AUDIO

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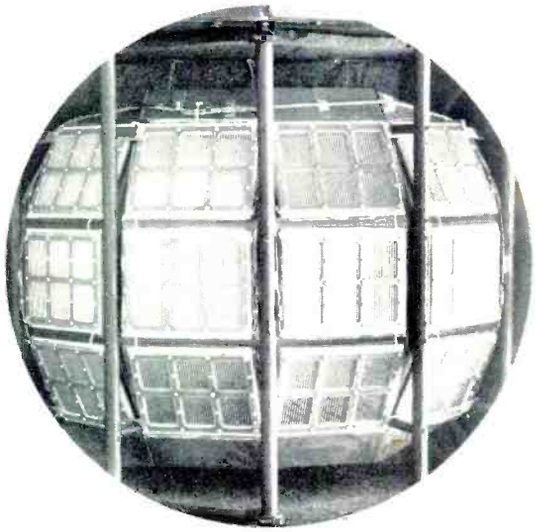
MAY, 1964

60¢

600 X
magnification
elliptical stylus tip
p. 33

No wall space? Hang it in a closet!
. . . p. 14

Telstar-shaped electrostatic
p. 19



New 345 Tuner/Amplifier... the engineering leadership you expect from Scott at an unexpected low price

The 345 is an exceptional accomplishment . . . even for Scott. It combines the features, the performance, the specifications of separate tuners and amplifiers and sells for less than $350. Achieving this rare combination of top performance and top value took many long months of painstaking research and around-the-clock work from the most imaginative engineering minds in high fidelity . . . the Scott Advanced Development Group.

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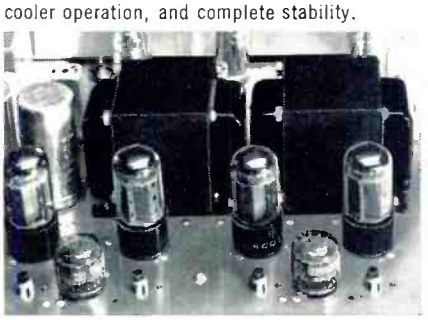

2. **Series-Gate Time-Switching Multiplex** provides probably the greatest stereo separation of any combined tuner-amplifier available. The 345 offers the ultimate in startlingly live stereo sound.

3. **Pulse Suppression-Limiting** effectively offers four stages of limiting for improved suppression of impulses from sources like automobile ignitions. 2.2 uv sensitivity for quiet noise-free FM sound.

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AUDIO Articles

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AUDIO Profiles

AUDIO in General

MEMBER INSTITUTE OF HIGH FIDELITY INC.

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Coming

Construction and Theory

- Constructing the Telstar-Shaped Electrostatic. R. Matthys. The design parameters are described this month, next month full construction details are given.

- Class-D Audio Amplifiers. Peter A. Stark. A summary of the operation and theory of class D audio amplifiers using switching techniques.

Sound Reinforcement

- Central - versus - Distributed Loudspeaker Systems. David L. Klepper.

- Basic Course in Commercial Sound, chapter III. Norman Crowhurst.

Profiles

- James B. Lansing "Olympus" Speaker System

- B & O Model 200 Stereo Ribbon Microphone

In the June Issue

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

AUDIO CLINIC

Joseph Giovanelli

Send questions to:
Joseph Giovanelli
2819 Newkirk Ave.
Brooklyn 26, N. Y.
Include stamped, self-addressed envelope.

Disc Playback and Tracking Force

Q. I have heard that, because of the nature of the record-cutting process, record grooves have slight imperfections in them. In order to obtain the best sound from the records, they should, when new, be tracked once or twice at 2–2.5 grams to remove these imperfections, and thereafter, at lower tracking forces (assuming that the cartridge tracks well at these lower forces). Is this true?

Is there any reliable way to check on stylus wear without taking the stylus to a shop?

At 1½ grams, approximately how man hours of life, without damaging records, will a 0.6-mil stylus give if used carefully with carefully cleaned records?

Is there any way to distinguish by ear between a worn stylus and one which is not worn but needs redamping? I understand that both of these effects sound alike. Leonard Drasin, Brooklyn, New York.

A. There is nothing to support the theory that a disc should be tracked heavier for the first two plays and then tracked lighter for all succeeding plays. I suppose the idea originated because of a phenomenon known as "cutter bounce." This is just what its name implies. The cutter tends to oscillate vertically to a very small extent. However, with a properly damped system employing heated stylus techniques, this bounce is not sufficient to cause playback distortion.

It is possible that there could be some bumps on the disc which this extra tracking force could smooth out. However, while the possibility exists, the likelihood is not great.

The one common type of pressing defect is what is known as a "non-fill." This is actually a small hole, or depression, in the surface of the disc. Increased tracking force will succeed only in digging this hole a little deeper—an effect quite the reverse of what you wish to take place.

There is the possibility that if some granular dust entered the grooves that the extra force might be sufficient to push this dust from the grooves rather than skipping over the dust. Even this is a remote possibility and probably will not be significant.

I do not know of any way to check stylus wear except by using a microscope. By the time such wear is audible the stylus has deteriorated to the point where it is damaging records and should have been replaced long before.

The sound of a worn stylus does not sound like the distortion which would appear when the damping material in the cartridge has disappeared. Worn styli sound something like severe tracing distortion when the wear is severe enough. Loss of damping results in somewhat higher output from the cartridge and will produce some peaks in the spectrum. Possibly there will be some sound like tracing distortion but this is not the outstanding feature of this kind of defect in my experience.

I cannot say how long a 0.6-mil stylus will last at a particular tracking force. This depends upon tracking force, tracking error and, to some degree, upon the condition of the records themseves. You can reasonably expect two or three thousand hours from the stylus, however. Even this can vary, depending upon the original burnishing of the stylus.

Sparking at Ground Connections

Q. I have noticed that whenever I attempted to connect a ground, I get a "hot" spark from the coldwater pipe, steampipe or radiator, or, understandably, the negative wire of our electric system (60 cps, 220 v). Is this strong, perceptible ground interfering with my high-fidelity system because of ground loops or a possibly grounded antenna. I feel we must have a leak somewhere in our electrical system.

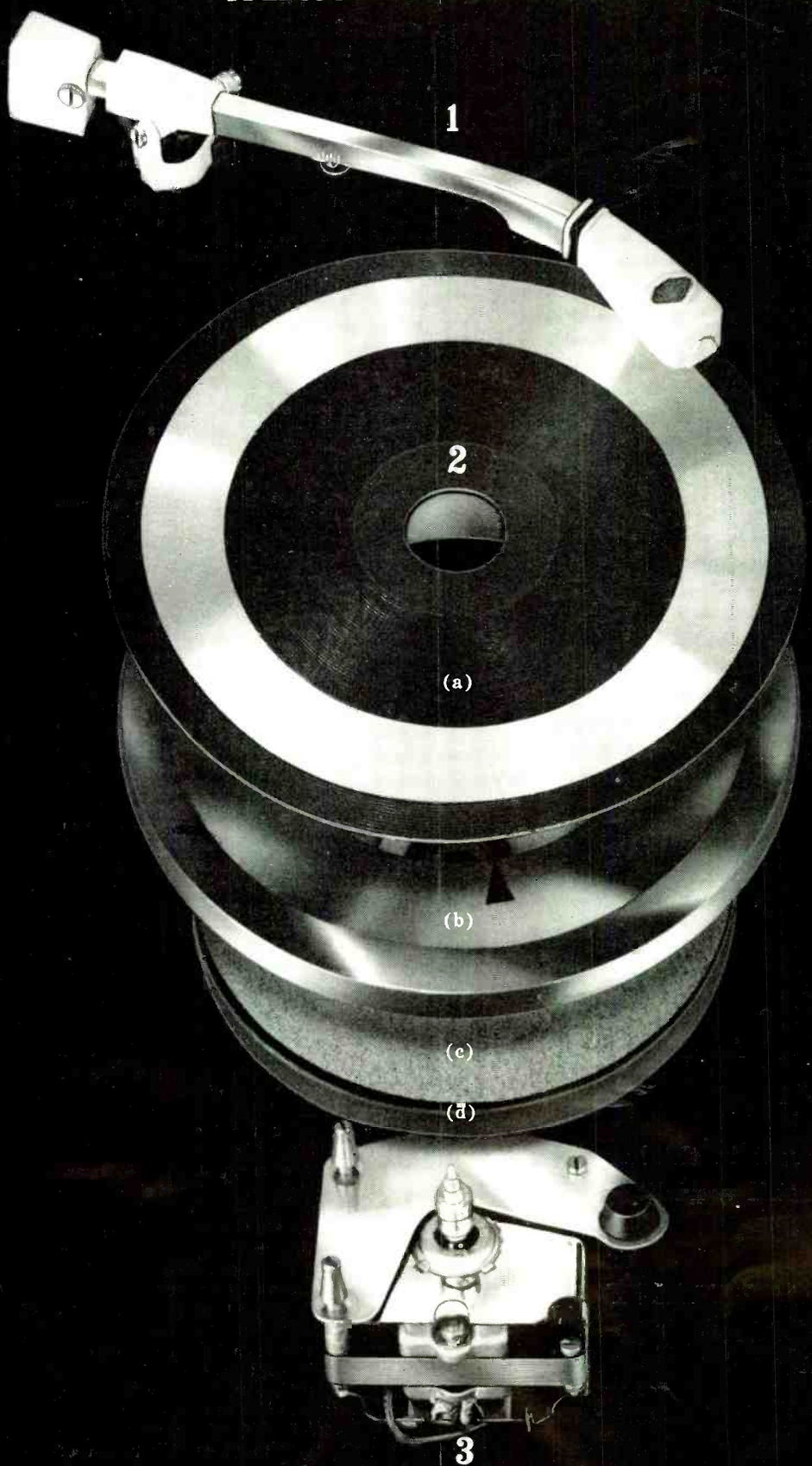
My only ground is for the pickup arm. While the preamplifier is on and I lift the pickup from the record, there is a loud buzz. It stops when the ground is connected.

Whenever we use our air conditioner, the picture on my TV screen jumps accordingly. A voltage regulator for the TV set reduced the jumping considerably. Alex E. Gold, Hempstead, Long Island, N. Y.

A. The effect of the air conditioner on the performance of the television receiver is in no way related to the problem of grounds. The problem there is one of voltage regulation. You solved that one as best you could. What is happening now to cause your picture to jump, is that the voltage regulator is not in complete control or that it does not act quickly enough to prevent the surge from affecting the television receiver. Hence, the residual quivering in the picture which you have indicated still exists.

The "hot" spark you see when grounding some of the equipment to the water pipe or radiator is natural and nothing to be concerned about. Just reverse the wall plug and the spark should disappear. If you have a number of pieces of equipment you may have to reverse several plugs before ridding yourself of the sparks. The most satisfactory procedure to follow is to disconnect all cables which interconnect your various pieces of equipment. Then ground each one, in turn, until you have eliminated the sparks by reversing the polarity of the wall plug.

consider this... with other units now offering counterweighted tone arms, oversized turntables, precision motors... what makes the Garrard so special?



You see before you three parts of the great Type A Automatic Turntable:

1. The counterweight-adjusted, dynamically balanced tone arm (which tracks the cartridge of your choice at the lowest pressure specified by the manufacturer).
2. The exclusive "sandwich" turntable system (a) ribbed rubber mat (b) heavy, cast, non-ferrous outer turntable (c) sound-deadening foam cushion (d) inner drive table... the entire assembly weighted and balanced for rumble-free, fly-wheel action.
3. The Laboratory Series® humless, noiseless, high-torque motor... developed for the Type A, engineered and built by Garrard.

However, these are only parts, and record playing units by other manufacturers offer some features reminiscent of these.

Then what makes the Garrard so special? Simply this... the Garrard is far more than the sum of its parts.

Creative engineering, rigid quality control, and 50 years of experience have joined together to make the Garrard an enduring source of satisfaction and pride to a legion of sophisticated admirers.

You'll find the Garrard a genuine pleasure to own. Over the years, your dealer has found it the same pleasure to recommend. That's why more people continue to buy Garrard than any other high fidelity component. They buy it for precision, for performance and to enjoy the convenience of single and automatic play, both at their fingertips.

But mainly, they buy it because it's a Garrard, and those who really know fine equipment have confirmed that a Garrard is indeed something special.

There is a Garrard Automatic Turntable for every high fidelity system. Type A, $84.50; AT6, $59.50; Autoslim, $44.50. For literature, write Dept. GE-14 Garrard, Port Washington, N.Y.

Garrard®

World's Finest

Circuit arrangements in some high-fidelity equipment are such that one side of the line cord is bypassed to chassis ground with a capacitor. This capacitor is used to prevent noise from the power line entering the set. If it should happen that the "hot" side of the line is the side with the bypass capacitor, the chassis will aso be "hot" because the chassis will be at the same potential as the "hot" side of the line. There will be a difference of potential between the chassis and ground. Naturally, when the chassis and ground are brought together, there is a spark. This spark is not dangerous because of the small size of the capacitance. Its reactance is high enough so that only a small amount of current can flow in this circuit.

If the polarity of the wall plug is reversed, the bypass capacitor is now on the negative, or more properly the neutral, side of the line. There is virtually zero voltage between the neutral and the waterpipe, and, of course, the chassis is at the same potential as the neutral. Therefore, when the chassis is now connected to ground, there is no sparking.

There are instances where both sides of the line are bypassed to the chassis. In such instances, you must simply live with the spark. However, the sparking is sometimes less with this arrangement than when only one side of the line is bypassed. This is so because the chassis is at a potential midway between the "hot" side of the line and neutral. You might say that the chassis is connected to the center of a voltage divider formed by two capacitive reactances. Again, there is nothing to be concerned about in this regard.

Your problem with the phonograph is another matter. You should ground your tonearm to the preamplifier. In turn, ground the preamplifier to the waterpipe. This places the tonearm and the preamplifier at the same potential. By following the procedure outlined in your letter there will be a slight potential difference between the arm and preamplifier and this may well be sufficient to introduce hum into your music system. This difference of potential can mean that the arm is not a proper shield. Therefore when you touch it hum voltages from around your body can be coupled into the signal leads capacitively.

Although it is true that the presence of a ground will not damage your equipment, it is also true that sometimes the presence of the ground will introduce more hum and noise than is present when the ground is disconnected. By trial and error you will discover which arrangement provides the best results in your particular installation.

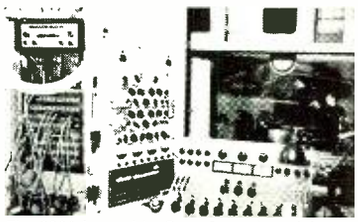
The physical safety of the equipment only holds true of those pieces of equipment in which the chassis or ground bus is not directly connected to the line. If you plan to incorporate such a piece of equipment into your system, care must be taken to insure that the chassis or ground bus side of the line is connected to the neutral side of the line rather than the "hot" side of the line. To eliminate this problem you should use a polarized plug which can be inserted into the wall receptacle in only one way.

The use of a ground will not affect the performance of antenna systems because the antenna terminals in your equipment are properly isolated from chassis so as to avoid this complication. In some instances, for AM reception, the ground can result in an improvement of signal strength because of the counterpoise (Marconi) action of the ground system. Æ

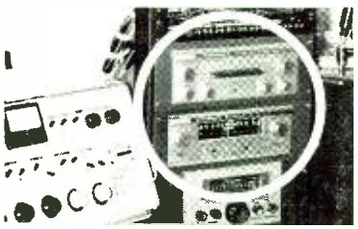
Now, Enjoy the Musical Perfection of PLAYBACK®

ALTEC ALL-TRANSISTOR 360A ROYALE II STEREO AMPLIFIER

TYPICAL PROFESSIONAL USE OF ALTEC PLAYBACK:



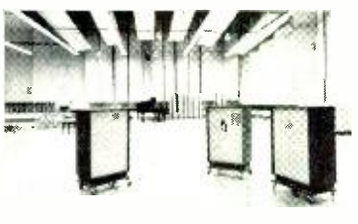
The 360A is used by Dave Sarser's and Skitch Henderson's famous "Studio 3" in New York.



Perfect partners! Rack-mounted Altec 360A works with Altec 314A Emperor Royale FM Multiplex Tuner at Sim-O-Rama Sound Recording Studio, N. J.

The film production service at Virginia State Department of Education relies on the 360A for power in conjunction with other Altec PLAYBACK amplifiers and controls.

United Recording Studios (Hollywood) uses Altec A-7 "VOICE OF THE THEATRE®" Speaker Systems for 3-channel PLAYBACK monitoring.



Interior of Columbia Records Studio (Hollywood) and Altec 605A "Duplex" loudspeakers used for PLAYBACK.

FIVE YEARS IN THE MAKING

At a time when most amplifiers were of the vacuum-tube type, we marketed our first all-transistor power amplifier for PLAYBACK applications. Today, the 351B model is credited as the most advanced single-channel amplifier of its type in the professional field, and has earned a reputation for reliability and quality to the extent that the three largest manufacturers of motion picture sound equipment have standardized on it for theatre work. Shortly after the 351, we introduced the now famous 708A "Astro"—the only all-in-one stereo center with all-transistor power output stages. Now, after five years of actual production experience with solid state circuitry, we take pride in introducing the 360A all-transistor stereo pre-power amplifier.

The difference in quality between the all-transistor Altec 360A and even the finest vacuum tube amplifier becomes most readily apparent through comparative A/B listening tests. Bass frequencies assume life-like solidity seldom heard outside a concert hall. Transient distortion, background hiss, and microphonics just aren't there. Even at loudest volumes, hum is so completely inaudible our engineers have concluded that it is totally absent. (In fact, we urge you to compare this feature with that of any other amplifier on the market!) Highs are so crisp, clean and transparent that listening to them approaches a new and revealing musical experience. You hear the highest frequencies in complete purity for the first time, since this amplifier neither contains nor needs the built-in bass boost found in ordinary units—one which affects the *entire* frequency spectrum.

NEW CONTROL CONVENIENCE

The new Altec 360A Royalle II Amplifier contains the *first* "KEYBOARD" control console. This exclusive Altec feature groups operating controls at one central location to eliminate confusion that is commonly found with the usual multiplicity of switches. Another convenience feature: *"Proscenium Illumination"* casts an even glow across the "keyboard" control console to provide clear visual selection of control keys even in the most softly lighted room.

PLAYBACK—THE CONSIDERED CHOICE OF PROFESSIONALS

Genuine PLAYBACK equipment is the considered choice of famous recording and broadcast studios—Capitol, ABC, Universal Recording, Columbia, and many others of equal stature. Just a few are illustrated at left. Professional studios depend for their income on the quality, the technical excellence, of the equipment they use. Shouldn't the equipment you select for your home reflect this same dedication to quality? If you agree, visit your nearest Altec Distributor (Yellow Pages) and hear the finest equipment in the world of sound: Altec PLAYBACK equipment. Be sure to ask for your courtesy copy of Altec PLAYBACK *and Speech Input Equipment for Recording and Broadcast Studios.* Though prepared specifically for the recording/broadcast industry, the conclusions to be drawn about your own home music center will be obvious. Or, for free copy write Dept. A-5.

FEATURES: POWER • 70 watts (IHFM); 35 watts per channel. ☐ INPUTS • 12, stereo or mono: magnetic or ceramic phono, tape head, stereo microphones, tape, radio, auxiliary. ☐ OUTPUTS • 7, stereo or mono: left, right and center speaker outputs, left and right channel recorder outputs, center channel voltage output for auxiliary amplifier, headphone output jack. ☐ KEYBOARD CONTROLS • Rumble filter, stereo-mono switch, tape monitor, channel reverse, hi-low gain, volume contour, scratch filter, phase reverse, headphone-speaker output switch. ☐ OTHER FRONT PANEL CONTROLS • Input selector, channel reverse, independent bass and treble controls (friction coupled), blend control, balance control, volume control. ☐ REAR PANEL CONTROLS • Magnetic-ceramic phono input selector, speaker impedance selector. ☐ PRICE • $366.00 including cabinet. Only 5½" H, 15" W, 11¼" D. ☐ SPECIAL FEATURES • Automatic reset circuit breakers for overcurrent protection of each channel and AC line. Diffused keyboard illumination plus daylight power indicator. Both headset and speaker monitoring for tape recording on front panel. Variable crossover type bass tone control for bass boost independent of mid-range.

ALTEC LANSING CORPORATION

LTV A Subsidiary of Ling-Temco-Vought, Inc.

ANAHEIM, CALIFORNIA

LIGHT LISTENING

Chester Santon

Tchaikovsky: 1812 Overture and Nutcracker Suite

London Tape LCL 75001

London is expanding its "Phase 4" series to include some of the lowest denominator classics in a "Phase 4 Pop Concert Series." The pronounced separation of earlier Phase 4 releases is immediately apparent in this four-track reel, a fact that may be of interest to tape users who have felt that United Stereo Tapes' older release of the 1812 (London L 80019) could have used more separation. This is an academic point at best because most tape fans probably settled quite happily upon the Mercury reel of the 1812 Overture some years ago. Those who have done so need have no fear that London has topped the cannon shots of the famous Dorati version. As Robert Sharples leads the London Festival Orchestra and Band in this new release, the climax of the piece produces bursts of sound that resemble flame throwers more than they do cannon. What I hear is a "whoosh" instead of the normal bang of a cannon. The bells here are okay but then they should have some impact when you consider the way the engineers bring up the volume of the bell channel (left side) each time the orchestra takes a breath. As for the rest of the performance, even a potboiler such as the 1812 would have benefited from the efforts of a top conductor and a normal concert setup in the recording hall. For another thing, Sharples has fewer than average strings to work with. Combine that with a desire for exceptional separation on the part of the producer and you have an 1812 that starts out with the left channel virtually dead as the deeper strings get under way on the right. Also unorthodox is the placement of the wind instruments in the left channel instead of center stage. Frequency response in this reel follows pretty much the usual pattern. A couple of added octaves in the upper end would have given this tape the overtones now available on darn near any stereo record played on latest-generation disc equipment. Bass response is another story that most of us are familiar with on tape releases. With no problems of groove overcutting to contend with, the bass drum of the recording has a chance to come through with very little inhibition of its true frequency. For all its anemic quality in the upper end, the tape duplicating process still delivers a very convincing signal in the bass region.

Melachrino Strings: Ballads of Irving Berlin

RCA Victor LSP 2817

To his 1962 album of Berlin waltzes George Melachrino now adds this attractive release of famous ballads by the Old Master. A recording of this type is backbone material for any collection of tasteful music based on arrangements of lasting appeal. The top Berlin films and shows from 1919 to 1950 are represented in this collection of classics delivered in the easygoing Melachrino style. An interesting technical point in this Dynagroove disc: this made-in-England recording manages to avoid virtually all of the problems that have been a part of the Dynagroove system. Instead of the suspended-in-space feeling you get from the absence of room acoustics in most Dynagroove recordings, Melachrino's orchestra occupies a recognizable studio environment, gratifying in its sense of space around the instruments. Equally encouraging is the almost total absence of tampering with the frequency range of the master tape. Each passing month seems to bring closer a solution of the Dynagroove situation: recordings with the term Dynagroove on the label to impress the table phono crowd but normal flat response in the grooves for those whose equipment can do it justice.

Percy Faith: Shangri-La

Columbia Tape CQ 591

Everytime I read about the fabulous response now being claimed in some quarters for 1⅞ ips tape, I can't help wondering when some of that response is going to rub off onto commercial 4-track tapes at 7.5 ips. Wouldn't it be nice if the lab people working on 1⅞ tape could take a little time off to demonstrate to the men in charge of duplicating our commercial tapes how thrilling their store product would sound if it went out reasonably flat to 10,000 cycles. For all its advantages of "high" speed, this latest tape by the celebrated Percy Faith orchestra follows a long established pattern in its high end. Treble boost begins in the low mid-range and rises so steeply you can cut off everything above 8,000 cycles and and still get an illusion of plentiful highs. This falls far short of the laboratory response claimed for the newest tapes at 1⅞ going past the latest breed of tape head. For all its intense work in ultra-slow-speed tapes, Columbia manages in this reel a sound that is only a shade above the industry average. The musical material on the tape is of predictable Percy Faith quality with a left-channel chorus adding glamour to Oriental and Pacific Island specialties such as *Kashmiri Song*, *Song of India* and *Moon of Manakoora*.

Belafonte at the Greek Theatre

RCA Victor LSO 6009

Here's another deluxe two-record album taped in the course of a Harry Belafonte concert. The 4,407 seat open-air Greek Theatre in Los Angeles was the site of this particular appearance last August by the latest Belafonte troupe. This is the largest supporting cast I can recall encountering on a Belafonte album. Taking part in the 1963 tour were a dance troupe, a chorus and a hefty-size orchestra. Drawing upon all of these resources, Belafonte sparks a long program that never fails to hold interest. The amazing diversity of the material is just as important in this regard as the virtuosity of the star performer. A typical Belafonte concert by now is a smartly paced mixture that is apt to include some of the darndest things. The prison songs, spirituals and calypso tunes he offers are no longer a novelty at this point in his career. The new element in the act is the increasing use of humorous characterization in order to build a personality capable of outlasting the current vogue of folk singers per se. One notch in the development of an all-around entertainer is Harry's imitation of a small youngster asking preposterous questions at bedtime in the song *Why 'N' Why*. Comedy also plays a large role in his current audience participation number, *Zombie Jamboree*. This gargantuan successor to *Matilda* runs about 17 minutes in the concert and takes up all of one record side. Before the audience itself helps to bring the program to an end with *Zombie Jamboree*, Belafonte introduces his dance group for a Boot Dance first presented in this country by Miriam Makeba. The orchestra recalls Sonny Terry and Brownie McGhee in an exhilarating version of Hoedown Blues. In the sweet ballad division, Belafonte has his most telling moments in *Try to Remember* from the off-Broadway show "The Fantasticks," and Fred Hellerman's *Sailor Man*. In the sound department this album demonstrates some of the positive virtues of Dynagroove's restricted dynamic range: volume level throughout is more uniform on Belafonte's hand held mike than it would have been in a regular recording.

Piaf at the Olympia

Capitol ST 10368

Edith Piaf's extraordinary singing career came to an end on October 11, 1963. This is the second recording issued by Capitol since her death. Recognizing that Piaf's fame in this country was second only to her renown in France, the label rushed out "Piaf and Sarapo at the Bobino" within a few weeks after her death. That recording, which also featured her husband, is followed by this program Piaf gave at the Olympia Music Hall in Paris when she played that famous institution for the last time in the fall of 1962. The interest here is a more historical than a musical one because the unique voice had already taken on a metallic sound that was nowhere evident in earlier Capitol discs such as "Piaf" (T-10210) or "More Piaf of Paris" (T-10283). As a performance, her reaction to the enthusiastic Olympia crowd is a fantastic testimonial to sheer will power as she belted out her songs despite the orders of her doctors. *Milord*, the greatest Piaf hit in recent years, emerges with astonishing intensity.

Georgia Brown Loves Gershwin

London Tape LPM 70078

It's a good thing the songs of Gershwin are made of enduring stuff. Even they, however, need all their resilient strength to stand up to the treatment of today's free-wheeling singers. One of the leaders of the new crop of improvisatory vocalists is Georgia Brown whose gusty performance in "Oliver" has earned her the label of "exciting" personality from those who value personality more than they do conventional singing. For my taste, this reel would make a more favorable early impression on the listener if the Porgy and Bess excerpts on one half of the tape had been placed on Side Two rather than Side One. The liberties Goergia Brown takes with the music are far less out of place in Gershwin's flippant pop songs than they are in the "arias" of his celebrated folk opera. At the very least, placement of a Latin-flavored *Fascinating Rhythm* at the beginning of the tape would have prepared the listener for the unorthodox approach in *Summertime* and the five other Porgy selections. Mannerisms certainly cannot undermine the seldom encountered *Blah, Blah, Blah* or *Slap that Bass*, an engaging dialogue as reconstructed here with the rhythm section on the left and Miss Brown's rich voice on the right. There is no lack of fervor in the great Gershwin love ballads, *But Not For Me* and *How Long Has This Been Going On?* In all the selections, conductor Ian Fraser rates a special nod for his work in keeping pace with Georgia Brown's flights of fancy.

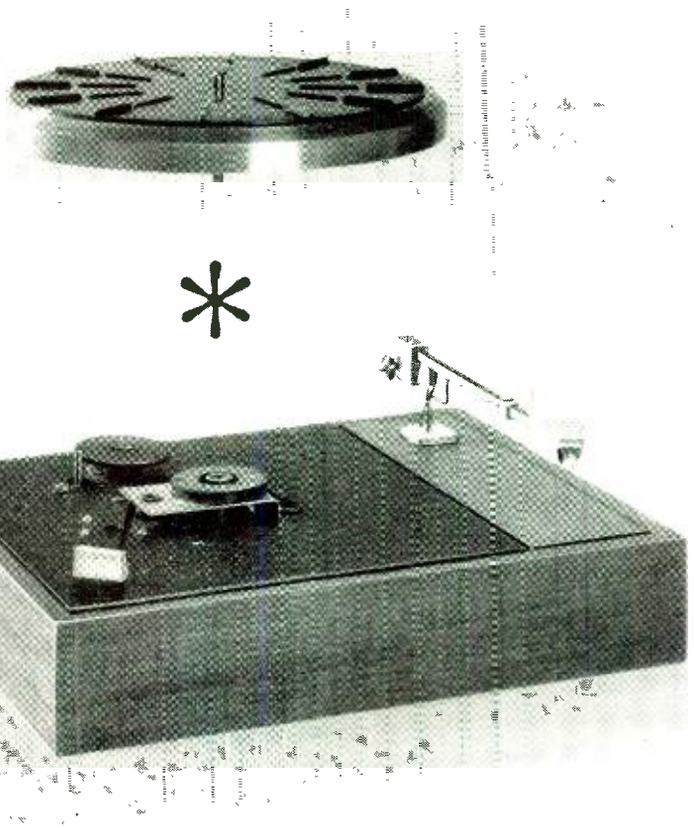
Jimmy Durante: Hello Young Lovers

Warner Bros. WS 1531

In the autumn of last year, Warner Bros. saluted the season with a Jimmy Durante album titled "September Song." The combination of the insouciant Durante voice and the praises of an autumnal love apparently proved a winning one with record buyers because the first effort has been followed by another album in similar vein. This turn of events may puzzle those who associate Jimmy Durante with the fractured-English comedy songs that have made him such a unique pillar of showdom. It would be stretching a point to say that Jimmy sings these songs "straight"; he has too much personality to find himself in such a predicament. In *Try a Little Tenderness*, his own *In the Other Fellow's Yard* and Gordon Jenkins' *This is All I Ask*, the Durante approach applies a fresh layer of logic and warmth to songs designed for the mature serenader. The arrangements by Roy Bargy, a longtime friend of Jimmy's, are discreetly to the point.

*GYROPOISE® MAGNETIC SUSPENSION **introduces a new perfection to the reproduction of sound. Its secret is silence!** The record platen rides on a cushion of air—suspended magnetically! Mechanical silence is the result. Vertical rumble is eliminated. But there's much more that recommends this remarkable turntable. It's a matched, balanced, coordinated system, complete unto itself. The arm and platen suspension have been unified to eliminate all mechanical feedback. The Unipoise® tonearm is balanced from a single bearing point. Its cartridge—the famous Stanton Stereo Fluxvalve—rides the record with a feather touch. The motor, too, is engineered for silence, rigidly mounted to the base to dissipate all possible vibration. The *800B Stanton Stereotable® System* even *looks* silent. The lines are slim, quiet and functional, with a base of natural walnut and fittings of gleaming brushed metal. See for yourself—and listen too—at your franchised Stanton dealer. Stanton Magnetics Incorporated, Plainview, New York.

STANTON



LETTERS

Zero Distortion?

SIR:

The policy of your magazine over the past several years has been to advance and support good audio. But an ad that appeared in the February, 1964 issue does not agree with your policy. This ad (page 12) claimed "absolute zero distortion." Come now, who do you think would believe this. It cannot be so in any sense of the definition of the word. You and the manufacturer are distorting the truth.

I am sure that the amplifier is exceptionally linear and must have very low distortion. However, it in no stretch of the imagination could have "no" distortion. Also, I am sure that I could demonstrate with instruments that there *is* distortion, be it harmonic, intermodulation, amplitude, frequency, or phase.

I cannot believe that it is ethical to claim zero distortion in leading audio publications. Why not claim just very low distortion?

DONALD R. SPANGLER
4557 Ridgebury Drive
Dayton 40, Ohio

Manufacturer Replies

DEAR SIR:

Theoretical physics teach us that there is no absolute linear, that there is no absolute vacuum or absolute zero temperature except in outer space. However, we are down here on earth producing high fidelity amplifiers of which the Quadramatic is the most advanced ever built here or abroad. There just isn't any instrument made, which can detect distortion in our system at 75% of full power and even at full power intermodulation readings are barely out of the area of residual noise so that reliable readings cannot be taken at any power.

This creates a sound image never before heard of and is primarily the reason we have had such tremendous response here and abroad. We will continue to make our statements until someone produces an instrument capable of reading intermodulation products below 0.02%.

G. C. DENCKER
President
Pure-sonics, Inc.
Oak Park, Ill.

Ceramic versus Alnico 5 Magnets

SIR:

This letter is intended to clarify some of the statements made on the comparison of ceramic and Alnico 5 permanent magnets in the Audioclinic for April 1964. Since the largest usage of ceramic magnets in audio components is in loudspeakers the following statements refer primarily to their use in loudspeakers.

A ceramic magnet can be used to produce a magnetic structure with magnetic performance equal to any Alnico 5 structure. Equal magnetic performance in this case means the structures will have identical magnetic air gap dimensions and air gap flux densities.

A ceramic magnet has higher coercive force than Alnico 5 permitting a shorter length magnet for the ceramic structure. A ceramic magnet operates with a lower magnet flux density than Alnico 5. This requires a larger ceramic magnet area to provide the same total air gap flux as the Alnico 5 structure.

(Continued on page 66)

"...by combining this unit, Citation A, with a solid state basic amplifier of comparable quality, a sound path could be set up that approaches the classic goal of amplifier design—a straight wire with gain."

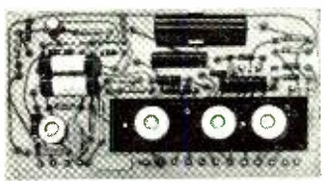
—HIGH FIDELITY MAGAZINE

THE NEW CITATION B

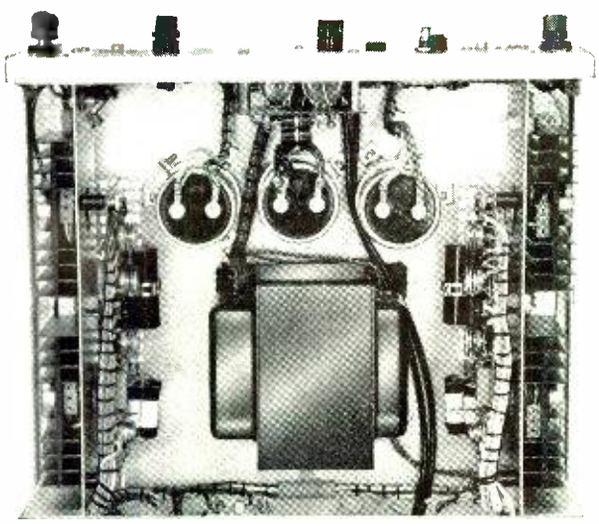
PROFESSIONAL 80 WATT SOLID STATE STEREO BASIC AMPLIFIER

Handsome front panel: facilitates custom installation. Features include current-adjustment meter, on, off switch with pilot light and low-cut filter. Removable bottom panel conceals idling adjustment controls.

Computer-grade silicon output transistors: heavy-duty, solid state devices, virtually impervious to abuse. Will take 100% more power than their use in Citation B will ever demand.



Driver stage: Wideband silicon driver transistors are mounted on rugged, military-type epoxy glass board. Board pivots for easy accessibility or removal.



Top view of chassis: computer construction throughout. Five sub-assemblies assure easy accessibility and minimum operating temperature through efficient heat dissipation; laced military wiring harness couples each stage.

Electrolytic capacitors: engineered to computer-grade specifications for unlimited shelf life and consistent, long-term performance.

"Heat sink": heavy-duty finned aluminum device which rapidly draws heat away from output transistors —insuring long life, fail-safe performance.

The "classic goal of amplifier design" is now reality. The big "B" is here. The Citation B. A power-packed "brute" loaded with 80 watts of flawless performance—a true product of the computer age. • The "B" has the widest frequency response of any basic amplifier—1 to 100,000 cps. • The "B" has the best square wave response—less than one microsecond rise time. • The "B" has the highest damping factor—50 to 1 at 10 cps. (No other power amplifier is even close.) • The big "B" is the only power amplifier completely free of hangover or clipping at full power output.

The Citation B reflects Harman-Kardon's solid state leadership in every way—performance, design and construction. "A straight wire with gain" when matched with Citation A, the big "B" will also enhance the performance of any other high quality stereo preamplifier. For more information — write Citation Division, Harman-Kardon, Inc., Plainview, N.Y., Dept. A-5.

harman kardon

A subsidiary of THE JERROLD CORPORATION

AUDIO ETC.

Edward Tatnall Canby

This column is a repeat of the column that appeared in April 1961. For an explanation of the repeat, see the Editorial on page 16.

Over and Out

A SOMEWHAT MUSICAL ASIDE, this month, time out from audio to observe that I am unhappy about the trend in the record business these days. I don't mean the records themselves, but the stuff that is on them and the people who are in business to provide it. Never forget that, as this column used to say every two or three months, the business of audio is music. And things are changing very fast these days in the musical end of recording.

(I'm not very happy either about a certain by-product of recorded music—record criticism. That—uh, pardon me—noble art is metamorphosing very rapidly too, and the shift seems to be towards the computer. The computer, you see, collates objective facts. It isn't at all critical. It doesn't have a point of view, nor a personality. But it processes data at an alarming rate of speed.)

The trend in records is, of course, upwards. It always is that. Right now, it's an upward spiral of costs and outlay, an upward expansion in the minimum size of the operations base. And especially, it's an upward jump in the direction of uniformity, conformity, and generally cautious duplication of safe, big-time music. There's a violent upward spurt in failures among smaller record companies, an upward jump of huge proportions in the withdrawals of listed LP items.

Stereo is on the up-and-up, numerically, and it costs so much that only the bigger companies can exploit it, in view of the odd fact that stereo doesn't sell. Mono recordings are moving upwards astronomically in the bargain-basement bins, where they do sell—but the supply is limited, and the limits are going ever higher, as the sales mount.

The trend in recording is towards virtuosity, ever more expensive, plugging performance, not music. It is towards ever-increasing numbers of recordings of the famous "fifty pieces" of standard repertory that Virgil Thomson cited many years ago. In fact, except in point of numbers, we are fast returning to the days before the LP came along. But now, instead of one or two each of the fifty, we have fifty recordings each, and more every month. (If not fifty yet, then fifty in a year or so, at the present rate.)

I suppose all of this is no more than old cry, that someone has yelled every year since the dawn of recorded history. Give us back the good old days! But them days is gone forever.

True enough, those some old pieces, from "1812" to the Schubert Unfinished, have been popping up again and again on records since electronics came in, and there have indeed been steadily mounting technical improvements, to give a good hi fi excuse. This is no fake reason. Just go back and play the hi fi spectaculars of, say, 1956, and see how they rate against today's stereo miracles. (A few will rate very high, but the general run show their age, and especially in the noisy, crackling LP surfaces that we accepted as standard only five years ago.)

It's true, also, that we need many versions of any well known piece of music. I'm the first to say that there is no "best" version, nor ever will be, and I make much out of audible comparisons between versions in my weekly radio program—I'd be lost without them. And it's also true that stereo has given us a legitimate excuse for doing all the same old pieces once again—and again and again—updated into the new medium. I would be the last to scoff at that.

It's true, though the reasoning is narrowly commercial, that every respectable company catalog must be "representative" in order to impress dealers and buyers, whether there's a need or no. What good is any symphonic catalog without a Beethoven Fifth or a "Pictures at an Exhibition"? What good is any artist roster without a fancy fiddler who'll re-play the Lalo "Symphonie Espagnol" periodically, in higher and higher fi? This catalog-itis adds volumes to the repertory expansion, and I suppose it is inevitable.

No—I can't really object to the upward trend in repertory. It's in the cards and always will be as long as there are records. Or tapes.

