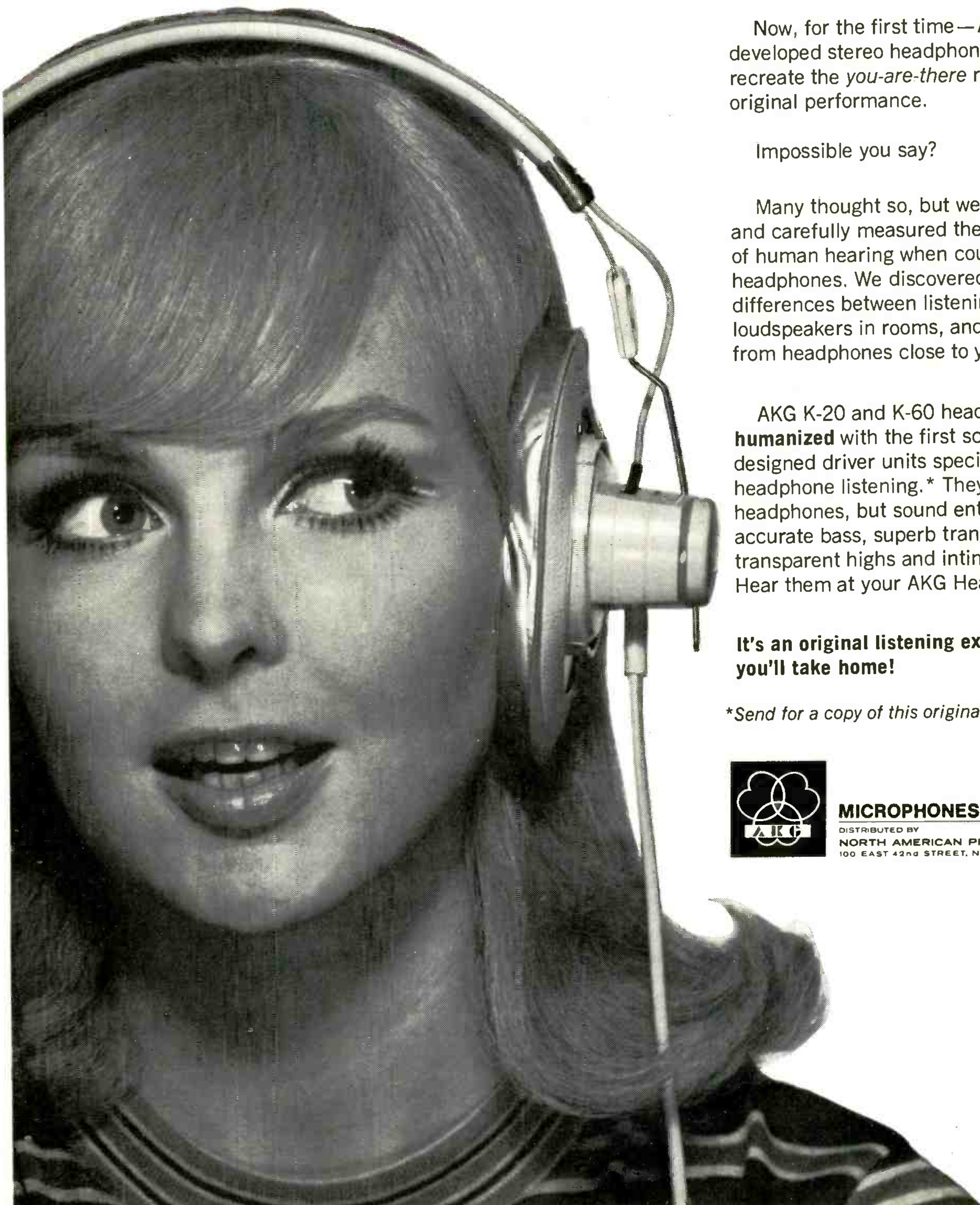
But sound is sound, and this is very expertly contrived sound, by leading exponents of their art from Germany, Poland, the U. S. and Belgium. The recording is excellent, and the extraordinary noises produced by the orchestra and, in the Belgian piece, a tape-recorded sound track as well, are ideal for hi-fi reproduction, full of astonishing color and rhythm.

The thing to do is simply to forget that this is perhaps "music"—just listen to it as so much very efficiently organized noise. You won't go for all of it but you may find a lot of fun in some of the effects.

The strangest thing about this latest instrumental music is that it now sounds like electronic music! Somehow, they have managed to make the old fashioned instruments play for all the world like a batch of oscillators. E.T.C.

Performance: (A?) *Sound:* A—

we've "humanized" headphones



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JAZZ, BLUES,

AND THE

SIREN SONG OF LUNG CANCER

BERTRAM STANLEIGH

ON HIS NEWEST RECORDING, Benny Golson, one of the great tenor saxophonists and a composer and arranger of major importance, has concentrated on the music to which Americans listen most often. It is highly unlikely that anyone in the United States has not at some time been exposed to most or all of the tunes in this new package. Devoted to the music that has been commissioned by Madison Avenue for its television commercials, Verve records has, for some reason, decided to be a bit reticent about revealing credits for these highly commercial tunes. Instead, they have been given slightly cryptic titles which are not likely to seriously obscure the messages of Polaroid, Diet Pepsi, Alka Seltzer, Benson & Hedges, Kent, Viceroy, and Marlboro cigarettes, and several other prominent advertisers.