Pioneers, O Pioneers

But what is really wrong with the record economy now is the disappearance of the small operation, and with it that really inspiring flood of imaginative, economical, wide-ranging recording that went on for the first half dozen or so years of the LP era. The standard repertory will continue to be kept topped-up, as the British would say. But the rest of music on LP will sadly fade away, and a big loss it will be.

I don't think enough of us realize what a splendid thing it was, that brave penetration into a thousand odd nooks and crannies of the silent paper-world of musical manuscripts by the little bands of enterprising LP promoters, who took off with a hundred bucks of capital and maybe a typewriter to launch a Record Company, full fledged. I am more and more reminded, as the early LP period passes into our history, of the pioneers of other ages, who similarly launched out towards adventure and the hope of gain, on a shoe string, in a Conestoga wagon, on foot or by sail, on land or by sea. There is now a universally admired aura of dash and *élan* to our pioneers, and to Columbus and Magellan and Sir Francis Drake of an earlier adventuresome period. They're all heroes, and so are the Forty Niners, the boys who went to Alaska for gold and, for that matter, every frontiersman who lifted an axe or blazed a trail a century ago.

And yet they mostly didn't take off to be heroes, these people, nor were they always as wholesome and delicious as we now assume. Plenty of hard-headed shrewdness was involved, plenty of pig-headedness, too. The "hope of personal gain" was often something rather more crude than those pretty words. Columbus was pig-headed, and wrong; he never did find the Indies where he said they were going to be. Neither did Elaine Music Shop have any prior intention of launching the history of the hi fi LP spectacular with the famous, #401, "Ionisation" by Edgard Varèse!—the theme song of the 1951 Audio Fair. (I think it was #401—somebody walked off with my red plastic first edition.)

There were unpleasant things about small-company LP, and stupid things. There were bad, indifferent, mediocre performances, skimpy orchestras. (But Columbus had some pretty skimpy boats to sail with.) There were endless forays into musical aridity—for the ocean of music history is dotted with barren islands, too. There was pettiness and small-time dishonesty. (But then, after all, Magellan didn't even get home alive. And look what happened to the men of the Bounty.)

Quick-Buck Operators?

It's all very well to say that most of the little LP people were merely guys out for a quick buck, who didn't make it. Most of them, in a sense, were just that; for every promoter of a business has to have a certain gleam in his shrewdly romantic (or foolishly romantic) eye, if he's going to get started at all. Aren't the odds always against him? I suggest that, actually, the quick-buck operators were few and notorious. Small LP companies were never exactly gold mines in cash, and those that did make visible money of the sort that gets flashed around were suspect right from the beginning. Shady deals, mysteriously obscure tapes from doubtful sources, dirt-cheap European orchestras, working overtime.

No, the bulk of the small companies were founded in the highest of hopes for a real musical service to the listening public. Don't laugh. People do that sort of thing, and are uplifted in the experience. Even if the music they sell is lousy, they don't think so. (Ask *me*—I'm a record reviewer.) They didn't used to like unfavorable reviews, and it wasn't because their sales were inhibited. It was because their pride was hurt. That's a much more poignant sort of dislike.

An FM tape stereo system of comparable quality would cost up to $850

start with the Eico receiver kit — only $154.95

You can build a complete, high quality FM tape stereo system from the new Eico Classic Speed Kit package for only $445. This system includes the Classic 2400 stereo/mono 4-track tape recorder; Classic 2536 FM MX stereo receiver and two HFS-8 2-way high fidelity speaker systems.

Completely wired you'd save nearly $300 on this system over other makes of comparable quality—factory wired price $570. You can also select any individual component at a remarkably low price.

Here's why it's so easy to build these superb components. The 2400 tape recorder comes with the transport completely assembled and tested—only the electrical controls and amplifiers need be wired. The 2536, is without doubt the easiest-to-build receiver ever designed. The front end and the IF strip of the tuner section are supplied completely pre-wired and pre-aligned, and high quality circuit board and pre-aligned coils are provided for the stereo demodulator circuit. Speaker systems are completely assembled in fine oiled finish walnut cabinet.

EICO CLASSIC 2400 STEREO/MONO 4-TRACK TAPE RECORDER Performance on a par with recorders selling at twice the price. 3 motor design enables each motor to be optimized for its particular function.

□ 3 heavy-duty 4-pole motors, capstan motor with integral fan □ DC braking of reel motors □ Standby operation between all transport modes prevents tape spillage, provides slur-free starts, permits easy cueing & editing □ Automatic end-of-tape switch & digital counter □ Jam-proof belt shift mechanism selects 7½ or 3¾ ips speed. □ Requires no head wearing pressure pads □ New combination erase and record-play 4-track stereo head □ Equalization selector provides uncompromised equalization on both speeds. □ Mixing mike and line level controls □ Dual electron-ray level indicator tubes □ Made in U.S.A. □ Oiled finish walnut base incl. in price of both semi-kit and wired versions. Semi-kit (transport assembled & tested) $199.95; wired $269.95.

EICO CLASSIC 2536 FM-MULTIPLEX STEREO RECEIVER Makes every other stereo receiver seem overpriced. Combines stable sensitive FM stereo tuner *plus* a virtually distortion-free 36-watt stereo amplifier with remarkable overload, transient and regulation characteristics.

AMPLIFIER SECTION □ all program sources—magnetic phono, adapted ceramic phono, tuner, tape □ Full control facilities—bass, treble, blend and balance □ Tape monitor switch □ Distortion at 10-w/channel 40 cps—0.5%; IHF, power bandwidth at 1% distortion, 30 cps—20 kc.

TUNER SECTION □ Low noise, shielded & temperature compensated front-end for drift-free performance □ 4 amplifier-limiter stages & ultra-wide-band ratio detector. □ Electron-ray tuning bar & stereo program indicator □ Velvet-smooth rotary tuning □ IHF usable sensitivity 3 μv (30db quieting); 1.5 μv (20db quieting). □ IHF distortion 0.6%; IHF capture ratio 3db. Kit $154.95; wired $209.95 (Incl. FET)

EICO HFS-8 2-WAY SPEAKER SYSTEM Compact 2-way speaker system in handsome oiled finish walnut cabinet. Full transparent bass; clean, smooth middles and highs. Two speakers: 8" high-gap energy woofer-mid-range transducer, and matched 2" tweeter. Wired only, $44.95.

OTHER NEW EICO CLASSIC SERIES COMPONENTS 2036—36-watt stereo amplifier. Kit $79.95; wired $109.95. 2200—FM/MX Stereo Tuner. Kit $92.50; wired $119.95 (Incl. FET.) 2050—50-watt stereo amplifier. Kit $92.50; wired $129.95. 2080—80-watt stereo amplifier. Kit $112.50; wired $159.95. Optional oiled finish walnut cabinet for the 2536, 2036, 2200, 2050 and 2080 are available for $19.95. Add 5% in West

FREE 1964 CATALOG
Dept. A-5

EICO

Eico Electronic Instrument Co., Inc., 131-01 39th Ave.., Flushing, N.Y. 11352 Export: Roburn Agencies, 431 Greenwich St., N.Y. 13, N.Y.

If our pioneers opened up the West in their own interest, so did the LP makers open up a new musical frontier in a hundred different directions, and the feeling, for awhile, was much the same: the burden of hard work and the satisfaction of a personal accomplishment, small, but perhaps brand new to records and to music in our day. Ask any of them—didn't it feel pretty good, back around 1953 or so, when those first shiny new advance copies came from the pressing plant, ready to ship out to a waiting world? I saw enough of this myself to have a large respect for all of those who indulged in small-company LP exploration in the days when one could still do it and keep a shirt on one's back, more or less.

I guess it was to some extent like the early days of our industry and invention, when big ideas were worked out by big brains in home workshops. The brief history of LP recording has already compressed a hundred years of that sort of thing into its short span, and already we have arrived at the expensive technological stage of high professionalism. Who could be a Ford or an Edison or a Firestone today? Not without General Motors—or Ford—to back you up. At first, "anything went" on LP. Plastic was bad, but nobody knew of any better. Distortion was all over the place, but so was playback distortion and not many listeners bothered to make the distinction. It was the new, exciting, unheard of music that got our imagination, the stuff that nobody would have believed could appear on records, and—after the 78—at such unbelievable length and at such low prices! We reveled in it as no one who had not been a 78 collector can now very well understand. And there were more new record companies every month, distortion or no.

I played over an early Haydn Society disc just the other day—there was a noble bit of tomfoolery!—and the obviously distorted sound was of a sort that simply would not be tolerated at present, though it was not of the sort that could obscure the sense of the music.

The music was priceless, two early symphonies of Haydn that had scarcely been known for several centuries and yet are among the world's musical masterpieces. Where but on the new LP's would they have then been heard? (Not in public concerts—not even now.) But at the same time, the performance itself on this record was dismally wooden, via a poor conductor and a confused, browbeaten orchestra. Misguided enterprise, poor artistic management, punk playing, and punk engineering, and the record is still worth any ten new ones today. Perhaps there was too much money in the Haydn Society, until it was all spent. The shoestring companies often did a better job with equally valuable material.

There is no substitute for the economical, centralized, small-company operation, as we all know in the hi fi equipment field. It is our stock argument against the so-called mass-produced "hi fi." The same argument holds true—or held true—for the small LP company, with the same advantages, with luck, of knowing and skilled direction, great flexibility, low overhead, adaptability. It all figured—back then.

Quality – Economy – Dependability

QUALITY WITH POWER

FM-3 Dynatuner with automatic multiplex facility and Stereocator. Low distortion and high sensitivity. Can be completely aligned without special test equipment.

PAS-3 Famous PAS-2 preamplifier with new styling. Outperforms preamplifiers of many times higher price.

MARK III 60 watt power amplifiers for a perfectionist's system. The Mark III has been chosen for public demonstrations of live versus recorded sound with outstanding success.

Complete $339.80 in kit form
Complete $479.80 assembled

DYNA designs rigidly adhere to one principle — the creation of a level of performance in audio reproduction which cannot be bettered regardless of price. This performance is not fully detailed by current measurement standards which are unable to define how the equipment SOUNDS. Check the printed specs rigorously, but in the final analysis — LISTEN!

LISTEN to any DYNA amplifier on the finest speaker system you can find. You will realize the DYNA amplifiers will not limit you, no matter what your associated components. Choose according to your budget and power requirements, for within their power ratings, all DYNA amplifiers yield the same superlative sound, free from noise and distortion. You may find a DYNA sounding better than its power rating would indicate. This is as it should be.

LISTEN to a DYNATUNER under the most difficult reception conditions. Try it on the weakest signals, in bad multipath locations, on overmodulated signals and in the shadow of the transmitter. It will stand comparison with any so-called professional monitor tuner. Further, alignment is no problem when you own a DYNATUNER. When in doubt — after tube replacement, shipping, etc. — just a few minutes spent with the DYNA home alignment procedure — no instruments — will assure you of laboratory results.

A product is only as good as its components. The kit builder recognizes and appreciates this. (Maybe that explains why most of our kit sales are owner recommendations.) DYNA pioneered quality etched circuit construction in the high fidelity field, and its advantages pay you over the years in dependability and ease of maintenance. DYNACO output transformers have a worldwide reputation for excellence and are used in much more expensive equipment than our own. They are the major factor in DYNA's quality sound.

It's easy to operate! We have tried to engineer complexity out of high fidelity. Those 3 large knobs do all the work! But, there is full flexibility for the enthusiast's subtle adjustments.

We devote a major part of our engineering effort to distillation and refinement of every design. This extra effort, primarily appreciated by the kit builder, means a more thoroughly proofed assembled DYNA tuner or amplifier too. DYNAKITS are easier to build, lower distortion in operation, and more trouble-free over the years.

You can pay more, but you can't buy better performance.

QUALITY WITH ECONOMY

FM-3 Combination of famous FM-1 tuner and FMX-3 multiplex integrator with new decorator styling. Its deceptively simple appearance masks the fact that this unit approaches the theoretical limits for high sensitivity and low distortion. Logical simplicity of control through full automation of stereo-mono switching and uniquely simplified tuning. Exclusive Stereomatic circuit locks in and signals stereo automatically and silently. FM listening was never so enjoyable; never before so simple.

SCA-35 New all-in-one stereo amplifier and preamplifier. Matchless listening quality from a moderate power, low cost unit which combines functional simplicity with full flexibility. Its compact size and modest 35 watt continuous power rating belie its impressive performance with even the most inefficient loudspeakers.

Complete $209.90 in kit form
Complete $309.90 assembled

ASK YOUR DEALER FOR A DYNA DEMONSTRATION

Complete descriptive literature available on request

DYNACO INC. 3912 POWELTON AVENUE, PHILADELPHIA 4, PA.

Boldness

Just look at an early slice of small-outfit catalogue with me for a moment—Esoteric, whose successor is Counterpoint. Be amazed at the boldness and variety of this company's musical offerings, as of 1953 or 1954. I've pulled its cards out of my back file catalogue, in numerical color, which is roughly the order of release. How often today do we get this sort of high-flying, wide-ranging, flamboyant exuberance!

#501: Schoenberg: Serenade, Opus 24, for septet and baritone, with Dmitri Mitropoulos conducting and Warren Galjour—a priceless combination that could cost a big company thousands of bucks right now, if Mitropoulos hadn't died recently, and a piece of music of historical importance and plenty of hi fi interest. (That's how they got the performers; they must have done it mostly for love, and quite rightly.)

#514: Flemish Choral Music. My card doesn't list the performers—a typist who worked for me neglected to type out the name of the pianist in a piano concerto. But this is music of the Renaissance, of a sort that is tremendously dear to my own heart (I conduct the same sort in my own Canby Singers) and of an importance and beauty beyond compare, as well as practically without recordings at this stage in the early history of LP. There's been a good deal since.

#515. Handel: Music for Ancient Instruments and Soprano Voice. This is an antiquated title, going back to the 'teens when old instruments were really "ancient" and rarely heard; but the recording seems to be about the first of literally dozens in this musical area of later date, by many groups. This was the New York Pro Musica, as it is now known, and was surely an unusual venture for a small company.

#522–524 Harp Music. Nicanor Zabalata. All over the lot! No sooner seen, or heard, than recorded! I don't remember the harp but to toss out three complete LP's of harp music in a series is really quite a small-label accomplishment. Reckless, even: but this is how things were done then.

#527 Greek Folk Songs and Dances. Royal Greek Festival Co. Aha! And *now* who puts out the various royal ballets and orchestras and the like? Huge companies. But Esoteric, 'way back, was already in the field with its recorders, ready to catch anything that came along and would consent to record. Enterprising.

#528: Handel: Concerti a quatre: Cello Sonata. Bach: Trio Sonata #1. Harpsichord Quartet. Who started the present rage for Baroque music? Well, the small LP companies, Esoteric included, had a big place in it. Now, everybody's in the act, but this record was still relatively a pioneering effort.

#530: Wolpe: Sonata, Passacaglia, Quartet. . . . Wham! Right back to the ultra-ultra modern. Stefan Wolpe is a Schoenbergian follower of high repute and tough listening qualities. Here was another love-labor, with the redoubtable David Tudor on piano, Frances Magnes on violin, Samuel Baron conducting, even the well known Robert Nagel on trumpet. Amazing how a bit of enterprise could get together the topmost performers for these LP innovations.

#532: Jazz Immortal, 1946; Jam Session. Sonny Berman.—And wham! again, right into historic jazz. I'd thought that Columbia had pioneered the historical jazz reissue on LP with its famed "Benny Good-

(*Continued on page 65*)

COVER INSTALLATION

With space limited in his city apartment, Tom Athans of Elmhurst, N. Y. chose to house much of his equipment in a closet in his den. In addition to the equipment indicated in *Fig.* 1 he stores in the closet a Marantz 8 power amplifier, Electro-Voice microphones, (1) Model 644 and (2) Model 664 and Atlas booms and stands. He has also an Ampex 881 stereo headphone and a Koss T-1 adaptor. Two AR-3 loudspeakers are located on the opposite wall. Miscellaneous equipment includes Kersting files, ESL Dust Bag, Grado Dustat and Duotone brush.

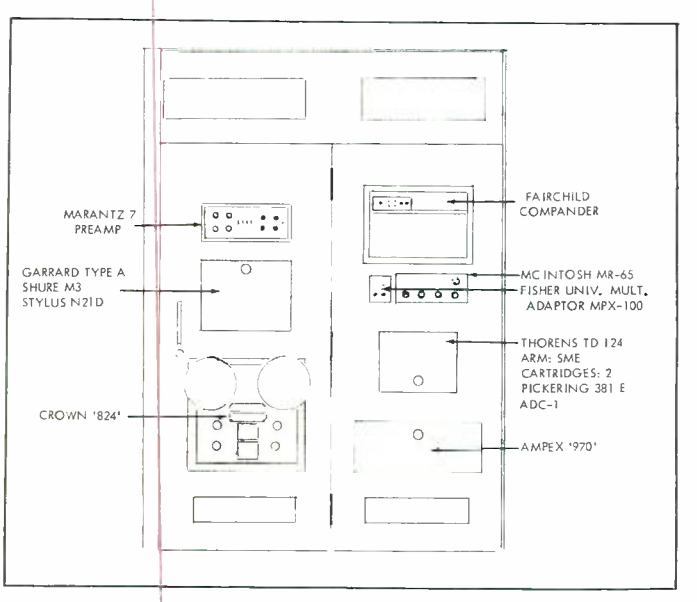
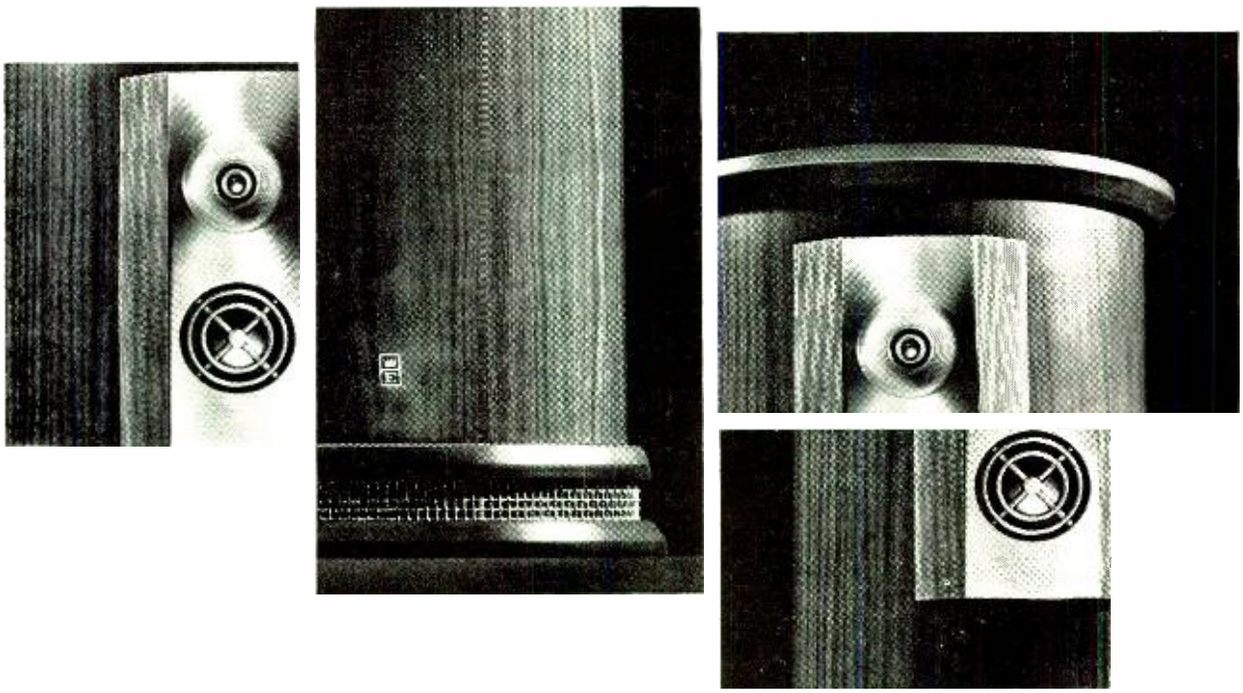


Fig. 1. Installation of an apartment dweller.

It's round...it's tall... its woofer faces downward and there is no grill cloth. It doesn't even resemble a loudspeaker...and yet it could change the listening habits of most every audiophile.



The complete story, with sound, of the new Empire Grenadier... divergent lens speaker system... is available at all Empire dealer showrooms. Color brochure can be obtained by writing...

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EDITOR'S REVIEW

BORROW FROM RUSSIAN?

LAST MONTH we described a sad situation: Due to legal restrictions we are constrained from using the term Triaxial except in referring to Jensen products. But we hadn't counted on the ingenuity of AUDIO readers, nor on their consuming interest in this fascinating subject. In short we received a potful of suggestions.

We read each of the suggested names very carefully, and in fact read them aloud to hear how they sounded too. Alas none of them as yet have the full swing and visual appeal of the forbidden term. We must seek further.

On the other hand we did get some rather interesting thoughts and explanations. For instance, one correspondent pointed out that "Triaxial" is technically incorrect. "The term implies that which has three axes," he says, "whereas in truth there is only one axis upon which three speakers, or cones, or radiating surfaces, or call-it-what-you-wills are aligned concentrically." Having made this point he then goes on to suggest terms such as "Triconical" or "Triconcentric." Almost, but not quite.

Another suggestion was that we borrow from Russian, and the resulting term was "Tryoc." Unfortunately, on translation, we discover that this term means Triaxial, which, it seems to us, brings us right back to our starting point. At least insofar as the term goes. After all, can it possibly be that a registered name can be gotten around merely by translating the name into another language?

And think of the grave international problems we might get involved in if we decided to use a Russian term to describe loudspeakers. For example it may be taken as proof that a Russian invented loudspeakers, or, by logical extension, the entire field of audio. (And every schoolboy knows that it was invented in Hollywood.)

On the other hand, it might be a good thing if we could transfer this "Triaxial" problem to Russia. Or the high fidelity definition hassle. If nothing else, the problems would be officially resolved: copyrights are non-existent in Russia, and high fidelity is a political doctrine.

A DOUBLE SABBATICAL

WHAT DO YOU CALL a sabbatical which occurs at the end of 17 years? We were faced with this semantic problem when Edward Tatnall Canby, our own ETC, requested some time off. Unbelievable as it seems, Ed has had almost a perfect "attendance" record for 17 years. Certainly he is entitled to time off, even though we will miss him.

Characteristically, he didn't ask for a whole year or even half, all he is allowing himself is the summer to recuperate from these 17 years of deadlines.

During his vacation, we will continue the column by having "guest" columnists and repeating selected columns. In line with the "guest" columnist idea, we would welcome any suggestions as to guests you would like to invite. Perhaps we can accommodate you.

Oh yes, Ed will continue to report on records during this period. When we questioned him about this he gave us the impression that he enjoys records so much he couldn't stop.

Anyhow, we wish him a refreshing sabbatical.

THE NAB CONVENTION

AT THE RECENTLY-CONCLUDED Convention of the National Association of Broadcasters in Chicago we had an opportunity to view the equipment broadcasters, AM-FM-TV, will be using in the ensuing year(s). Two major trends were clearly in evidence: automation of AM and FM stations by means of tape cartridge devices; and the rapid spread of transistorization.

The first trend was characterized by a large number of rather sophisticated devices for handling, playing, and cueing tape cartridges. It is now possible for the broadcaster to automate as much of his broadcast day as he wishes. Of course, this in itself is not new, we viewed similar devices at previous NAB Conventions. What is new is the large availability of such devices, with the attendant reduction in prices. It is now becoming economically possible for the small broadcaster to automate. Properly used, automation of programming may make it possible for small AM and FM stations to survive. It may also make it possible for them to provide an improved diet for their listeners.

The second trend, transistorization, has literally entered every facet of broadcast electronics excepting those last strongholds, the transmitter and the picture tube. Everywhere else, however, transistors were used. And by a variety of exhibitors. The most common application was in audio mixing consoles. But they were also used in a variety of high-frequency applications for both TV and radio transmission. The most startling change involved in the use of transistors for these applications was the reduction in size. Amazing how much can be crammed into a little space.

Another trend noted at the NAB convention was the increased availability of, and emphasis on, color TV equipment. Of course this is natural enough considering the increased sales of color receivers.

One topic broached at the Convention, which was not technical in nature, centered about the recent action by an old-line AM-FM station in accepting liquor commercials. The topic was broadened somewhat by the contention that cigarette advertising should be limited to those times of the day when children are not expected to be in audience. Thus the problem boils down to the responsibility of broadcasters towards their audience. In a way the problem is rather tough to focus on since broadcasters are supposed to be responsible to their audience anyhow, legally. The basis of their broadcasting license is derived from public grant. The question thus evolves to what is in the public interest, and who decides it. In the past, much of the decision has been left to the broadcasters themselves. For instance the liquor commercial restriction was self-imposed by a broadcasters code. Now that this voluntary code has been broken, we are again faced with the fact that an ethical code voluntarily adopted by profitmaking institutions is only as strong as the profit picture.

The answer? Mandatory codes. The broadcasters should have codes which are binding to the extent that if broken the punishment could be suspension of license. Otherwise they are inviting some external authority to step in and do it for them. Plus other restrictions.

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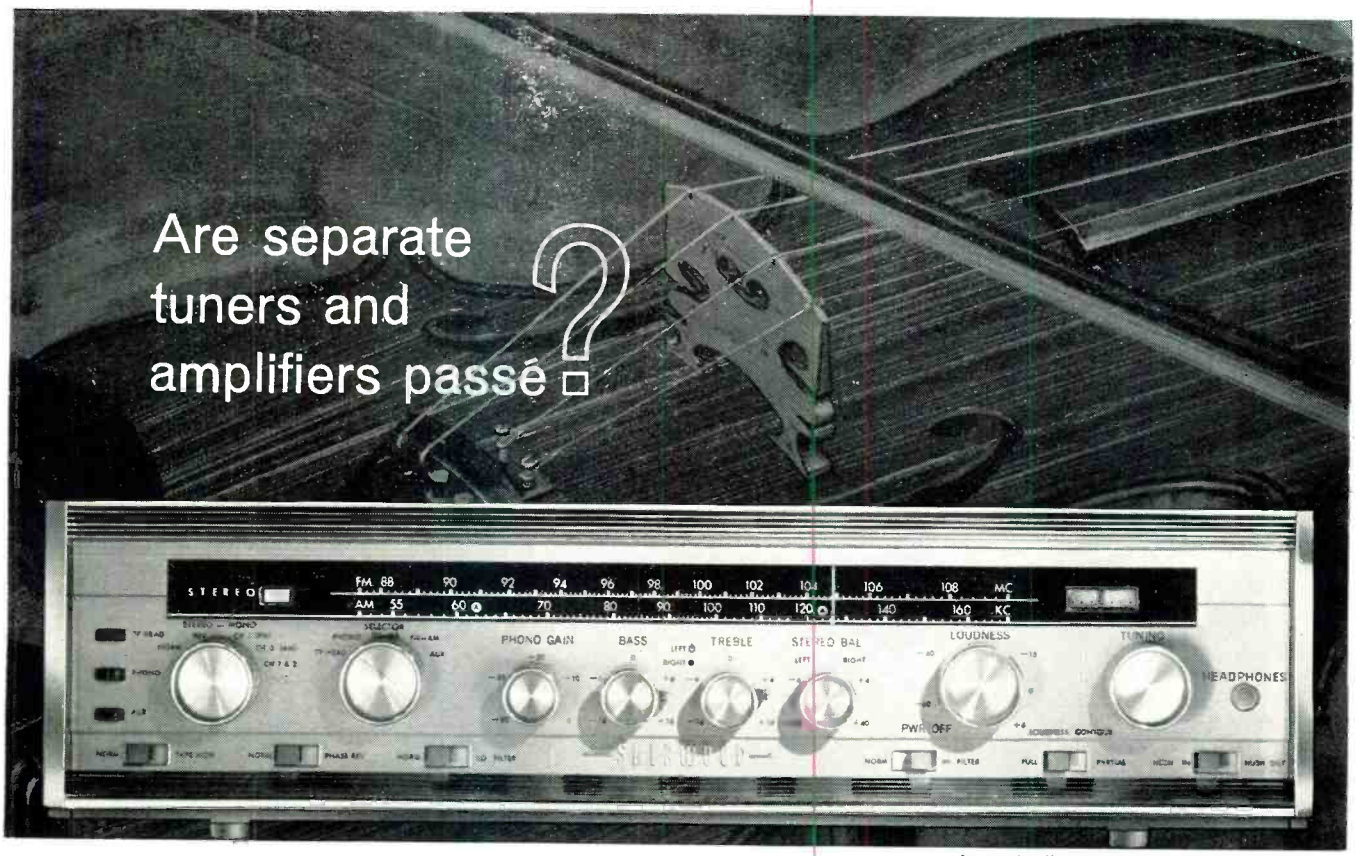

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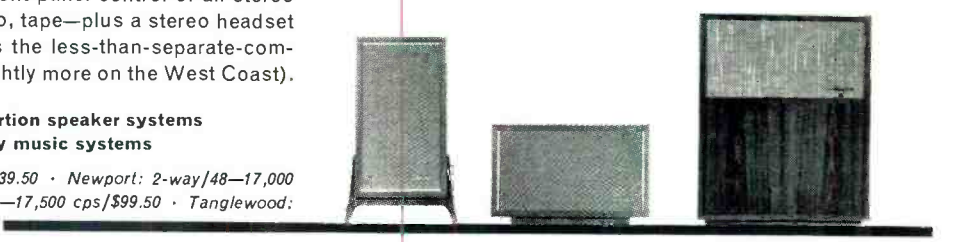

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IN TWO PARTS—PART I

WOULD YOU LIKE to have the very best loudspeaker known today? I firmly believe that the electrostatic loudspeaker is the finest loudspeaker that anyone knows how to make today. Furthermore, you can make one yourself easily and inexpensively in your basement workshop, with a few ordinary tools. Individual electrostatic tweeter units can be made for 15 to 40 cents each. Individual electrostatic woofers can be made for about $3 to $10 each. This article is written for a specific purpose: To describe the design and construction of electrostatic speakers so that others can build and enjoy them.

The first part of this article describes the general characteristics of full range electrostatic speakers. The second part shows how to design one. The third part tells how to build your own electrostatic speaker and sufficient data is given to build a tweeter or to start you on the way to building a full range.

I. General Characteristics

The modern electrostatic speaker consists of a thin plastic diaphragm located in the center of a small airgap between two parallel metal grids or plates. A cross-sectional view of one is shown in *Fig.* 1. The diaphragm in this unit is coated on both sides with graphite to make it electrically conductive, and it is biased with a high d.c. voltage with respect to the two metal grids. The electrical connections to the speaker are shown in *Fig.* 2. Push-pull audio signal voltages are applied to the two metal grids, and this drives the diaphragm back and forth by means of the electric field forces developed between the diaphragm and the metal grids. The sound must pass through the metal grids, and to permit this the metal grids usually consist of an array of parallel round rods or wires, spaced at intervals to allow air to pass through them. The high voltage d.c. bias supply provides very little current, as the only load is the leakage current through the airgap spacers. The speaker is usually designed to be connected to the 8- or 16-ohm output tap on a power amplifier, and the stepup transformer shown in *Fig.* 2 steps up the low voltage on the 8 or 16 ohm tap to the high level required at the speaker plates. This stepup transformer can be an ordinary audio output transformer connected backwards so that its low impedance secondary winding is actually used as the primary.

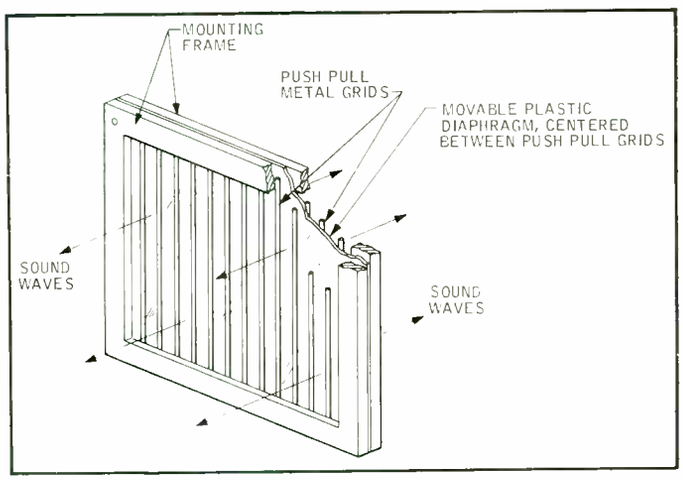


Fig. 1. Cut-away view of a push-pull electrostatic speaker element.

Electrostatic speakers have been made that will cover the entire audio frequency range from 20 cps to 20,000 cps with a single diaphragm.[6, 8] But a single diaphragm speaker is very inefficient. For reasons to be given later, it is much more efficient to use a two-, three-, or even a four-way speaker system. A large diaphragm is used as a woofer and proportionately smaller diaphragms as midrange and tweeter units. The size of the airgaps (*d* in *Fig.* 2) between the diaphragm and the push pull metal grids or plates is important, and varies inversely with frequency. The airgaps in a woofer might be 0.1-in. while a tweeter might have airgaps of 0.001-inch. Crossover networks are used to feed the proper frequency range to each speaker.

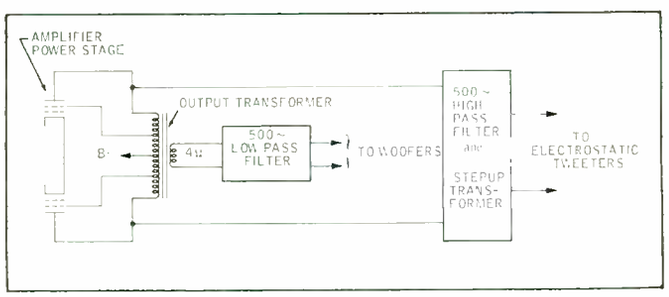


Fig. 2. Electrical connections to the electrostatic speaker.

* *2731 Hayes St., N.E., Minneapolis, Minn.*

Of the two full-range electrostatic speakers commercially available, one is a two-way system and the other is a three-way system.

The outstanding sound quality of the electrostatic speaker is due almost entirely to two factors: 1. The very low mass of the moving diaphragm, and 2. the electric driving force being applied uniformly over the entire diaphragm area. The diaphragm has low mass because it is very thin, on the order of 0.00025- to 0.0005-in. thick. The mass of such a thin diaphragm is approximately equal to a ¼-in. thick layer of air! The low mass gives the speaker excellent transient response because the diaphragm can be moved quickly and the resistance of the air load damps out any "overshoot" of the diaphragm. The low mass of the diaphragm also gives a flat frequency response up to 20,000 or 30,000 cps where it starts to drop off at 6-db per octave.

The second factor, applying the driving force uniformly over the whole diaphragm area, almost completely eliminates "cone breakup." Cone breakup is a major cause of tone color in moving-coil speakers. Thus the second factor gives the electrostatic speaker a degree of naturalness and transparency that must be heard to be appreciated.

A third factor is low distortion. Janszen[9] and Hunt[3] both report distortion levels of 0.5 per cent, which is much lower than for moving-coil speakers.

The low-frequency cutoff for an electrostatic speaker is the same as it is for a moving-coil speaker—the fundamental resonant frequency of the diaphragm in free air. The frequency response is flat down to approximately this frequency. The fundamental resonant frequency of an electrostatic speaker diaphragm is inversely proportional to its diameter. Thus the fundamental resonance, and consequently the low-frequency response, can be lowered by increasing the speaker diameter. An 8-in. diaphragm will have a fundamental resonance of about 40 cps. Diaphragm material is available up to 36-in. wide, and consequently the frequency response and the fundamental resonance can be extended down to about 10 cps if desired.

The low mass of the diaphragm, being approximately equal to a ¼-in. layer of air, has a very good impedance match directly to the air load on the speaker. This means that no baffles, horns, or cabinets of any kind are needed. The author's tests, and also tests reported by Walker,[5] show that the use of a baffle, horn, or cabinet of any kind actually degrade the sound quality of the electrostatic speaker because of the internal resonances inherent in these devices. What a contrast to moving-coil speakers, where these devices are needed to beef up speaker performance! The best way to mount an electrostatic speaker is as a free-standing unit without a cabinet of any kind, letting the diaphragm radiate freely from both sides. Using one as part of a room divider or a wall would give excellent results.

The efficiency of the electrostatic falls in between that of the normal high-efficiency cone speaker and the so-called low-efficiency bookshelf types. Briggs[7] reports the electrostatic speaker as being 3- to 6-db less efficient than a good high-efficiency cone speaker. This agrees with the author's experiments.

The acoustical directivity of the electrostatic is about the same as that of a moving-coil speaker of equal size, which means it is highly directive at high frequencies, and corrective measures are needed. The corrective measures can take various forms. Walker[5] describes several of them, one being to make the tweeter diaphragm in the form of a long narrow vertical strip. Malme[6, 8, 14] describes an interesting method of electrically accomplishing the same thing—the horizontal width of the diaphragm decreases uniformly as the frequency increases. The author prefers to use an array of tweeters mounted on a spherical surface to solve the directivity problem.

The electrostatic speaker is inherently a high-impedance device. And the lower the speaker's frequency range is, the higher is its input impedance. This means high voltages are required to operate the speaker, especially at low frequencies. To indicate some approximate values, the bias voltage for a tweeter might be 200 volts d.c. The bias for a midrange unit might be 2000 volts d.c., while a woofer might have a bias voltage as high as 20,000 volts d.c. These voltages are not as dangerous as one might think, because the very high resistance (10 to 1000 megohms) in series with the bias supply naturally limits the current. However to prevent any accidents, the speaker is enclosed by a grounded metal screen.

The electrostatic speaker has one undesirable characteristic—the input impedance of the speaker is almost a pure capacitance over its entire frequency range. The capacitive input impedance is probably the most important single factor in the design of an electrostatic speaker because of the drastic effect it has on efficiency and amplifier loading. This is discussed later in more detail.

There is a definite limit to the acoustic power that can be obtained per unit area of the diaphragm. This limit is voltage breakdown across the gaps between the push-pull metal grids and the diaphragm. The speaker response is linear right up to the point of voltage breakdown. To increase the power output beyond this point, the radiating area of the speaker must be increased.

An electrostatic speaker cannot generate as much power per unit area as a moving coil speaker, and consequently the electrostatic must have more radiating surface for the same acoustic power rating. When the power rating of an electrostatic speaker is increased, it is more efficient to add more speakers of the same size in parallel than to increase the size of the speaker diaphragms. The reasons for this are given later.

The preceding characteristics basically determine what an efficient full-range electrostatic will look like: It will be quite thin, 2- to 3-in. at most; it will have a relatively large surface area and will be a two-, three-, or four-way system containing woofers, midranges, and tweeters; the speaker will be free-standing in the room and will not use a cabinet or baffle of any kind; the woofer, midrange, and tweeter sections of the complete speaker will each consist of an array of identical speakers whose diaphragm size has been scaled to that frequency range; the individual speaker diaphragms can be round, square, or rectangular in shape.

A three-way system might consist of the following: The woofers would all be alike with a diameter of about 20-in. and airgaps, (d), of 0.2-in. for a fundamental resonance of 20 cps; each midrange unit would have a diaphragm diameter of about 2-in. and airgaps, (d), of 0.02-in. for a fundamental resonance of 200 cps; each tweeter unit would have a diaphragm diameter of about 0.2 inches and airgaps, (d), of 0.002-in. for a fundamental resonance of about 2000 cps. The number of woofer, midrange, and tweeter units is chosen so that the total diaphragm area in each frequency range is sufficient to produce to acoustic power required in that frequency range. The sizes and resonant frequencies given here are approximate, and are based on using Saran, 0.0004-in. thick, as the diaphragm material. If a different material or thickness is used, the sizes and frequencies will change.

II. Design

The design of an electrostatic speaker is primarily based on four factors: input capacitance, efficiency, diameter of the diaphragm, and the size of the airgaps between the diaphragm and each push-pull plate. A flat frequency response is obtained by maintaining a constant amplitude audio signal between the push-pull plates at all frequencies.

The speaker's input capacitance or load impedance as seen by an amplifier consists almost entirely of the electrical capacitance between the metal surfaces of the two push-pull plates. Over the audio frequency range of 20 cps to 20,-

thing is to make the diaphragms rectangular, with the length of each diaphragm equal to eight times the width.

To make the airgap as small as possible for maximum efficiency it is important to know what the maximum diaphragm travel is. Maximum travel occurs at the lowest frequency each speaker radiates. The maximum diaphragm amplitude at different frequencies is shown in *Fig.* 3. This is a calculated curve, based on a bias voltage gradient of 100-volts-per-0.001-in. with the peak value of the audio input voltage between one plate and the diaphragm set equal to the bias voltage. The air load on the diaphragm is assumed to be resistive. The author's experience indicates that the actual diaphragm amplitude is somewhat less than that shown in *Fig.* 3.

Another factor affecting efficiency is the shunt capacitance in the speaker frame. It is very easy for the shunt capacitance in the frame between the push-pull grids to be two- to three-times greater than the "useful" capacitance through the movable part of the diaphragm. This means that two-thirds to three-fourths of the total audio power into the speaker would be wasted in the capacitance of the speaker frame without doing any useful work in moving the diaphragm. The shunt capacitance can be minimized by reducing the surface area of the frame between the grids, and by using an airgap spacer material that has a low dielectric constant. The shunt capacitance in the frame of the electrostatic tweeter made by the author amounted to 50 per cent of the "useful" capacitance between the grids. Thus $\frac{1}{3}$ of the audio input power is wasted in the frame capacitance of this tweeter.

The third major factor in electrostatic speaker design is the diameter of the diaphragm. The diaphragm diameter determines the lowest frequency the diaphragm will radiate. The low frequency cut-off is the frequency of the fundamental diaphragm resonance, which is inversely proportional to the diameter of the diaphragm. The larger the diaphragm the lower the cutoff frequency.

For reasons of efficiency and stability it is desirable to use the smallest possible diaphragm diameter, which means the fundamental resonance should be as high as possible. The smallest diameter is obtained by setting the fundamental resonance a little below the lowest frequency to be radiated by the diaphragm. For example, a mid-range speaker designed to cover a frequency range of 200 cps to 2000 cps might have its fundamental resonance placed about an octave lower than 200 cps, or at 100 cps. A diaphragm diameter of 4-in. will give a fundamental resonance of about 100 cps. Application of the minimum-diameter rule to woofers, midranges, and tweeters results in tweeters of small diameter, mid-range units of medium diameter, and woofers of large diameter; with the fundamental diaphragm resonance of each being set about an octave below the low end of each speaker's frequency range.

Stability Problems

There are two stability problems in the electrostatic speaker. These are the static and dynamic stabilities of the diaphragm. The static stability problem will be discussed first. When bias voltage is applied to the diaphragm, the resulting electric field between the diaphragm and the two push-pull plates acts as a spring which pulls the diaphragm away from its center position toward one of the two plates. Because the diaphragm is stretched taut in its mounting frame, this mechanical tension also acts as a spring which pulls the diaphragm back toward its center position. Thus we have two spring forces pulling the diaphragm in opposite directions. For the diaphragm to be stable, the mechanical tension in the diaphragm must be greater than the electric field forces generated by the bias voltage. If the tension is too low the electric field forces will pull the diaphragm away from the center, and the diaphragm will oscillate back and forth from one plate to the other, making a noise like a stack of paper being shuffled.

There are two solutions to the static stability problem. The first is to reduce the diameter of the diaphragm. This will increase the spring constant of the diaphragm tension. The second is to increase the airgap which will decrease the spring constant of the electric field bias forces. These two solutions lead to a certain ratio of diaphragm diameter to airgap size that must not be exceeded if the diaphragm is to be stable. Limited experiments by the author indicated that diaphragms of any size, made of 0.0004-in. thick Saran Wrap, will be statically stable if the ratio of diaphragm diameter to airgap size $\left(\frac{L}{d}\right)$ is about 100-to-1 or less. This ratio is based on a bias voltage gradient $\left(\frac{V_b}{d}\right)$ of 100 volts-per-0.001-in., and assumes that the diaphragm has been stretched taut in the speaker frame so as to obtain a suitable diaphragm tension.

The static stability problem does not appear to be much of a practical limitation in designing an electrostatic speaker. In the tweeter built by the author, the ratio of diaphragm diameter to airgap size needed for static stability gave an airgap size very close to what was needed for maximum diaphragm travel. If an audio oscillator is available it is easy to experiment with this instability effect. The ratio of the two spring constants can be measured by noting how much the fundamental resonance frequency of the diaphragm changes when the bias voltage is applied. The fundamental resonance of the author's tweeters drops about 20 per cent when the operating bias of 1500 v. d.c. is applied.

The second stability problem is the dynamic stability of the diaphragm. When an audio signal is applied to the push-pull plates the diaphragm moves away from center, moving in turn toward each of the push-pull plates. For large audio signals the diaphragm will come very close to the push-pull plates. To prevent the diaphragm from being "pulled into" one of the plates when it gets very close to one, a large resistance is put in series between the bias supply and the diaphragm. This resistance provides a condition of constant charge operation on the diaphragm, and reduces the bias voltage on the diaphragm in proportion to the position of the diaphragm toward either plate. In this fashion the voltage difference between the diaphragm and the nearest plate goes to zero as the diaphragm approaches it, and there is no arcing if they happen to touch, because there is no voltage difference between them at the instant of touching. Hunt[3] has shown that if the RC time constant of this resistance and the capacitance between the diaphragm and one of the push-pull plates is at least four times greater than the time interval of one-half cycle of the lowest frequency to be radiated, the diaphragm will be dynamically stable at any location between the plates.

Because the diaphragm is clamped at the edges, it does not move as a rigid plate but forms a curved surface when displaced from its center position. The only way to obtain true constant charge operation for each part of the diaphragm under this condition is to put a high series resistance on the diaphragm itself in the form of a high resistance coating. The high resistance in series with the diaphragm and the high resistance coating on it have several other advantages in addition to making the diaphragm dynamically stable, such as: 1. Reducing the even and odd harmonic distortion to 0.5 per cent or less, and 2. limiting the short-circuit current if the speaker happens to arc over.

Design Summary

The design of a full range electrostatic speaker is summarized as follows. To obtain high efficiency the speaker is designed as a two-, three-, or four-way system. The woofer, mid-range, and tweeter sections will each consist of several speakers connected in parallel, preferably so that the diameter of the array in each section will be at least one-third of the wavelength of the lowest frequency

000 cps the impedance of this capacitance will vary by 1000 to 1. Connecting a load whose impedance varies by 1000 to 1 to a constant impedance source such as a power amplifier means that a tremendous mismatch in impedance occurs over most of the frequency range. This makes it impossible to get a good impedance match, and consequently if the entire frequency range is covered by only one diaphragm the efficiency is very low.

If the speaker is a two-way system, the frequency range each speaker must cover is only half the total, and the impedance variation of each speaker as seen by the amplifier is then only about 30 to 1. The efficiency of the two-way system is thirty-two times greater than a one-way or single-diaphragm speaker because of the reduced impedance mismatch. If the speaker is a three-way system, each speaker covers only one-third of the frequency range, and the total impedance variation of each speaker as seen by the amplifier is then 10 to 1. The efficiency of the three-way system is about three times greater than the two-way system. If the speaker is a four-way system, the impedance variation is reduced to about 6 to 1, and its efficiency is about twice as good as a three-way system. Thus for maximum efficiency and to reduce the variation in load impedance seen by the power amplifier, a full range electrostatic should be designed as a multi-way speaker system.

Amplifiers do not like to drive the capacitive load presented to them by an electrostatic speaker. There are three reasons for this. First, the input impedance of the speaker varies with frequency, and amplifiers like to work into a constant load impedance and not into a load that changes with frequency. Also, the low load impedance that occurs at higher frequencies drastically limits an amplifier's power output at high frequencies. When the speaker is a multi-way system, the woofer, midrange, and tweeter sections are each connected to the amplifier with a different transformer turns ratio, so as to give a more constant load impedance over the whole audio frequency range. The stepup turns ratio for each section is proportional to the size of the airgraps, (d), in that section.

The second reason amplifiers don't like capacitive loads is that the load line for the power output tubes becomes a circle instead of a straight line, and the performance of the amplifier's power output stage changes. In practice, the crossover coupling networks used between the amplifier and the speaker drastically change the speaker's capacitive input impedance to a much more resistive impedance, and this helps the amplifier loading problem considerably. Janszen[15] has used the coupling network to improve the input impedance of the KLH Model Nine full-range electrostatic speaker so that it is resistive over half the audio-frequency range and does not vary more than about 35 per cent from its nominal impedance value over the 20 cps to 20,000 cps frequency range.

The third reason amplifiers do not like capacitive loads is that most hi-fi amplifiers use feedback and work best with resistive loads. The large capacitive load presented by an electrostatic speaker can ruin an amplifier's transient response and also make the amplifier become unstable. This problem is discussed later in more detail in the sections on the crossover network and amplifier loading effects.

The second major factor in electrostatic speaker design is efficiency. Without giving the derivation, the efficiency

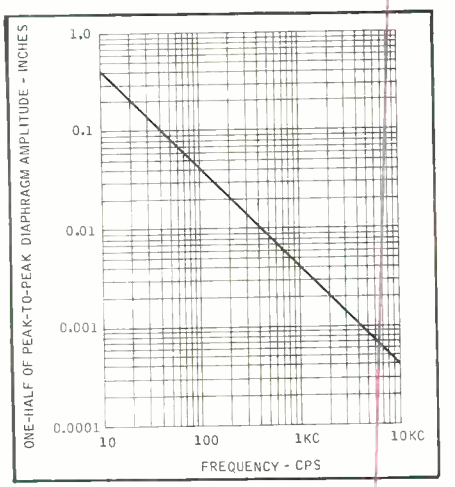


Fig. 3. Maximum diaphragm travel vs. frequency.

of an electrostatic speaker can be shown to be

$$\text{Efficiency} = \left(\frac{V_b}{d}\right)^2 \frac{k}{fd}$$

where

k = a constant
f = frequency
d = airgap distance between the diaphragm and each plate
V_b = bias voltage on the diaphragm

The term in parenthesis, $\left(\frac{V_b}{d}\right)^2$, is the bias voltage gradient in volts-per-inch in the airgap between the diaphragm and each plate. This term says that for maximum efficiency the bias voltage gradient should be as high as possible, which means just short of corona and voltage breakdown. Note that it is the bias voltage gradient in volts-per-inch that is important, and not just the bias voltage. A woofer has a larger airgap than a mid-range or a tweeter, and consequently will need more bias voltage to get the same voltage gradient. The author uses a bias voltage gradient of 100-volts-per 0.001-in.

The terms f and d (frequency and airgap size) in the denominator of the efficiency equation show that the efficiency decreases as both the frequency and the airgap size increase. The efficiency decreases as the frequency increases because of the greater reactive amplifier power that must be "dumped" into the speaker's input capacitance at high frequencies to maintain a constant voltage between the push-pull plates.

The airgap size, d, affects the efficiency because the energy stored in the input capacitance is proportional to the air volume enclosed between the push-pull plates. The mechanical force that drives the diaphragm is proportional to the square of the voltage gradient in the airgap. The same voltage gradient can be obtained with a small gap as with a large gap, and since less energy has to be stored if the volume is smaller, the efficiency increases as the airgap size becomes smaller. Thus for maximum efficiency the airgap is made as small as possible for maximum diaphragm travel.

A woofer has the same efficiency per unit area as a tweeter because the tweeter has a smaller airgap than a woofer, as the diaphragm amplitude is much less at high frequencies. To put it another way, the frequency and airgap terms (f and d) in the efficiency equation complement each other, and consequently woofers, midranges, and tweeters all have the same efficiency per unit area.

The diameter of a single electrostatic diaphragm (round or square) is about 1/24th of the wavelength of sound at the diaphragm's resonant frequency. Since the air load on a diaphragm is reactive and not resistive when the diameter is less than one-third of the wavelength, a single electrostatic diaphragm will see a reactive air load in the frequency range between the fundamental diaphragm resonance and about eight times this resonant frequency.

Walker[5] has shown that an electrostatic speaker reacts quite differently to a reactive load than does a moving-coil loudspeaker. With a reactive air load the amplitude of an electrostatic diaphragm increases at 12-db per octave as the frequency decreases, instead of the 6-db per octave of a resistive air load. If the airgap is increased to handle the larger diaphragm amplitude that occurs with a reactive load, the efficiency will be lowered. The best solution is to add speakers of the same size in parallel until the diameter of the speaker array is one-third the wavelength of sound at the fundamental resonant frequency of the diaphragms. This solution solves the reactive air load problem by making the air load resistive at all frequencies above the fundamental diaphragm resonance. Another way of accomplishing the same

each is required to radiate. The diaphragm diameter, airgap size, and bias voltage of each speaker increase directly as the frequency range and the fundamental resonance of that speaker are lowered.

To get the best efficiency the diaphragm diameter is made as small as possible, and is selected to place the fundamental diaphragm resonance about an octave below the lowest frequency the diaphragm is required to radiate. With midrange and tweeter speakers the crossover frequency is considered to be the lowest radiated frequency. For best efficiency the airgap is made the smallest size that will still allow for maximum diaphragm travel. *Figure* 3 shows the maximum diaphragm travel as a function of frequency. *Figure* 3 can also be used to determine the approximate diaphragm diameter needed to obtain a particular fundamental diaphragm resonance. To do this the frequency scale is interpreted as the fundamental resonant frequency desired, and the airgap scale is multiplied by 100 and interpreted as the diaphragm diameter that will give this resonant frequency.

To make the diaphragm stable under static conditions (bias voltage only, no audio signal) the ratio of the diaphragm diameter to airgap size $\left(\frac{L}{d}\right)$ should not exceed 100 to 1. To make the diaphragm stable under dynamic conditions (bias voltage and audio signal) and also to obtain the very low distortion that the speaker is capable of, the resistance in series with the bias supply and the resistance of the graphite coating on the diaphragm must be increased as the fundamental diaphragm resonance is decreased. The RC time constant of the sum of these two resistances times the capacitance of the diaphragm to one plate should be equal to at least four times the time interval of one half cycle of the lowest frequency each diaphragm will radiate. For maximum efficiency the bias voltage gradient is set at the highest possible value, just short of corona and voltage breakdown. The maximum bias voltage gradient, $\left(\frac{V_b}{d}\right)$, is about 80 to 120 volts d.c. per 0.001-in.

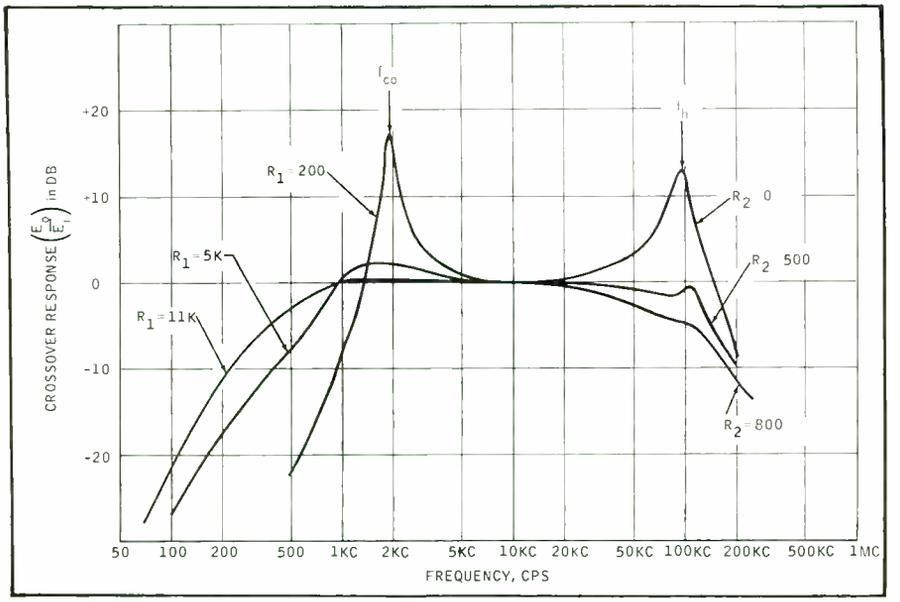


Fig. 5. Frequency response of 500-cps crossover network with an electrostatic tweeter load.

The power rating of the speaker is proportional to the total diaphragm area in each frequency range. For a constant power rating at all frequencies, the total diaphragm area should be the same in each frequency range. If more power is wanted, more speakers must be added in parallel, as the acoustic power per unit of diaphragm area is limited by voltage breakdown. If desired the total diaphragm area in each frequency range can be pro-rated to match the power-vs.-frequency requirements of music.

The high-frequency response is limited by the mass-per-unit-area of the diaphragm to about 20,000 to 30,000 cps with present diaphragm materials, with a 6-db-per-octave rolloff above this point. The low-frequency response is limited only by the diameter of the diaphragm. The larger the diaphragm the lower the cutoff frequency. Saran Wrap is available up to 36-inches wide, which would give a low-frequency cutoff of about 10 cps.

For maximum efficiency the shunt capacitance in the frame around each diaphragm should be minimized, as it can absorb 25 to 75 per cent of the audio power into the speaker. This power is wasted.

For those interested in further study of the design of electrostatic speakers, the bibliography at the end of Part II lists most of the pertinent references on electrostatic speakers.

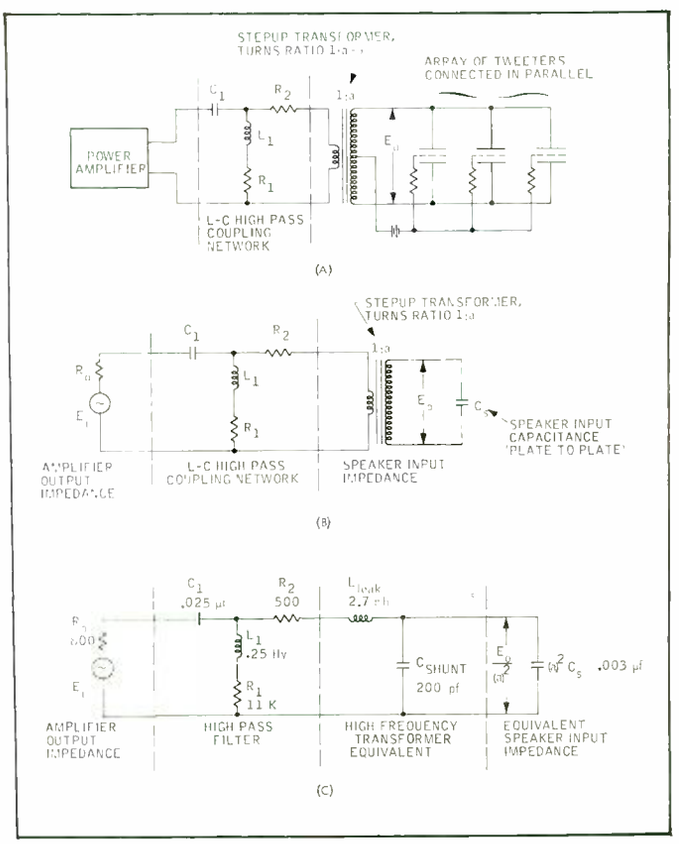


Fig. 4. Equivalent circuits of electrostatic speaker and crossover network.

The Coupling Network

The coupling or crossover network used between the amplifier and the electrostatic speaker is very important, much

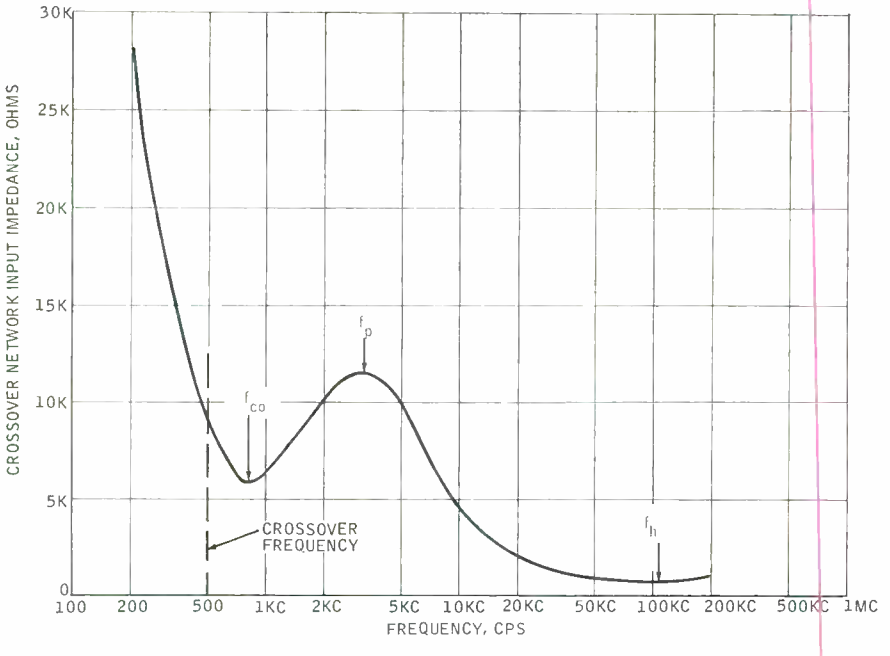


Fig. 6. Input impedance of 500-cps crossover network with an electrostatic tweeter load.

more so than for a moving-coil speaker. The crossover network for a tweeter will be discussed first. *Figure* 4A shows an L-C crossover network for coupling to an electrostatic tweeter. This network was first used by Janszen in his Model 130 electrostatic tweeter. *Figure* 4B shows the amplifier output impedance, the L-C crossover elements, the stepup transformer to the high impedance tweeter, and the capacitive input impedance (C_s) of the tweeter itself. *Figure* 4B also shows two resistors, R_1 and R_2, which play an important role in the network.

Both the frequency response and the input impedance of the coupling network provide useful information. For a tweeter, the audio voltage between the push-pull speaker plates should be constant above the crossover frequency and should drop off at 12-db-per-octave below the crossover frequency. The input impedance of the crossover network should be as constant as possible over the frequency range to make it easier for the amplifier to drive the speaker.

The frequency response of a 500-cps crossover network for a tweeter is shown in *Fig.* 5. The data in *Fig.* 5 were taken from measurements on the author's tweeter. It shows that what was supposed to be a high-pass network is actually a bandpass network. With R_1 and R_2 equal to zero an undesirable peak occurs in the response curve at each end of the bandpass. The two other curves in *Fig.* 5 show that the correct value of R_1 (about 11k ohms) will eliminate the peak at f_{co} near the crossover frequency, and that the correct value of R_2 (about 500 ohms) will eliminate the high-frequency peak at f_h. A flat frequency response in the bandpass is thus obtained.

The behavior of the network can be explained by redrawing *Fig.* 4B using the equivalent circuit for the stepup transformer as in *Fig.* 4C. What happens is that the resonant peak at or near the crossover frequency f_{co} is caused by C_1 and L_1 going into series resonance at this frequency, and R_1 is used to limit the current at this resonance. The resonant peak f_h at the high end of the passband is caused by the transformer leakage inductance (L_{leak}) and the speaker input capacitance (a^2C_s) going into series resonance at this frequency, and R_2 is used to limit the current at this resonance.

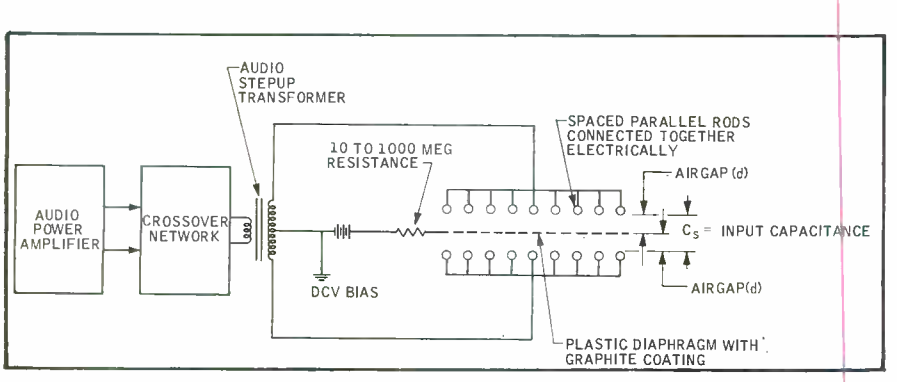


Fig. 7. Connecting the electrostatic tweeter and moving-coil woofers with their crossover networks to the amplifier.

The load impedance that the amplifier sees is the input impedance of the crossover network. The input impedance of the author's 500-cps crossover network with an electrostatic tweeter as a load is shown in *Fig.* 6. The input-impedance curve in *Fig.* 6 shows series resonances at 800 cps and 110,000 cps (f_{co} and f_h), and a parallel resonance at 3000 cps (f_p). The resonance at f_p is caused by the parallel resonance of L_1 with the speaker input capacitance (a^2C_s). The resistors R_1 and R_2 affect the resonant frequencies to a certain extent and hence the frequencies are slightly different from what would be calculated from just the inductive and capacitive elements.

Normally the stepup transformer and high-pass filter would be connected to the 8- or 16-ohm output tap of the power amplifier. The author chose to bypass the amplifier's output transformer, however, and connected the high-pass filter directly to the plates of the power output tubes as shown in *Fig.* 7. The amplifier used to drive the tweeter is a 60-watt Dynakit Mark III amplifier. The stepup transformer used in the high pass network is a UTC LS-33, which for many reasons is almost ideal for the purpose. For experimental work it provides a large variety of turns ratios for matching almost any tweeter capacitance to the amplifier.

The output tubes in the Dynakit Mark III amplifier have a rated load impedance of 4300 ohms plate-to-plate. If you wish to connect the electrostatic tweeter described in this article to the 16-ohm output tap on your amplifier, the impedance of the high-pass filter elements should be reduced by the ratio of the square of the impedances, $\left(\frac{16}{4300}\right)^2$, and the transformer stepup ratio should be increased by the square root of the impedance ratio, $\left(\frac{16}{4300}\right)^{1/2}$. Any other amplifier output impedance such as 4 or 8 ohms can be accommodated in a similar manner.

Network Design

The design of the coupling network between the amplifier and the tweeter is basically a tradeoff between efficiency and the highest frequency to which the tweeter should provide full power output. This is because the tweeter's capacitive input impedance at high frequencies decreases as the frequency increases, and when the impedance drops below the amplifier's rated load impedance the amplifier's maximum available power output drops off too. For instance if one wanted

(*Continued on page 73*)

A Solid-State Ultra-Linear Wideband FM Demodulator

RALPH GLASGAL

Using modern logic modules an FM demodulator is achieved which needs no tuned circuits, requires no alignment, and has a bandwidth of over 10 mc

IT HAS BEEN OBSERVED that the search for high fidelity is a never-ending quest for perfection. The advent of the solid-state era has resulted in the development of preamplifiers and power amplifiers that have a more-than-adequate frequency response and excellent linearity. Thus among the purely electronic hi-fi system components only the FM tuner still remains to be brought to this same high level of performance. By extension one might anticipate that transistors provide a way by which improved tuner characteristics may be obtained. From the standpoints of distortion, bandwidth, and alignment stability the Achilles heel of the modern FM tuner is the demodulator section, usually a variation of the Foster-Seeley discriminator or ratio detector. This article describes a very modern circuit which makes use of a very old pulse-counting technique. A brief discussion of digital logic and Boolean operations will enable the audiofan to appreciate fully the theory behind the circuit design. A review of currently-used detectors is included to provide a background against which the new technique can be better evaluated and understood.

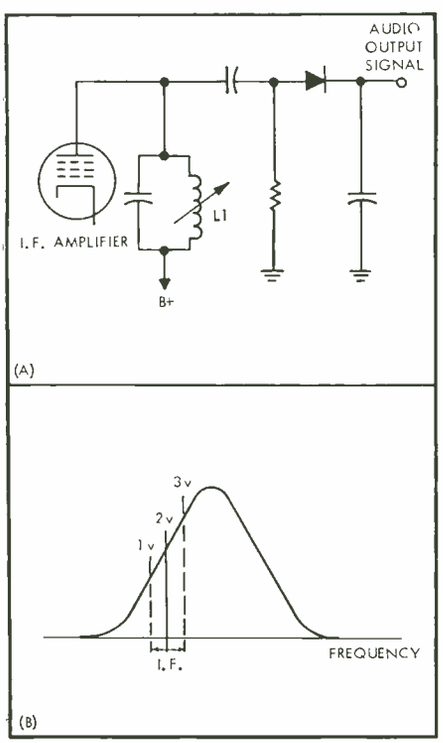


Fig. 1. Slope detector circuit, (A) and slope detector response characteristic, (B).

Existing Detectors

The simplest form of FM detector is the slope detector shown in *Fig.* 1 The gain of the i.f. amplifier tube varies with frequency because the plate load impedance varies with frequency. Thus the FM signal is amplitude modulated according to the impedance curve of the tuned circuit. These amplitude variations are detected by the diode rectifiers producing an output proportional to the frequency of the i.f. signal. The fidelity of this detector is determined by the linearity of the slope of the response curve. Since this slope may be as high as a 12-db-per-octave, or as low as 0-db-per-octave, and since the slope is constant only over a small portion of the response curve, this type of slope detector is unlikely to be acceptable in high-fidelity equipment. Even if the tuned circuit is replaced by an inductor or capacitor whose self resonance is well above the frequencies of interest, the interaction of the reactance with tube and detector impedance either limits output amplitude severely or results in large nonlinearities.

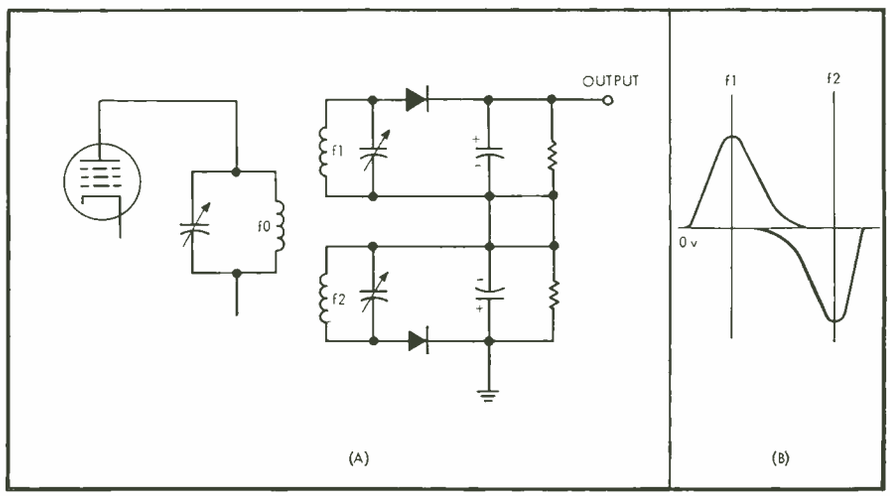


Fig. 2. Double-tuned discriminator, (A), and response characteristic, (B).

Two slope detectors added together in series are called a double-tuned discriminator. One tuned circuit is resonated at a frequency above the i.f. and the other symmetrically below it. (See *Fig.* 2.) This circuit has the advantage of maintaining a 12-db-per-octave slope over a wider range of frequency. However, its linearity is dependent upon how closely the response curves of the two cells can be made to match. Also the circuit is very difficult to align, if the coils are tuned too far apart there will be a plateau in the S-curve at the center frequency and if they are tuned too close together, both bandwidth and linearity are lost. The primary winding and both secondaries are unavoidably coupled together, therefore tuning any one of them affects the shape of the response curve of the others, which makes it almost impossible to achieve an adjustment that

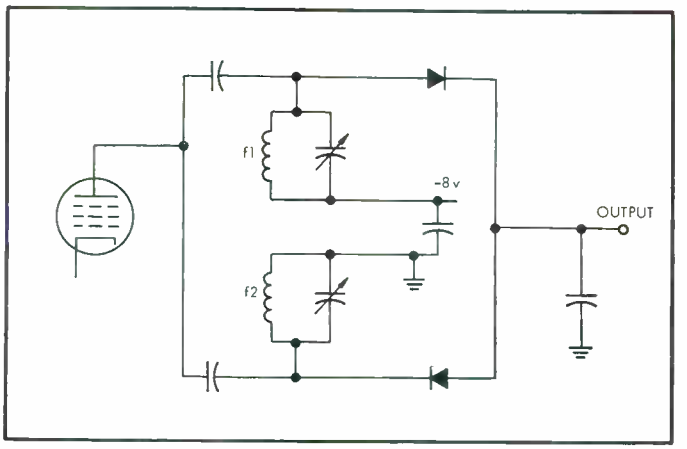


Fig. 3. Basic schematic of National Criterion double-tuned discriminator.

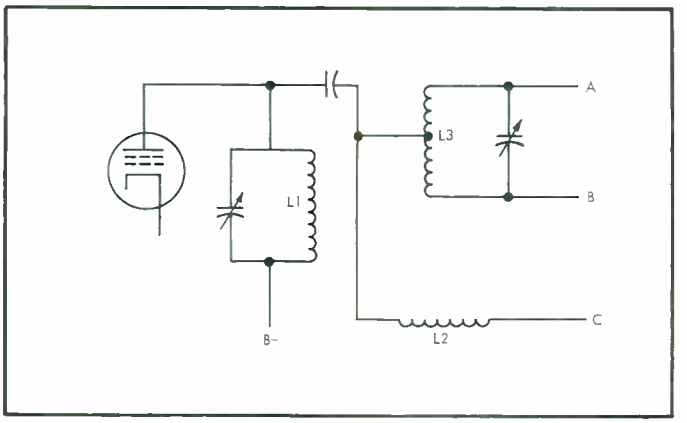


Fig. 4. Typical ratio and Foster-Seeley coil circuits.

yields simultaneously perfect linearity at a specific center frequency over a sufficiently wide bandwidth.

Some years ago, a circuit very similar to the double-tuned discriminator was used in the National Criterion FM tuner. This circuit was mistakenly called a pulse or frequency counter in several publications. We will discuss it in detail to end any misunderstanding. The circuit is shown in *Fig.* 3. The alignment difficulties are overcome here by eliminating all mutual coupling between the coils. This is accomplished by doing without a primary winding entirely and using capacitors to couple independent resonant circuits to the i.f. stage. This circuit still has the disadvantage that the bandwidth and the linearity are functions of the resonant circuit curve or Q and so the coils must be made to tight tolerances and aligned exactly to the right frequencies.

Similar design and alignment difficulties are also inherent in the ratio and Foster-Seeley detector even though the circuit configurations and operating principles are somewhat different from the circuits considered above. *Figure* 4 shows a typical coil configuration for either the Foster-Seeley or ratio detector. For simplicity the diode and resistor connections which distinguish these detectors from one another have been omitted. L_2 is coupled capacitively to L_1 and the voltage across L_1 is essentially the same as that at the plate of the stage driving L_1. Coil L_2 is in series with each half of the secondary winding AD and BD. Voltages V_{AD} and V_{BD} are each phase shifted 90-deg. with respect to V_{DC} and L_3 is resonant due to normal secondary current flow.

At the resonance, $V_{AD} + V_{DC}$ is equal to $V_{BD} + V_{DC}$ in magnitude. At frequencies away from resonance the secondary load impedance is no longer purely resistive and the phase shift will no longer be 90-deg. As V_{AD} moves closer to V_{DC} in phase, their vector sum becomes larger. Simultaneously the vector sum of $V_{BD} + V_{DC}$ is becoming smaller. After rectification and filtering these voltages are the demodulated FM signal. Obviously the linearity of this detector depends upon the linearity of phase shift with frequency in the secondary coil. This type of detector is also inherently bandwidth limited since it is possible to shift the phase only by 90-deg. from the starting point and, depending upon the Q of the coil used, the 90-deg. shift will take place within a relatively narrow range of frequency. A low-Q coil does increase bandwidth but at the expense of greatly reduced output voltage. Maintaining phase linearity with frequency can be a problem since the current through the inductance is a function of frequency and the inductance, due to partial saturation of core materials, is itself a nonlinear function of current. Perfect linearity over a given bandwidth is very difficult to obtain. Although some excellent designs exist which are satisfactory, provided their alignment is adjusted periodically, it is evident that tuned FM demodulators all have inherent weaknesses which are not easily overcome.

Pulse Counting

Let us now consider the nature of the FM signal and the theory of pulse counting detection. A limited FM signal consists of a train of square waves that differ only in width (*Fig.* 5A). If a unipolar pulse is generated for each positive going zero crossing (*Fig.* 5B) then the average value of these pulses will be the demodulated FM signal that we are loking for (*Fig.* 5C).

The width of the pulse generated must be less than the width of the narrowest square wave expected in the FM square wave train and both the width and the amplitude must be maintained exactly constant regardless of the number of pulses being generated per second. Once the pulse train has been generated sim-

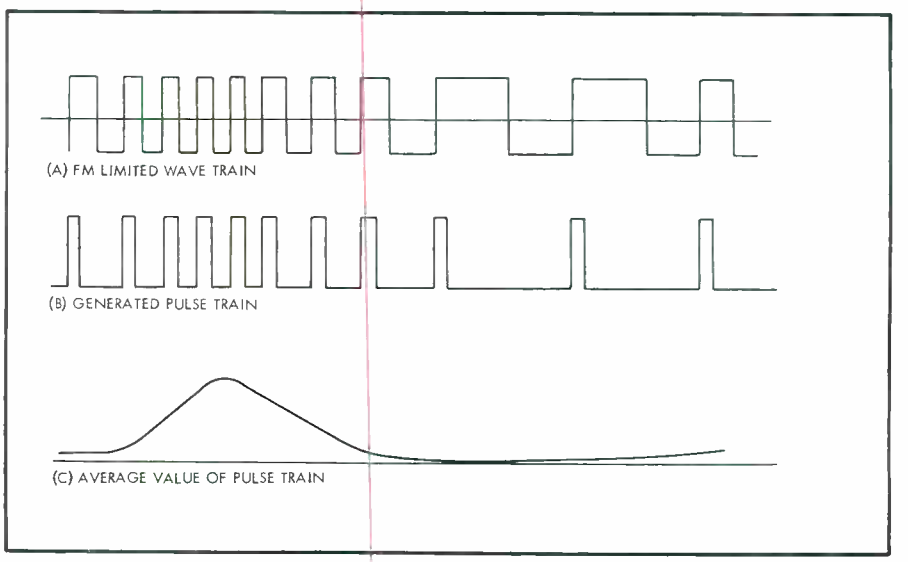


Fig. 5. The resultant pulse train and its antecedents.

A MAJOR BREAK-THROUGH IN SOUND PURITY

. . . BY SHURE

THE SOUND FROM THE NEW SHURE V-15 STEREO DYNETIC® CARTRIDGE WITH ITS REVOLUTIONARY BI-RADIAL ELLIPTICAL STYLUS HAS NEVER BEFORE BEEN HEARD OUTSIDE AUDIO LABORATORIES

by S. N. SHURE, President, Shure Brothers, Inc.

The sound from the new Shure V-15 Stereo Dynetic Cartridge is unique. The unit incorporates highly disciplined refinements in design and manufacture that were considered "beyond the state of the art" as recently as the late summer of 1963. The V-15 performance specifications and design considerations are heady stuff—even among engineers. They probably cannot be assimilated by anyone who is not a knowledgeable audiophile, yet the sound is such that the critical listener, with or without technical knowledge, can appreciate the significant nature of the V-15 music re-creation superiority. It is to be made in limited quantities, and because of the incredibly close tolerances and singularly rigid inspection techniques involved, it is not inexpensive. Perfection never is.

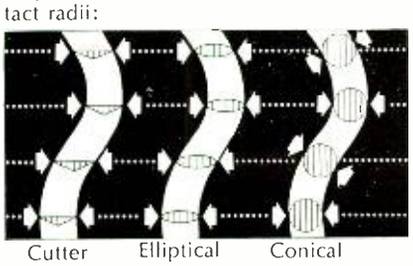
THE BI-RADIAL ELLIPTICAL STYLUS

The outstanding characteristic is that the V-15 Stylus has two different radii . . . hence the designation Bi-Radial. One is a broad frontal plane radius of 22.5 microns (.0009 inch); while the actual *contact* radii on each *side* of the stylus are an incredibly fine 5 microns (.0002 inch). It would be impossible to reduce the contact radius of a conventional spherical/conical stylus to this micro-miniature dimension without subjecting the entire stylus to "bottoming" in the record grooves.

The Shure Bi-Radial elliptical stylus, because of its larger frontal radius of 22.5 microns (.0009 inch), cannot bottom . . . and as you know, bottoming reproduces the crackling noise of the grit and static dust that in practice cannot be eliminated from the canyons of record grooves.