In listening to this material, one is conscious not only of the skill and talents of the Golson group performing this music, but also of the remarkable tunesmithing that has gone into the creation of these huckstering ballads. These are some of the best bits of contemporary song writing at the moment, and it is an indication of that high quality that several of these tunes have managed to bridge the gulf that normally exists between the commercial jingle and the pop hit. Both *Happiness Is* and *Music to Watch Girls Go By* have made the grade as pop tunes, and nearly any one of the other ten numbers on this platter has the stuff to compete with the current top ten.

What Golson has done with this material is pleasant and agreeable. With a band of talented, but anonymous sidemen and a small vocal contingent, Benny turns in some swinging arrangements that are only a shade more avant garde than the versions that interrupt the Late Show. This is rather conservative music-making for the composer of *I Remember Clifford* and former arranger for Dizzy Gillespie and John Coltrane, but it is nonetheless skillful, colorful and highly appropriate to the music. The disc could be a quiet shocker, slipped onto the turntable as a piece of background music for an unsuspecting audience, and the identification of each commercial sponsor could easily become an amusing bit of parlor entertainment.

The idea of a disc of swinging jingles is, of course, not new with Verve and Golson. Half a dozen years ago, Granville "Sascha" Burland, composer of paeans of praise to such assorted delights as Nestle's Instant Coffee, Flit, Schaefer beer, and Alka Seltzer, produced a platter for the lamented Riverside label in conjunction with Leonard Feather. Titled *Swingin' the Jingles*, that now unavailable collection offered some highly inventive arrangements by Eddie Sauter and Bill Finegan and some outstanding solo work by men like Hal McKusick, Howard McGree, and Ernie Royal. It was the first effort I had encountered that used commercial tunes as a basis for jazz. However, I do recall a much earlier 78 rpm recording of a successful commercial item. Sometime in the late forties, Moe Asch's Disc label brought out a simply stunning instrumental version of Chiquita Banana, that wonderful 1945 exhortation against keeping bananas in your refrigerator.

Surprisingly, neither of these two two earlier platters had the kind of commercial success that I would have expected for them. Maybe the public wasn't yet ready to accept Madison Avenue as the patron of creative achievement, or maybe these two highly specialized labels were directing their output to an overly limited audience. In any event, times have changed. Commercial tunes have an acceptance they did not previously command, and to paraphrase television's arch rival, commercials are better than ever. It will be a pleasure to turn to this set long after the originals of these numbers have departed from our receiving tubes, to breathe again the air of Marlboro Country and dream about those skinny Diet-Pepsi chicks.

Benny Golson: Tune In, Turn On
Verve Stereo V6-8710 ($5.98)

Performance: A — *Sound:* A

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JAZZ (continued)

John Coltrane: Expression
Impulse Stereo A-9120 ($5.98)

The last recordings made before the death of this most expressive and dedicated of musicians, they are among the finest performances he ever put on discs. Coltrane is heard on both tenor and flute with his regular group. While these are his last tapings, it is welcome news that Impulse still has a number of unissued tapes in its files.

Performance: A+ *Sound:* A+

Doc Watson: Home Again!
Vanguard Mono VRS-9239 ($4.79)

This is a welcome collection of rare and familiar material from the blind, country musician and folk singer. He sings familiar tunes such as *Winter's Night*, *Froggie Went A-Courting* and *Matty Groves*, and less known items like *Down in the Valley to Pray* and *The Old Man Below*. In addition, he spices up his offerings with a novelty tune called *Sing Song Kitty*, a black-face minstrel piece called *Rain Crow Bill* played on the mouth-organ, and *Dill Pickle Rag* and *Victory Rag*, two country instrumental pieces that are performed in impeccable fashion by this first class guitar picker. Merle Watson, guitar, and Russ Savakus, bass, fill out the accompaniments. The recording is close up and warm.

Performance: A *Sound:* A

Art Farmer Quintet: The Time and the Place
Columbia Stereo CS 9449 ($4.79)

Farmer's trumpet and fluegelhorn are combined with Jimmy Heath, tenor; Coleman Walton, piano; Walter Booker, bass; and Mickey Roker, drums; in a live concert recording that offers some of the most consistently appealing mainstream-modern playing available on wax.

Performance: A *Sound:* B

Erroll Garner: That's My Kick
MGM Stereo SE-4463 ($4.79)

A bright, bouncy piano romp to the accompaniment of bass, drums, guitar, and bongos. Garner spreads lighthearted good humor as he swings and grunts his way through a mixture of standards and Garner originals with typical bravura.

Performance: A *Sound:* B+

LIGHT LISTENING

CHESTER SANTON
ROBERT SHERMAN

Dinah Washington: Dinah Discovered
Mercury SR 61119 stereo ($4.98)

One of many indications of an artist's importance is the number of records we find being released years after his or her death. This record is by no means the only Dinah Washington album released since her passing in December 1963. In this latest production, Washington fans—and they are considerable in number as the catalogs still show—will find her lending her talents in highly personalized rhythm and diction to a program almost exclusively devoted to songs from motion pictures.

For some reason, Mercury chose not to release immediately the material in this album when it was recorded in Hollywood in January of 1961. It's a pleasant and well-balanced program spanning thirty years of music-making in the film capitol. A deft and relaxed accompaniment is supplied Miss Washington by a string ensemble conducted by Belford Handricks with a fine rhythm section composed or Ernie Freeman on piano, Barney Kessel and Rone Hall the guitarists, Red Callender on bass and Earl Palmer on drums.

It's not surprising to find Dinah somewhat more at home in the earlier songs—*Cabin in the Sky, Pagan Love Song, Blue Skies* and *Stormy Weather*. In most of the other tunes, such as *Three Coins in the Fountain, Love Letters, On Green Dolphin Street* or *Six Bridges to Cross*, there are many touches, very Washingtonian in nature, that recall the period she spent swinging with the Lionel Hampton band.

This is by no means the album most typical of Dinah Washington in her prime. It will, however, be valued by her followers for the fresh glimpses it offers of a very enganging personality. C.S.

Performance: B *Sound:* B+

Steam in the 60s, Vols. 1 & 2
Mobile Fidelity MF 18, 19 stereo ($6.79)

Those indefatigible steam people are at it again — and steam still goes on down the track. Will it ever end? Amazing how they manage to find the old choo-choos still in full blast, whistles blazing, just like the olden days! Awhile back, this company put out "Twilight of Steam" (MF 13). This set must be at the eleventh hour, practically midnight.

Needless to say, most of the aural "shots" are taken of assorted "fan" trains, including the inevitable Canadian visitor, a huge locomotive sent down from that country's sizeable heirloom collection, just to take the fans out for a day's trip. Also sounds from Mexico, another inevitability. (Lots of our old locos were shipped down there for further duty.)

Once again, *Mobile Fidelity* produces superb sound. And medium-good drama, though I'd say they're learning. That is, learning how to make a sequence of train noises reasonably exciting. It takes some art, I assure you. The notes are vital in this respect, and those on these volumes are more informative than some I remember in the past. I enjoyed the whole thing—all four sides.

You can forget the slightly feeble attempt to update the sales appeal here via a subtitle: "A Stereo Happening, Over 38 Minutes of Camp Sound, a phonograph record giving off loving and harmonious sonic vibrations." Also a vaguely psychedelic cover. These are the same old sounds that we (some of us) love so well, and just as old fashioned as ever. Some happening! E.T.C.

Performance: B *Sound:* A

Today's Themes for Young Lovers: Percy Faith conducting his Orchestra and Chorus.
Columbia CS 9504 stereo ($4.79)

If Percy Faith had lavished the same imagination and wit on the choral arrangements that he brought to the orchestrations, this would have been a great album. Even so, it's a pretty good one, since the tunes are representative of the better pop trends today, and the performances are light and listenable. There's nothing wrong with the singing, mind you; it's just that the settings are very similar (sort of well-behaved New Christy Minstrel type), and the songs consequently lose some of their individuality. "Feelin' Groovy" and "Windy" are among the winners here, along with "Yellow Days" and a charming Faith original called "A World of Whisperers." Technically, the recording is first rate, with well-defined stereo separation, excellent balance between voices and instrumental sections, and in general, a warm, natural sound. R.S.

Performance: B *Sound:* A

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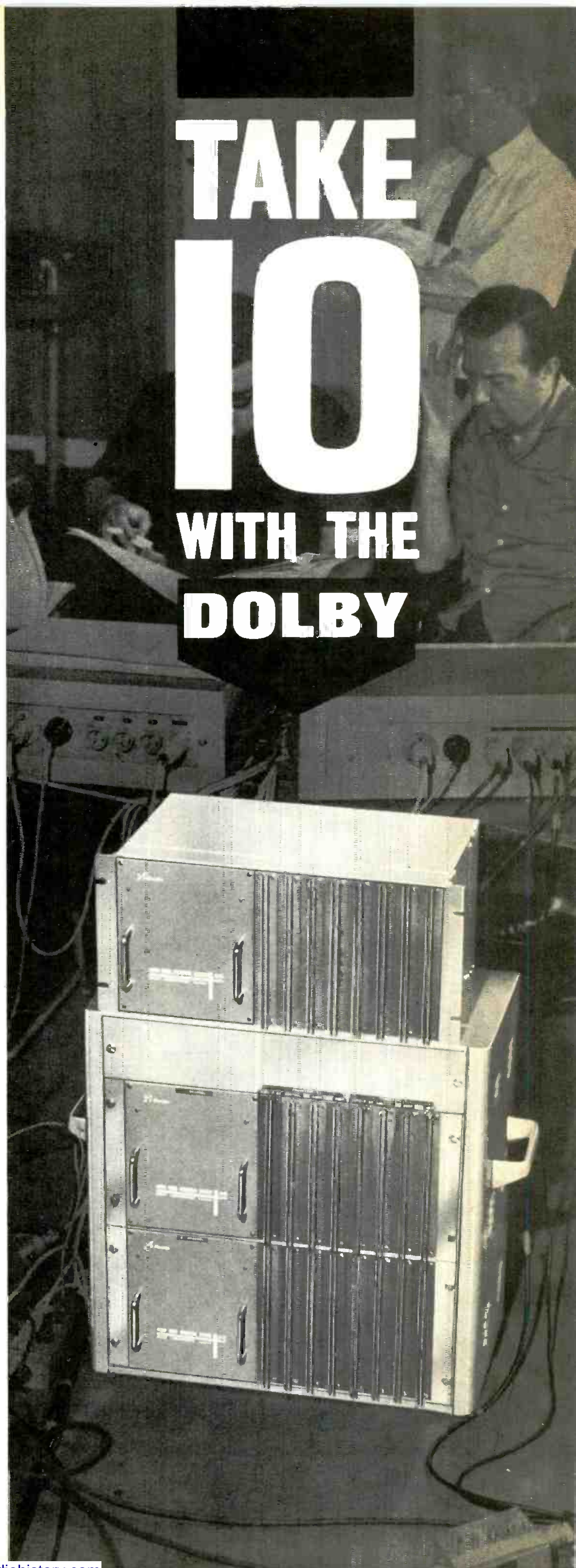