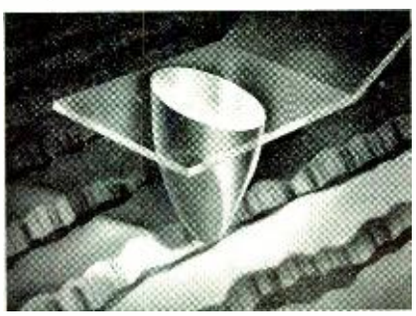
TRACING DISTORTION MINIMIZED

The prime objective in faithful sound re-creation is to have the playback stylus move in exactly the same way as the wedge-shaped cutting stylus moved when it produced the master record. This can't be accomplished with a spherical/conical stylus because the points of tangency (or points of contact between the record grooves and the stylus) are constantly changing. This effect manifests itself as tracing distortion (sometimes called "inner groove distortion"). Note in the illustration below how the points of tangency (arrows) of the Bi-Radial elliptical stylus remain relatively constant because of the very small 5 micron (.0002 inch) side contact radii:



Cutter Elliptical Conical

The Shure Bi-Radial Stylus vastly reduces another problem in playback known as the "pinch effect." As experienced audiophiles know, the record grooves are wider wherever and whenever the flat, chisel-faced cutting stylus changes directions (which is 440 cycles per second at a pure middle "A" tone—up to 20,000 cycles per second in some of the high overtones). An ordinary spherical/conical stylus riding the upper portion of the groove walls tends to drop where the groove gets wider, and to rise as the groove narrows. Since stereo styli and cartridges have both vertical and horizontal functions, this unfortunate and unwanted up-and-down motion creates a second harmonic distortion. The new Shure Bi-Radial elliptical stylus, on the other hand, looks like this riding a record groove:



You'll note that even though it has a broad front face with a frontal plane radius of 22.5 microns (.0009 inch), and it measures 30 microns (.0012 inch) *across* at the point of contact with the groove, the small side or contact radii are only 5 microns (.0002 inch). This conforms to the configuration of the cutting stylus and hence is not as subject to the up-and-down vagaries of the so-called "pinch-effect".

SYMMETRY, TOLERANCES AND POSITIONING ARE ULTRA-CRITICAL

Frankly, a Bi-Radial elliptical stylus, however desirable, is almost impossibly difficult to make CORRECTLY. Diamond, as you know, is the hardest material . . . with a rating of 10 on the Mohs hardness scale. It's one thing to make a simple diamond cone, altogether another to make a *perfectly* symmetrical Bi-Radial stylus with sufficiently close tolerances, actually within one ten thousandth of an inch! Shure has developed unprecedented controls, inspections and manufacturing techniques to assure precise positioning, configuration, dimensions and tolerances of the diamond tip. It is a singular and exacting procedure . . . unique in the high fidelity cartridge industry. And, unless these inspection techniques and safeguards are used, an imperfectly formed elliptic configuration can result and literally do more harm than good to both record and sound.

THE V-15 IS A 15° CARTRIDGE

The 15° effective tracking angle has recently been the subject of several Shure communications to the audiophile. It conforms to the effective record cutting angle of 15° proposed by the RIAA and EIA and now used by the major record producing companies and thereby minimizes tracking distortion.

The major features, then, of the V-15 are the Shure Bi-Radial Elliptical Stylus, the singular quality control techniques and standards devised to produce perfection of stylus symmetry, and the 15° tracking angle. They combine to reduce IM and harmonic distortion to a dramatic new low. In fact, the distortion (at normal record playing velocities) is lower than the inherent noise level of the finest test records and laboratory measurement instruments! In extensive listening tests, the V-15 proved most impressive in its "trackability." It consistently proved capable of tracking the most difficult, heavily modulated passages at a minimum force of 3/4 grams (in the Shure-SME tone arm). The entire V-15 is hand-crafted and subject to quality control and inspection measures that result in space-age reliability. Precision machined aluminum and a special ultra-stable plastic stylus grip. Exact alignment is assured in every internal detail—and in mounting. Mu-metal hum shield surrounds the sensitive coils. Gold plated terminals. Individually packaged in walnut box. The V-15 is a patented moving-magnet device—a connoisseur's cartridge in every detail.

SPECIFICATIONS

The basic specifications are what you'd expect the premier Shure cartridge to reflect: 20 to 20,000 cps., 6 mv output. Over 25 db separation. 25 x 10^{-6} cm. per dyne compliance. 3/4 gram tracking. 47,000 ohms impedance, 680 millihenries inductance per channel. 650 ohms resistance. Bi-Radial stylus: 22.5 microns (.0009 inch) frontal radius, 5 microns (.0002 inch) side contact radii, 30 microns (.0012 inch) wide between record contact points.

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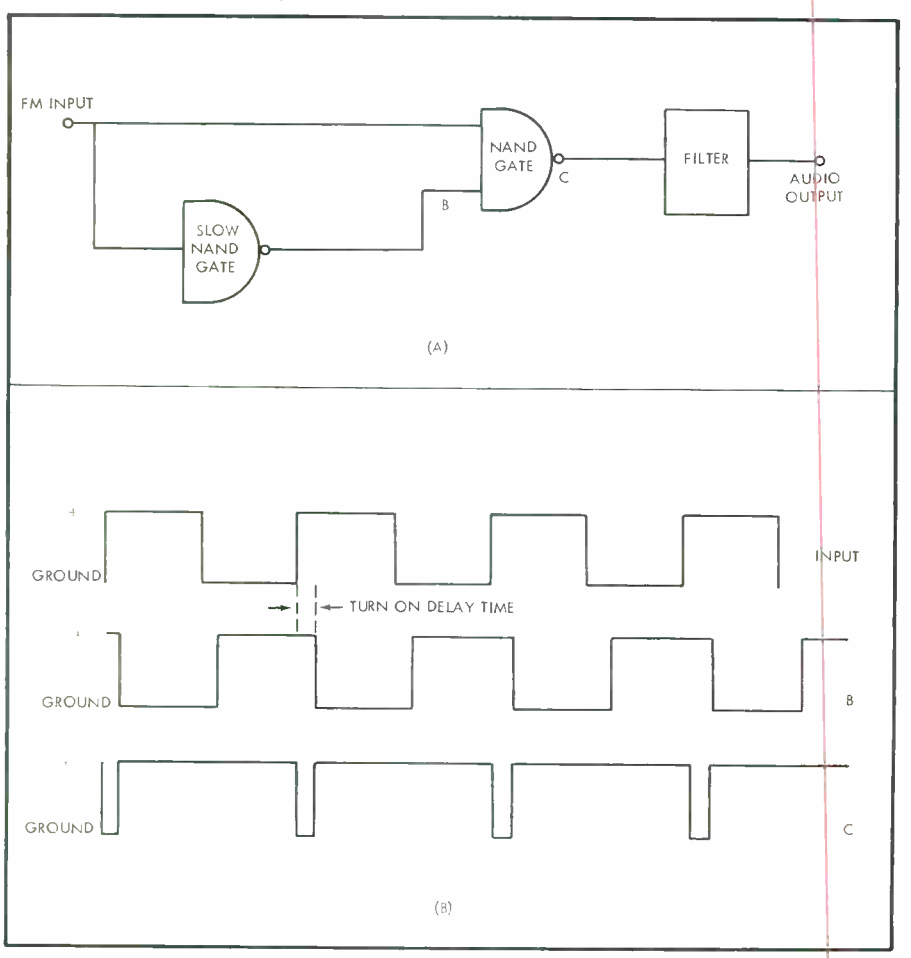

Fig. 6. Block diagram of pulse counter detector, (A) and timing diagram of pulse counter detector, (B).

ple filtering provides the average value. Since the average value is directly proportional to the number of pulses generated per second, this type of detector is inherently linear. Note also that the pulse or square wave may jitter in position due to noise or imperfect limiting without seriously affecting the average value at the output and that since only zero crossings are used to generate pulses, changes in square wave amplitude or wave shape will not affect the output. Thus we would expect unusually good noise rejection properties from a demodulation system of this type. Let us now develop some simple equations to better understand the action of a pulse counter.

The FM signal may be represented by:

$$FM = E_c \sin (2\pi f_c t + RE_m \sin 2\pi f_m t)$$

where

f_c = the carrier frequency
f_m = the modulation frequency
E_c = the amplitude of the carrier frequency
E_m = the amplitude of the modulation frequency
k = the peak frequency deviation

If a pulse is generated of amplitude E_p and width t_p for each cycle of the above waveform, then the number of such pulses (N_p)

$$N_p = f_c + kE_m \sin 2\pi f_m t$$
$$N_p \max = f_c + kE_m$$
$$N_p \min = f_c - kE_m$$

The average value of the pulse train E_{AV}

$$E_{AV} = N_p \times t_p \times E_p$$

From this equation it can be seen that E_{AV} is directly and linearly proportional to the number of pulses N_p if t_p and E_p the pulse width and amplitude are held constant. Since N_p, (after the carrier frequency is filtered out) is equal to $kE_m \sin 2\pi f_m t$, E_{AV} is the same as the original modulation waveform.

The main problem now, is how to generate pulses of constant width and amplitude regardless of the rate at which the pulses are being generated. Circuits that have been used in the past to generate these pulses include: blocking oscillators, one shot multivibrators delay lines, differentiators and saturated inductors. All these methods have serious drawbacks. It is very difficult to stabilize the width of blocking oscillator pulses or one shot multivibrators against changes in temperature, power supply voltages, triggering waveform and gain. The differentiation method involves the generation of pulses directly from the limited square wave by differentiating one of the edges of the waveform. However, both the amplitude and the width of such pulses are then dependent on the rise time and amplitude of the square wave and therefore also on the signal strength and limiting characteristics of the tuner. Also because of the difficulty of using all these circuits at an i.f. frequency of 10.7 mc, a second conversion to an i.f. of 200 to 400 kc has usually been required.

The method described here for generating pulses makes use of a standard digital logic NAND gate and a delayed inverter. No tuned circuits or inductors are required. The NAND gate has two input terminals and performs the following logic function: When either or both inputs are at ground the output voltage is positive. When both inputs are positive the output is at ground. If the signal at one input is the inverse polarity of the signal at the other, both inputs cannot be positive at the same time and

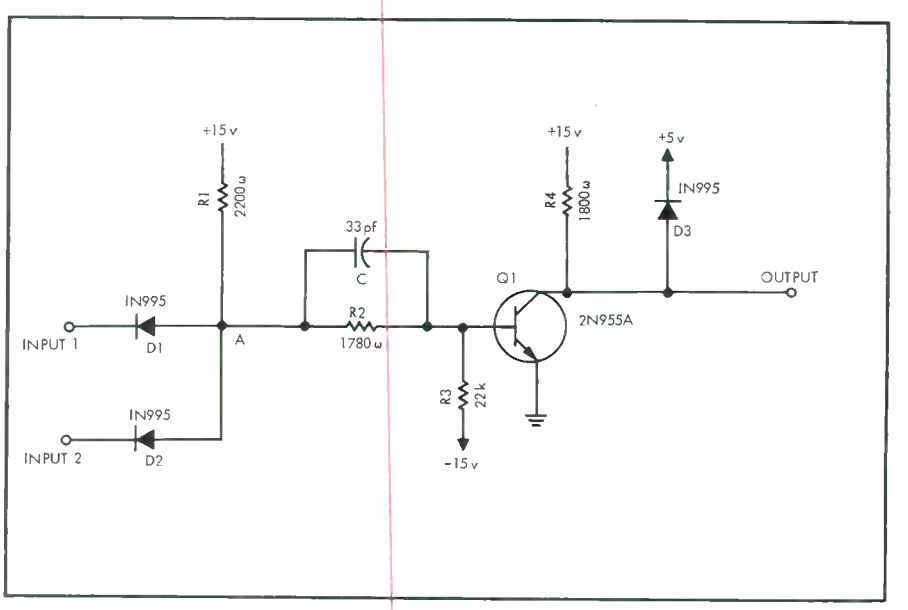

Fig. 7. Standard "NAND" gate circuit.

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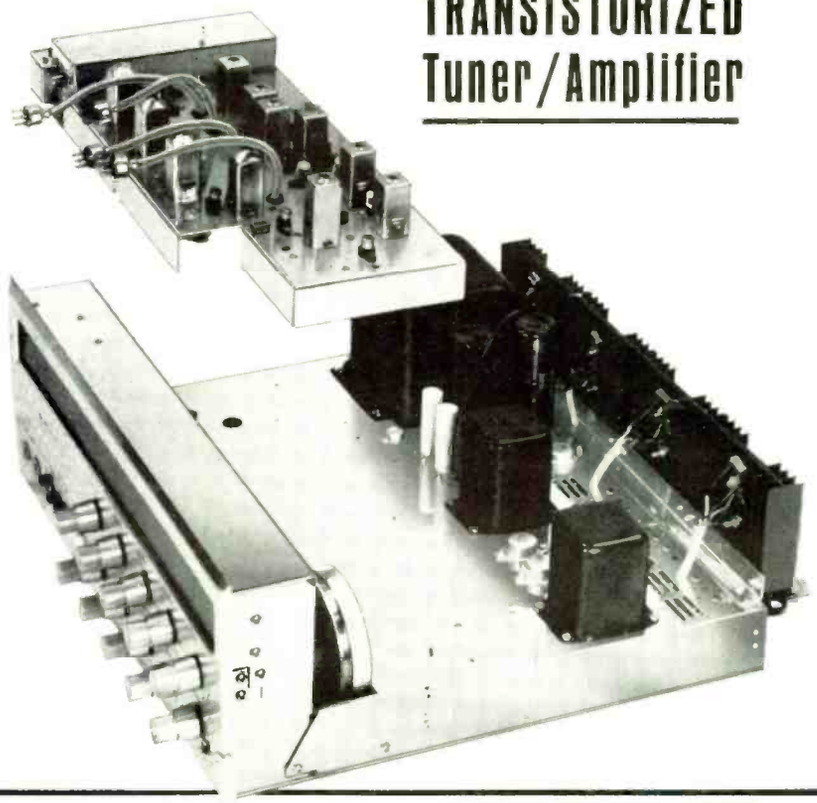

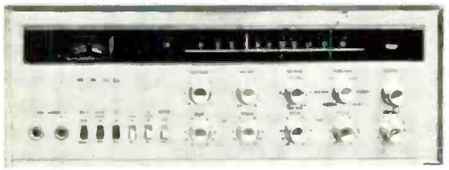

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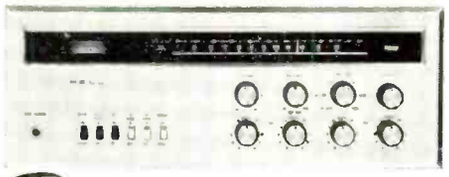

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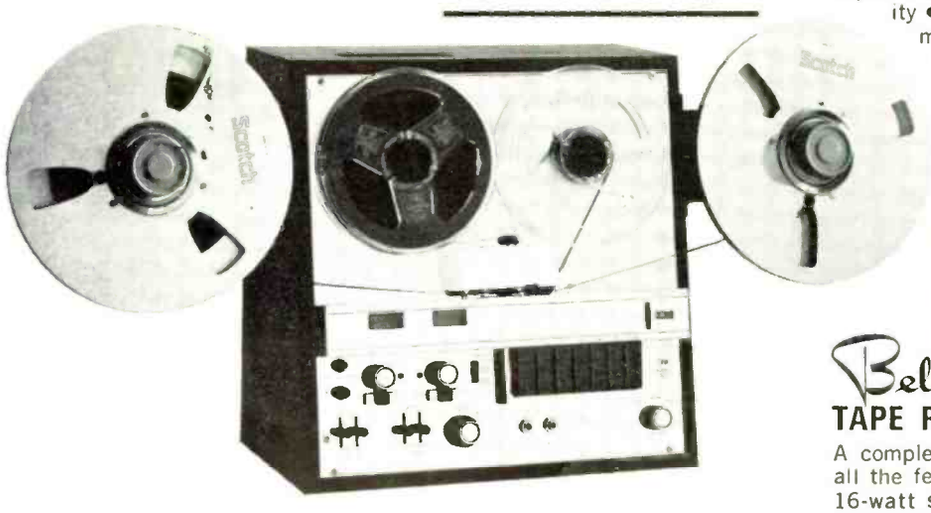

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Take a good look at the new Fisher all-in-one stereo receiver on the facing page. Then consider with equal attention the new Fisher control-amplifier and tuner, shown directly below it. You have now witnessed the coming of age of solid state stereo.

No, these are not the first transistorized stereo components of their type. Nor even the first costly and very ambitious ones. They are ahead of all others in *performance,* but even that would not make them revolutionary. The big news is that these solid state units are consistently and invariably *reliable.* Each will perform as well as, or better than, the production prototype on which the specifications are based—and *maintain* that performance indefinitely, under the heaviest use, year after year. Thus the original and most meaningful promise of transistors in high fidelity equipment — reliability of the install-it-and-forget-it kind — is at last fulfilled. No one will be surprised that it was Fisher who did it.

Ever since the first appearance of transistors in high-quality audio components, Fisher has been wary of the 'hot-rod' engineering philosophy that seems to be prevalent in this field. It is Fisher's belief that the high fidelity enthusiast who pays a premium price for transistors has the right to expect more than just 'super-specifications' and spectacularly clean-textured sound. That is only part of the potential capability of solid state stereo. The other part — the more difficult part when it comes to series production — is the assurance of faultless operation in the hands of *every* user. Fisher insists that premium-priced transistorized components be not only failure-proof but immune even to the tiny annoyances and minute deteriorations occasionally encountered in the use of quality vacuum-tube equipment.

With these considerations in mind, Fisher engineers developed high-reliability solid state circuitry in four basic categories—power amplifier, preamp-control, FM tuner, and multiplex. The Fisher TX-300 combines the first two; the Fisher TF-300 the latter two. The remarkable Fisher 600 combines *all four*—without modification or compromise! It can be unconditionally stated that, even ignoring reliability, there exist no circuits of higher over-all performance—either tube *or* solid state. It is with full justice that Fisher prints "Professional Series" on these units.

In addition to the inherent advantages of transistorized design — such as reduced chassis size, low-temperature operation, freedom from hum and noise, wider frequency response — the new Fisher solid state stereo components offer a number of truly original design features. These are summarized along with the specifications below.

For the rest, the actual numerical 'specs' should suffice. Keep in mind when you read them that they represent the performance of the particular unit *you* may buy — not wishful thinking from the lab. And, by the way, take a look at those new front panels!

Technical Features and Specifications

600-T

AMPLIFIER SECTION:

- 100 watts total IHF Standard music power output at 8 ohms.
- 45 watts per channel rms power output at 8 ohms.
- 0.5% harmonic distortion at 1 kc and rated output.
- 0.5% intermodulation distortion at rated output.
- 12 to 35,000 cps IHF power bandwidth.
- Receiver chassis only 11⅞" deep

...until now.

The new Fisher 600
Transistor Stereo Receiver

components featuring Fisher reliability.

despite tremendous amplifier power.
- No output transformers – therefore no limitation of bass performance or of transient response because of transformer characteristics.
- *Four* output transistors in *each* channel for conservative operation at high power (instead of the conventional *two*).
- Impedance selector switch, for best possible match of output impedance to 4-ohm, 8-ohm or 16-ohm speakers.
- Exclusive Fisher DIRECT TAPE MONITOR*.

TUNER SECTION:
- 1.8 μv FM sensitivity (IHF Standard).
- Exclusive Fisher *Nuvistor*-GOLDEN SYNCHRODE* FM front end, for highest sensitivity and lowest noise, plus overload resistance beyond the capabilities of transistor front ends.
- *Five* wide-band IF stages and *five* limiters.
- Wide-band (one megacycle) ratio detector of highest linearity and lowest distortion, for unusually accurate detection of multiplex signals.
- Better than 40 db stereo separation at 400 cps – *an industry* FIRST.
- Exclusive Fisher STEREO BEACON* for automatic switching between FM-mono and FM-stereo modes, and automatic visual indication of stereo broadcasts.
- Variable-threshold muting with front-panel adjustment and defeat.
- D'Arsonval tuning meter for perfect center-of-channel tuning.

Size: 16¾" x 5⅛" x 11⅞" deep.
Price: $595.00 (walnut cabinet $24.95)

*PATENT PENDING

TX-300

- 90 watts total IHF Standard music power output at 8 ohms.
- 36 watts per channel rms power output at 8 ohms.
- 0.5% harmonic distortion at 1 kc and rated output.
- 0.5% intermodulation distortion at rated output.
- 12 to 50,000 cps IHF power bandwidth.

Other features identical to those listed under *amplifier section* of 600-T above.
Size: 15⅛" x 4⅞" x 11¼" deep.
Price: $329.50 (walnut cabinet $24.95)

TF-300

Features and specifications identical to those listed under *tuner section* of 600-T above.
Size: 15⅛" x 4⅞" x 11¼" deep.
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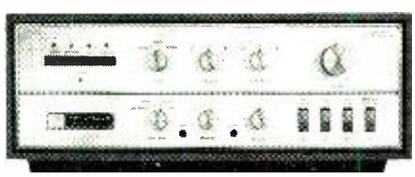
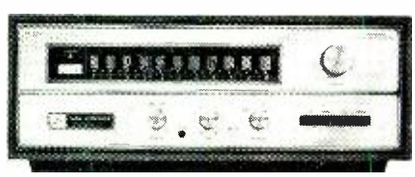


The new Fisher TX-300
Transistor Stereo Control-Amplifier



The new Fisher TF-300
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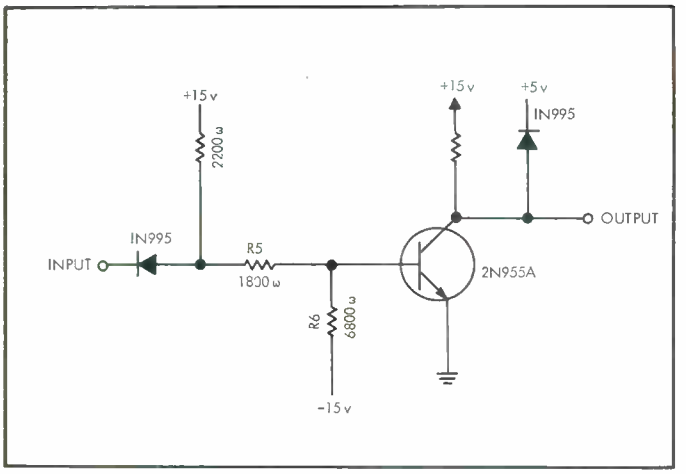

Fig. 8. Slow gate inverter circuit.

the output will remain positive. A NAND gate with only one input functions as a polarity inverter. When its input is at ground its output is positive and when its input is positive its output is at ground.

Consider now the circuit of *Fig.* 6A and the timing diagram of 6B. The input square wave is applied to one input of a NAND gate and to the input of a NAND gate inverter. The output of the inverter is the second input to the NAND gate. The NAND gate inverter has been altered, in a manner to be described later, so that the signal through it is delayed in time by a fixed amount. Thus the inverted signal arrives at the second input to the NAND gate a short time after the input signal does. Since a NAND gate only produces an output when both its inputs are positive at the same time, a negative-going pulse occurs only for the period when the positive portions of the two gate input signals overlap. (See *Fig.* 6B). Observe that one pulse is generated for each cycle of the input. The width of the pulse depends only on the delay of the slow NAND gate and its amplitude depends only on the power supply of the NAND gate.

Now we shall examine the circuitry of the NAND gates. *Figure* 7 is the circuit diagram of a modern high-speed logic gate. High-speed capability is essential if the detector is to operate at the standard FM i.f. frequency of 10.7 mc. The recent development of switching transistors with f_t's of 1000 mc make it possible to design a pulse counter that generates and counts pulses only nanoseconds wide. The RCA 2N955A germanium transistor and RCA 2N2475 and the Sylvania 2N2784 silicon transistors are examples of the relatively low-cost high-speed switching transistors now becoming available. The NAND circuit of *Fig.* 7 operates as follows. With no inputs connected, or both inputs high, current from the 15-volt supply flows through R_1 and R_2 to the base of Q_1 causing Q_1 to conduct heavily and become essentially a short circuit between the output and ground. If one of the inputs is connected to ground, point A will be practically at ground and no current from the +15-volt supply will be able to reach the base of Q_1 to keep it conducting. In addition a negative bias from the -15-volt supply, via R_3, insures that the transistor is firmly cut off when one or both of the input terminals are grounded. Since the transistor is cut off its output collector is open circuited and diode D_3 will open due to the current from the +15-volt supply, via R_4, and set the output to +5 volts. D_3 is essential to limit the maximum collector-to-base and collector-to-emitter voltages to a safe value. D_3 also improves the rise time of the waveform and therefore the switching speed. R_2 limits the base current to a value just large enough to ensure that the transistor will be fully on when point A goes to +5 volts due to a +5-volt signal at both inputs. Capacitor C_1 bypasses R_2 to permit higher turn-on currents thus shortening the turn-on time and has a similar effect in shortening the turn-off time by absorbing stored charge in the base region of Q_1.

The inverter circuit shown in *Fig.* 8 is used to invert and delay the input signal. It is almost identical to the circuit of *Fig.* 7 except that capacitor C_1 has been omitted entirely and R_3 has been reduced from 22k to 7k. These changes have the desirable effect of greatly increasing the turn-on time delay of the circuit. When the transistor is not conducting its base sits at a large negative bias due to the voltage-dividing action of R_5 and R_6. Because of the base-to-emitter capacity of the transistor and the absence of a capacitor across R_5 it takes an appreciable time after the appearance of a positive voltage, at the input, until the base voltage and current are sufficiently positive to permit the transistor to conduct. Note that the delay is independent of the amplitude of the input voltage or its frequency. It depends only on power supply voltages and the turn-on characteristics of the transistor.

It is also possible to use a delay line to delay the signal but this method is quite expensive and bulky. Using the turn-off or storage time of a saturated transistor as the delay element, is also possible. A further refinement is to generate two pulses per input cycle, one for each input transition edge. This has the advantage

(*Continued on page 61*)

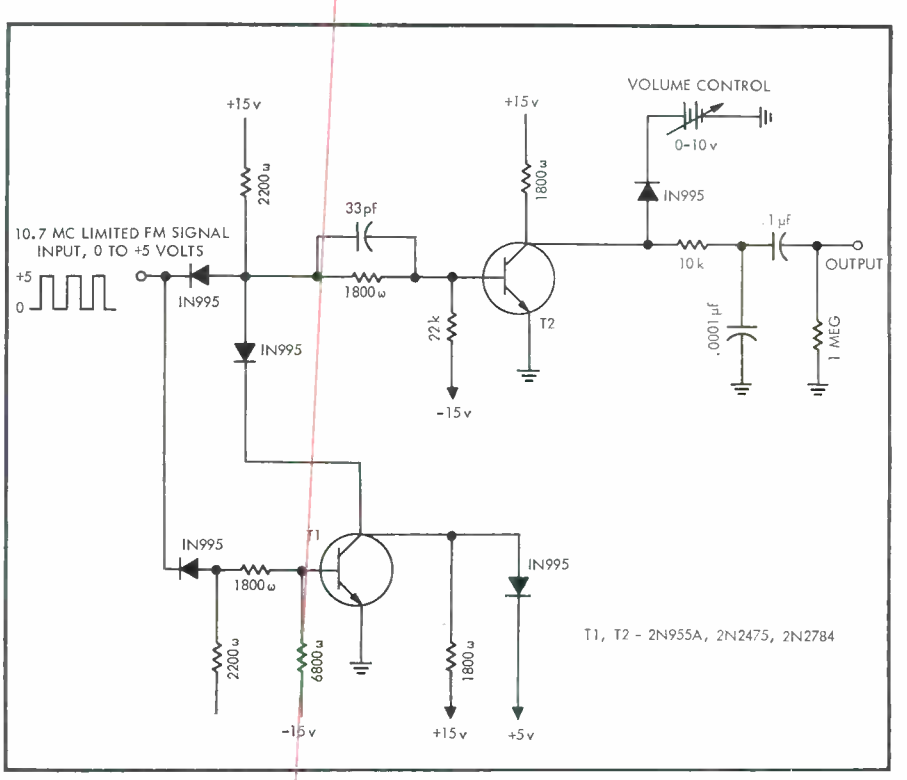

Fig. 9. Complete schematic of ultra-liner FM detector.

The Elliptical Stylus

J. KOGEN[1] and R. SAMSON[2]

A properly-made elliptical stylus can reduce tracing distortion significantly with negligible effect on record wear if tracking force is kept below 1.5 grams.

PROBABLY THE MOST UNDERRATED criterion of phonograph cartridge performance has been that of distortion. Although the subject of distortion has been analyzed and discussed at great length for many years, consideration given to this factor in measuring and rating cartridges has not been great. The main reason for this is probably the difficulty in relating distortion measurements to subjective reactions in human listening.

On the other hand, the most emphasized characteristic in the evaluation of phonograph cartridges has been frequency response. It has been generally recognized, however, that two cartridges with pretty much the same frequency response can sound quite different. While many factors contribute to this, certainly the amount of distortion must have an important bearing on the sound.

Distortion products can be created in many ways:

1. *Tracking Distortion*

Two types of tracking distortion have been discussed at considerable length in the literature: lateral and vertical. Both of these forms of distortion are produced when the center of rotation of the playback stylus differs from that of the stylus used in cutting the master record. Lateral tracking distortion can be minimized by proper design of the tone arm. Vertical tracking distortion can be minimized by matching the motion of the playback stylus to the vertical tracking angle which has been cut into the record.

2. *Tracing Distortion*

This is the distortion that arises from the fact that the playback stylus has a different shape from the cutting stylus. The following discussion will deal with this subject in some detail.

3. *Dynamic Distortion*

By this we mean the distortion which occurs under dynamic conditions when the stylus deforms the record material and therefore follows a contour which is not exactly the same as that which is present in the record under static conditions. Since no standard or accepted terms exist for this effect, we have coined the term "dynamic distortion."

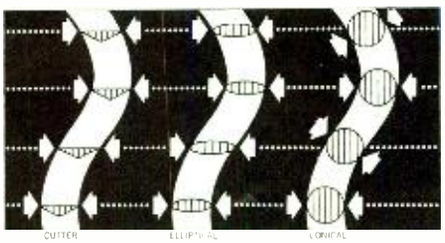

Fig. 1. Tracing groove modulation.

4. *Distortion Caused by Loss of Contact Between Stylus and Groove*

This is simply distortion which occurs when the needle starts jumping off the record surface or to use a colloquialism "rattling around in the groove." This can occur with highly modulated passages. An extreme case of such distortion results in the stylus actually jumping out of the groove.

What Is Tracing Distortion?

The stylus used in cutting a record has a wedge shape similar to that shown in (A) of *Fig.* 1. The object when playing a record is to have the playback stylus move in exactly the same manner that the cutting stylus moved when it produced the master record. An exact reproduction of this motion cannot be accomplished with a round-tipped stylus because the point of tangency between the round stylus and the record changes as a function of the modulation of the groove (see *Fig.* 1). Although the change in this point of tangency is small, there is some calculable and measureable deviation in the motion of the playback stylus as compared to the cutting stylus. This difference in motion results in what is termed "tracing distortion." This distortion is proportional to frequency and cutting velocity, and inversely proportional to groove speed squared. Stated in other terms, tracing distortion is most noticeable towards the center of the record for highly modulated passages containing high frequencies.

The difference in shape of the cutting and playback styli also produces pinch effect, a type of distortion most noticeable on lateral records when played with a stereo cartridge. Referring again to *Fig.* 1, it can be observed that the groove cut by the wedged shaped stylus will be such as to impart a vertical motion to a playback stylus with a round tip. Note that the perpendicular distance between points of tangency for the round tip is smaller where the sine wave crosses the zero axis that it is at the peaks of the wave. Since stereo cartridges respond to vertical as well as horizontal motion an electrical output will be produced. This output is primarily a second harmonic of the lateral modulation.

Minimizing Tracing Distortion

For many years it has been recognized that one effective way to minimize tracing distortion and pinch effect is to make the radius of the playback stylus as small as possible. There is a minimum size for a round-tipped stylus because making the tips smaller causes the stylus to ride in the bottom of the groove. This causes undesirable noise and distortion. A radius of 0.4–0.5 mil has generally been accepted as the practical minimum round stylus.

Minimum tracing distortion would be obtained by the use of a playback stylus shaped exactly the same as a cutting stylus. The problem in this case, of course, would be that the sharp edges of the stylus would cause undue wear on the record. A good solution therefore, would seem to be a compromise between the round stylus tip and the wedge-shaped tip of the cutter.

The ideal shape for a playback stylus would have the following characteristics:

1. Minimum radius at the points of contact with the record.
2. An optimum radius at the bottom of the stylus tip which would both keep the stylus out of the bottom of the groove, yet well into the groove.
3. Symmetry between the two tip radii at the points of contact with the record in order to insure identical characteristics for each of the stereo channels.

This combination of requirements lead to what we are for brevity calling an

[1] *Chief Engineer,* [2] *Development Engineer, Shure Bros., Inc., 222 Hartrey Ave., Evanston, Ill.*

elliptical tip. Actually, the exact shape of the tip is not significant provided that the shape meets the three previously cited specifications. We have proposed the use of the term "biradial" to indicate the existance of two different radii, one at the point of contact with the record and the other at the bottom of the tip. We feel, however, that the term "elliptical" is simpler and will have better acceptance. In using the term "elliptical tip" we are considering this in a generic way as a stylus which exhibits the characteristics we have just discussed.

Measuring the Stylus

Thus far we have discussed some theoretical ideas of how tracing distortion might be minimized. These approaches are certainly not new, and have been tried in one form or another on commercial phonograph cartridges. There have been two major reasons which have probably prevented the elliptical stylus from becoming more popular. First of all, distortion from other sources has been relatively greater than tracing distortion and it has not been until quite recently that we have reached the state of the art where both the recording techniques and playback cartridges have minimized many of these sources of distortion. As these other sources have been relatively diminished, the importance of tracing distortion has become more significant. Second, manufacturing a really good elliptical tip is very difficult. The problem of maintaining the required tolerances, both on dimension and symmetry while still retaining a satisfactory polish, is rather severe. To simply make the stylus noncircular is of no value at all. Maintaining the dimensions to meet the three major requirements we have cited is of paramount importance and requires a precise and costly manufacturing process.

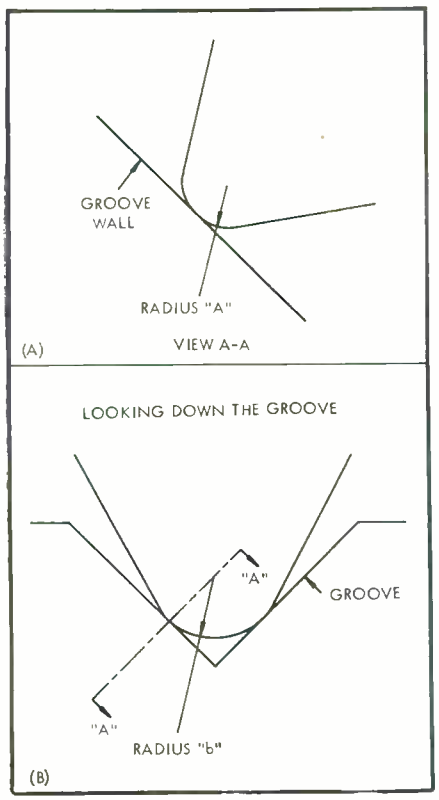

Fig. 2. Stylus in groove showing points of contact with record.

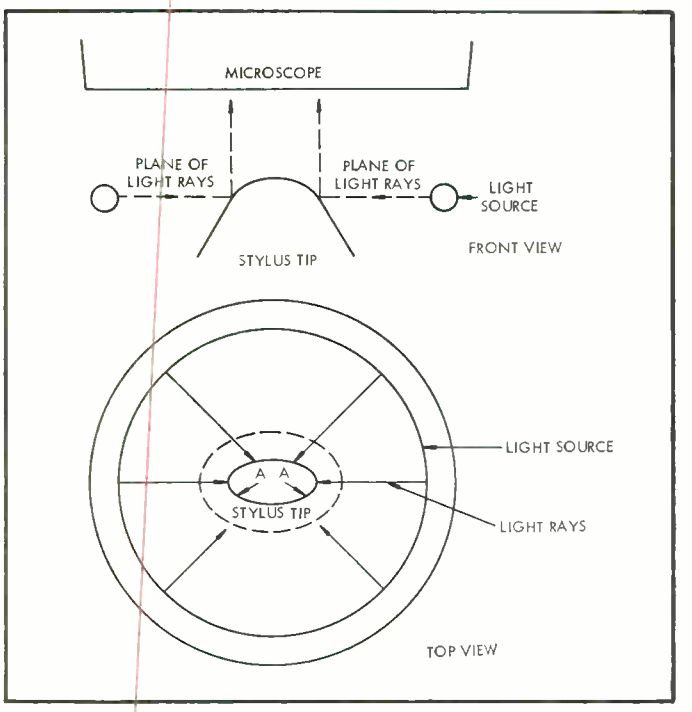

Fig. 3. Method of using high power microscope to measure elliptical tip.

The problem of making uniform elliptical tips includes the need for accurately measuring these tips. This need for accurate measuring techniques is important, not only to insure consistent quality control, but also to allow for laboratory measurements which will help in correlating the shape of the stylus with distortion and sound reproduction characteristics of the finished product.

Figure 2 shows the dimensions which are of significance in the elliptical tip. Dimension "A" is at the points of contact on the record and is seen in a plane perpendicular to the groove wall, which is at a 45 deg. angle to the surface of the record. Dimension "B" is at the bottom of the stylus, and is in a plane perpendicular to both the record and the groove wall.

Two methods can be used for measuring radius "A":

1. A shadowgraph can be used by shining the light in such a way that it will be oriented at a 45 deg. angle with relation to the major axis of the tip. Care must be taken to accurately orient the tip with respect to the light beam. A slight misorientation in any direction can cause significant error. It is important therefore that highly accurate fixturing be provided for holding the tip and stylus shank when the measurement is made.

2. An accurately calibrated microscope can be used in the manner depicted in *Fig.* 3. In this system a plane of light is directed at the stylus tip. Light is reflected upward into the objective lens of the microscope from all surfaces on the tip oriented at an angle of 45 deg. to the plane of light. Photographs of tips viewed in this manner are shown in *Fig.* 4. The curvature measured by this method should be related to the curvature perpendicular to the groove by a factor of $\sqrt{2}$. This method is excellent in showing the symmetry of the tip for the two radii "A". (*Figure* 4B shows a 0.5-mil round tip, 4A shows an elliptical tip.)

Dimension "B" can be measured reasonably well with a shadowgraph (plus a proper holding fixture) since it is not as critical as dimension "A."

Results of Measurements on Production Elliptical Tips

In the development of the biradial, elliptical tip, a great deal of consideration had to be given to developing good means of measuring tips as well as a repeatable manufacturing process. Quantities of tips were then produced and measured using both the shadowgraph and microscope techniques just described. Measurements were made in order to correlate distortion with the dimension of radius "A." Additional measurements were taken to determine the effects of a symmetry between the two sides of the tip and the orientation of the tip in the stylus shank. Comparisons were made between the elliptical and conventional 0.5-mil and 0.7-mil tips.

The primary objective in these measurements was to determine the effect of stylus tip shape on tracing distortion.

Fig. 6. Photograph of poorly formed elliptical tip using apparatus of Fig. 3.

tip could have distortion products five to six times that of a good 0.5 or 0.7-mil round tip. Obviously, the use of the term "elliptical" for such non-round tips would not in any way guarantee that the cartridge would minimize tracing distortion shown. It is of utmost importance that the stylus be produced with great care and consistency in order to produce the reductions in tracing distortion shown in Tables I and II. Naturally this means the very highest degree of quality control. Quality control, of course, means both that the product must be produced with quality and that it must be measured accurately to insure that the quality is present.

Effect on Record Wear

Having demonstrated the decrease of distortion with the dimension of radius "A," we must concern ourselves with the effect of this radius on record wear. We know that decreasing this radius to the point where the stylus becomes chisel-shaped would result in exceedingly high contact pressures between the stylus and the record, even with very light tracking force. We must surmise that there is some optimum dimension for radius "A" which will diminish tracing distortion while not appreciably affecting the life of the record. In order to determine the effect on record life, tests were run on records both with test signals and program material.

Since record wear is directly related to the contact pressure between stylus tip and record, we must consider the factors which influence this pressure. These factors include the tip radius, tracking force, and the dynamic characteristics of the stylus record combination. The last mentioned item is determined by the effective stylus inertia, stylus and record compliances, and damping forces as contributed, for example, by visco-elastic bearings. These latter parameters are fixed for a given stylus design so that the major variables are tip radius and tracking force.

Several methods have been proposed for checking record wear. Two major factors must be considered, the effect of broadband background noise and the alteration of the modulation in the record groove. Several tests were performed to measure these indications of wear and to provide a comparison between elliptical and round tips.

1. *Background Noise.*

The test record employed in this test was the CBS-STR 100 band 6A and 7A which is modulated at 1000 cps at a recorded velocity of 3.54 cm/sec. A wave analyzer was used to measure output at discrete frequencies across the audio range. Measurements were made during the first playing of the record with a 0.2-mil radius elliptical tip, played at 1.5 grams. The record was played 30 times and the measurement was repeated after every ten playings. *Figure 7* shows output versus frequency after the first and after 30 playings. The output at 1000 cps, 2000 cps, 3000 cps, and so forth indicates the modulation cut into the record plus residual distortion products. Output at other frequencies shows background noise.

Our conclusion from this test was that background noise did not change to any measurable degree even at the maximum tracking force for this cartridge. Some increase in output was noted at about 12,000 cps, the resonance of the stylus and record. Additional tests indicated that this small amount of wear can be eliminated under identical test conditions by reducing the tracking force to 1 gram or less.

A second test for broadband noise was run at 10,000 cps using the elliptical tip at 1.5 grams. For this test a harmonic distortion meter was employed which measured the output of all frequencies except 10,000 cps. Total distortion plus noise measured 2.2 per cent during the first playing and 2.8 per cent during the 70th playing. This is a rather moderate change in noise for 70 playings of the record.

2. *Frequency Response.*

Alteration of the groove modulation should be indicated by a change in frequency response as measured on a new versus a worn record. Tests were performed using the CBS-STR 100 record, bands 1A and 2A. Recordings were made of cartridge output-versus-frequency for a variety of tracking forces and tip radii on new records and after a significant number of playings. The results of these tests were:

a. At 1 gram with the 0.2-mil elliptical tip, no measurable change in frequency response could be detected.
b. At 1.5 grams with the elliptical tip, a slight alteration in response was noted between 10,000 and 20,00 cps after 100 plays.
c. At 3 grams with the elliptical tip, a significant effect on the output in the 10,000 to 20,000 cps range was detected.
d. A 0.7-mil circular tip at 3.0 grams influenced the 10,000 to 20,000 cps response to a small degree after 100 playings, about the same as the 0.2-mil tip at 1.5 grams.

Our conclusion is that, if this test has significance, the tracking force for a 0.2-mil elliptical tip should be no greater than 1.5 grams maximum and more optimally 1.0 gram.

3. *Square Wave Tests.*

As an alternate for the frequency response measurements a series of tests were run on square wave modulation using the CBS-STR 111 record. This record has bands of 1000-cps square waves modulated laterally, vertically, left channel and right channel stereo.

Tests were performed with the 0.2-mil elliptical tip at 1.5 and at 3.0 grams. Results were as follows:

a. At 1.5 grams a very small change was detected after 25 plays. This change showed up as about 10 per cent increase in amplitude of the first overshoot. This correlates with the frequency response tests in that the frequency and amplitude of the overshoot is directly related to the upper frequency response. The effect of the elliptical tip at 1.5 grams appears to be reasonably small for the vertical and lateral, as well as stereo modulation.
b. Wear after 25 playings at 3 grams

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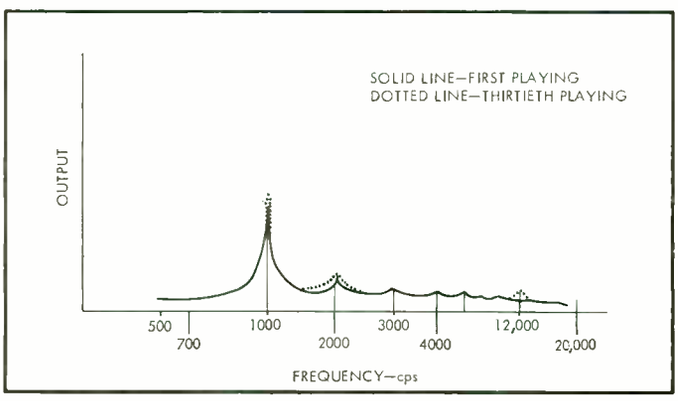


Fig. 7. Noise at discrete frequencies for record modulated at 1000-cps during first and 30th playing with 0.2-mil elliptical tip, tracking force 1.5 grams.

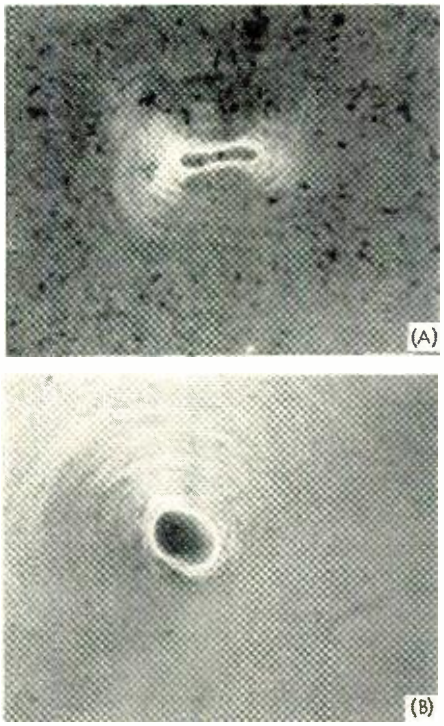


Fig. 4. (A) Photograph of elliptical tip using apparatus shown in Fig. 3 (magnification 600 times); (B) round tip.

For this reason, special precautions were taken to minimize any other forms of distortion which could be minimized during the tests. A special turntable was built to eliminate vertical and horizontal tracking distortion. This turntable (*Fig.* 5) is mounted on a pair of pivots so that it can be rotated on an axis which is across the top of the record. By adjusting the turntable, vertical tracking distortion can be minimized. The tone arm is mounted on a movable base so that it can be adjusted to eliminate distortion caused by the lateral tracking error. Unfortunately, we know of no way to eliminate the dynamic distortion. Nevertheless, comparison of measurements between the elliptical and the round tips of varying dimensions allows us to determine the relative effect of the tip dimensions on tracing distortion. Both harmonic and intermodulation distortion were measured during these tests. Harmonic measurements were made on a test record with 1000 and 2000-cps bands respectively cut with a velocity of 21 cm/sec and 24 cm/sec. This record was cut with vertical modulation using a Westrex 3C cutter, modified to provide the 15-deg. vertical tracking angle. A Quantec Model 303 wave analyzer was used in making these measurements. Intermodulation measurements were made using the Columbia STR 111 test record on bands containing a 4000-cps tone recorded at 2.5 cm/sec and a 400-cps tone recorded at 20 cm/sec. This record also employs vertical modulation and was cut with a modified Westrex 3C cutter. IM distortion was measured with an Audio Instrument Model 167 IM meter.

Tables I and II show the relative percentages of distortion measured for 0.7-mil, 0.5-mil, and elliptical tips. All measurements were made using a Shure V15 phonograph cartridge. Averages were made using a sufficiently large number of units to validate the averaging technique. The elliptical tips used for these tests had a nominal radius "A" of 0.2-mil, a nominal radius "B" of 0.9-mil. All tips had symmetry between the two radii "A" of ± 0.05-mil maximum.

Table I. % second harmonic distortion on vertically modulated groove as a function of tip radius.

Tip Radius	% 2ND HARMONIC DISTORTION			
	1 KC, 21 cm/sec		2 KC, 24 cm/sec	
	Meas.	Calc.	Meas.	Calc.
0.7-mil	9.2	8.0	13.5	16.8
0.5-mil	6.2	5.7	9.7	12.0
elliptical, 0.2-mil	5.2	2.9	7.6	6.0

Table II. I.M. distortion versus tip radius measured on CBS STR-111 400–4,000 cps + 12-db band.

Tip Radius	I.M. Distortion
0.7-mil	6.8%
0.5-mil	5.8%
elliptical, 0.2 -mil	3.9%

Discussion of Tables I and II

The most important characteristic indicated in these tables is the change in distortion as a function of the tip dimensions. The absolute measurements of distortion must be evaluated in terms of the many variables that can affect the measurement. These include distortion which may have been cut into the record, as well as the fact that the records were cut at a very high modulation velocity—in excess of 20 cm/sec. Since the average level at which most records are cut is in the order of 3 to 5 cm/sec, the distortion percentages as shown are much larger than one might normally expect on a typical commercial record.

The trend indicates that the elliptical tip measures roughly 20 per cent less harmonic distortion that the 0.5-mil circular tip, and about 40 per cent less harmonic distortion than the 0.7-mil tip. On intermodulation measurements the elliptical tip shows 27 per cent less distortion than the 0.5-mil tip, and 43 per cent less distortion than the 0.7-mil tip. Since some of the measured distortion is caused by factors other than tracing distortion, the calculated improvement is, as expected, better than it was possible to measure.

Effect of Asymmetry

Measurements were made on tips which were asymmetrical in a two-to-one ratio. For example, radius "A" on one side was 0.4-mil and on the other side was 0.2-mil. As expected, the distortion on the 0.4-mil side was significantly greater than on the 0.2-mil side. There is also some indication that the asymmetrical tips produce differences in frequency response between the channels.

Effect of Poorly Shaped Radii

In order to determine what a really poor elliptical tip might do, a number of tips were made with poorly-shaped radii "A" and considerable asymmetry. *Figure* 6 shows how an inferior elliptical tip might look using the microscope technique of measurement. Such tips can easily be made by simply grinding off part of a standard round tip. Such a tip would be noncircular and could even be claimed to be elliptical.

Our measurements indicated very clearly that a poorly formed, non-round (we refuse to use the term elliptical)

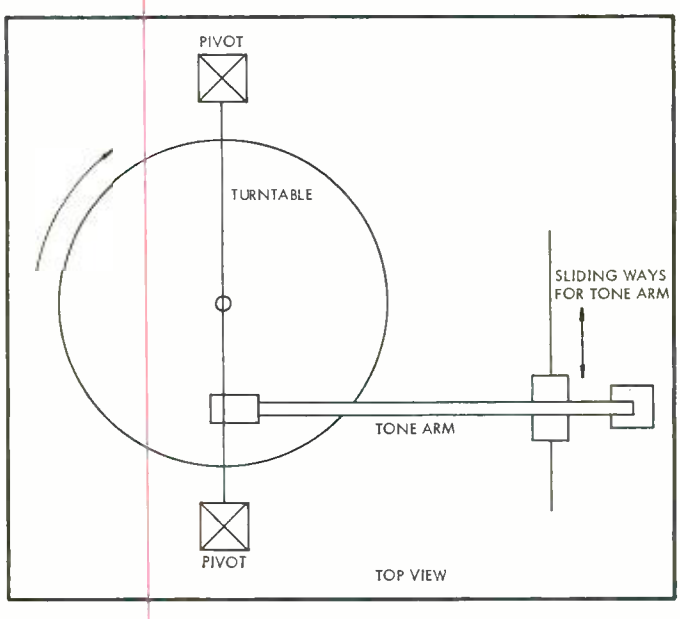


Fig. 5. Tiltable turntable for minimizing vertical tracking error.

HERE'S WHY

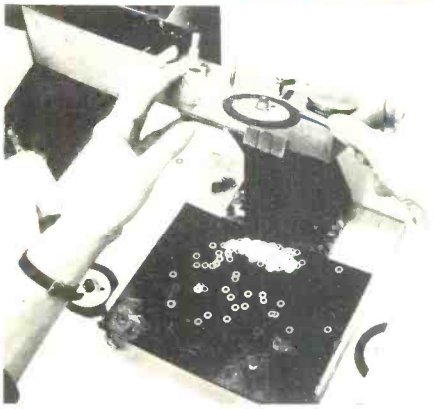
RE Tandberg®

TAPE RECORDERS

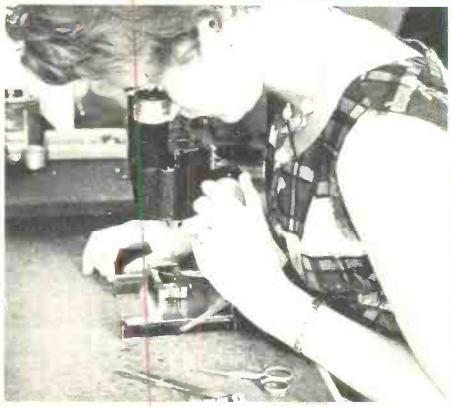
OFFER DISTINCTIVELY "BETTER, CLEARER, MORE NATURAL SOUND"

A VIEW OF THE TANDBERG TAPE RECORDER PRODUCTION LINE

n pressure wheels must
e standards.

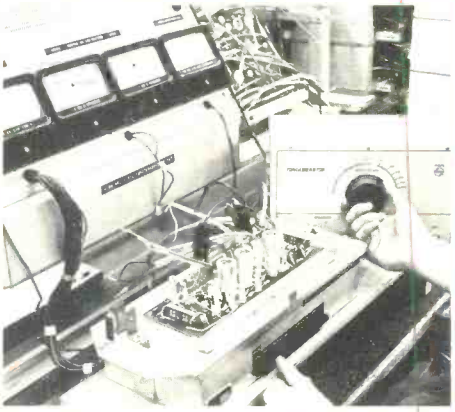


Adjustment of transfer wheel brackets.



Tandberg manufactures its own Record, Playback and Erase heads. Every head is checked for precision.

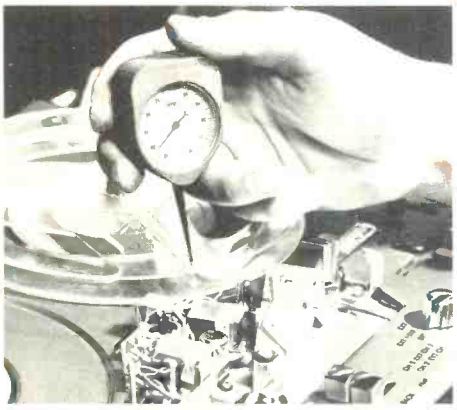
Dip soldering techniques undergo magnifying glass inspection.



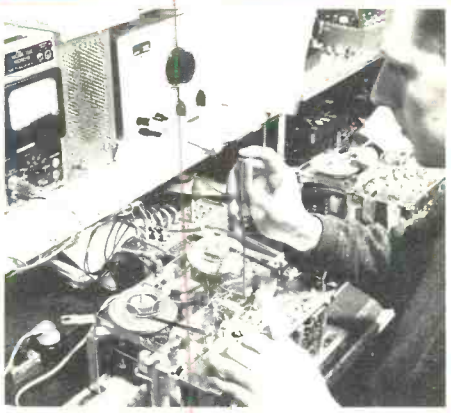
All printed circuit boards are checked for all electrical functions exactly corresponding to application in the recorder.

The consistent, conscientious application of skill and pride of workmanship by Tandberg personnel is unsurpassed anywhere.

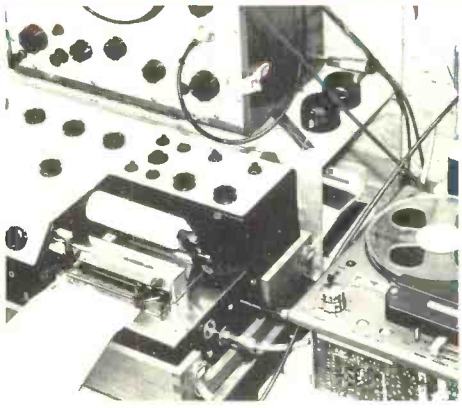
turn-table.



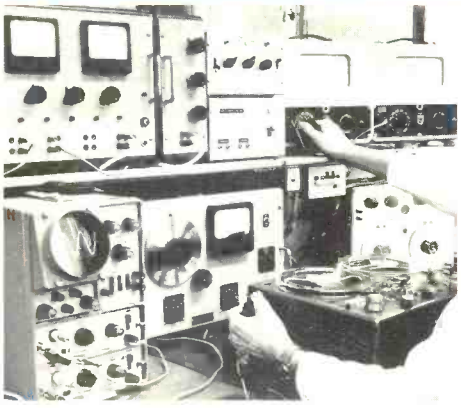
Take-up torque on the right turn-table is inspected for accurate performance.



Azimuth adjustment of the recording head.



During the quality control sample test, frequency response is checked at all speeds.



Production model recorders are thoroughly analyzed and tested for several days to assure quality performance.

Endurance tests in climate chambers expose units to extreme humidity and heat to insure reliability.

RE Tandberg®

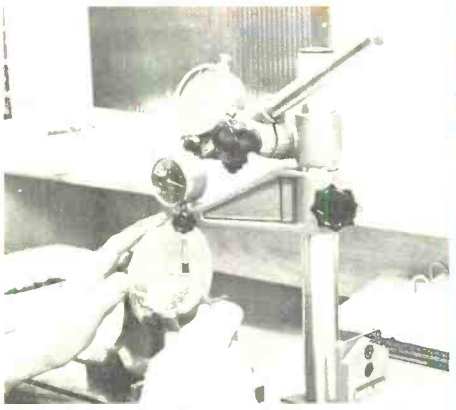
TANDBERG TAPE RECORDERS GO THROUGH MORE THAN 150 CHECKS PRIOR TO COMPLETION

Rigorous Quality Control Techniques Assure Fine Performance And Long Lasting Reliability.

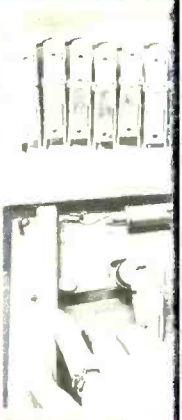
The Tandberg reputation for producing the "world's finest tape recorders" stems from many factors. Careful concept and design are basic. So is painstaking engineering. But, to these one must add the very best components and a complete dedication to fine craftsmanship by technicians, factory personnel, engineers and executives. However, the Tandberg "pursuit of perfection" does not stop at pride alone. A rigid quality control program demands performance of the highest caliber from every electronic component, every mechanical assembly and subassembly, and every key production step in the manufacturing complex. The more than 700 skilled assembly workers, 100 technicians, 50 engineers and 15 university-trained, professionally recognized electronics experts employed at the modern Tandberg facilities in Oslo, Norway, make sure that these standards are met at all times. To check and re-check these efforts, Tandberg maintains a tape recorder quality control team that consists of 22 engineers and technicians under the guidance of an electronics expert.

On this page you will see a number of photographs taken at the Tandberg factory detailing the careful production and quality control techniques employed. To the Tandberg tape recorder owner, these steps translate themselves into "Better, Clearer, More Natural Sound" . . . at all times.

PARTS & SUB-ASSEMBLIES

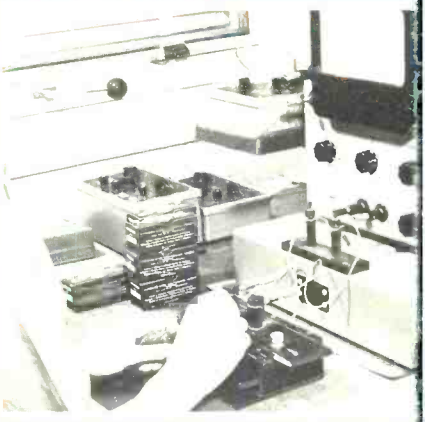


Technician checks turn-table accuracy.



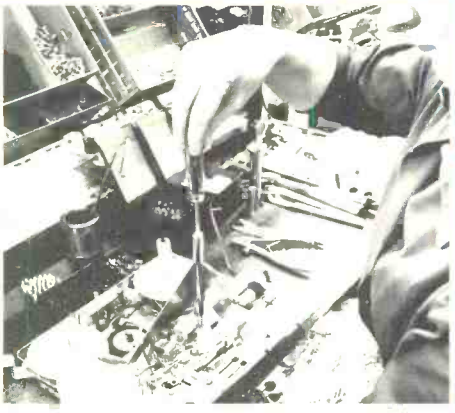
Spring tension o
meet performanc

ELECTRICAL PARTS



Checking incoming electronic componer

PRODUCTION



Careful assembly of upper mounting plate with a special jig assures accurate capstan positioning.

Technician align

FINAL PRODUCTION CHECK

Frequency curve is checked; wow and flutter is tested. The recorder is then given a 2 hour bench test and is then rechecked.

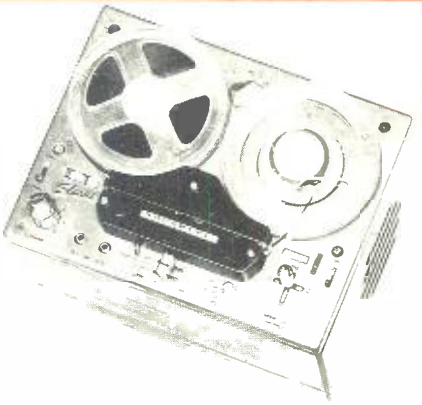
SAMPLE & ENDURANCE TESTING

Ask your Tandberg dealer for a demonstration of Tandberg quality performance.

MODEL 64 STEREO

Internationally famous as **the** standard of tape recording excellence! This distinguished 3 speed/4 track record-playback deck installs into new or existing high fidelity systems, yet may be used as a completely portable tape recorder. It provides convenient push button controls, instantaneous start/stop pause, free position tape threading, automatic tape stop and vertical mount facilities. The superior performance qualities of the Model 64 are matched only by its versatility which permits; direct record of FM Multiplex Stereocasts, echo effects, sound-on-sound, track adding and direct monitor. It features 3 separate precision laminated heads, a hysteresis synchronous motor, 2 recording pre-amplifiers and 2 playback pre-amplifiers. In all, the Model 64 is acknowledged as a superior instrument that offers professional-like quality for every use.

List—$498.00



MODEL 74 & 74B STEREO

The complete stereo tape music system for the home that incorporates built-in amplifiers and two built-in speakers! Combining outstanding record and playback quality with ease of operation and unfailing dependability, this is the machine that has been top-rated. It is compact, lightweight and provides the unstinting quality that only the name "Tandberg" can offer to a recording enthusiast. Among its features you will find facilities for adding external speakers and other high fidelity equipment; FM Multiplex Filter; free position tape threading; instantaneous start/stop/pause control; precision laminated record/playback head; a selective erase head; source monitoring facilities. The Model 74 is housed in a handsome teakwood cabinet and, as with all other Tandberg recorders, has lowest tape tension and virtually no wow or flutter. Naturally, the 74 is a 3 speed/4 track instrument with record and playback frequency response that is unequalled.

List—$449.50

Tandberg Tape Recorders are unconditionally guaranteed, by Tandberg of America, Inc., for a period of one year against factory defects in parts or workmanship.

MODEL 92 MONAURAL

Year after year, hour after hour, this 3 speed, two track monaural record/playback instrument will deliver the finest performance and the most natural sound you'll ever hear from a comparable unit! Every design innovation, every engineering feature that experts look for are part of the Model 92; high fidelity speaker; built-in power amplifier; remarkable frequency response for both record and playback; high efficiency combination head with separate erase head; slide switch for start/stop/pause control; free position tape threading; 4 digit tape program indicator; and lightweight, compact versatility . . . at all times. No matter how you use the Model 92 — for family fun, education, music, the professions, it will perform to your fullest satisfaction.

List—$269.50

Also available in the "F" model with built-in solenoids and separate foot pedal for remote control — start, stop and reverse.

List—$344.50

SERIES 8 MONAURAL

Offered in two speed, 2 track or 4 track record/playback models and unerringly true to the Tandberg tradition of excellence in every respect! Also available with built-in solenoids and foot pedal for remote control operation, as well as with quarter-track or half-track precision laminated heads. With a Series 8 recorder you get mono playback at 3¾ and 1⅞ ips; direct switching for public address from microphone; free position tape threading; overall higher fidelity with little or no wow or flutter and the lowest tape tension. The Series 8 portable recorders also feature a separate combination record/playback head and ferrite constructed erase head. Check the specifications on this precision engineered instrument. Compare with others. You will find that a Tandberg Series 8 offers unrivaled quality, higher fidelity and trouble-free operation.

List from $219.50

LISTEN TO THE BETTER, CLEARER, MORE NATURAL SOUND OF . .

RE Tandberg®

OF AMERICA, INC.,

8 THIRD AVENUE, PELHAM, NEW YORK

PRINTED IN U.S.A.

A Basic Course in Commercial Sound

Norman H. Crowhurst

Chapter II

Background Noise

A noise-level meter is a very useful adjunct in estimating commercial sound installations, but the results need careful interpreting. One thing you should never do, is estimate background noise by how it sounds. Many installations have proved totally inadequate through this error. Human hearing can accommodate to varying background levels to an unbelievable degree, and yours is no exception. You must have some way of checking the effect of background noise, *relative to the problem in hand.*

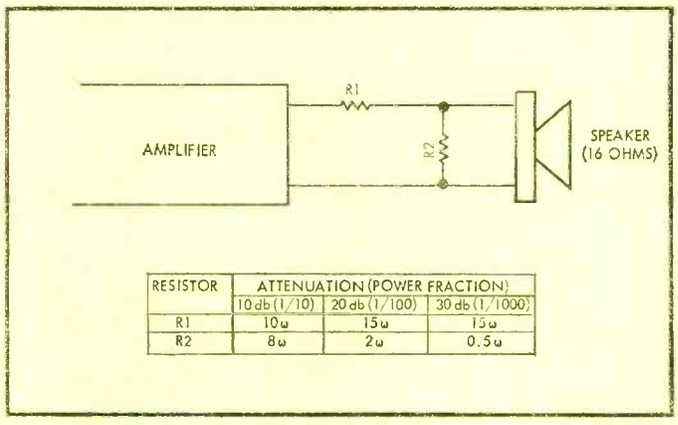
You may have an installation near a railroad spur, or an airport runway that gets only occasional use. You may find that so many speakers with, say a 25-watt amplifier, serve quite adequately when all is quiet. On the basis of the apparent sound level, you may feel that 50 watts should be sufficient even when the noise occurs. You'll probably be wrong. You may well need 10 times the power (250 watts) or a different speaker arrangement that will bring the sound closer to the audience, or both.

If you do use a sound-level meter, in addition to observing the reading at various points, you need to notice what kind of sound you are measuring. Program, or wanted sound, should over-ride unwanted or background sound by at least 10 db, and preferably by 20 db or more, for comfortable listening. But there are cases where a lesser apparent margin may be quite satisfactory, or where even more is needed.

For example, if the background noise consists mainly of low-frequency rumbling sounds, while the program is speech which needs to be heard intelligibly, the margin can be very much less. According to the meter, the program may not over-ride the background at all, yet still be quite intelligibly audible. On the other hand, if the noise happens to predominate in the region where the human ear is most sensitive, consisting of whistling or hissing sounds, then an even greater margin may be needed for comfortable listening.

The extremely subjective nature of this kind of judgement means that a noise meter is no infallible guide. A practical method is to use a small portable amplifier and speaker, fed from a portable tape recorder as a source of program material. This enables the actual program type for which the installation is intended to be duplicated—music, speech, or what-have-you.

Turn the level up so that a known wattage is delivered to the speaker. This can be judged by the point where distortion just begins to be noticeable. Then see how audible the sound is. Except in cases of extremely high background noise, you may want to limit the power to less than the full output of the amplifier. This you can do with a rough-and-ready attenuator, using wire-wound resistors (*Fig.* 2-1). If the background noise is too severe, the small speaker will scarcely be audible, even with full power, unless you get quite close to it. This is a good way to check effective background level or, what is more



RESISTOR	ATTENUATION (POWER FRACTION)		
	10 db (1/10)	20 db (1/100)	30 db (1/1000)
R1	10Ω	15Ω	15Ω
R2	8Ω	2Ω	0.5Ω

Fig. 2-1. Details of attenuators to use at amplifier outputs for estimating the power needs of an installation.

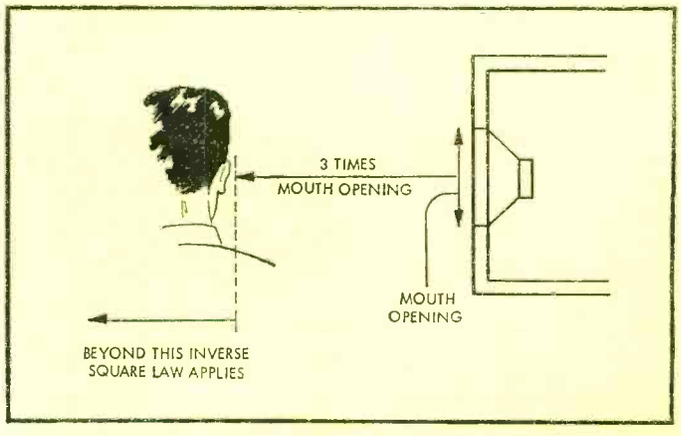


Fig. 2-2. Limit to the validity of the inverse square law.

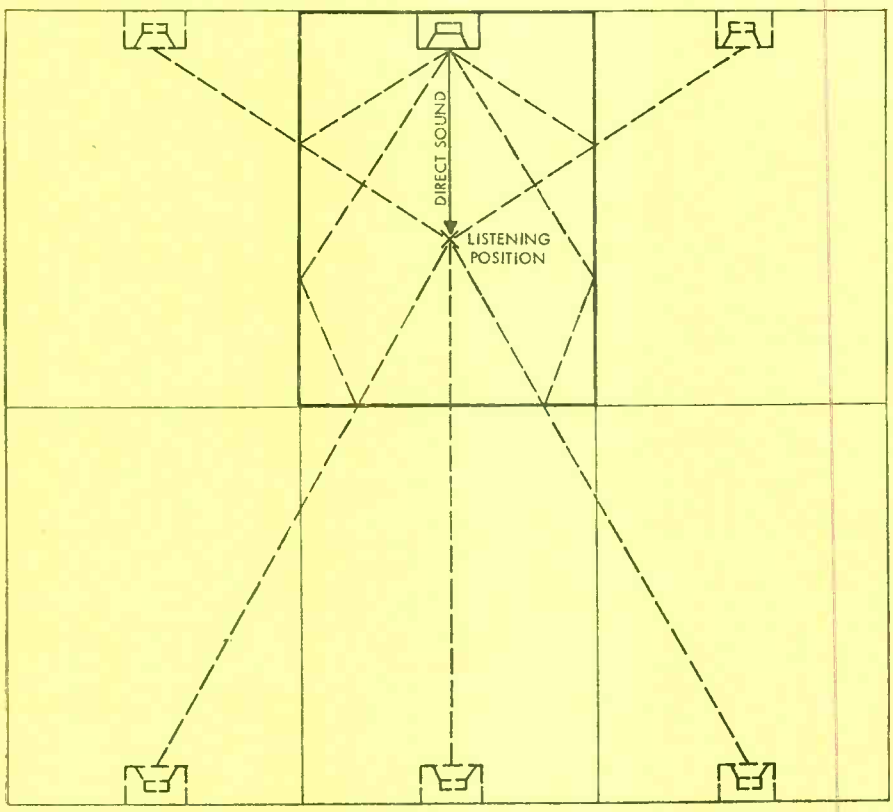


Fig. 2-3. Reverberation or echo can be understood or analyzed by regarding it as being due to image sources.

important to you, the level you have to provide in the installation to over-ride it.

Background noise usually fills a room with reasonable uniformity. But the sound from your speaker will follow the "inverse-square law" for intensity *versus* distance from the source, unless you are so close that the sound wave has not had space enough to develop (*Fig.* 2-2). This is how it works: suppose you find you need to get within 2 feet of the speaker to hear it comfortably and that the nearest practical mounting distance from the audience listening position is 10 feet; this is five times the distance, which will need five squared, or 25 times the sound power from the speaker.

If your speaker is attenuated down to work at ⅕ watt, you will need 5 watts per speaker. If the speaker was working at 5 watts in your improvised check, you will need 125 watts per speaker! Obviously, somehow, you need to get the speaker nearer to your audience in the latter case. If you can make it 6 feet—three times the measured distance—9 times the power will be 45 watts per speaker, which may be possible. If you use this kind of power, of course, you will need heavy duty units, of one kind or another. This inverse-square law is very important where relative level is a problem.

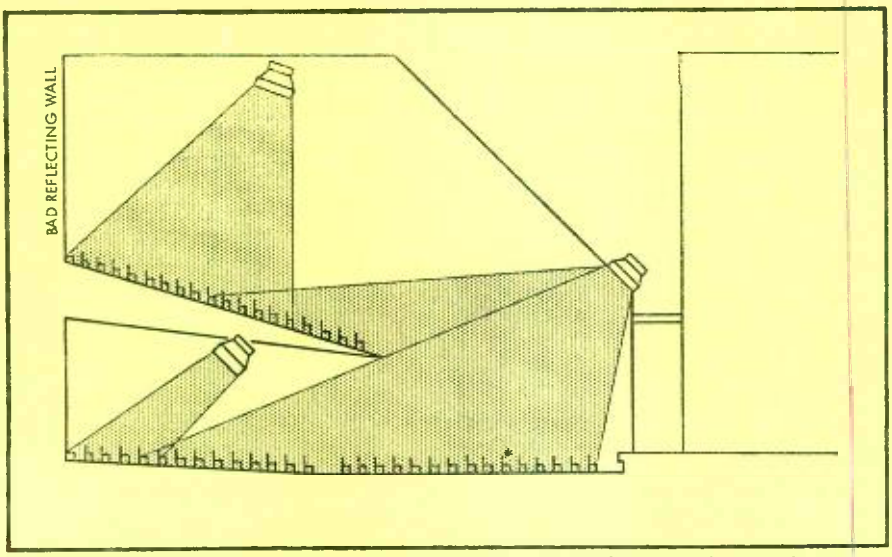


Fig. 2-4. Avoiding a major echo by the manner of directing the speakers.

Reverberation

Where background noise is not related to the "wanted" sound, the method is simply one of using however many units are needed, at whatever distance, to overcome background noise. Reverberant sound — echo — behaves very much like background noise, in interfering with listening to the direct sound, but its treatment is somewhat different. Background noise you can overcome by raising the level of wanted sound. Do this with reverberation and you aggravate the trouble.

Another way to look at this is to regard reverberation as the creation of so many "image" sources of sound (*Fig.* 2-3). Clarity of the program, against its own reverberation as background, depends on how much louder the direct sound is than its many reflections. As well as applying the inverse-square law, there is an absorption factor, which is what prevents the sound bouncing around forever. Usually, in buildings where reverberation is a problem, reflection is more than 50 per cent, so you can most easily regard the intensity of the images heard as being strictly on the basis of an inverse square of their effective distance.

Clearly, moving the speakers closer to the audience will make little difference to the apparent loudness of the reflected sounds, while increasing the direct sound in the inverse-square ratio. Ac-

tually, when you move them closer, you'll turn the level down, thus keeping the same direct-sound loudness, but reducing reverberation loudness.

Thus, if speakers are placed at half the distance, direct loudness will be the same if level is reduced to one fourth the power, reducing image reflections in the same proportion. You will need more speakers to cover the audience area, but a two-to-one change in speaker distance from audience, in a difficult hall, can achieve considerable improvement in effective performance, as well as saving total power needed. It may well make the difference between an impossible installation and one where there is no apparent problem.

Specific Echoes

Another method, used by acousticians years before sound equipment came into vogue, is to use a pair of wooden blocks as clappers, and listen to the sound "come back," or echo. A sharp sound such as this, produces an echo with quite directional qualities, so that you can hear reflections from various parts of the auditorium as separate entities. A particularly strong element in the echo will call attention to a hard reflecting surface that can give you trouble in an installation, if you don't do something to avoid "hitting" it.

In a theater, it may often be the back wall in the gallery section (*Fig.* 2-4) that gives such a

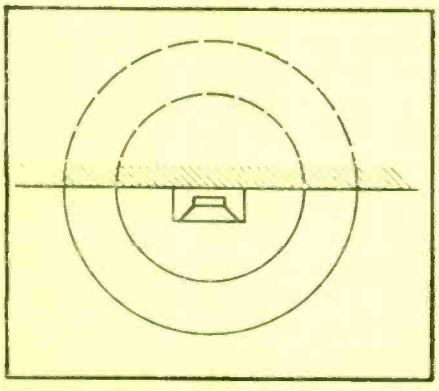


Fig. 2-5. Reinforcement obtained by placing a speaker with its back to the wall.

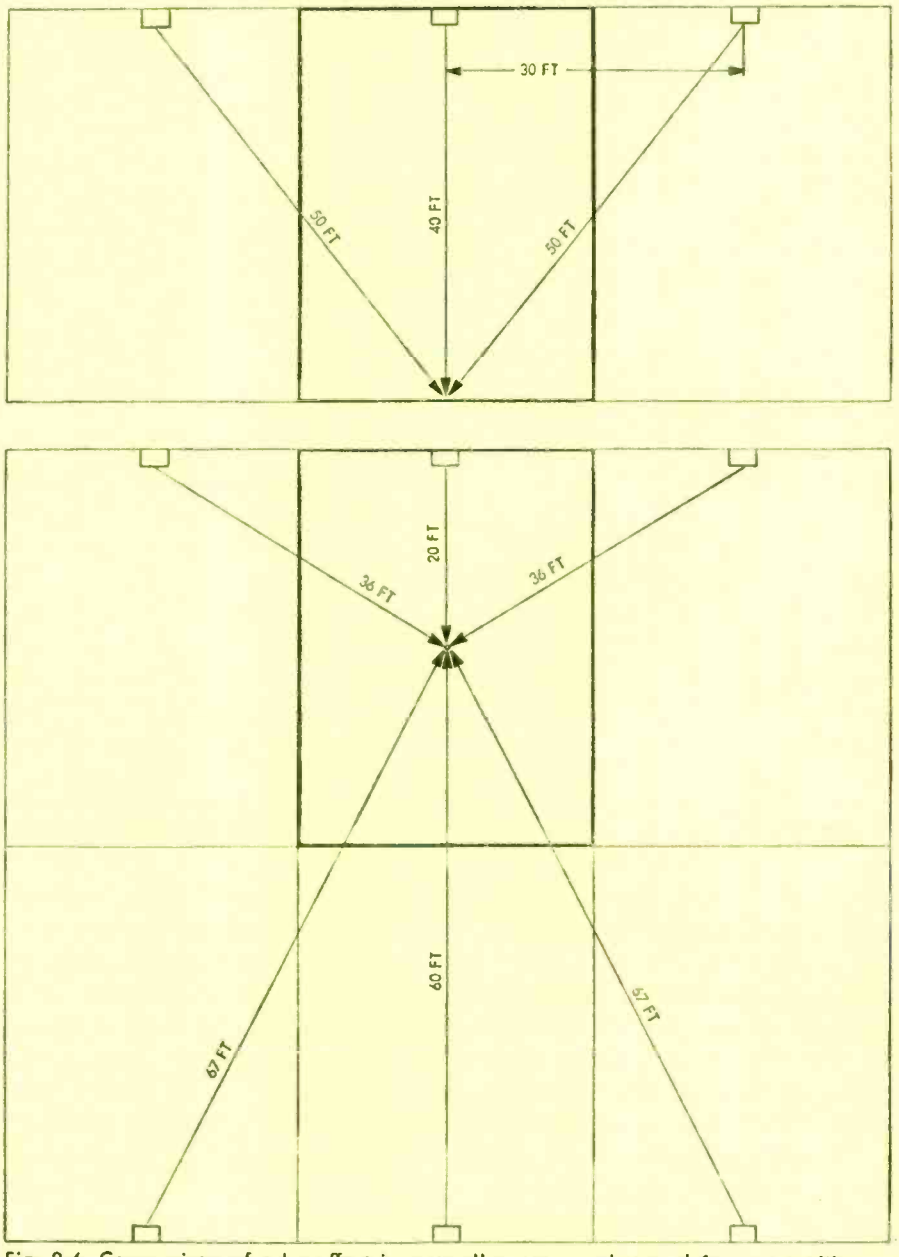


Fig. 2-6. Comparison of echo effect in a small room, as observed from a position at the back (top) or in the middle of the room (bottom).

reflection. In such a case, plan your installation so this section is not fed by speakers directing their sound toward the back wall. Use units over the proscenium, or even higher on the ceiling, so the sound is directed downward, toward the gallery seating area. Remember that human bodies represent the best sound absorption there is. The fortunate fact that you want sound to reach ears on these bodies can often help solve a difficult echo problem!