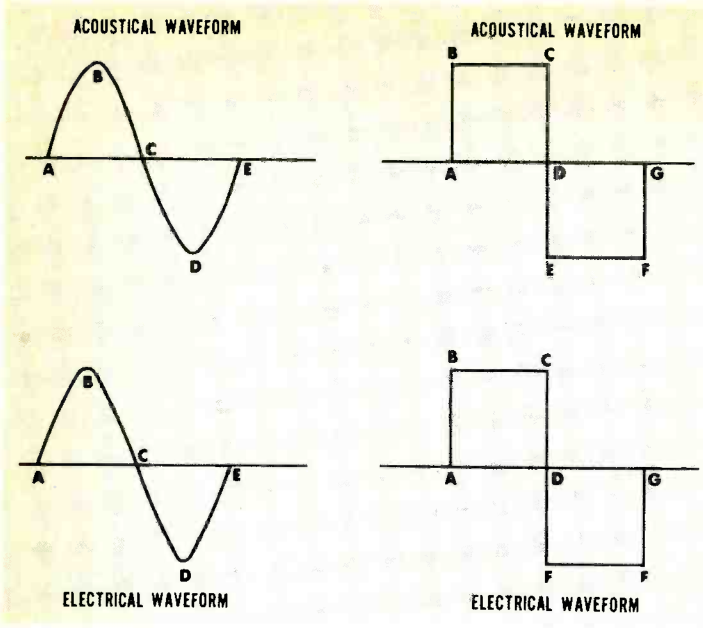


Fig. 8—Condenser microphones generate output signals in step with acoustic waves.

MICROPHONES FOR SOUND REINFORCEMENT

(Continued from page 38)

use today. (This is not to say that poor condenser microphones are not produced, but the potential for superior performance is inherently available in the condenser microphone.) There are drawbacks, too, to be sure, including high cost relative to other types, bulkier size and potential for breakdown due to the need for a power supply.

Here are some of the advantages that the condenser microphone offers over other types:

1. Diaphragms with the least mass and greatest rigidity, yet providing sufficient output.

2. Smoothest, most extended, and most stable frequency response (witness the measuring microphones, such as: the Western Electric 640AA, Altec 21BR series, and the Bruel & Kjaer series, among others).

3. The most ruggedness and endurance. They can be designed to withstand high SPL. They are used to measure over-pressures during rocket launches, and exhibit exceptional freedom from temperature changes.

(In its original form, the condenser microphone was not so rugged. An American recording expert, carefully smuggling home the first post-World War II European condenser microphone system, found that it had a large gold-sputtered diaphragm, against which was a pressure-type electrical contact. The microphone had been brought back on a propeller-type aircraft, it seems, and the steady excitation of the diaphragm by the large amplitude, low frequency engine noises had worn the gold off the diaphragm at the contact point. The diaphragm was re-sputtered, making the unit operational again.)

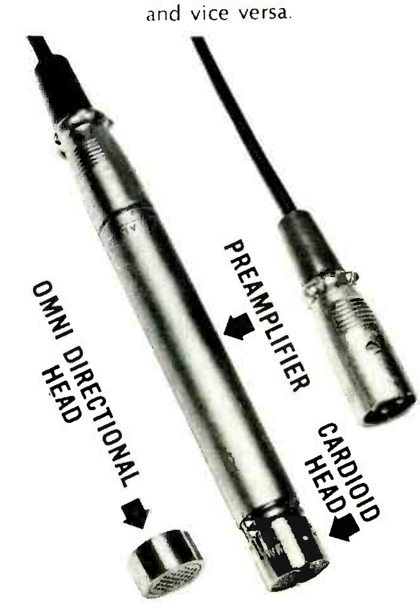
4. They generate an output electrical waveform in step with the acoustical waveform and can be adapted to measure essentially d.c. overpressures. (See Fig. 8.)

5. They provide the lowest noise and highest sensitivity. The proper use of the capacitor head to control a small FM oscillator can result in exceptionally low-noise microphone performance when electronic stability of the oscillator circuit is carefully maintained.

6. Because of small head size, they provide the least diffraction interference of any microphone type. This does not apply where, due to styling or other causes, the condenser microphone is made physically large. Because diffraction problems appear at that frequency where the wavelength/4 = the diameter of the front of the microphone, it can be calculated why the very best quality microphones have diaphragms that range between ½-in. and 1-in. in diameter.

7. Versatility. It is possible to use one preamplifier base and carry both an omnidirectional head and a unidirectional head in your pocket to meet whatever requirements the situation at hand calls for. (See Fig. 9.) Æ

Fig. 9—Some condenser microphones offer the flexibility of changing heads from omnidirectional types to unidirectional types and vice versa.



The concluding article of this three-part series will continue next month.

LETTERS FROM READERS

(Continued from page 2)

because the lamp does not have to overcome the thermal inertia of the cold filament.

The addition of S_1 and its associated capacitors gives the variable release time while S_2 and its associated capacitors give the unit variable attack times. If, at the builder's option, the diode, S_1, S_2, and their capacitors are eliminated, the circuit will still be less complex and slightly more flexible than Mr. Denny's circuit.

The control element may be more economically made from a suitable pilot lamps and CdS photocell enclosed in a short length of heat-shrinkable tubing. The use of the inexpensive MJE370 transistor eleminates the need to parallel smaller devices.

Steven B. Fuller
Webster Groves, Mo.

The term "symmetrical clipping" is unfortunate. The device does not clip, symmetrically or otherwise, and did not appear in the original manuscript.

Certainly the operation of the limiter can be improved as suggested. However, it was the author's purpose *to provide a device for use by non-technical personnel concerned with the recording of local (mostly student) groups. At present they are required merely to preset the recorder gain controls so that limiting starts at 0 VU (approximately). Gain is then controlled at the limiter.*

The suggested scheme for control of attack and recovery time constants is attractive; it is planned to lengthen the recovery time in the manner shown. —*Ed.*

• In the printed circuit layout shown in Arthur Gladfelter's "Solid State Flutter Meter" (AUDIO, March-June, 1966), C_{27} is completely short-circuited and the input side of R_{29} (which should connect half of the discriminator to Q_9) is instead connected to signal grounds. The necessary changes are far easier to make before the circuit boards are etched than through trouble-shooting procedures after construction! Credit for their detection must be given to Mr. John Hanna, Director of Audio-Visual Aids, Lake Erie College.

There are two further errors of lesser consequence: (1) the meter-protecting diode is shown in the circuit diagram with polarity reversed; (2) readers will search the Allied catalogue in vain for a power transformer matching the description given in the parts list. It is in fact listed as a "low-voltage rectifier transformer," a multi-tap unit described as "10-20CT-40CT."

Despite these, AUDIO is to be commended for presenting Mr. Gladfelter's excellent instrument, the more so since this crucial piece of equipment is absent from the catalogues of the major kit manufacturers.

CRAIG L. STARK
Painsville, Ohio

• In the August 1967 issue, *Audioclinic* was way off base on "Power Output vs. Impedance." Part of the answer was, ". . . an impedance change of 100% above or below the optimum impedance of a solid-state amplifier will decrease power by about 25 to 35 per cent."

The fact is that in direct-coupled (transformerless) solid-state amplifiers an impedance increase of 100% decreases power output by about 35%. But a decrease in load impedance of 50% will *increase* power output as much as 40%. These figures depend mainly on power supply regulation, but also on feedback, among other things. Also note that you cannot have a decrease of 100% or you are left with zero!

RALPH HARTZ
Hazlet, N. J.

AUDIOCLINIC

(Continued from page 2)

ing behind the rod enables it to move and actuate a switch.

The outside "setup" mounts above the keyboard and attaches to the piano by an easily-removable clamping arrangement, designed to fit most any style of piano.

Where the system is to be permanently installed, the bracket is different, and is called the "inside setup." It fits inside most pianos. The exact operation escapes me, but electrically it does the same thing as the "outside setup" does.

This equipment is no longer manufactured, but it was intended for the Organo, a small organ for limited-space applications, activated from a piano keyboard. I have described it here with the thought that you might come upon one by some good luck.

If space is no problem, you might just as well use a standard organ keyboard.

I do not know what all of this would cost. If the price rises high enough, it just might pay you to investigate the possibility of constructiing a harpsichord kit. That will present you with a challenge of another kind. Æ

STEREO DISC PLAYBACK

(Continued from page 28)

ers and play the same passage a second time. The wiring arrangement which produces the loudest low note is the in-phase condition. Once established, these connections should remain the same for the tests to follow and thereafter. The wires should be marked to insure that they can be reconnected to the proper terminals of the amplifiers and speakers at any future time.

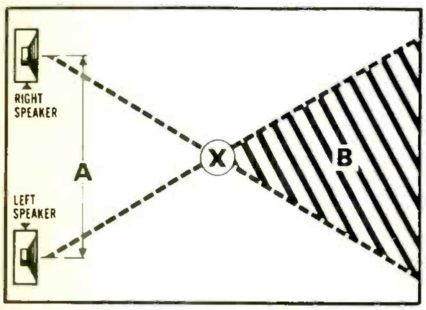


Fig. 4—Yardstick guide to setting up stereo speakers. (A) is distance between speakers; (X) is same distance, between speakers; (B) is the area where stereo effect is most pronounced.