Sometimes echo can help rather than hinder sound reinforcement. This possibility should not be overlooked. If the time interval between direct and reflected sound is short enough, less than say a hundredth of a second (10 milliseconds), it will not confuse, but will seem to reinforce the original sound. This means that if the difference in path length is 10 feet or less, the reflection can be regarded as "adding" to the original sound.

A speaker mounted with its back flat to the wall, has the sound which normally would radiate from the back forced to come from the front (*Fig.* 2-5). Side walls can help, too, where the geometry is such that the difference between direct and re-

flected path is not more than 10 feet.

For example, in the rectangular room of *Fig.* 2-6, the direct path from front to back is 40 feet, while the reflected path is 50 feet. At the back of the room, the two side reflections will add to the apparent intensity of received sound. With 100 per cent reflection, the relative intensity of each reflected sound will be $(40/50)^2$ or 16/25 of the direct sound, making 32/25 for the two together. Unless the wall absorption is more than 20 per cent (less than 80 per cent reflection), the reflections will double the effective intensity at the back.

For a position nearer the middle of the room, this does not work so conveniently. The direct sound travels 20 feet, while side-wall reflections travel about 36 feet and the back-wall reflections travel 60 feet and more. The differences are 16 feet and 40 feet respectively. Following the inverse-square law, the side-wall reflections will have an intensity $(20/36)^2$ of the direct, totalling 60 per cent for the two together, which could result in a troublesome "double sound"—not separate enough to be identified as an echo. The back-wall reflection will be 1/9 the intensity of the direct, followed by two more, with only milliseconds time difference, adding up to about ¼ total—a level difference of 6 db, which represents a serious, but not necessarily impossible echo.

A speaker so placed in a predominantly reflecting room should be operated at low level, so that direct sound is considerably more audible than its echo. If background level is too high to allow this, another treatment must be sought. Better cover the walls with some absorbency, perhaps. The important thing to note is that quite a small room, such as this example, can give this kind of trouble, unless favorably handled.

Question—Chapter II

Now, as an exercise, can you think of a better arrangement, using not more than one extra speaker, for handling a reflecting small room, if it is not practical to change the wall surfacing? After giving this some thought, look at the answer on this page.

Answer—Chapter II

One answer to this is to use one speaker in each front corner. Incidentally this improves speaker efficiency, by getting both back-wall and side-wall reflection, with virtually no time difference. In the center of the room, at any distance from the front or back, both speakers augment one another at equal intensity (*Fig.* 2-7A). Toward the sides, listeners are nearer one speaker than the other, but this difference is not great enough to cause confusion at the back, while nearer the front, the ratio of distances is enough to prevent confusion.

For example, if a listener is 10 feet from the nearer speaker, at the same side, he is 32 feet from the other one: a ratio of more than 3:1, with 10-db level difference, and a difference of 22 feet. At the back, the ratio is 4:5, resulting in a level difference of only 2 db, but the distance difference is only 10 feet (*Fig.* 2-7b).

You will notice that this kind of arrangement tends to offset the inverse square law to some extent. Although people at the back get sound at reduced *direct* level compared with people at the front, they get more reinforcement from the other unit, or from reflections, than do people at the front. Before the next installment arrives, give some thought to whether it is possible to extend this idea, with the use of directional types of loudspeaker.

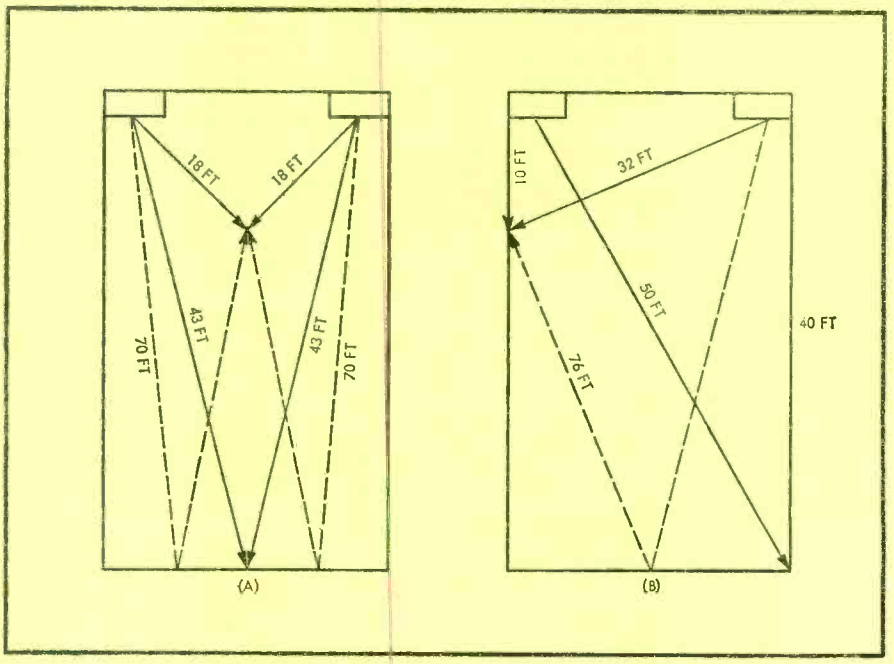
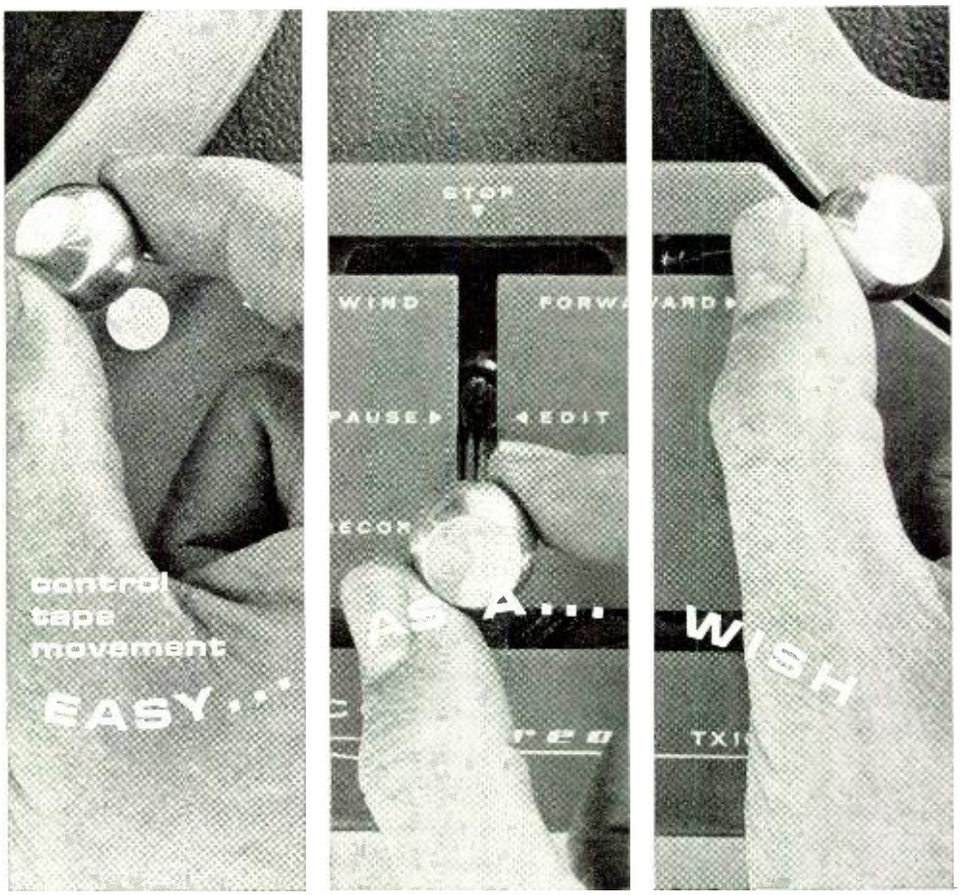


Fig. 2-7. Illustrating the remedy suggested.

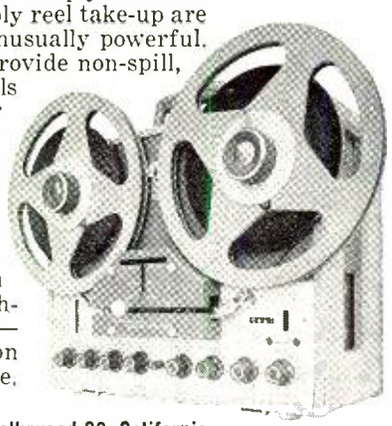


THE NEW NEWCOMB TX10 SERIES

STEREOPHONIC TAPE RECORDERS

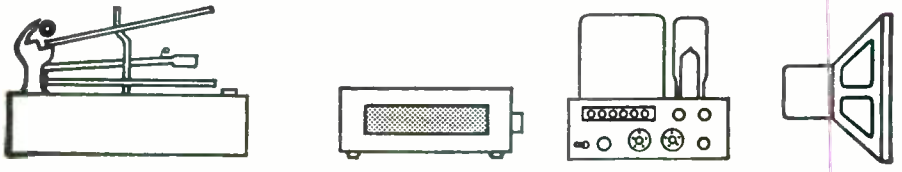
SOUND ON SOUND UNLIMITED / HYSTERESIS SYNCHRONOUS MOTOR/MONITOR FROM TAPE OR PRE-AMP/TAKES 10½" REELS

Designed for instant, intuitive reaction to your thought, the Newcomb TX10 integrates all tape motion control through a single, central joystick. But this is only the beginning. The TX10 is outstanding for its simple, straightforward, dependable operation; exceedingly gentle tape handling; quietness; coolness. Small as a suitcase in size, big as a studio in scope, the TX10 has separate mixing controls for each channel. There is a separate knob for "Mike" and a separate—not concentric—knob for "Line" for each channel. Two recording-level/playback-volume meters are arranged pointer-to-pointer in the same illuminated window for ready stereo comparison. Plug-in transformers instantly convert mike channels for use with low impedance microphones. The TX10 has three heads, no pressure pads on heads. Major tape guides are stainless steel. To load the machine, tape is simply held in a straight line and dropped in the slot; automatic shut-off and supply reel take-up are automatically re-set. The new hysteresis motor is cool, quiet, unusually powerful. Differential braking on both reels and a unique tape tensioner provide non-spill, no-stretch, ever-so-gentle stops even with fully loaded 10½" reels rewinding at the rate of 2400 feet in 90 seconds—18 miles per hour! A four-digit counter gives accurate location even with a full reel of triple-play tape. You can record sound on sound, back and forth as many times as you wish, either channel serving as master. All TX10 models are two-speed machines. The push-push speed selector automatically supplies proper speed-frequency correction. There are four models in the series. Standard are 3¾-7½ i.p.s. recorders with either two or four tracks. On special order you can get 7½-15 i.p.s., two or four track. Throughout, the Newcomb TX10 is the instrument for the perfectionist—dedicated professional or amateur enthusiast. For a description in depth write for your free copy of the new TX10 brochure.



NEWCOMB AUDIO PRODUCTS CO., Department T-5, 6824 Lexington Avenue, Hollywood 38, California

EQUIPMENT PROFILE



BELL "IMPERIAL" FM-STEREO RECEIVER, MODEL 1000

The Bell "Imperial" 1000 is an unusual and new concept in the component field; it combines separate components on a single chassis to make an integrated receiver. The basic chassis contains the power amplifier, preamplifier, control center, and tuning dial. The second chassis contains the guts of the FM-stereo tuner. The tuner chassis just plugs into the basic chassis, and *voilà* we have a receiver.

Thus one can purchase the amplifier without the tuner, and when economics permit, purchase the tuner. Also we can change either section for an improved model, when available. Thus we have the flexibility of components plus the togetherness of a receiver.

Description

The Bell Imperial 1000 encompasses a 40-watt per channel (IHF) solid-state stereo amplifier, a solid-state stereo preamp, and an almost completely solid-state FM-stereo tuner (the front end uses three Nuvistors).

On the front panel there are 10 controls and rotary switches, six slide switches, two stereo headphone jacks, and the tuning meter.

The controls include contour, volume, balance, function (FM Mono, FM Stereo, Tape, Aux, Phono 1—magnetic, Phono 2—ceramic, tuning, bass (left and right), treble (left and right), and muting.

The slide switches include meter (this switch has been changed on more recent models to local-distance), stereo filter, afc, high filter, low filter, monitor.

The meter on the model we received has a dual function; tuning and stereo signal indication. On more recent models this has been changed so that the meter is used only for tuning, and the presence of a stereo signal is shown by means of an illuminated sign. As a result of this change, the slide switch formerly used for meter function selection is now used to insert attenuation at the input to prevent strong local stations from overloading the tuner. In fact these changes have eliminated the primary criticisms we had of this unit: the inconvenience of having to switch the meter between the tuning and stereo-indication functions; and the tendency of the tuner to overload in the presence of strong signals.

The contour control is rather unusual for this type of instrument in that it is continuously variable. It is used in conjunction with the volume control to provide a contour which is relatively independent of variation in level between program sources. One need only set the volume control to a level just exceeding normal level (contour control in off position), then use contour control to bring the level down to the proper listening level. From then on one uses the contour control rather than the volume control. More precise than the usual contour switch method, but also more trouble. (As someone or other always says, "You pays for what you gets!")

Muting is also continuously variable and quite effective. We found it rather easy to mute interstation noise without introducing distortion (a common fault of muting systems).

A valuable feature of the Imperial 1000 is the easy accessibility of the circuit for servicing. For instance, the front panel folds forward baring the entire control section. If you have ever tried to troubleshoot some of those tight-quartered preamps you will cheer at the wide-open access to this front end. Also, since the tuner is on a separate, easily detachable chassis, it is really a snap to service. And with the tuner section removed from the main chassis, everything else has enough space around it to satisfy a Texan.

Tuning "feel" of the Bell Imperial 1000 is excellent; smooth but yet positive. Feels like power steering, the kind that still permits road feel to come through.

The over-all circuit includes 35 transistors, 19 diodes (15 are silicon), and 3 Nuvistors. The amplifier output stage is driven by a transformer and is stabilized by means of thermistors in the bias circuit of both output transistors. A feedback loop is provided from the output to the emitter of the driver transistor (which drives an emitter follower and in turn the phase splitter). The output stage is directly coupled to the speakers in the case of an 8–16 ohm unit. A 4-ohm resistor is in series with the 4-ohm speaker connector. Apparently this amplifier prefers a speaker with an impedance of 8 ohms. The power supply is quite stiff and uses a pair of 4000 μf capacitors for brute force filtering of the positive and negative supplies, and a pair of transistors to regulate the negative supply. A separate winding and rectifier provides 70 volts for the tuner.

The tuner circuit, although quite well conceived, provides no surprises. As we noted, Nuvistors are used in the critical front end (rf amplifier and converter) in order to prevent overload and provide a good crossmodulation index. We also noted that later models than the one we received incorporated an attenuator for strong signals which definitely was helpful. The tuning meter is of the zero-center type and indicates balance of the ratio detector. Afc is provided although it was not necessary to prevent drift..

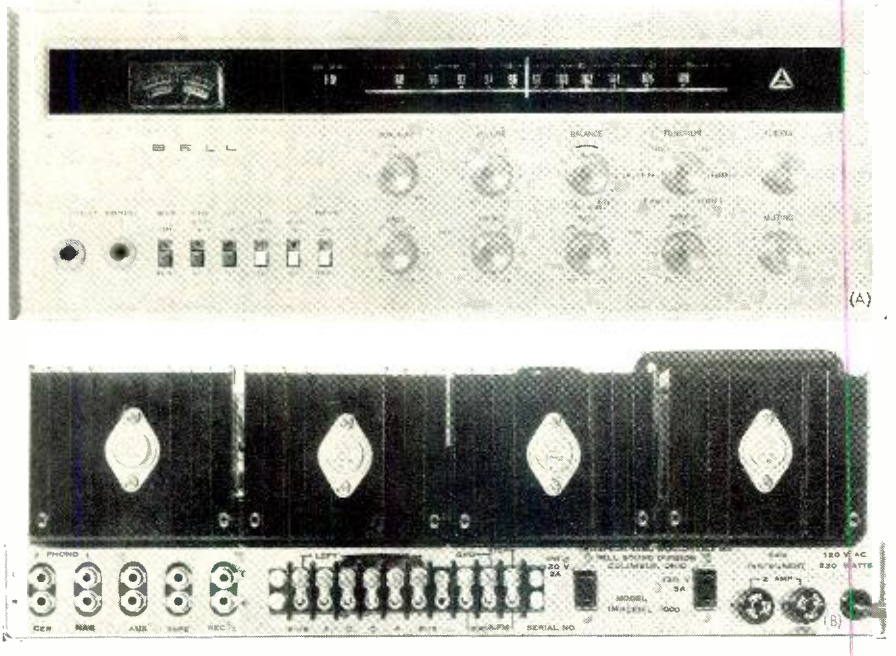


Fig. 1. Front view of the Bell Imperial 1000 Solid-State Stereo Receiver, (A); and back view, (B).

AR-2a loudspeakers in the background, a Maillol bronze in the foreground

Even a jazz band isn't loud enough to fill the sculpture garden of the Museum of Modern Art, where a series of concerts was given during the summer. An amplifying system was needed that would preserve the natural quality of the live instruments. Mechanical "public address" sound would not do.

AR and DYNAKIT at NEW YORK'S MUSEUM of MODERN ART

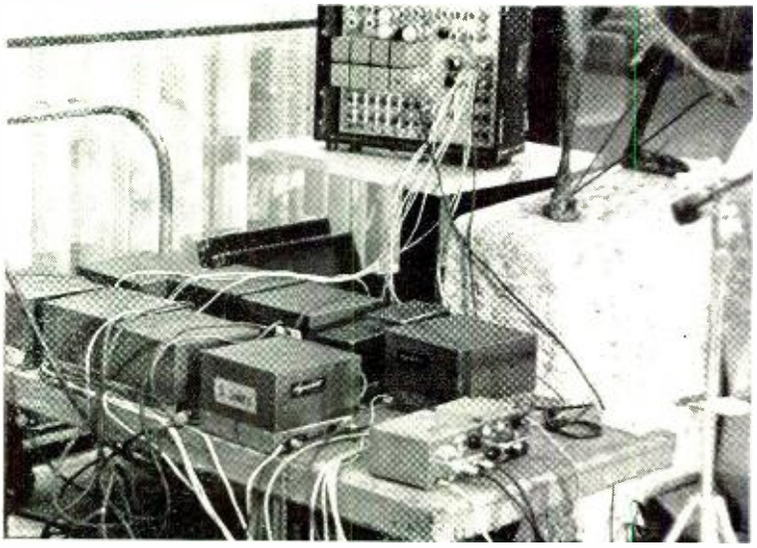
The audio components chosen for the job — eight Dynakit Mark III amplifiers and eight AR-2a loudspeakers — are often used professionally because of their high quality, but they are designed primarily for home high fidelity systems. They are in the low-medium price range.

The Gerry Mulligan quartet

Concert reviews don't usually include references to electronic equipment. A review in the New York Herald Tribune congratulated the Museum on its "superb new sound system."

AR SPEAKERS and DYNAKIT AMPLIFIERS may be heard together at AR Music Rooms, on the west balcony of Grand Central Terminal and at 52 Brattle Street in Cambridge, Massachusetts. No sales are made or initiated at these showrooms.

Literature is available on request from either of the two companies listed below.



480 watts of Dynakit power — eight Mark III amplifiers

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge 41, Massachusetts

DYNACO, INC., 3912 Powelton Avenue, Philadelphia 4, Pennsylvania

Photos by Jack Bradley

Statistics

Amplifier section: Power output was 25-watts per channel continuous with an 8-ohm load (although the amplifier is rated at 40-watts per channel IHF, we were cautioned that the output transistors would not withstand continuous 40-watt dissipation for extended periods of time so we did not try it—we thus will refer to 25-watts continuous as full power output); intermodulation distortion, 0.62 per cent, at full power, 60 and 7000 cps mixed 4 to 1; harmonic distortion at full power was less than 0.7 per cent from 20–15,000 cps; frequency response was within 3 db from 10–70,000 cps at full power; sensitivity was 170 mv at the ceramic phono input, 1.65 mv at the magnetic phono input, and 0.20 volts at both the auxiliary and tape monitor inputs; noise was 77-db below full power at the auxiliary input.

Tuner section: Crossmodulation index was 78 db; selectivity 34 db; capture ratio, 2 db; pulse-noise rejection was excellent; sensitivity, 1.7 μv IHF; stereo separation better than 31 db from 20–15,000 cps. On our standard antenna it pulled in 37 stations loud and clear.

Altogether, the Bell Imperial 1000 is an excellent tuner-amplifier combination with features and performance which place it in the Cadillac category. Cadillac lovers take heed. **E-21**

THORENS "MASTERPIECE" AUTOMATIC TURNTABLE, MODEL 224

In recent years we have come to know the term automatic turntable in connection with a breed of record changers whose individual parts are of turntable and separate tonearm quality, more or less. Still they suffer from the necessity of accommodating a stack of records so that the arm is set to track best at some compromise height, say four records worth. Although the amount of distortion introduced by this is relatively unimportant when balanced against the convenience, it is sufficient to eliminate this breed from the system of the purist who would not trade convenience for distortion.

Well, the purist can have both now!

The Thorens TD-224 is a TD-124 turntable combined with a BTD-12S tonearm, and a record changing mechanism which handles records like royalty. The records are piled up *beside* the turntable, not on it, and there is only one record on the table at a time.

Here's how it works: When you press the operating lever to the Reset-Start position, the transport lever raises, moves over the unplayed record stack (there are two stacks on the storage arm, the unplayed upper stack and the played lower stack), picks up the top record by the center hole, brings it over the turntable and lowers it slightly, the tonearm swings over and feels the diameter of the record, the transport arm then lowers the record onto the spindle, and the tonearm swings over and lowers the pickup into the lead-in grooves. After the record is played, the tonearm moves out of the way, the transport arm (which has been hovering over the record) descends and picks up the record, lifts it up, brings it to the played pile, drops it, then goes to the unplayed pile and picks up the next record, if there is one, and brings it to the turntable as before. If there is no record on the pile, the transport arm continues through its cycle, but the tonearm initiates the "cut off" because it doesn't "feel" a record. Everything is turned off.

The transport arm lifts the record by means of a hollow and split spindle which is compressed to slip into the center hole and expands to grab it, the lip along its bottom edge preventing the record from slipping off. 45's or any large center-hole record is handled similarly. A pop-up spindle is provided for large-holed records.

Power to drive the transport arm, as well as the tonearm, is derived from the 16⅔-rpm shoulder of the four-stepped speed-change pulley of the turntable. Naturally, since this power is used only during record changes, it does not interfere with normal operation of the table. In fact, although there is a certain additional amount of mechanism, the turntable and tonearm are entirely free of encumbrances while a record is being played.

One of the things to marvel at in this unit is the superb precision. For example the transport arm moves up and down and swings in bearing race with 48 precision ball bearings separating the vertical shaft of the arm from a steel outer tube. The outer tube is fixed but both the arm shaft (about 5-in. long and ¾-in. dia.) and the ball bearing sleeve move. The absolute precision of these parts must be seen to be believed.

We have reported before on both the TD-124 and the BTD-12S so that all we need say now is that they are both still amongst the finest available. And rugged too.

In conjunction with the precision changing mechanism provided, we truly have the best of both worlds. Thus we can say unequivocally, that the Thorens TD-224 provides both the convenience of an automatic record changer and the uncompromised performance of a first-line turntable and arm.

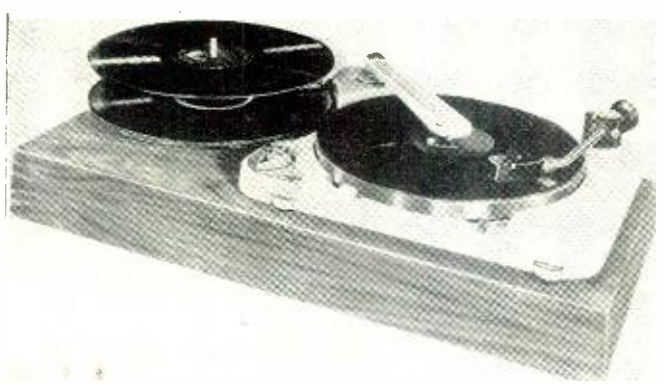


Fig. 2. Thorens "Masterpiece" Automatic Turntable, Model TD-224.

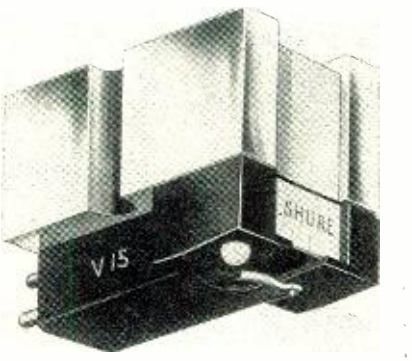


Fig. 3. Shure Stereo Cartridge, Model V-15.

Of course a precision mechanism like this is not inexpensive ($250), but that's to be expected of a "Masterpiece." **E-22**

SHURE STEREO CARTRIDGE, MODEL V-15

The Shure V-15 is a 15-deg. cartridge which incorporates an elliptical stylus. These measures were incorporated in order to reduce tracking and tracing distortion respectively.

Before discussing the cartridge, we would like to take special note of the truly handsome case; it is crafted of solid walnut and would add elegance to almost any home as a cigarette box or jewel case. A handsome gift for the wife to divert her attention from the fact that you have just bought another cartridge.

In truth though, the Shure V-15 is not just another cartridge. In our estimation it is a distinct step forward towards the true goal of high fidelity: perfect, undistorted reproduction of program material. Our listening group was unanimously enthusiastic.

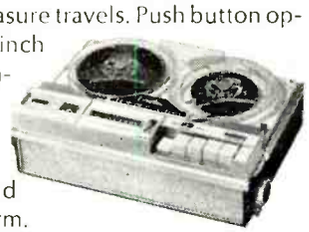
Although the statistics for this cartridge are properly impressive, they are not sufficiently different from measurements registered by other good cartridges to explain the significant sound qualities. Our guess would be the elliptical tip and unusually careful manufacturing techniques.

(For those who like numbers, the V-15 performed as follows: frequency response, 20–20,000 cps, within 2 db; stereo separation was 28 db at 1000 cps; compliance 23×10^{-6} cm/dyne; it could track well at ¾ gram but all tests were conducted at 1 gram; distortion was below 2.8 per cent; and it handled recorded square waves very well.)

Unfortunately we ran out of space this month, but we must repeat that the Shure V-15 was enthusiastically acclaimed by our listening panel. It is a great cartridge. **E-23**

All you have to do is relax. Enjoy the continuous music programming. Let the Caravelle do the work automatically. Only the Caravelle lets you record or play four-track stereo tape in both directions without reel turnover. Reverse-o-matic® and *six* heads record or play the tape back and forth endlessly. Sound complicated? It's not. All you have to do is push one button. Concertone's Caravelle is unique in the tape recorder field. That's why we say it's incomparable. It has more exclusive features than any other recorder. Caravelle's performance can't be matched. And for price there's no better bargain. It costs less than $399. It costs less than $399. It costs less than $399. It costs less. For details about Caravelle and your dealer's name, write Concertone, Box 3162, South El Monte, California.

THE COSMOPOLITAN 400—For people on the go... a combination tape recorder with AM radio. Light weight and compact size make it a versatile companion for business and pleasure travels. Push button operation. Five inch reels. All transistorized. Big recorder features in a ten pound miniature form.



CONCERTONE

Tape Recorders and the Copyright Law

ERIC DARMSTAEDTER*

The Copyright Law is similar to the late unlamented Prohibition Law in that most tape recorder owners ignore it and transgress it frequently. Also it is impossible to police. All the ingredients of a bad law.

THE purpose of this article is to try to shed some light on this complicated legal matter called the Copyright Law and to bring out the viewpoint of some parties involved who are affected by this law.

Law

The basic law which governs the controversy is the Copyright Act of 1909. A prominent lawyer, Mr. Stanley Rothenberg, expresses his interpretation of the law as follows:

"The Copyright Act confers upon the proprietors of copyrighted music control over mechanical reproduction (e.g. tape recordings) of their copyrights. Until the proprietor records or licenses recordings of a copyrighted composition he has the unqualified right to prohibit any recordings thereof. "After the proprietor records or licenses recordings he is subject to the 'compulsory license' clause of the Copyright Act which enables anyone else to record for a statutory fee of 2¢ per composition (multiplied by the numbers of recordings). The fee was established in 1909 with 'popular' compositions in mind. Although the clause has remained intact the recording industry generally does not exercise the license with respect to 'serious' music, rather it negotiates on each item as in the case of other copyrighted works.

"The Act does not except from its coverage 'private' or 'home' recordings. Therefore, *such recordings are unauthorized.* On the other hand, the particular infringers are not known to the proprietor. However, if a radio station should invite listeners to record on tape, the proprietor does know that unauthorized recordings are most probably being made and he knows who is contributing directly. Thus the proprietor may go after the contributory infringer. In the absence of knowledge as to actual unauthorized recordings, damages might be unavailable. However, the proprietor would probably be entitled to an injunction against such future acts. After a few incidents, a proprietor of many copyrights may be entitled to a blanket injunction against use of his catalog. Even if the number of actual unauthorized recordings are unknown, a judge may think it is within his discretion to estimate the number and award damages on that basis. The damages could amount to 8¢ per composition multiplied by the number of estimated recordings.

"Apart from the question of infringement of copyright, which could be circumvented by using musical compositions which are in the public domain, there is the problem of misappropriation of the property of performers and record companies. An unauthorized recording falls squarely into this tort—whether it is labeled unfair competition, invasion of rights of publicity or privacy or simply common law misappropriation of property."

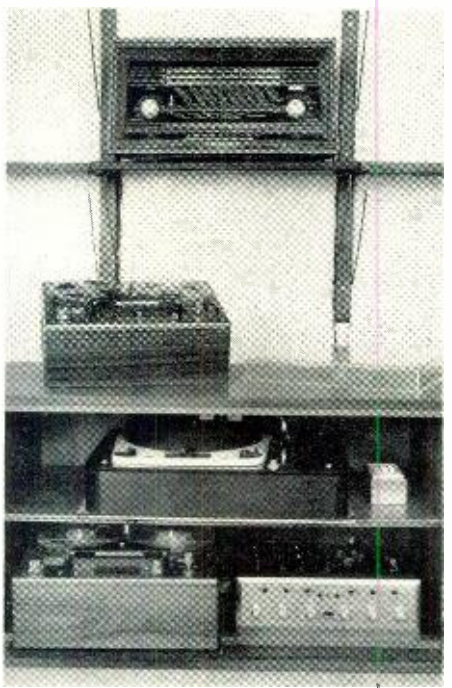


Fig. 1. A typical audio setup with a variety of facilities for copyright violation. Equipment consists of Tandberg Huldra AM-FM tuner, Thorens TD-124 turntable with Ortofon arm and pickup, Tandberg Model 64 and 74 tape recorders and H. H. Scott Model 299B amplifier.

What is a copyright? A copyright is a legal grant of specific privileges for a period of 28 years and is renewable for a second period of 28 years. The copyright protects the creator against copying without the consent of the copyright owner.

The existing copyright law was passed in 1909 and although changed by statute, nevertheless it remains substantially the same. A great many of the copyright problems of today are caused by this fact, namely, the law has not been seriously modified since 1909 in order to keep up with changing times.

Copyrights protect the "writings" of an author. The copyright law lists classes of copyrightable works, for example, Class "C" covers lectures; Class "D" covers a dramatic composition; Class "E" covers a musical composition and Class "F" covers maps, and so on. A recorded musical performance, as distinguished from a writing of a song, does not come within the scope of the present copyright law.

There can be no copyright or exclusivity when the writing is in the public domain, that is when the copyrights have expired, or when the copyright statute has not been complied with, or when the writing does not contain sufficient original material.

A sound recording is not subject to protection under the copyright law; however, judges have protected the sound recording on the theory of "unfair competition."

That is, that it would be unfair to the one who made the recording to let another copy it without expense, and so on.

Copyright consists of four primary rights:

1. Publishing rights
2. Adaptation rights
3. Performing rights
4. Recording rights

(*Continued on page 69*)

* *President, Tandberg of America, 8 Third Ave., Pelham, N. Y.*

INTRODUCING THE WORLD'S NEWEST MICROPHONES... GUARANTEED FOR FIVE YEARS!

ALL NEW DESIGN...ALL NEW PERFORMANCE—Today... from the laboratories of University...an advanced technology has produced a great new breed of microphones for broadcasting, TV, professional and home recording, P.A., ham and CB applications. Each one represents a clean and dramatic break with tradition...with outmoded notions. Each one is far superior to any other microphone in its class. Let other microphone manufacturers offer the usual two to three-year warranty. Every University microphone—whether designed for the professional studio or the home recordist —is sold with a five-year warranty. For complete specifications, write: Desk R-5, LTV/University, 9500 West Reno, Oklahoma City, Oklahoma.

EXAMPLES OF THIS GREAT NEW LINE!

MODEL 8000—A high performance dynamic cardioid for only $29.95 net! Response: 70-13,000 cps. Sensitivity: −156 db (EIA). Output Level: −59 db/1mw/10 dynes/cm². Includes 15 ft. cable with Cannon plug and receptacle, and desk stand adaptor.

MODEL 2040—VOICE REALISM AT ITS BEST! New omnidirectional dynamic microphone that has astounded hams in initial trials! Modulation free of the harshness and muddy effect common to most microphones in this class. Ideal for upgrading P.A. and home tape recording performance as well.

MODEL 1000—CARDIOID DYNAMIC. Unique directional characteristics provide unexcelled discrimination against unwanted sounds—assure superior results even in noisy or reverberant locations. Internally shock-mounted—sensitive elements float, vibration-free, on polystyrene ribs! For any application requiring a truly discrete sound source.

LTV UNIVERSITY

A DIVISION OF LING-TEMCO-VOUGHT, INC.

U-47

HERMAN BURSTEIN

(Note: To facilitate a prompt reply, please enclose a stamped, self-addressed envelope with your question.)

Herman Burstein
280 Twin Lake E., Wantagh, N. Y.

Stationary Guides and Flutter

*Q. I have built a tape deck from surplus parts and it is identical to what is shown in the **** manual with the exception of the right and left tension arms and rollers, which were not available. I am using stationary tape guides, and the results seem generally good except that some flutter shows up at times. Voltages on the takeup and supply motors are correct. Am I expecting too much in trying to get by with stationary guides?*

A. The tension arms play an important role in minimizing wow and flutter. Perhaps you can purchase these parts directly from the company in question.

Home-Built Flutter Bridge?

Q. To measure wow and flutter of my tape machine, I wish to build a flutter bridge and have looked for the schematic of one in books and magazines, but with no success. Is such a bridge within the scope of an experienced "elektroniker"? Could you recommend the source of a schematic or construction article?

A. I have checked several sources, but can't readily come up with a reference to a flutter bridge that you can build. However, one knowledgeable party states that he has found a fairly good correlation between the results obtained on a flutter bridge and those obtained on an IM analyzer (such as the Heath) when testing turntables. He has noticed that readings on the IM analyzer tend to run about three times that on a bridge. For your purposes, it may be satisfactory to have relative rather than absolute flutter readings.

Testing Tape Recorders

Q. Can you briefly describe your basic approach to testing tape recorders? I am interested in knowing what test equipment you use and what procedures you follow in making these tests.

A. I use the following equipment in checking tape recorders: Heath audio oscillator, Heath harmonic distortion meter, Heath audio analyzer (which includes a sensitive a.c. VTVM and an IM meter), EICO VTVM, EICO oscilloscope, monitoring amplifier and speaker, test tapes, bulk eraser, high quality tape (such as Audio or Scotch), tape stroboscope, and an assortment of cables. Tests are as follows:

1. *Playback frequency response at 7.5 ips.* Ampex test tape 31321-01 is played back into the oscilloscope, monitor speaker, and VTVM. Readings are taken from the VTVM, and monitored by speaker and oscilloscope.

2. *Record-playback response at all machine speeds.* At a recording level at least 20-db below that which produces 3 per cent harmonic distortion on the tape, the same frequencies as on the Ampex test tape are recorded: 50, 100, 250, 700, 1000, 2500, 5000, 7500, 10,000, 12,000, and 15,000 cps; also 30 cps and, if tape speed permits, 20,000 cycles. The tape is played back and checked in the manner of Item 1 above.

3. *Distortion at maximum indication of the record-level indicator.* A 400-cps tone is recorded at a level that causes the record-level indicator to reach the maximum permissible point—eye closure in the case of a magic eye tube or 0-VU in the case of a VU meter. The tape is played back and distortion is measured with the harmonic distortion meter. (It is widely accepted that in a highly fidelity home machine, eye closure should correspond to 3 per cent harmonic distortion; and the 0-VU reading should correspond to 1 per cent harmonic distortion, allowing about 6-db margin for the mechanical lag of the pointer on transients, so that harmonic distortion reaches 3 per cent at a recording level about 6-db above 0-VU.)

4. *Signal to noise ratio.*
   a. *Record-playback.* A 400-cps tone is recorded at the 3 per cent harmonic distortion level, and the playback signal is measured. The same tape is again put through the recording process, but with input shorted. This tape is played back, and the signal—containing noise produced by the record and playback amplifiers and by the bias oscillator, plus signal due to inadequate erasure—is measured. The ratio between the first and second measurements is the signal-to-noise ratio.
   b. *Playback.* This ratio has significance with respect to playback of prerecorded tapes, where noise developed in recording and inadequate erasure should not be counted against the machine. A 400-cps tone is recorded at the 3 per cent harmonic distortion level, and the playback signal is measured. (If the tape machine is a playback-only unit, the tape is recorded on another machine.) The tape is bulk erased, played back, and the playback noise is measured. The ratio between the first and second measurement is the signal-to-noise ratio.

5. *Wow and flutter.* This test can be performed by ear, based on recording and playback of a 3000-cps tone. The steadiness and purity of the reproduced tone are compared with that of a high-quality reference tape machine. Of course to obtain "numbers" you would use a flutter meter and a test tape with known flutter content.

6. *Speed accuracy.* This is measured at 7.5 ips, using Dubbings D-110 test tape, which contains three timing beeps covering two 5-minute intervals. A tape stroboscope is also used for confirmation.

7. *Crosstalk.* Program material is recorded on one channel at maximum permissible recording level as shown by the record-level indicator. The other channel is played back, and the results are judged by ear. Single tones of 50, 400, and 1000 cps are recorded on one channel. Playback is measured on the recorded channel and on the unrecorded channel. The ratio between the two measurements is the crosstalk ratio for each tone.

8. *Construction.* The mechanism, electronic circuitry, and schematic are studied to gain an impression of the quality of design, components, and assembly.

9. *Operation.* The machine is put through all its mechanical and electrical modes of operation to ascertain how rapidly, deftly, and gently it handles tape; and how flexible it is in terms of tape speeds, mixing of inputs, mixing of outputs, special effects (such as sound on sound), and so on.

Shielding against RF

Q. Whenever I play a tape or whenever I am monitoring a tape from the playback amplifier while recording, I get a concurrent noise at regular intervals from a nearby military installation. When I monitor the input to the recorder, however, I get no such noise, indicating that I am picking up the noise through the tape transport. The heads have a mumetal shield around them, so I believe that the wiring in the tape transport is picking up this noise. The thing that confuses me is that the noise seems to come more from the left amplifier, which is closest to the tape transport, than from the right amplifier. From previous experience I believe this noise to be from a pulsed r.f. emitter. My problem is how to shield out this noise with moderate expense.

A. You may be able to eliminate the noise pickup by inserting a 10,000-ohm resistor between the lead of the playback head and the grid of the first playback tube. You might also try putting a 5 picofarad capacitor between the grid and ground.

Test Tapes

Q. Where can I get a list of test tapes and their purposes, and where can I order these?

A. Query Ampex (Redwood City, California), RCA (Custom Records Division, 155 E. 24th St., New York City), electronic mail order houses (such as Allied Radio, 100 N. Western Ave., Chicago, Illinois; and Lafayette Radio, 111 Jericho Turnpike, Syosset, L. I., N. Y.).