Next, the sound output of the speakers should be balanced. This can be accomplished by standing several feet in front of the speakers, midway between them (location X, Fig. 4 is recommended) and, listening to a mono record, manipulate the balance control until the sound appears to come from a point directly in front of you.

Next, try the speakers in different locations. They should be spaced between six and ten feet apart, depending upon the size of the room and the distance from the listening area. Placing the speakers in the corners of a long narrow room may be found to stimulate room resonances, producing a booming sound. Placing them away from the corners of a long wall may result in an undesirable loss of bass. The location of the speakers which is judged to produce the most natural sound is the one to use, assuming that it does not create havoc with room decor.

After the speakers have been located, the tone controls may be touched up to compensate for less-than-ideal room acoustics. Æ

EQUIPMENT PROFILE

(Continued from page 46)

ously sized etched circuit panel. Our major criticism was the arrangement of the power switch. In the usual British fashion it pushed down to turn on. American users might well want to rotate it 180 deg. so it turned the power on when it was pushed up (we did).

Several interesting ideas were employed in making the power supply/carrying case, all of which serve to reduce costs, and the savings are passed along to the user. The frame of the case, as described previously, consists of the 4" x 4" x 12" U-shaped structure, with the power supply occupying the center 7-in. compartment. A sturdy strip of aluminum is attached to the power supply housing and serves as a handle and as protection for the pilot light which is located underneath it. A 20-in. strip of rubberized cloth material is held in place by the pilot light mounting and extends over the top of the case and down the open ends of the U-shaped structure. Metal ends are pressed onto the rubber material and

Fig. 11—Frequency response of the Hammond M-100 condenser microphone taken at 0-deg. and at 90-deg.

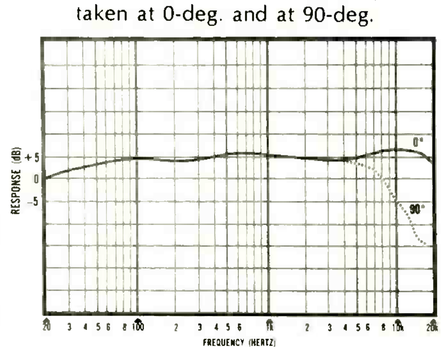
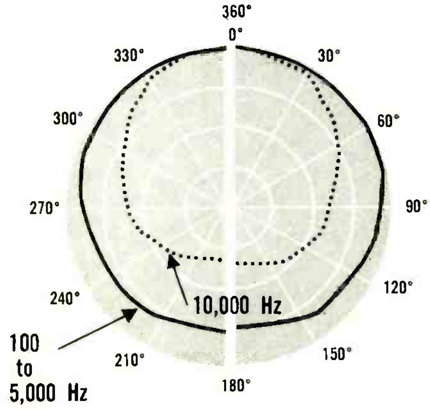


Fig. 12—Polar pattern of the M-100.



catch under notches on the ends of the housing, eliminating a built-up case, fasteners, hinges, and the like, and yet performing like a proper case for the entire assembly.

A minor low-end rolloff is provided, since like any good condenser microphone, the low end response is practically to d.c. unless some reactances are provided in the output coupling circuitry. This rolloff results from the use of a 400-μF, 4-volt coupling capacitor between the cathode of the Nuvistor and the output lead. This should provide a 3-dB rolloff at 7 Hz, when the unit is working into a 50-ohm load, which is hardly noticeable at all. For a higher rolloff frequency, this capacitor could be changed, and in fact, it should be, probably, when working into a high-impedance circuit.

The microphone circuit is conventional, except for the use of a Nuvistor instead of an ordinary vacuum tube. This does make possible the use of smaller microphone cases, however. The signal is developed across a 92-Megohm load resistor by the condenser head, and is fed to the grid of the Nuvistor through a small capacitor without a grid resistor. The plate is fed with approximately 105 volts, while the polarizing voltage to the condenser head is somewhat higher. The cathode is led to ground through a 1200-ohm resistor, and the output coupling capacitor connects to the cathode. One heater lead is grounded, while the other is fed from the regulated supply.

The multi-lead cable which connects to the microphone carries five leads, and may be extended to a maximum of 200 ft. An adjustment is provided in the power supply to increase the heater current to maintain proper operation in case the lead is extended to greater than 50 ft.

Output from the microphone is sufficient to feed practically any tape recorder or amplifier provided with a microphone input. Many recordists will find that they will obtain improved results when they employ the M-100 in place of dynamic or ribbon models they may now be using. We would like to see these units provided with cardioid heads which could be interchanged with the omnidirectional ones which are (apparently) not removable. However, there are plenty of uses for the omni pattern, and the M-100 certainly provides the recordist with the much-desired condenser microphones at a price that still lets him buy a better tape recorder, assuming he is working with a fixed total for his recording system. Check 99

ABZ's of FM

(Continued from page 14)

is really just another form of FM modulation. In fact, many forms of FM transmitter systems employ simple phase modulation as the first step in the creation of wide-band frequency modulation. So in the context of our analysis, the two terms may be thought of as being synonymous.