Replacing ½-Track with ¼-Track Heads

Q. I have a tape deck with half-track stereo heads. The machine has given me what I consider good service, but now the heads are worn and need to be replaced. Do you think that it would be a good idea to have quarter-track heads, or should I expect a loss in quality?

A. Assuming that you use first-rate heads together with first-rate record and playback tape amplifiers, quarter-track heads can give you excellent recording and playback quality. If you play prerecorded tapes, this is all the more reason for going to quarter-track heads inasmuch as most such tapes are made on a quarter-track basis.

collector's item

The Concord 884 transistorized stereo tape recorder is designed for the connoisseur of sound, the collector with tastes and demands above the ordinary. No other recorder, regardless of cost, has all the Concord 884 professional quality features.

Three separate heads—one record, one playback and one erase—assure professional quality reproduction from FM multiplexing, stereo records and live performances. Four completely separate preamps—two record and two playback—and full transistorization assure maximum reliability. A flip of the AB monitor switch lets you compare source vs. tape while recording.

A few of the other features are: built-in sound-on-sound switch for effects such as electronic echo chamber; stereo headphones output; automatic reel-end shutoff; 3 speeds; 2 lighted VU meters. All push-button operation; 15 watt stereo power amplifier and separate 7" full range speakers complete your 884 stereo system. Model 884 under $450.* Other models from $100.*

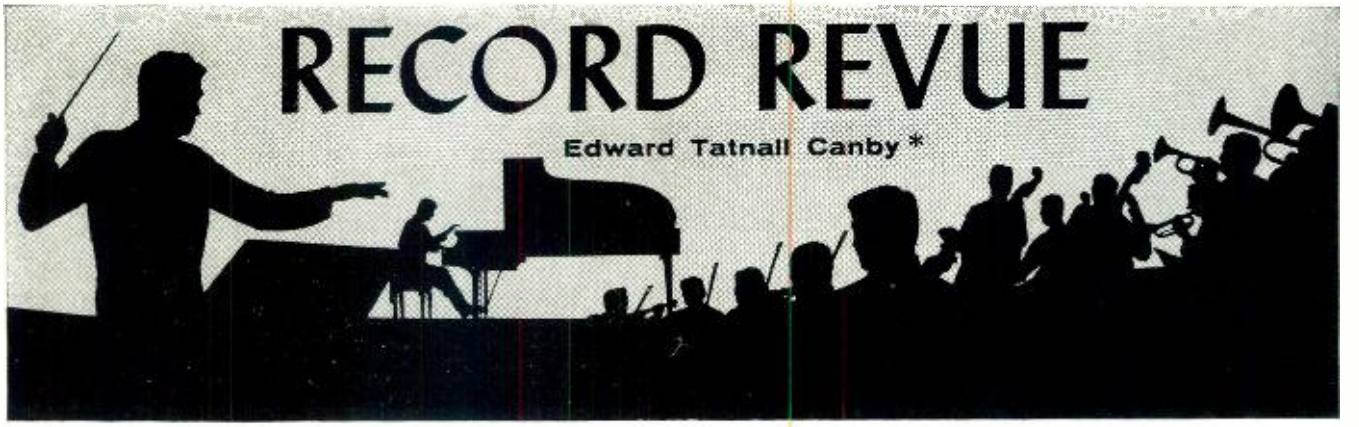
*Prices slightly higher in Canada

For Connoisseurs Of Sound

CONCORD 884

CONCORD ELECTRONICS CORPORATION 809 N. Cahuenga Blvd., Dept. L, Los Angeles 38, Calif. / In Canada / Regal Industries Ltd., Montreal-Toronto

THE SIGNATURE OF QUALITY ■ *Tape Recorders/Industrial Sound Equipment/Dictation Systems/Communications Devices/Closed Circuit Television*



THE ORGAN BOOM

Bach Recital (Preludes, Fantasia, Fugues). Albert Schweitzer, organ at All Hallows, Barking-by-the-Tower. (Recorded 1935)
Angel COLH 89 mono

This comes from one of two 78 albums recorded in the mid-thirties by the great doctor and Bach authority. The other was of chorale preludes and when I bought the two big albums, real prizes, I preferred the chorale prelude collection. But the preludes and fugues played here, were magnificent, all the same, and the great G Minor Fantasia and Fugue performance was my introduction to that tremendous work.

The music was recorded in the days when Bach organ records were extremely scarce and the present revival of the Baroque organ of Bach's day, both in restored old instruments and in countless brand new ones, had hardly begun. Schweitzer, too, is of another generation, brought up to play Bach on huge Romantic organs; he was a pioneer in today's authentic style of playing, minus swell boxes, with steady, bright colors, but his thousands of students now make him sound slightly old fashioned where once he was revolutionary.

The British organ with the lovely name, All Hallows, Barking-by-the-Tower, was barked out of existence by the Nazis during the last war. It was for its time a good Bach organ, out in the open, clearly speaking and with a fine independent pedal. The church was surprisingly dead in acoustics and so the organ generates a very short reverberation time, which allows for clarity in the sound and probably prompted Schweitzer's rather rapid moving-on from one section of the music to the next, where we usually expect longer pauses.

Like Artur Schnabel, Schweitzer was a finer musician than keyboard man; there are some clumsy spots and a few outright slips here (no tape editing to fix them up) and an academic organist would probably frown, if he hasn't already. But the spirit is grand, the understanding profound, the music dignified and noble. The preludes and fugues require a generally fixed registration (tone color and volume choice) and so not much is lost here by the lack of highs in the old recording, though the sound is inevitably a bit dull and somewhat grainy by modern standards.

I'm hoping the other Schweitzer album comes through too. The quiet, wonderfully colored chorale preludes (based on hymn tunes) were done in a profoundly moving fashion by Schweitzer, in contrast to many a flashy "Baroque" playing by more superficial musicians of today.

Bach: Chorale Preludes. Edouard Commette, Great organ of the Cathedral Saint-Jean de Lyon, France.
Angel 36119 stereo

Edouard Commette took over this organ in the year 1904; he has played it for sixty years. The organ itself is purest French, out of the 19th century in spite of some revisions —too early for the Baroque revival. It is wholly, completely non-Baroque, a splendid example of the extreme opposite kind. So is Edouard Commette as an organist. Yet I found this Bach record extremely beautiful.

One must remember that fine musicians live in every age. One must keep always in mind that a really alive musician can make fine music even on the "wrong" instrument and in the "wrong" style. Bach, after all, has been (perhaps unwisely) called the universal composer. Well, if Bach sounds good on the alien piano when played with understanding, he sounds even better on the anti-Baroque French organ!

Commette is of Schweitzer's generation and plays somewhat in his manner, without the Schweitzer revolutions of that early day—a smaller, more Bach-like organ, for instance. Commette plays somewhat slowly, with beautiful phrasing and a good deal of *rubato* (uneven rhythms)—anathema to young organists. His registrations all sound enormous, all are of about the same dun color on the huge organ, but they are skillful (after sixty years!) and not a note of the music is lost in the blur. No matter that the big pedal stops sound vaguely like fog horns, the colors in the upper works are dim and brownish, so to speak, weathered all alike. The music still comes through, and with humanity. It is a sobering record, this (and Schweitzer's too) for all who think that the newest style is always the best. More authentic—yes. But maybe not always more musical.

Romantic Organ Music. Carl Weinrich, organ of Symphony Hall, Boston.
RCA Victor LSC 2698 stereo

A number of points to be made here, including one concerning acoustical mud.

First—wherever you go these days you find a new Aeolian Skinner organ. This is one of their new-type mammoths (others make 'em too) combining the old-fashioned lion-roar kind of an organ with elements of the revived Baroque instrument so that all the organ literature can be played—with some compromise, in one way or another, of course. (Baroque organists don't approve of this idea at all.)

So here's Symphony Hall's mammoth in the big-time music of the 19th century, à la Weinrich. The chestnutty "Pièce Héroique" of Franck has worn me down to the point of nonjudgment; he wasn't a ranter and roarer by nature and that's what this one tries to do. Then there are two Bach-style works ("after" Bach) by Mendelssohn and Brahms, the M. sounding his usual slightly softened, rather too cloying self, the B. a typically dark-brown textured fugue, reserved and quiet.

But—Point Two—the big piece here is the Liszt Variations on "Weinen, Klagen, Sorgen, Zagen," a passacaglia-fantasia work of extreme chromaticism that to my ears is far ahead of Wagner himself in approaching the musical language of the early 20th century. Of course it has its high drama, its long, pregnant pauses (so hard to record), its moments of Romantic fury. That's Liszt, in his time. But the sheer inner tension generated by the extraordinary harmonies Liszt manages to tie to the basic key of F minor grows greater with each hearing; the sudden, bland entry of the hymn at the end is an astonishing effect, after so much chromatic torture. It's a great piece and will grow greater as Liszt comes back into fashion.

Third, a note about mud. Dynagroove had a tough time with this piece. What mainly seems to happen is that during the pregnant pauses, the near-whispered stretches, RCA's fine mechanism (or something) brings up the background noise more noticeably than the music itself. We become aware of a gradual increase

(*Continued on page 67*)

STEREO—1956–1964

R. Strauss: Death and Transfiguration; Till Eulenspiegel. Vienna Philharmonic, Reiner.
RCA Victrola VICS 1004 stereo

R. Strauss: Also Sprach Zarathustra. Phila. Orch., Ormandy.
Columbia MS 6547 stereo

Interesting comparison, first-line new Columbia stereo with second-line RCA stereo (first-grade performance). The RCA job dates from the very beginning of modern stereo and first appeared on two-track stereo tapes 'way back in May of 1957. (In case you're interested, the cost of the two works, in two boxes, was $17.90 plus tax.) The recording was done in September of 1956 and the new Victrola low-price disc even re-uses some of the liner notes from the old tapes. I have them before me.

Well, tape was a great invention! On close comparison, I found the Columbia disc only a bit cleaner and sharper, a small trace less grainy in the louder parts. Not by much. Either disc is up to normal standards for a modern recording. The old RCA tapes had real built-in quality. But there is, however, an interesting difference in the stereo.

Though both are recorded in a good concert hall liveness, the Columbia sound is larger and more reverberant, according to newer styles of thinking. And I noticed at once that there was a much more positive stereo effect, more consciously arranged. I tried shifting between mono and stereo playback; decidedly less difference in the RCA recording.

This, I think, reflects no more than the differing techniques used in the miking of 1956 and today. The RCA stereo in 1956 was simpler, probably done in the earlier over-all manner (still basically the European approach), using perhaps only two mikes. The Columbia of today reflects the newer multi-miked, multi-mixed, three-tracked American style, for pointed-up stereo sound. (RCA's newest U. S. stereo is very different too, featuring a lot of pin-point separation, close-up and a diminution of hall reverb.)

Yes—stereo has moved along fast in sheer miking technique in these years, quite aside from technical progress in other areas. The changes have often been rash, the effects periodically exaggerated. But in the long pull, the accumulating know-how is ever more telling in its effect upon recorded music. After eight years, I find stereo a splendid thing for the musical art, and getting splendider.

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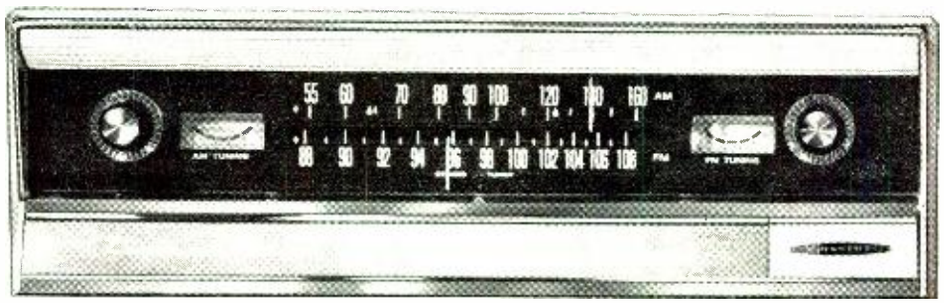

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JAZZ and all that

Bertram Stanleigh

Jazz Odyssey Volume 1, The Sound of New Orleans (1917–1947)
Columbia Mono C31 30

As an attempt to capture the special qualities of the New Orleans genre, this present collection succeeds as no previous anthology has ever managed to do. To achieve this end its producers, Frederic Ramsey, Jr. and Frank Driggs, have conscientiously assembled a group of forty-eight performances that are more impressive for the light they shed on a style of playing than for their individual merits. Not that the individual merit of these reissues is not substantial—with such performers as King Oliver, Sidney Bechet, Clarence Williams, Johnny and Baby Dodds, Jelly Roll Morton, Kid Ory and Albert Nicholas the music is bound to be great. But in this three record package, it is the total impact that overwhelms one. No attempt has been made to crowd together the usual assortment of "classic" performances known to every collector. Instead we have a set in which each performance has been selected for the way it helps to illustrate the sound of a kind of jazz.

Some of the less familiar groups contribute a great deal to the overall picture, particularly the Sam Morgan Band of 1927, to which an entire side is devoted, and white groups headed by Johnny DeDroit, Wingy Manone, Johnny Bayersdorffer and Norman Brownlee. Indeed, no previous anthology of New Orleans jazz has been as fair in exposing the very important contributions made by white bands. More than a third of these forty-eight numbers are by white groups, most of whom have heretofore been unknown to all but a very small coterie of specialists.

With the exception of one previously unissued master by the Noble Sissle Orchestra of 1937, all of this material had been released previously, mainly on the Okeh and Columbia labels, but many of the 78's from which this set derives were originally distributed only in the New Orleans area. It is only in recent years, when archives of the record companies have been made available to jazz researchers, that scholars have become aware of some of these early issues and of the personnel represented on them. Groups like the Halfway House Orchestra and the New Orleans Owls have previously escaped expert attention; however, the samples of their work included here lead one to hope that additional discs were cut by these combos and that additional reissues by them will appear in the near future.

A handsome thirty-two page booklet with knowledgeable, but unpedantic, notes by Frederick Ramsey, Jr. does much to enhance the value of this set. Quotations from contemporary newspapers and periodicals as well as conversations with important musicians demonstrate the very thorough research that has gone into these notes, and, together with the thirty-three photographs of bands and individual musicians, they provide vivid insight into the origins and golden age of New Orleans jazz. Complete personnel is also detailed for each selection. Only the "photographic essay" by Lee Friedlander, consisting of a dozen rather gray pictures of New Orleans musicians, serves as a reminder that many names are not included in this collection—Billy and DeeDee Pierce, Alphonse Picou, Alcide "Slow Drag" Pavageau and others.

What has been included is enough material to recreate the quality of the New Orleans style, and we can all be grateful to Columbia for giving us so much music on each disc. By placing eight numbers on each side, instead of the usual six, they have given the record buyer a real break. These three lp's contain the equivalent of four normal twelve inch 33's. As to the sound, it's hard to make any kind of judgment without having heard the pressings from which these performances were transferred. Something is always lost in the process of filtering out surface hiss, but there is so much vigor and excitement to the music in this set that reservations are pointless. The sound is easily good enough to clearly hear and enjoy each performance. There are no numbers so belabored with pops, ticks and inner groove scraping that one is compelled to rely on the album notes to discover what's on the record.

Over the years Columbia has given us a number of notable jazz reissue sets. Their generosity in releasing them has usually not been matched by a willingness to retain them in their catalog for an extended period of time. Consequently, it would be unwise for anyone to delay very long in buying this album. No other collection of records is more basic to any platter library. This set is as rare a treasure as *The Bessie Smith Story* or the Schnabel reissues of the Beethoven Sonatas. If your record dealer has closed for the night, don't wait until morning. Break down his door right now!

Charlie Mingus: Mingus, Mingus, Mingus, Mingus
Impulse Stereo A-54

The spread-out sound of this stereo waxing is in its way just as impressive as the warmth and color of these fine performances. Mingus can always be counted on for deeply felt, highly personal music making, but the special problems of recording a bass in proper perspective are rarely handled with the skill encountered here. Never is the level of Mr. M's instrument cranked up to overpower the other players, and never is it lost in the general din of a mighty climax. At all times it can be heard crooning darkly from a spot midway between the two speakers. The arrangements are all scored for a ten piece group, and although slightly different personnel is employed on three of the seven tunes, the results are largely the same, first rate Mingus. In addition to a fascinating version of Ellington's *Mood Indigo*, six Mingus originals are presented: *II B.S., I X Love, Celia, Better Get Hit in Yo' Soul, Theme for Lester Young* and *Hora Decubitus*.

Garry Burton, Sonny Rollins, Clark Terry: 3 in Jazz
RCA Victor Stereo LSP-2725

In one respect this is a very strange record: it deviates from normal commercial practice by presenting three different groups on a single platter. Probably the main reason such combinations are usually avoided is the extreme difficulty in ending up with a well balanced disc that does not unduly favor one or another of the ensembles. In the present instance, that balance is ably maintained throughout, and the contrasting performances effectively complement one another. Each of these groups is a small one in which the quality of the leaders' playing contributes the basic coloration of the combo. Burton, on vibe', Rollins, tenor sax, and Terry, trumpet and fluegelhorn, all turns in highly agreeable performances with their respective sidemen. Everything is relaxed, and the total effect is a little like listening to a succession of combos in a night club. An excellent background for drinking.

Chad Mitchell Trio: Reflecting
Mercury Stereo SR 60891

Each new release by this sprightly threesome provides fresh insights into their versatility. In the present instance, versatility proves their undoing, for the resulting collection is one of the most disturbing juxtapositions of unrelated and mismatched selections ever grouped together on a long playing platter. Individually the numbers are first rate, and the performances have the musical crispness and emotional impact that have brought this group to top prominence in Folk circles. Side A opens with an exuberant political lampoon, *Barry's Boys*, about the Youth for Goldwater movement. This is sung in best tongue-in-cheek fashion and is sure to split the sides of anyone other than a confirmed Birchite. *The Virgin Mary Had a Baby Boy* follows immediately, and this tender spiritual receives a deeply felt interpretation. But the contrast between the two numbers is not merely unfortunate, it is in bad taste, and the uncomfortable feeling engendered by this gaff does much to distract from the disc's merits. A pity since it contains good performances of witty numbers like Shel Silverstein's *The Hip Song*, traditional songs like *Queen Elinor's Confession* and a sensitive and moving medley of *In the Summer of His Years* followed by *Rally Round the Flag*.

Lightnin' Hopkins: First Meetin'
World Pacific Stereo 1817

In July of 1960, Lightnin' Hopkins stopped off in Los Angeles on his way from Houston, Texas to a folk festival at the University of California at Berkeley. By rare good luck, Brownie McGhee and Sonny Terry were completing a six week stint at a local club, and Big Joe Williams had arrived from St. Louis on a vacation. This was an historic meeting of great importance. Brownie McGhee and Lightnin' had long admired one another's styles on discs, and eighteen years earlier Brownie had recorded a *Letter to Lightnin' Hopkins* in an effort to lure him to New York. This, however, was their first face-to-face encounter, and we can all be thankful that World Pacific was able to steer them into its studios to document the occasion. The results are a set of earthy blues with that rare quality of complete resignation without bitterness. All six songs—*Ain't Nothin' Like Whiskey, Penitentiary Blues, If You Steal My Chickens You Can't Make 'Em Lay, First Meetin', How Long Has it Been Since You've Been Home?* and *Wimmin From Coast to Coast*—are gems. This is what you expect from performers of major stature who have been working together for years. In a sense these artists have been in close collaboration for many years by means of recordings. But never have they sounded so good as in this splendid new stereo sound in World Pacific.

Tut Taylor & The Folkswingers: 12 String Dobro
World Pacific Stereo 1816

The Dobro is a native American guitar with a round, perforated convex metal plate, or resonator, and two additional sound holes on the front of the instrument's body. It employs steel strings; originally there were six on the instrument developed by the Dopera brothers in 1925. But Tut Taylor, a sign artist by trade who collects stringed instruments as a hobby, devised a twelve string version, and it is this instrument that he demonstrates here in a collection of country tunes. As a continuation of the excellent series of instrumental records with The Folkswingers, a group made up of banjo, guitar, mandolin and bass, this set is an effective showcase of an instrument that has gained wide acceptance in country and western music. Don't let the fact that Tut Taylor plays as a hobby create the impression that he is less than an accomplished performer on the instrument he developed. He's a real virtuoso.

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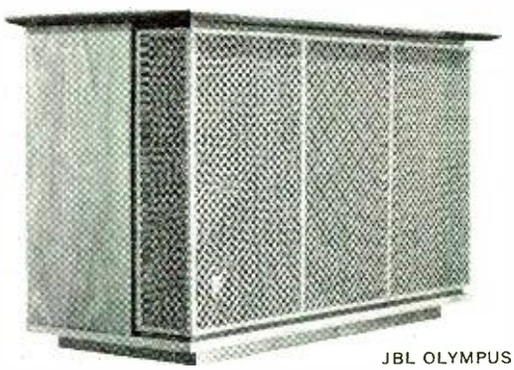

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ABOUT MUSIC

Harold Lawrence

American Symphonic Life—Too Many Orchestras, Too Few Professionals?

We are constantly being told that America is in the midst of a cultural explosion. In the world of music, for example, roughly 1200 symphony orchestras perform a total of 7500 concerts a year, employ about 75,000 musicians, earn over sixteen million dollars, play to an estimated eleven million people, and make recordings that are heard by millions more. The fact that more money is spent on tickets to symphony concerts than on baseball games has become a cliche. Yet, in this symphonic boom, no orchestra operates on a profit, only one provides its members with full-time employment, and the average income of players in all but a few of the nation's orchestras ranges from $300 to $1,000 annually.

Does this mean that our orchestras are in trouble? The answer is that they are and always have been. Being in trouble financially is a way of life for American symphonic organizations. By its very nature, the symphony orchestra is an unsound institution: operating costs are too high, the prices of tickets are too low, and rehearsals produce no income. If tickets reflected the actual costs of production, they would rule out all but a handful of wealthy music lovers in the community. But let's examine the economic facts of symphonic life in the United States.

According to studies made in 1961 by the American Symphony Orchestra League, Inc., our orchestras can be classified on the basis of annual expenditures, as follows: (1) college orchestras; (2) community orchestras; (3) metropolitan orchestras; and (4) major orchestras. For the purposes of this article, we will skip the 250 college orchestras.

There are 883 community orchestras operating on budgets of less than $100,000. Of the 55,000 members of these orchestras, only 12 per cent (approximately 6,600) are professional musicians, and they occupy most of the first chairs. The others are musicians by avocation: dentists, teachers, salesmen, and so on. The professionally trained players include young people who hope to rise to positions in the major orchestras, and former members of the majors who have given up full-time orchestral playing and now work in other professions. The average income of these players is $300 a year. Even with a season of five or six concerts a year, community orchestras have a difficult time meeting expenses. Says conductor Joseph Levine, they "struggle season-to-season on a tottering basis of frantic fund raising, door-bell ringing, pre-season ticket sales, social teas, and out and out begging."

The metropolitan orchestras are to community orchestras what Triple-A ball teams are to the Sally Leagues. Operating on annual budgets of $100,000 to $250,000 are twenty-one orchestras based in such cities as Honolulu, San Diego, Tulsa, Omaha, Providence and New Haven. Some of these orchestras are composed entirely of professional musicians. Approximately 1,400 of the 1,800 musicians playing in metropolitan orchestras derive their main income from music, although the average wage in the orchestras is $1,000.

In the major leagues are twenty-six orchestras with annual budgets ranging from $250,000 to over two million dollars. The majors are located in the following cities: Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Houston, Indianapolis, Kansas City, Los Angeles, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Rochester, St. Louis, Salt Lake City, San Antonio, San Francisco, Seattle and Washington. These orchestras employ some 23,000 players. Salaries extend from $1,600 a year to $15,000 for a limited number of musicians. Only about half a dozen of these orchestras can support their musicians the year around. The average income of the major orchestral player was $4,512 (1961–2 season).

American symphony orchestras will probably take in enough money this season through ticket sales, concert fees and such to meet 55 per cent of their operating expenses. The rest will have to be raised through contributions from business and industry, benefit concerts, foundations, and from the musicians themselves. The latter make their contributions in the form of accepting lower wages, in the same way that actors take salary cuts in order to keep their show on the boards.

In 1900 the United States had less than ten orchestras of professional calibre. Today it has over a thousand more. Is this musical progress? Some regard it with mixed feelings. "Too many orchestras fill our concert halls with mediocre performances played by part-time sloppy musicians and conducted by maestri who can hardly beat time," a publisher's representative said to me recently. "Wouldn't it be better if there were fewer orchestras?" he suggested. "Then we could concentrate our best players in a more select group of orchestras. Think of it; each state with its own symphony orchestra."

On the surface, the state-supported orchestra seems like a neat and sensible idea. But it presents some knotty problems. Take the case of Michigan. The logical place to form a Michigan State Symphony would be in Detroit, which already boasts one of the nation's best-trained ensembles. With all the state's orchestral money going to Detroit, however, what about Kalamazoo and East Lansing, cities that are struggling to keep alive their own symphony orchestras? Attracted by the lure of full-time employment, the best players in these orchestras would naturally gravitate toward Detroit, leaving their former orchestras without a professional core.

Until the day when American orchestras are directly subsidized by Federal, state and local governments, the economics of orchestra life will continue to discourage musicians, especially string players, from embarking on an orchestral career. And many of those players ambitious enough to do so will often abandon their chairs to take up other occupations that will provide them with decent incomes.

Opportunities for the serious orchestral player are perhaps greater in New York than anywhere else. Rank and file members of the Philharmonic, for instance, earn about $14,000 annually from concerts, rehearsals, tours, television and recordings. Some 300 free-lance musicians (ex-members of the N.B.C. Symphony, former concert artists, and so on) shuttle between Town Hall, Carnegie Hall, Philharmonic Hall, the City Center and various recording studios around town playing everything from TV jingles to Haydn symphonies. The New York orchestral player lives where the action is.

But even in the musicians' Mecca,

most players have to work a hefty schedule to afford a New York living. The New York musician, and orchestral players in general, was the subject of a panel discussion recently on New York's Channel 13. To the question: What can be done for the serious musician?, George Marek, R.C.A. Victor top executive, replied: "There are no miracle drugs. Doctors earn more money than musicians because more people are sick than want music. It's the inexorable law of supply and demand." A free-lance musician on the panel rebuked Marek for having "withdrawn support of the Metropolitan." (At one time a few years ago, R.C.A. Victor made several opera recordings with the orchestra, chorus and soloists of the Metropolitan Opera.) "It was a question of economics," Marek replied. "To record a three-LP set here would cost us $100,000. We can do the same work in Rome, with the same cast of singers and conductor, for $60,000. And it still takes us years to amortize the latter."

The free-lance musician then accused Marek and other record firms of "taking money away from us and spending it in Europe." Marek countered with: "It's hypocritical to say that record companies are supportive institutions. We have to make our books balance. If we didn't record in Europe, we would not be able to afford to record the Boston Symphony."

To the musician in Tulsa or Sioux City, the plight of the New York musician is hardly a plight at all. Nevertheless, one goal is shared by all orchestral players: full-time employment. In his book on the American Symphony Orchestra, John H. Mueller correctly wrote that "the ideal toward which American orchestral history has been moving is the 'permanent' orchestra." He goes on to define the term, 'permanent' orchestra," as having the following traits: "(1) exclusively professional membership; (2) full season contracts; (3) the orchestra as principal employment of its members; (4) all other employment (e.g. teaching, concert, etc.) compatible with priority of orchestral requirements; (5) regular and adequate rehearsals; (6) financial base sufficient to insure the above conditions. The obvious intent of these conditions is to provide continuity of organization, without which high artistic standards are impossible." Æ

STYLUS

(*from page 36*)

was much more pronounced for this test on the stereo channels. After 25 playings the first overshoot increased in amplitude to roughly twice what it was on a new record. Very little change was noted in the laterally modulated groove and, surprisingly, the vertical groove.

These tests were all relative, of course, and provide no indication of how much change would be significant. Nevertheless, the square wave tests do correlate with the frequency response and corroborate our conclusion that 1.5 grams is the top limit in tracking force for a 0.2-mil elliptical tip.

4. *Listening Tests.*

The absolute evaluation of record wear must be made using program material. To perform this test a record was chosen which contained a great deal of high frequency energy at high modulation levels. The record was played 100 times with a 0.2-mil elliptical tip at 1.5 grams. This record was then compared on an A-B basis with a new record. Three expert listeners could not detect any difference between the two records. Microscopic viewing of the record which had been played 100 times showed "some loose" material in the grooves indicating that wear had taken place. This wear was not detectable in the sound.

Conclusions

Our conclusion from these experiments is that tracing distortion can be appreciably diminished through the use of a biradial, elliptical stylus. It is imperative that the stylus be made to closely controlled dimensions and that measuring and quality control techniques be performed to insure the consistency in production of these styli. It is important also that the styli be made with a good polish, and that symmetry between the two points of contact at the record groove exist.

We also conclude that an elliptical tip with radius "A" of 0.2-mils will have a negligible effect on record wear when played at a tracking force less than 1.5 grams. With a tracking force of 3 grams, some increase in record wear at high frequencies should be expected. Whether this change will be sufficient to be detectable on normal program material will depend upon the type of program material on the record, as well as the quality of the remaining portion of the reproducing system.

Although we must admit that much work must be done to achieve perfection

in phonograph reproduction, the biradial elliptical tip can contribute significantly to minimizing distortion. This has been demonstrated by electrical measurements on test records. More important, it has also been demonstrated by a large number of listening tests on a variety of program material. Æ

FM DEMOD.

(*from page 32*)

of doubling the output voltage but requires additional gates.

Both the value of R_6 and the negative supply voltage may be varied to adjust the turn-on delay time and therefore the pulse width. It is desirable to use as wide a pulse as possible in order to get the greatest output possible. Let us calculate what this value is for a 10.7 mc center frequency. The peak deviation for commercial FM transmission is limited to 75 kc but to allow a safety margin let us assume that the FM signal varies by 100 kc from 10.6 mc to 10.8 mc. The time for one cycle at 10.8 mc is 92.6 nanoseconds. The maximum pulse width which is practical then in this circuit is 45 nanoseconds wide or just less than half the complete period. The timing diagram of Fig. 6B shows that it is impossible to generate pulses of greater than a half period width using just this simple logic configuration.

Assuming a 45 nanosecond pulse width the peak-to-peak output voltage that can be expected from the detector for a deviation of ±75 kc is:

$$E_{out}\ max_{pp} = E_{AV}\ max - E_{AV}\ min = (t_p \times F_p)(N_{pmax} - N_{pmin})$$

$$E_{out}\ max_{pp} = (45 \times 10^{-9} \times 5)(150{,}000) = 34 \text{ millivolts}$$

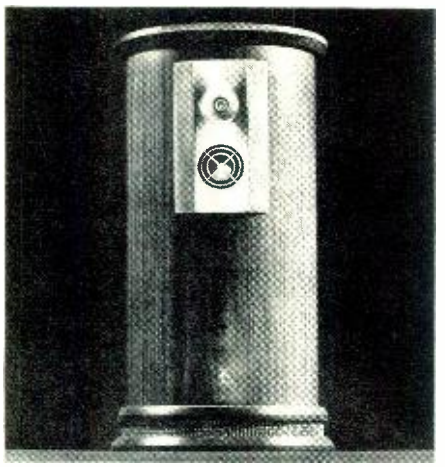
Note that this voltage while somewhat higher than the output of the average magnetic phonograph cartridge is quite a bit lower than the output of the average wideband ratio detector which has a level of hundreds of millivolts. Low output voltage is the price which is paid for the advantages of absolute linearity, no alignment, and wide bandwidth. The maximum bandwidth of the detector is directly related to the width of the pulse generated. If a 25 nanosecond pulse is used the bandwidth would be of the order of 10 mc. It is an exceptional ratio detector indeed that has a bandwidth of even 1 mc.

The output voltage may be doubled by doubling the pulse amplitude. This has been done experimentally with both the 2N955A and the 2N2475 by raising the 5-volt supply to 10 volts. A simple volume control which has no undesirable frequency response characteristics can be made by making the 5-volt supply to the NAND gate variable.

The schematic is shown in *Fig.* 9. Æ

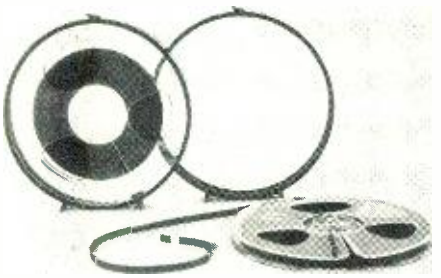
NEW PRODUCTS

● **Column-Shaped Speaker System.** Empire Scientific Corp. has introduced the "Grenadier," a divergent lens speaker system. A 360-deg. dispersion eliminates the need for painstaking location and balancing of speakers. Two years in the making and the designing, the new Empire Grenadier features a symmetrical "Sonic Column" design which is acoustically engineered to fit any room layout and to fit any decor. Fits in corner or against walls and is totally rigid without resonance. Other features include: Mass loaded woofer with floating suspension and four-inch voice coil. The woofer faces downward, close to the reflecting floor surface. It feeds through a front-loaded horn with a full



circle aperture throat. This provides 360-deg. radiation for full dispersion of sound and prevents standing waves from developing in the room. Die-cast mid-frequency high-frequency full dispersion acoustic lens. The mid-range are handled by a direct radiator and the high frequencies by a low-mass domed tweeter. A rigid and damped cabinet which is made of acoustic material and completely wrapped with walnut. Complete symmetry of design with terminals concealed underneath. Frequency response is 30–20,000 cps; nominal impedance is 8 ohms; power handling capacity is 100 watts, music power, and up to 60 watts sine wave power. Price is $180 per speaker. Empire Scientific Corp., 845 Stewart Ave., Garden City, N. Y. **E-1**

● **Tape Recording Accessory.** Hudson Photographic Industries, Inc., has developed a simple "snap-around" ring to enclose a standard 7-in. diameter recording tape reel which prevents warping, tape spillage and dust contamination. Although not a storage can, the HPI reel container, called "Lock-A-Matic Ring Stand," provides all of these functions in one easy-to-handle plastic ring which snaps around

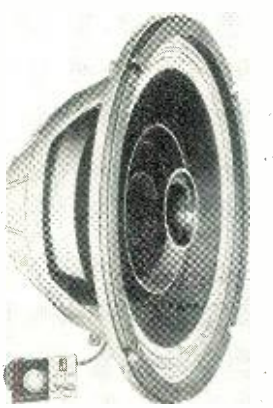


the outer rim of any style seven inch diameter recording tape reel. The ring has a simple snap lock to secure the ring to the reel. Each Lock-A-Matic Ring Stand has a foot section to allow reels to be stored vertically. Cost 39¢ each or 3 for $1.00. Hudson Photographic Industries Inc. Irvington-on-Hudson, N. Y. **E-2**

● **Booster-Coupler for TV and FM.** A new Booster-Coupler, Model BC-208, has been released by the Winegard Company. Designed to run one to four TV or FM sets, the BC-208 has +8-db gain to each output. For improved isolation between outlets, Winegard uses a balanced resistive method. This new circuit completely isolates sets in the system preventing any

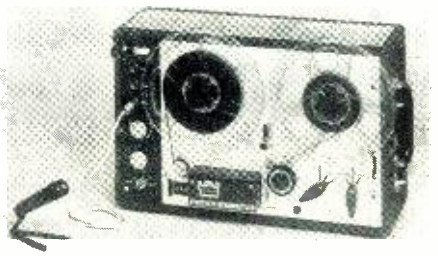
interaction. A new, larger chassis dissipates heat for longer component life. All terminals are no-strip and unused terminals need not be terminated. Wiring is precision module type and provides optimum control over variables. Other features include a new mounting bracket for wall mounting that permits removal of the unit without unscrewing the mounting bracket, fully enclosed isolation transformer, easily accessible connections and on-off switch. The models BC-208 can be used in fringe, near fringe and even close-in installations. It takes up to 350,000 microvolts of signal input. List price, $29.95. Winegard Company, Burlington, Iowa. **E-3**

● **Low-Cost Speaker Series.** Jensen Manufacturing Company has added a new line of low-cost high fidelity speakers called the Delta Series. The Series consists of the Model DL-220, a 3-element, 12-inch coaxial unit priced at $34.75; Model DL-120, a dual-cone, 12-inch speaker priced at $21.50; and Model DL-80, a dual-cone, 8-inch loudspeaker priced at $15.25. Each of the speakers in the Delta Series offers these features: Syntox-6 magnetic systems; Flexair suspensions; binding post terminals; die-cast housings and stable spider



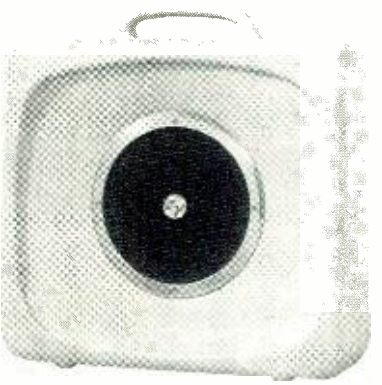
suspensions. The Model DL-220 provides 25 cycle resonance compression high frequency unit with mid-range radiator. Power capacity is 20 watts. Frequency range is 25–16,000 cps. Resonance is 25 cps. The Jensen DL-220 comes equipped with a fully adjustable high frequency balance control on 30-inch cable. The Model DL-20 is similar to the DL-220 but without the coaxial HF unit. Power capacity is 20 watts. Frequency range is 40–15,000 cycles. The Model DL-80 has a frequency response of 50–15,000 cps and a power capacity of 20 watts. Jensen Manufacturing Company, Chicago, Illinois. 60638. **E-4**

● **Light-weight Tape Recorder.** Roberts Electronics has introduced a new light-weight, high fidelity tape recorder at a price of $169.95. The Model 1600, weighing 22 lb., features a VU meter, index counter



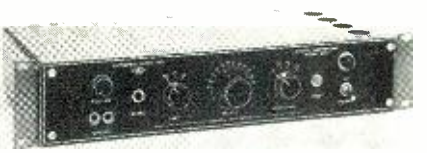
and microphone together with its capability of recording at speeds of 7½ ips, 3¾ ips and 1⅞ ips. The Model 1600 is a monophonic, 2-track tape recorder. Roberts Electronics, Los Angeles, Calif. **E-5**

● **Portable Hi Fi Unit.** Effortless portability and high-fidelity sound quality are two of the features of the new Electro-Voice Sonocaster. The eight-inch coaxial driver unit employed in the Sonocaster is designed for portable and outdoor high fidelity use. Weighing only eight pounds, it may be placed temporarily wherever sound is desired, or it may be mounted permanently. The housing is molded of a durable, crack-proof plastic material similar



to that used in travel luggage. The housing shields the driver unit from weather yet is itself immune to the effects of the elements. The eight-inch speaker employes a rigid die-cast frame designed to withstand severe abuse without functional damage, a ceramic magnet assembly, and a double-wound voice coil which provides wide-range frequency response and high efficiency. Electro-Voice, Inc., Buchanan, Mich. **E-6**

● **Digital Metronome.** A functionally designed digital metronome combining the features of fully transistorized computer type circuitry and replacing the old-fashioned "click track" has been introduced by University Audio, Inc. Covering a different tempo-beat range from 1 to 100, this timing device finds broad application in musical scoring of motion pictures. Output is



from 1 beat per 6 frames to one beat per 30 frames of film in ¼ frame steps. Tempo-beat is based on 24 frames per second. Accuracy is ± 250 microseconds with non-cumulative error. Price $689. Universal Audio, Inc., Hollywood, Calif. **E-7**

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NEW LITERATURE

● **Popular Electronics Book.** Monroe Upton, author of "Electronics for Everyone," has written a second book "Inside Electronics." The book is an introduction to radio, TV, stereo and hi fi. It contains 272 pages and 72 line drawings. Price, $5.95. Published by the Devin-Adair Company, New York 10, N. Y.

● **Transistorized Miniature Amplifier and Tuner Application.** Lafayette Radio offers a 96-page publication describing its miniature printed circuit transistor amplifier and tuners. Rufus P. Turner, the author, has compiled 60 applications in six chapters. Chapter 1 gives necessary performance data on the various amplifiers and tuners and information on building modular amplifiers and simple stereo systems. Succeeding chapters discuss ueful ham and citizen band accessories, control applications (relays), test instruments, miscellaneous amplifier applications such as hearing aids, intercoms, electronic stethoscope, and tuners and their applications. Cost of booklet is $1.50. Lafayette Radio, Syosset, N. Y.

● **Speaker and Enclosure Publications.** Two new Electro-Voice publications have been issued. One is the "Guide to Compact Loudspeaker Systems," a colorful catalog describing their new series of acoustic suspension systems. A distinctive feature is the fact that this booklet incorporates considerable information designed to help the newcomer to high fidelity. The other publication, "Design and Construction of Bass Reflex Enclosures," deals with home construction of bass reflex enclosures. Despite the tremendous popularity of complete loudspeaker systems, a great many people still prefer to buy component speakers and mount them in custom made enclosures. Certainly a great deal of information on reflex enclosures has already been printed, but this new booklet provides more information than has been available previously outside of textbook. Electro-Voice, Buchanan, Mich. **E-8**

● **Loudspeakers for Special Applications.** Jensen Manufacturing Company, Chicago, is offering a new, 2-color, 16-page catalog, Number 1090, fully illustrated and describing the many items in its Concert, Viking, and Weather Master Series of general purpose and replacement loudspeakers—with complete descriptions and easy-to-read specification tables. The Concert Series is a comprehensive line, including oval, electronic musical instrument, special automotive, high fidelity replacement, and miniature loudspeakers, as well as models for intercom, communications and aircraft. The economically-priced Viking Series is also described as well as the Weather Master Series. The latter Series features speakers for drive-in theatres and other outdoor applications. The catalog concludes with an interesting and informative discussion on the permanent magnet, first introduced in loudspeakers to the United States market by Jensen. Catalog 1090 is available from Jensen Manufacturing Company, Chicago, Illinois. **E-9**

● **Terminals Reference Catalog.** A colorful 24-page catalog that lists, describes, and illustrates a complete line of plain and locking terminals, is now available from Shakeproof, Division Illinois Tool Works Inc. The catalog describes both plain and locking Shakeproof terminals in bronze, bross, copper and steel, in a wide range of designs for almost every application. The catalog is organized to clearly identify the broad lines of Shakeproof standards, specials, and custom specials. The catalog is particularly easy to use because it groups terminals of the same general shape by style numbers. Both locking and plain terminals of the same type are listed under the same style number for clarity. Shakeproof, Division Illinois Tool Works Inc., Elgin, Illinois. **E-10**

AUDIO ETC

(from page 14)

man Concert" at Carnegie Hall, but here's a small-company bid in the same direction. You'll see the like everywhere now (when they aren't already withdrawn), but again, this must have been a saucy, fresh, new idea back in December of 1954. So I'd guess, anyhow.

#536: Les Bords du Saint-Laurent. French Canadian Folk Songs. Pierette Champoux. No stone unturned by the roving Esoteric tape recorder. Enter folk music.

#545: Smoky Mountain Ballads. Harry and Jeanie West. And more folk song this time looking pretty authentic. I'm going to have to look this record up and listen to it.

#546: Renaissance Motets, Renaissance Chorus (N.Y.)

#2002: Music of the Arab People. . . . Going to have to stop here, with Esoteric's wild leap into Arabia, straight from upper Manhattan. The details aren't important and my historical attribution of Esoteric "firsts" may not always hold water; perhaps some other label got there first, instead of Esoteric. But the principle is upheld, namely that until the middle fifties, the small LP operator could and did attain a really remarkable freedom of enterprise, to the limit of his imagination and with a minimum of high finance.

Where do we go from here?

What has happened? Well, in a sad sort of way, recording has grown up, put on weight, raised its technical standards. We're used to LP and we are used to innovations. We had them until they came out of our ears. Now, a novelty must be really unusual, or really superb in musical value, or particularly well played, if it is to catch the roving collector's jaundiced ear. Good, in a way. But it does discourage the kind of free-wheeling recklessness that led to the whole development of LP repertoire.

On the technical side, stereo has added painfully to the cost of marginal recording, and the smaller the business the more agonizing the cost. The plain fact is that very few small companies can afford stereo at all, what with that beastly necessity for stereo and mono duplication. The big companies alone can swing stereo and the stereo-mono joint release. (I hate to suggest it, but I suspect they are well aware of this convenient strangle-hold on small business. Dreadful thought—maybe they don't *want* to convert to all-stereo and the single release, and thus let in the competition from below.) There has been good stereo on small labels, but the promoters' bravery is almost painful to watch.

Finally, there has been a relatively large rise in processing costs, notably for those who must farm their processing out—the smaller labels, I am very conscious of this because of a side-effect, the impact of the price boost on private and independent recordings. My chorus, the Dessoff Choirs, used to make itself a good little income (a) by selling its music to assorted small

commercial companies and (b) by making membership recordings, for private sale. Now, most of our small companies are dead, and our records with them; those which are alive aren't taking on much business of our sort. And the processing costs to make a private recording are now so startlingly high that we can scarcely afford to make our own records any more. Our heyday is definitely over as far as LP is concerned.

Yes, a good deal of this cost goes back to the rise in technical standards, and to stereo. Things are no longer done in the old slap-happy way. Recorders have to be good, now, and associated equipment is always tops, too. Engineers charge plenty, and editing costs a whale of a lot. (I used to do our editing, in the old days.) Altogether, making a good record now is a slick, polished, professional job and as an audio man of sorts I can't say I object.

Perhaps it is just as well that standards are now high and worth it, that everything costs more (including music) and is better.

But music, the recorded musical library, suffers, and will suffer a lot more as the happy days of LP pioneering move further from us.

P.S. Perhaps you'll be surprised to find that most of the Esoteric recordings of 1953 and 1954 are still listed in the Schwann catalogue, under the same numbers. Here's one small company that has managed to keep going, even under its new name, and to keep the best of its past records in stock.

Double P.S. It's another subject—but now the middle-sized companies are folding their tents, too. Westminster, paragon of musical hi fi, went out and is back, barely. Unicorn, a would-be mid-sized outfit, died very thoroughly. Others are reportedly on the rocks, though I mention no names out of concern for them. Even the new middle-graders of recent launching seem to flounder these days. The big problem for them is just the one we have been studying—shall they ape the biggies, plug standard repertory (at huge expense) for wishfully big sales; or shall they push the out-of-the-way stuff, for more prestige and less expense?

And with that, I must return to my Deccas, RCA Victors, Columbias and Capitols, my Mercuries, Angels, Everests, Londons. Where are the half-a-hundred labels of yesteryear? Æ

LETTERS

(from page 8)

A typical ceramic structure will have a shorter length, larger area, lower weight and lower cost than an equivalent Alnico 5 structure. In some cases the use of a ceramic magnet permits structure length to be reduced to ½ of the length of an equivalent Alnico 5 structure.

Magnetic structure performance is normally measured at room temperature conditions. Changes can occur in a permanent magnet as a result of heating or cooling the magnetic structure. The change may be either reversible or irreversible. A reversible change is one in which the magnetic conditions are identical before and after exposure to the temperature change. Exposure of a ceramic structure to any temperature, from room temperature up to approximately 460 C. (860 F.), always causes a reversible change and therefore no change in the performance of the magnetic structure.

An irreversible change is one in which the magnetic conditions are different before and after exposure. A ceramic structure exposed to low temperatures may experience either a reversible (no loss) change or a reversible change (some loss). The type of change which occurs depends upon the design of the magnetic structure and the temperature of the exposure. A ceramic structure can be designed to have no loss after exposure to temperatures as low as −60 C. (−76 F.). These changes are entirely dependent upon the lowest temperature which the magnet reaches in exposure and is not affected by the number of cycles of exposure.

Ceramic magnets will supply magnetic structure performance equal to an Alnico 5 structure with a saving in cost, weight and overall depth.

CHARLES R. HOHMANN
Senior Development Engineer
Jensen Manufacturing Company
6601 S. Laramie Ave.
Chicago, Ill. 60638

Live FM Broadcast

SIR:

I was most pleased to read Mr. Kregg's comment on the quality of WFMT's live stereo broadcast of the Boston Symphony Orchestra and the recital of Guiseppe de Stefano, both from Chicago's Orchestra Hall. Many listeners have commented on these broadcasts, and other live programs,

which makes us feel very good that there are many people who do appreciate good sound.

Actually, we had several handicaps that a recording company would not have. It was not possible to test out microphone positions, set levels or anything else for either of these broadcasts. We had to make some educated guesses in both cases. This is not like a recording, and we could have only one "take."

Secondly, frequency response, distortion and noise level were degraded by the telephone company lines. Anyone who has ever tried to get two *identical* 15kc. plus, lines from the phone company knows how difficult it is, and expensive too.

I though it might be of interest to your readers just how the two live pickups were made. Both were different. For the Boston Symphony we used two widely spaced U-47 condenser microphones. These were located about twenty-five feet up and forward of the Orchestra. The microphones were set for cardioid. With the more recent de Stefano concert we used two Neumann KM-56 condenser microphones in the "MS" system of stereo. The announcer's microphone was bridged in on the "center," or M, channel of the MS matrix. Mixing of the KM-56's was done *prior* to the matrix. This gives a very good level control system with the added feather that left-right balance can not change with mixer settings. MS was selected for this broadcast because Mr. de Stafano was to be placed on the "center channel," and MS would give a better monophonic signal than would spaced cardioids or crossed microphones.

We have done many live and recorded stereo broadcasts and are pleased with listener response. After all, that's what makes it worthwhile.

ALFRED C. ANTLITZ, JR.
Director of Engineering
WFMT, Chicago

RECORDS

(from page 54)

in mechanical noises in the organ; the pipes sound coarse in tone and air seems to be hissing all around; there's a higher ambient reverberation in the hall noise; you hear pins dropping (so to speak) like golf balls, beams cracking, chairs creaking—everything but music. Not good.

You can't ever *audibly* tamper with the level of the ambient background in recording; it must at least *seem* to stay the same, all the time, regardless of level in the music. That's because opening up the volume on a big-hall background tends to change the perspective; the hall grows audibly larger, the sound details move in much closer, magnified. If you *must* change level, then the music should adroitly cover the change, to distract the attention. It doesn't here. That's exactly the trouble.

It's better, even on records, to let Liszt drop down into the acoustical mud, as was intended. Can't be helped. Unless you ask your organist to play louder. (He'll refuse, natch, on artistic grounds.)

The King of Instruments—Two Great Organs. (Philharmonic Hall, New York; Asylum Hill Congregation Church, Hartford.) Albert Russell.

Aeolian Skinner AS 318 S stereo

Symphony Hall's big organ was, I think, one of the first of the new breed of organ combining "Baroque" and modern features in the one instrument. Things are not, of course, quite that simple, as is indicated by these recordings of one brand new organ and another that, I would guess, also is new. The over-all sound of these, as far as we can judge from the samplings, is already very markedly changed from that of Symphony Hall. Much brighter, all over, shinier, more insistent, less "organy" in the oldish church sense, reflecting the over-all change in organ conception that has come in with the revived Baroque.

No, these don't sound like Baroque organs—not by a long shot. Even the early-type stops, used for Buxtehude, Bach, Handel, are in a sense parodies of the genuine Baroque sound, super-Baroque in an unmistakeably very modern way. Like an Elizabethan costume fixed up by Hollywood. Even the modern music, the near-Romantic music (Healey Willan, Marcel Dupré) sounds brighter, steelier. I would guess that organ design is changing almost as fast as everything else these days.

Mr. Russell is decidedly a young organist of the new generation—you can tell that in ten seconds. Fast, peppy, metrical playing, without a sigh or a die, impersonal, efficient, humorous, expertly fingered and pedalled. The antithesis of Edouard Commette on Angel (but Russell is a good musician of his type). On his two organs he plays Dupré, Buxtehude, Bach, Langlais, Healey Willan, Handel, with equal and indeed, identical facility. Like the soprano who can produce folk song and Puccini, Mozart and singing commercials.

P.S. I count well over three seconds reverberation in Philharmonic Hall after the big chords here. Dead? Who said so?

GENTLY MODERN

Prokofieff: Symphony-Concerto for Cello and Orch. Op. 125. Fauré: Elégie. Samuel Mayes; Boston Symphony, Leinsdorf.

RCA Victor LSC 2703 stereo

Here's a big, new Romantically inclined work of the beloved late composer in a rewrite version—it was formerly a cello con-

certo, composed between 1933 and 1938, but was revised in 1940 and then taken apart for reassembly on a more important scale in 1950 and 1952 at the very end of the composer's life. It has in this new form an interesting sound, part out of the 1930's—the period of "Peter and the Wolf," the ballet music "Romeo and Juliet," the popular Fifth Symphony—and part out of the recent Russian past with Shostakovitch's slightly military-sounding influence to be heard.

It's awful' long, a side and half. But awful' melodious, too, and the cello does much gymnasticizing without too often sounding like a grunting pig, the way cellos do at times in cello concerti. The Fauré Elégie is a turn-of-the-century trifle, apt for filling up the rest of an LP side.

The new Boston sound, via Dynagroove, brings a lot of close-up effects and not too much expansiveness, plus that curious impression of constant loudness over too long a time that is presumably the Dyna contribution to better living with small phonos.

Gershwin: An American in Paris. Milhaud: A Frenchman in New York. Boston Pops, Fiedler.

RCA Victor LSC 2702 stereo

Bright idea—RCA commissioned the French composer to write the other side of this LP record. And RCA got just what it asked for, since Darius Milhaud, an aimable soul, has been a veritable music factory these forty years and more; he came through right on time. New York with Fog, Horse and Carriage in Central Park, Baseball in Yankee Stadium (fugue). And more of the same.

What did RCA get? A big, fat mish-mash of nothing very much, expertly written, beautifully scored, full of every Milhaudian cliché of the last almost-half century and, all in all, a piece from which the mind wanders easily while the players work their hardest. Wonderful for them, if plenty tough in plenty of spots (Milhaud loves scratchy super-high violins). Pretty dull stuff for the listener, I say.

Funny thing is, it's so dissonant, this music, that it sounds dated! Right out of the "modern music" of the 1920s. Those eternal polychords, coupla ordinary chords one piled on top of the other and swearing like cats, tinny, foursquare little bits of French tune, like sawed-off folk songs. It's glorified TV music as of 1920.

Next to Milhaud, Gershwin is positively concise! His ever-fresh score is too hugely blown up in the sound—it should be drier, in the 1920s manner—but the playing is alive and very appreciative. That's what counts. The Boston Pops always is like that.

Milhaud: Sacred Service for the Sabbath Morning. Heinz Rehfuss, Orch. du Th. Nat. de l'Opéra, Chorus de la RTF, Milhaud.

Westminster WST 17052 stereo

Now here's a really thoughtful work by Milhaud, a pleasure to hear on records as, I am sure, it is gratifying to hear as a part of the Jewish service. Also a pleasure to perform, no doubt. It is long, with orchestra, chorus and a single solo, a baritone; but it is quiet, too, full of rahter lovely melody written in flowing counterpoint among the choral parts, scored cleanly in an almost Mahleresque manner, a few instruments at a time, often very low and very high together. Only the central portion rises to some fairly loud music. There are 20 sections, each with its Hebrew title (English translation provided, but no Hebrew; you have to find your own way). The chorus and the soloist work fairly constantly and the whole sweeps onward with an elegance and dignity that opens one's eyes to the power of this good natured and rotund Frenchman, who pours out music at the drop of a hat, most of it enormously skillful and a lot shamelessly repetitive and superficial.

If you ask me, RCA should have commissioned another Sacred Service, instead of that "Frenchman in New York" thing they thought up.

Hovhaness: Symphony No. 4 Giannini: Symphony No. 3. Eastman Wind Ensemble, Roller.

Mercury SR 90366 stereo

Now here are two moderns you'll find easy to listen to, especially since both are composing for modern wind band, super-stereo hi-fi. No strings attached.

Hovhannes, the melancholy Boston Armenian, says of his work, "I admire the giant melody of the Himalayan Mountains, seventh-century Armenian religious music, classical music of South India, orchestra music of the Tang dynasty China around 700 A.D., opera-oratorios of Handel." Take all that, including Handel (who might be a bit bothered, himself), plus a giant tam-tam, assorted vibes, marimbas, xylophones and lots of trombone, mix in a further Hovhannessism: "I would prefer the massive free rhythm bell orgies of Zurich to the spineless glockenspiel chimes and vibraphone of our industrial orchestras . . ." and you'll run for the nearest record shop to find out what Hovhannes has to say in music! You won't be disappointed: it makes grand hi-fi and the best aural intermodulation test I've yet heard. (Tam-tam at about 70 cps, very loud and continuous, against a trombone choir, for instance.)

Vittorio Giannini is less picturesque, but he is an honest and unpretentious academic composer, who lets Brahms and Wagner peek out incongruously from his semi-modern wind music whenever they have a mind to, which is quite often. One of those works that sounds *almost* old-fashioned, but not quite. Skillfully written for a lot of brass and percussion.

Boy, does Mercury know how to get a big hi-fi sound onto discs. Phew!

TAPE RECORDERS AND THE LAW

(*from page 50*)

There are innumerable restrictions on each of the above four categories and in addition a restriction called "fair use." That is, that a small part of a copyrighted article may be quoted without permission if the copyist has a good reason to do so, for example, book reviews and newspaper items.

1. The copyright owner has the exclusive right to 'publish' his copyrighted work. Anyone who copies may be sued. A copy is a tangible reproduction of the author's creation. A recording is not deemed a 'copy'.

2. Adapt the copyrighted work, for example, translate it into other languages, dramatize a nondramatic work, arrange a musical work, and so forth.

3. Performing rights are, generally speaking, of two kinds: (a) public performance; the right to exclusively control any performance given in public, is confined only to 'dramas', (b) public performance for profit. The law does not define public performance. It does not include performance in the home. It does include performances that are open to the public regardless of the size of the audience. In between these two extremes lies the twilight zone which courts are called upon to decide. A performance for profit does not require that admission tickets be sold. It would be deemed a performance for profit if there was direct or indirect compensation to the copyist.

4. The copyright owner of a musical composition has the exclusive right to make the first sound recording of his creation or, if he wishes, to license someone else to make the first copy. Upon the making of the first recording, the copyright owner loses his exclusivity insofar as additional recordings are concerned and anyone may record the work without the consent of the copyright owner on condition, however, that (a) the copyist notifies the copyright owner of his intention to do so (and additional paperwork to the copyright office), and (b) pay the copyright owner a royalty of 2 cents on each record.

A home tape recording of a musical broadcast would not be deemed a performing right violation unless it was done for profit. It is a violation, however, of the recording right of the copyright owner. A home recorder, however, could apply for the statutory licensing right if he wishes to pay the 2 cents for each recording that he makes. There is, however, another problem that the home recorder may be violating the rights of the recording company, as the courts have already held that the recording companies have an interest in their master record.

A new legal problem will shortly arise under the new labor agreements, wherein musicians are given royalties on their performances. Star performers have usually had royalty rights in their performances and received a royalty based upon the number of records that were sold.

In summary, there is no doubt that in the strict sense of the law, most tape recordings, whether the source is a record, another tape recording brought out by the commercial recording companies, recordings from radio or television stations, and everything that falls into this classification is a violation.

Viewpoint of Government and Copyright Owners

A. The Federal Communications Commission in Washington has no objection to our indicating in the framework of this article that copyright matters are not covered by the Commission's Rules and Regulations.

B. The Copyright Office in Washington has a very similar point of view. They state, in addition, that as long as this question has not been adjudicated by any court in this country, no definite opinion can be expressed.

C. Counsel for another organization which enforces the rights of copyright owners told us very clearly that they want strict enforcement of the law. They consider every type of authorized recording as bootlegging. They think the law of 1909 is too lenient and should be revised. On the other hand, they do not want to be quoted or bound to any statement whatsoever.

D. Agencies such as ASCAP and BMI state that as performing rights societies they are not engaged in licensing the right to manufacture or duplicate records or tapes. This right is reserved to their individual members. Therefore, these societies did not answer this question.

Viewpoint of Broadcasters

Many radio stations and major record manufacturers do not wish to be involved. They prefer not to give any definite opinions as to whether tape recordings by private individuals are permissible. They believe there is nothing definite enough to warrant the venturing of opinions in this matter. It has, however, been pointed out very clearly that inviting the public to record over the air, or to record from discs, is illegal and may be prosecuted. That means that a tape recorder manufacturer should be careful when advertising. He may be subject to suit should he invite the tape recorder owner to record music or any signal over the air, from records, from pre-recorded tapes, or any similar source.

"A lawyer for one of the large broad-

casting systems, whose opinion we had requested, writes us that he strongly disapproves of any kind of recording of programs on tape by private persons. Apart from the fact that it is illegal to tape programs, this practice takes advantage of the end product of considerable time and effort on the part of skilled and creative people—performers, writers, musicians, directors and technicians. It is, therefore, unfair to copy such performances for the benefit of private persons. Also where commercial records are copied off the air or borrowed, the performers and composers are deprived of their royalties, which they would get if the record were purchased.

"In contrast, it is interesting that administrators and officers of radio stations who are not lawyers, have a completely different opinion." The following letter illustrates the point: "I have checked with our attorneys in Washington who indicate to me that there is no legal problem with respect to an individual taping off the air for playback in his home for his own pleasure.

"* * * * will always welcome commercials from a manufacturer such as yourself inviting people to utilize Tandberg equipment to tape record our programming at home."

When multiplex originated some time ago, a group of broadcasters came up with the idea of transmitting a signal together with the carrier wave, so that anyone who would use a commercial tape recorder to record such signals on tape, would record an audible tone which would spoil the recording. The tone may result from a combination of the emitted sound with the bias frequency used in the tape recorder. There are also other ways to spoil the recording for the home tape recorder user. However, such a violent reaction resulted at this time that the broadcasters discarded this idea completely. It seems that this avenue of approach to the copyright law has been completely discarded.

Viewpoint of the Hi-Fi Enthusiast

It is only fair to give the opinion of users and buyers of tape recorders. Following is a typical letter:

"I was bitten by the hi-fi bug in the early fifties and have never recovered. If anything, the disease has worsened for I now own not only an array of the usual audio equipment, but several tape recorders as well.

"Since the purchase of my first machine I have taken advantage of all recording opportunities and now have several hundred recorded tapes to show for it. Music by far comprises the bulk of my collection, though there are a number of taped movie soundtracks, TV shows, and poetry readings.

"FM offers a wealth of music to the tape recordist with its many live or taped

broadcasts of major symphony orchestras and its programs of jazz, folk, and popular music. Recording popular music from FM can be very economical. 45-rpm singles at nearly a dollar apiece can run into a considerable sum if one is hot on popular music. Recording them on tape, however, can represent substantial savings as roughly twenty or so pop tunes can be fitted on a 1200-ft. reel of tape.

"Recording classical records is another thing. They are often handsomely packaged with artistic covers and fine liner notes. Still, the temptation is to record the disc when it is played over FM (or borrowed), rather than to go out and purchase it. Of late, I have confined my purchases to discs of limited appeal, those seldom played on FM or, if played, not in their entirety.

"Public libraries very often have records, and my local one has a collection of approximately 500 discs.

"Live recording, though infrequent, is probably the most exciting and creative part of tape recording. Needless to say, I have always asked permission when recording live performances.

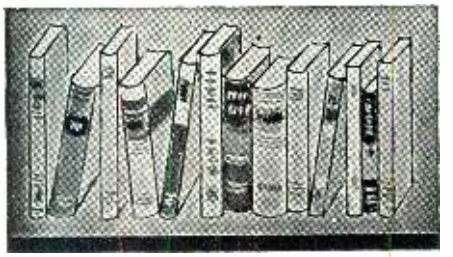
"As regards the copyright laws on tape recording, I have never seen them printed in full. I realize that certain of my actions may be 'technically' improper, the recording of discs from the public library and the copying of radio and TV programs, for instance. I have never heard of any home recordist being sued or punished for doing this. I think we should be allowed to record copyrighted material free as long as we do not sell the recording."

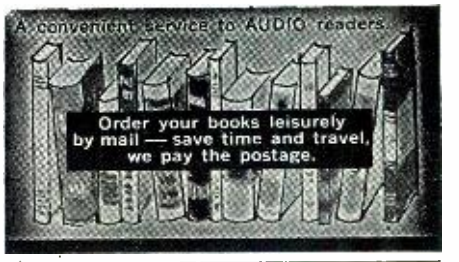
Viewpoint of the Tape Recorder Manufacturer

The tape recorder manufacturer is definitely in a predicament. He wishes clarification of the situation, and a more clearly-defined law. Judging from the information of the parties involved, with the exception of the lawyers, the saying "Let Sleeping Dogs Lie" seems to apply. Actually, the border line is now clearly drawn. It is regarded as common practice for people who buy tape recorders to record programs and music over the air. Recorders are sold by the thousand and hundred thousands for such purposes without any serious objection. However, as soon as any company wishes to advertise these facts, the law steps in, and tells us that this is a borderline case and cannot be done.

Summary

Everybody concerned agrees that the situation is extremely complex. The law of 1909 is outmoded. Non-commercial tape recording from sources such as commercial recordings, broadcasts, and so on, is not permissible in the strict sense of the law. Most people feel that it should be permissible. Æ





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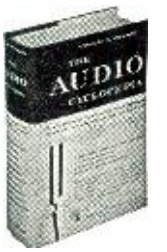

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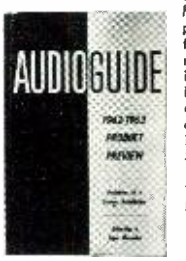

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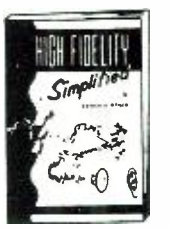

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TELSTAR-SHAPED ELECTROSTATIC

(*from page 24*)

maximum power at all frequencies up to 20,000 cps, and if the amplifier's rated plate-to-plate load impedance was 4300 ohms, then the capacitive input impedance of the tweeter as seen by the amplifier at the primary of the stepup transformer should be 4300 ohms at 20,000 cps. This is the impedance of a 0.0018 μf capacitor. The turns ratio of the stepup tranformer is then adjusted so that the actual input capacitance of the tweeter, which is the capacitance between the two push-pull speaker plates, is reflected to the transformer primary as 0.0018 μf.

If you are not a hi-fi purist you can "fudge" a little and improve the efficiency somewhat by saying that full power to 20,000 cps is not needed for music reproduction, and that full power to 11,000 cps or so with gradually decreasing power to 20,000 cps would be adequate. The author fudged, and 4300 ohms at 11,000 cps represents a capacitance of 0.003 μf. The transformer stepup ratio was adjusted to reflect 0.003 μf on the primary instead of the 0.0018 μf. The fudging increased the efficiency by 65 per cent.

Referring back to *Fig.* 4C, the capacitive load impedance seen by the amplifier, (a^2C_s), has been selected as 0.003 μf. Once this capacitance value is selected, the values of the other components in the tweeter coupling network are fixed with the exception of L_1. The other components are determined as follows: the capacitor C_1 should be about ten times larger than (a^2C_s) as it is in series with the speaker input load capacitance, and any voltage drop across C_1 is wasted in terms of speaker effieiency. C_1 in *Fig.* 4C was chosen as 0.025 μf, and represents an 11 per cent voltage loss in terms of the 0.003 μf speaker load capacitance. The leakage inductance and shunt capacitance of the stepup transformer, which should be as small as possible, are determined by the transformer selected. R_2 is set equal to the impedance of the speaker, (a^2C_s), at the upper resonant frequency, f_h, which is the resonant frequency of the transformer leakage inductance (L_{leak}) with the speaker capacitance (a^2C_s).

The resonant frequency, f_h, can be determined by measuring the values of (L_{leak}) and (a^2C_s) individually or by sweeping the frequency range with an audio oscillator and watching for the resonant peak at f_h in the frequency response of the network with a VTVM. R_1 is set equal to the impedance of C_1 at the crossover frequency, which in this case was 500 cps. The value of L_1 apparently has to be determined experimentally with an audio oscillator and VTVM, and is selected to eliminate any peaking or drooping in the response curve at the crossover frequency. L_1 has a second useful purpose in "unloading" R_1 from the amplifier at the high end of the frequency range where the amplifier is heavily loaded by the 0.003 μf speaker load capacitance.

Woofer and Midrange Crossover Networks

The author has not yet built a crossover network for an electrostatic woofer or midrange speaker, so only a few guidelines will be offered. The basic crossover network shown in *Fig.* 4A can be used for a mid-range speaker by adding an appropriate inductance in series with R_2. For a woofer, the components C_1, R_1, and L_1 in *Fig.* 4A would be eliminated and an appropriate inductance would be added in series with R_2. The values of the various components in the

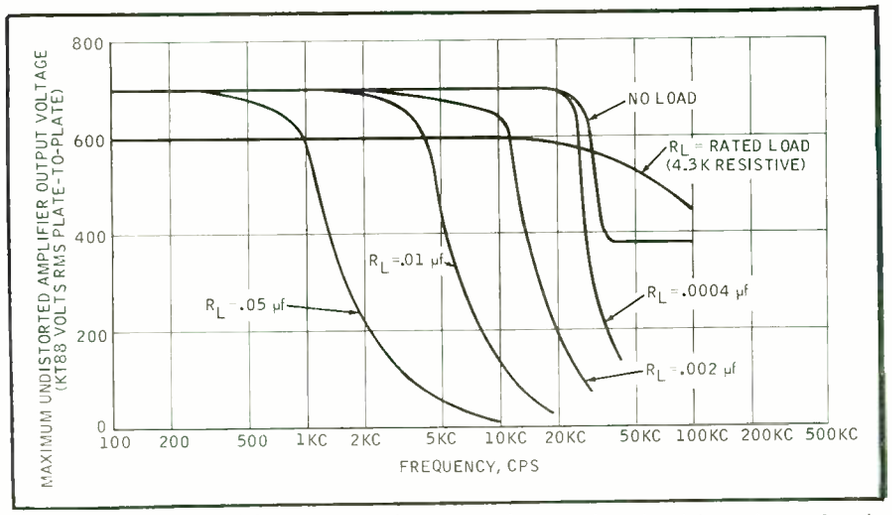

Fig. 8. Maximum omplifier output voltage vs. plate-to-plate load impedance for the author's 60-watt Dynakit omplifier.

crossover networks would be selected to give the desired crossover frequencies.

There may be other kinds of crossover networks that would work well with electrostatic woofers and midrange speakers. For example, if the crossovers were designed as RC networks instead of RLC, it may be possible to use the input capacitance of the speakers themselves as the capacitance elements in the network.

Amplifier Loading Effects

The author was curious as to what effect a capacitive load would have on the amplifier's power output at high frequencies, since the load line for the power output tubes becomes a circle instead of a straight line. *Figure* 8 shows the maximum undistorted plate-to-plate output voltage versus frequency of the author's 60-watt Dynakit amplifier for various resistive and capacitive loads. The amplifier's response is flat up to the frequency where the reactance of the load capacitance plus the 0.0015 μf winding capacitance in the output transformer equals the rated load impedance of 4300 ohms. The maximum output voltage then drops off at 9- or 12-db-per-octave above that point. The amplifier's maximum voltage output with the actual crossover network and electrostatic speaker load is slightly better than that indicated by *Figure* 8. The maximum output voltage (measured at the push-pull speaker plates) corresponds approximately to the curve for the 0.002 μf load in *Fig.* 8.

When tested with square waves the amplifier exhibited excellent transient response at high frequencies with the electrostatic tweeter and 500-cps crossover network as a load. To make the test realistic, two moving-coil woofers were connected to the amplifier at the same time through a 500-cps low-pass network. No ringing or overshoot was observable, and while a little rounding of the corners of the square waves was present it was much less than expected.

The outstanding transient response of this amplifier with a capacitive load is due to the design of the feedback networks used in it which I think makes the Dynakit one of the best amplifiers commercially available for driving an electrostatic speaker. The amplifier's one small drawback in its otherwise excellent design appears to be a slight tendency toward low-frequency instability. The author's Dynakit exhibited a 6-db peak in its frequency response at 8 cps (with no load on the amplifier). Both the peak at 8 cps and the tendency toward low-frequency instability were eliminated by changing the KT88 grid coupling condensers in the amplifier from 0.25 μf to 2.0 μf.

(Concluded next month)

Industry Notes . . .

• Superscope buys majority interest in Marantz. In a move that caught the industry by surprise, Superscope, Inc., U. S. distributor of Sony tape recorders, purchased a majority interest in the Marantz Company. According to Mr. Marantz, the change will allow the Marantz Company to increase production on various of its products which have been in short supply for some time, and also to develop new products. Distribution patterns and policies will be unchanged, according to Mr. Marantz, although representation in the New York and California markets will be handled through the existing Superscope offices.

• AKG Microphone Warranty Extended. AKG of America, the sole manufacturer's representative in the United States for microphones, headphones and accessories manufactured by AKG of Vienna, has undertaken to recognize currently valid warranties on AKG products sold in the United States prior to January 1, 1964. After January 1, 1964, AKG of America will recognize *only* the warranties with respect to products sold through AKG of America or its official distributors and dealers.

• Citation Helps Venus Space Shot. Correlated Data Systems Corporation based in Glendale, California, recently announced the use of forty Citation HB basic power amplifiers manufactured by Harman-Kardon Inc. as part of an elaborate and carefully regulated square-wave power supply. The Citation amplifiers were part of a complicated system which provided output waveforms up to 100V push-pull with rise and fall times to 3 micro-seconds. Citation was chosen by Correlated Data Systems because of its exceptionally wide, linear response at high power levels.

• Allen Becomes Gotham VP. Hugh S. Allen, Jr., was elected Vice President of Gotham Audio Corporation, New York City. Mr. Allen joined Gotham as Sales Director in January, 1963. In broadcasting and recording since graduation in E.E. from the University of California in 1940, Mr. Allen previously has been Sales V.P. for Langworth Feature Programs, New York with whom he spent 13 years: Supervisor in charge of Telecommunications Operations of the United Nations; and was associated with other recording and broadcasting activities on the West Coast before and after World War II. During World War II, Mr. Allen was an electronics officer and saw duty from Guadalcanal to the Philippines. He emerged with the rank of Lieutenant Commander. As Vice President for Gotham, he is responsible for advertising, sales, engineering and administration.

• Reeves Soundcraft Appoints Western Regional Manager. John E. Borg has been named Western Regional Sales Manager for Reeves Soundcraft Division of Reeves Industries, Inc. Borg will be responsible for sales of all Reeves Soundcraft magnetic recording products to the government, industrial and consumer markets. Borg formerly was Marketing and General Sales Manager of Technical Associates in Burbank, California, manufacturers of nuclear instrumentation products. He has also been associated with the Inet Division of the Leach Corporation and the Industrial Division of United Transformer Corporation in various sales and marketing positions.

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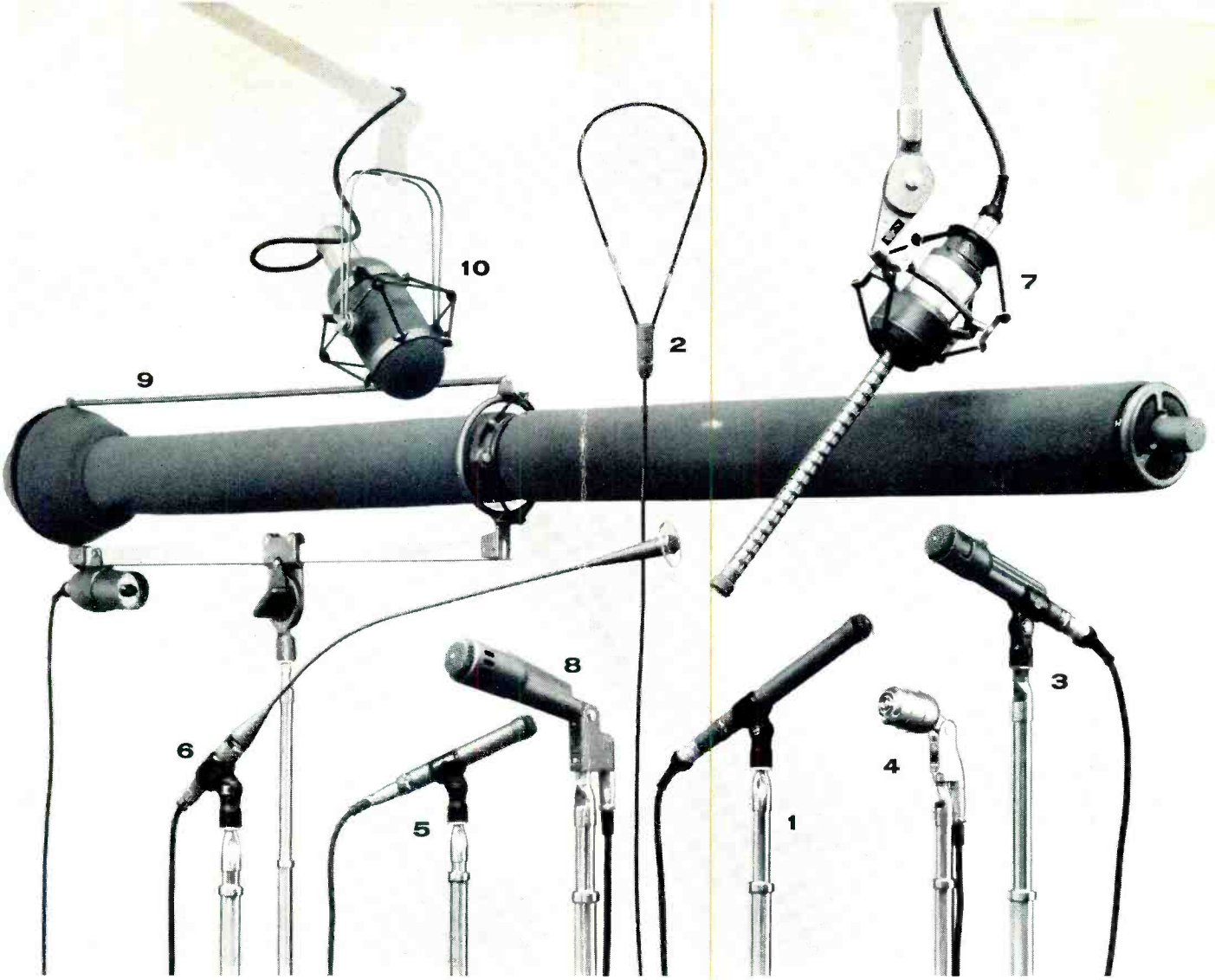

Ten Good Reasons Why Leading Audio Engineers (Who'll Stop at Nothing to Improve Quality) Choose E-V Professional Microphones!

1. High FIDELITY is your stock in trade. And the peak-free 40-20,000 cps response of the E-V 655C provides it simply and directly, with no complex added equipment to burden you.

2. It's quite easy to maintain complete COMPATIBILITY between the sound of lavalier microphones and stand units. Simply use the tiny E-V 649B with your larger E-V microphone. Voice quality mixes perfectly.

3. The reputation for RELIABILITY enjoyed by the E-V 666 comes from its ability to deliver superb cardioid response even after accidental abuse that would destroy many a lesser microphone.

4. The ready AVAILABILITY of E-V professional microphones at leading radio parts distributors everywhere is an E-V pioneered policy begun back when the "workhorse of the industry", the E-V 635, was introduced.

5. Outstanding in its FLEXIBILITY is the new E-V 654A. This versatile microphone slips easily into floor or desk stands, or can be hand held or used as a lavalier.

6. Ten E-V professional models give you unusual VARIETY. For instance, if you require close-up sound pickup, yet mustn't hide the performer, the ultra-thin E-V 652 solves both problems handsomely.

7. The CREATIVITY of E-V engineers comes from intimate knowledge of field problems. It earned them an Academy Award for their unique solution to film and TV sound problems with the E-V 642 microphone.

8. ECONOMY is vital in every studio operation, yet quality must be upheld. And the E-V 665 is ideal where superb cardioid performance is needed, but the utmost in mounting flexibility is not required.

9. Even the 7-foot long E-V 643 ultra-directional microphone is protected by this unique E-V GUARANTEE: except for refinishing, all repairs are *free* no matter what happens to the unit during the first two years!

10. The VITALITY of E-V design comes from constant improvement of existing models, plus fresh new ideas that solve your problems. Newest is the E-V 668, specifically created for boom microphone applications.

Put all ten good reasons to work for you in your studio or in the field by choosing the E-V Professional microphone that's right for your sound pickup requirements. Your E-V distributor can offer up to 15 years of experience in assisting studios to better sound. See him today, or write for a complete distributor list and free microphone catalog.

ELECTRO-VOICE, INC.
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Electro-Voice®
SETTING NEW STANDARDS IN SOUND