To summarize, whenever two signals (close in frequency) appear at the input of a receiver, their resultant will be amplitude and phase modulated. In AM sets, the amplitude variation creates the "beat" or whistle note. The phase modulation adds a small amount of frequency modulation. Both of these new components constitute a departure from the original signal and, in an FM set, must be eliminated. Amplitude variation is by far the simpler to remove. This is done by means of "limiter" stages to which we shall devote considerable discussion in later installments. For the moment, Fig. 2 will serve to illustrate the principles of limiting. Since an FM receiver need sense only changes of carrier frequency, we can, by use of proper circuitry, "slice off" any amplitude variations without removing any desired intelligence from the signal.

The undesired phase modulation is not so easily eliminated. We can quickly show, however, that its effect on performance will be minimal compared with the normal or desired frequency excursions caused by the program information.

Using the example cited earlier, it can be shown that if the desired and undesired signal differ in amplitude by two to one and in frequency by 400 cycles, then the indirect FM produced by the resultant phase modulation will be ±200 Hz. That is, the resultant carrier will have an added frequency shift (over and above that caused by normal program material) of 200 Hz above and below the central or nominal frequency. If we compare this shift with the normal maximum deviation of 75,000 Hz authorized by the FCC for wideband FM we see that the maximum signal-to-interference ratio is 375:1 or better than 50 decibels. To put it another way, this little bit of undesired "FM" interference will be all but inaudible under these conditions. And, bear in mind, that these conditions, as stated, were quite extreme. It is not usual to have an interfering signal nearly half as great as the desired signal. More typical might be ratios of 1 to 10 or 1 to 20, in which case the

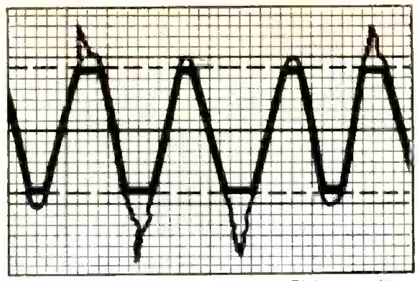
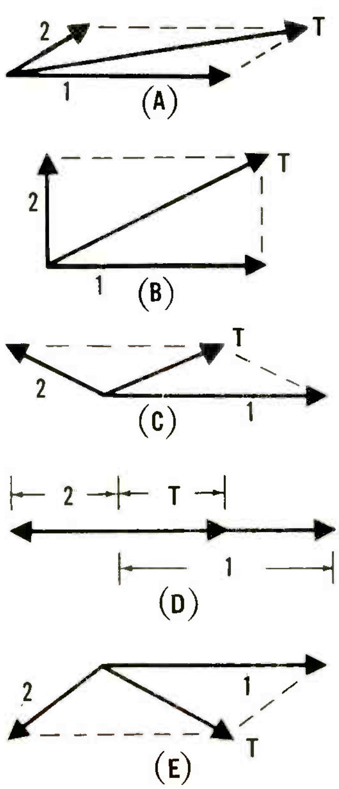


Fig. 2—Limiter circuits in FM receivers "slice off" amplitude variations caused by all forms of interference. Therefore, the waveform distortion does not affect the recovered signal.



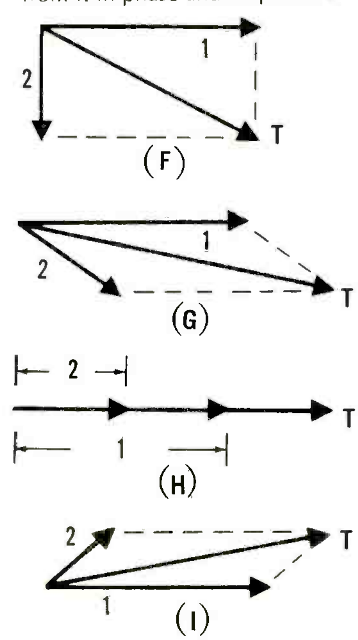


Fig. 3—Vectorial representation of resultant (T) when carrier (1), the larger of two carriers, encounters interference by carrier (2). Note that resultant (T) pivots about desired carrier (1), but constantly differs from it in phase and amplitude.

effect of the undesired "FM" would be far less.

Strong Signal Domination

A series of vector diagrams, shown in Fig. 3, will help to bring home the concept of "capture" of the stronger of two signals in FM. While the full specification of *capture ratio* (ability of a receiver to favor the stronger of two FM signals received on the same frequency) depends in part upon certain facets of the receiver design itself, the ability of FM in general to discriminate against an only slightly weaker of two incoming signals is inherent in the FM system, rather than in one given receiver design.

In all of the diagrams of Fig. 3, let us assume that vector 1 represents the desired carrier, "rotating" at 100 mHz. Vector 2, the undesired signal, is also rotating, but at a frequency of 100.005 mHz, 5,000 Hz higher in frequency than the desired signal. (All rotations, by the way, will be assumed to move counterclockwise.) Since vector 2 is rotating slightly faster than vector 1, it will, in effect, pull ahead of vector 1 as we look at the successive diagrams. The resultant vector, T, will also rotate. If we "stop the action" at various points in the rotation of vector 2 relative to vector 1 and examine resultant T we see that it fluctuates or "wobbles" about vector 1.

In Fig. 3C it has shifted to its maximum position ahead of vector 1, whereas at 3E it has fallen maximally behind vector 1. The back and forth fluctuations of the resultant vector T represent the phase modulation of the resultant carrier. Note, however, that the resultant is wobbling back and forth about vector 1, the larger signal. Thus, vector 1 (the desired signal) and the resultant vector T have the same *average* frequency. The signal heard in the loudspeaker of the FM set will be determined primarily by vector 1. If we were to make signal 2 the larger of the pair, the resultant would swing about vector 2, and it would predominate.

Further examination discloses that the amplitude of resultant vector T differs from that of desired vector 1, but we have already stated that these amplitude variations are readily eliminated by means of limiters in the design of the given receiver. The phase modulations of the resultant, while still present, represent a minimal FM deviation compared with the normal program deviation and can therefore be largely ignored. Once the ratio of the interfering to desired signal reaches 1:2, the effect of the smaller signal upon the larger becomes negligible, whether the interfering signal is another, distant station or any other form of random noise. Æ

AUDIO ETC.

(Continued from page 10)

along with the leaves on the other trees. But unlike leaves, pine needles have no cross-section. They are two-dimensional. Now here comes the audio.

When these ornery needles start moving earthward they tend to spiral down fast, and they arrive, often with quite some momentum — points first. They penetrate, into the grass, into corners, crevices, cracks, and there they consolidate. They interlock neatly in compact bunches, orientated in the easiest direction.

My first thought, as I tackled the pine needles last fall was: magnetic domains. Yeah, yeah (rake, rake) . . . that's it! Random interlocked formations.

Now what happens when you start to rake pine needles? They — so to speak — become magnetized. Remember, they are two-dimensional, with a North and a South. So of course, as you rake, they line up in parallel. Because they come in clumps (five to a clump in white pine), the North ends neatly point all one way. And the darn things just stay right where they are. All you've managed to do is to "magnetize" your lawn. The needles are still there, but all of them pointing one way.

Well, the next time I went out to rake (no sooner do you clean up the needles, somehow or other, than a new batch comes spiralling down), I found myself shifting analogies. That was because I had at last found how best to cope with the ornery, sticky, unbudgeable things. And the physical action reminded me forcefully of another aspect of audio. The stereo groove.

My first solution to this problem was precisely that which was first used in stereo disc to get two signals into one groove. I combined vertical and lateral motions.

First I raked one way all over the lawn. Lined 'em all up. Then I came upon the lawn sidewise, and raked at a 90 degree angle. That caught the needles with their magnetic domains orientated crosswise—and they had to give in. Once I had got them up and out of the grass, the corners, crevices and cracks, the rest would be easy, more or less.

But I wasn't finished yet. You'll remember that the original lateral-vertical system for stereo disc, though it worked, offered a number of doubtful features, principally the lack of uniformity between the two systems, lateral-cut and vertical-cut. When one stereo channel was assigned wholly to each, the requisite uniformity of sound was lacking. In a word or two, lateral music just didn't sound the same as vertical; nor did various other parameters come out the same either.

I found that the lateral-vertical pine needle system just wasn't working. So, taking a leaf, or rather a needle, from the stereo disc book, I tried what the stereo people tried. 45-45! It worked like a charm.

Now, if you follow me, I rake my needles with a channel-A, channel-B sort of stroke; one stroke of the rake out to my right at an angle of 45 degrees, the next out to my left. The two sets of strokes are identical, but always 90 degrees apart, plus or minus a small tolerance (too small for the pine needles to notice). And no matter which way I retreat (one rakes backwards, of course, the way one rows a boat), the 45-45 relationship remains fixed. The needles are neatly caught in the cross-raking, and I can move along in flexible fashion, following the curves and irrationalities of the terrain just as I wish. Wonderful! It only takes twice as long as raking leaves.

3. Transposition

Sometimes I look at what I have written here—months afterwards, of course—and marvel at the unintelligibility of it all. Sometimes, anyway.

A splendid example, I thought, was that second installment of my study of Lawrence Lessing's "Man of High Fidelity," all about Major Howard Armstrong, the radio pioneer and inventor of FM. Digging out the carbon of my MS, I feel better about it. It's a simple case of transposition.

If you will quietly *remove the top three lines of Column 2, p. 8* of July issue, you will find out what I was talking about—the closing down of Armstrong's pioneer FM radio station at Alpine, N. J.

And if you will carefully transport those three lines in a Northeasterly direction, placing them delicately *on top of Column 3,* you will clear up another area of Total Canby Incomprehensibility. What I tried to say *there* was—"The trend towards 'rehabilitation,' both of Armstrong's own importance and toward recognition of his work and of his inventions themselves, has gone onwards as projected in the final pages of his written life. The rest of the story, up to date, has now been added by Lessing . . ."

Make sense? Good. And I now can add a footnote: *Man of High Fidelity,* with the extra updating included, *is* now on the way to paper book publication at a very easy price. Look for it.

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