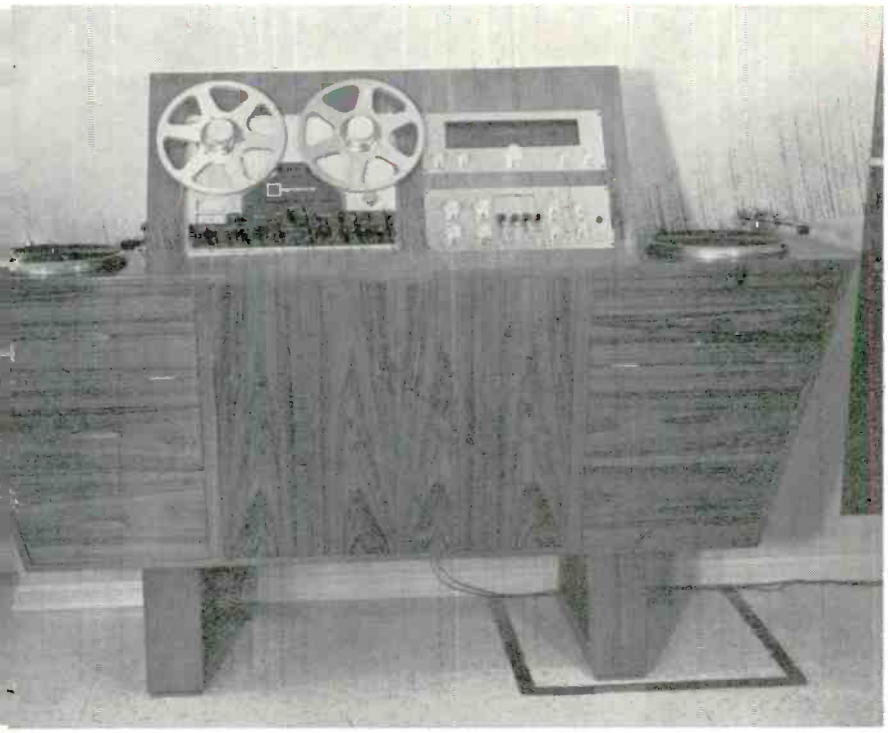
AUDIO

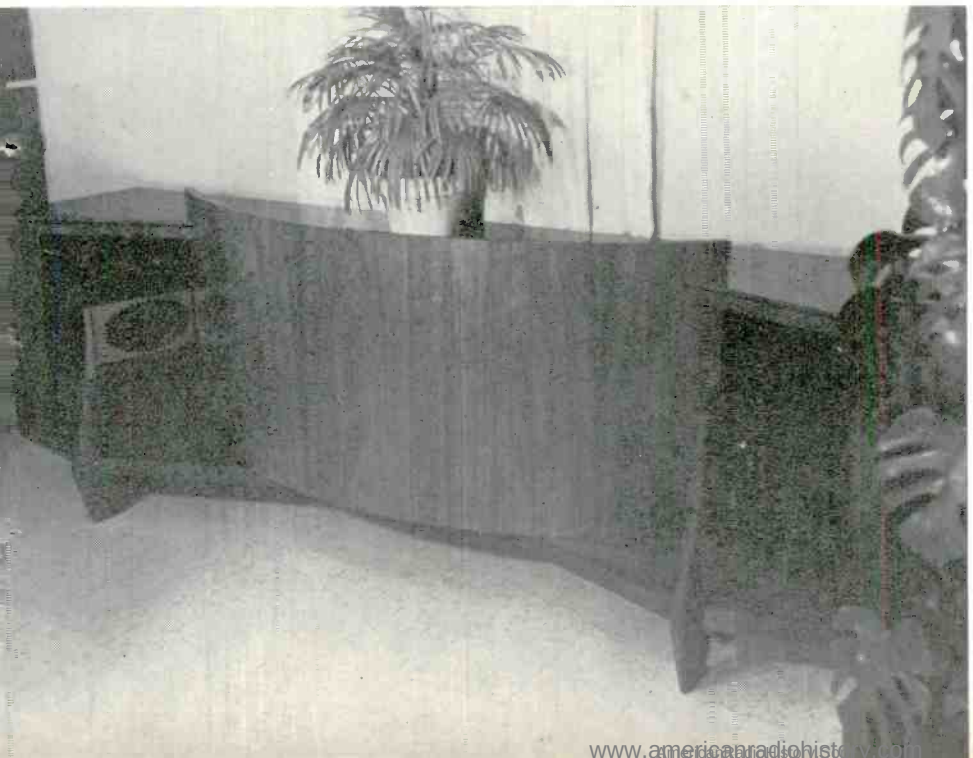
OCTOBER/1965
60¢

...the original magazine about high fidelity!



PERFECTIONIST'S AUDIO-IN-THE-HOME SYSTEM JUST LIKE YOU'D LIKE

See Page 42



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

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

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

All Critical Circuitry Pre-Wired

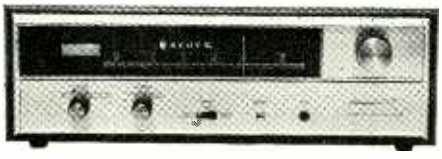
To insure perfect results, your LT-112 arrives with all critical circuitry pre-wired, pre-tested, pre-aligned, and mounted on heavy-duty printed circuit boards. Wires are all color-coded, pre-cut, and pre-stripped to the proper length. Scott's exclusive life-size, full-color construction book fully details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

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

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

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

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



SCOTT®

For complete specifications on the LT-112, write:
H. H. SCOTT, INC., Dept. 35-10, 111 POWDERMILL RD., MAYNARD, MASS.
Export: Scott International, Maynard, Mass. Cable HIFI. Prices slightly higher west of Rockies. Prices and specifications subject to change without notice.

Circle 100 on Reader Service Card

October, 1965 Vol. 49, No. 10

AUDIO

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AUDIO Articles

AUDIO Reviews

AUDIO Profiles

AUDIO in General

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COMING

ARTICLES

Evaluating the performance of stereo cartridges. By James H. Kogen. A description of the methods used by a cartdirge manufacturer, with sidelights on how to adapt the procedures to home use.

Accent on Stereo. By William G. Dilley. Another example of what can be done to provide high quality reproduction in the home with a definite consideration of appearance as well as performance.

Application of dual-track techniques to the recording of lectures with audience participation. By C. B. Hagen. Providing good coverage of both the lecturer and the questions from the audience if sometimes a problem, but this technique simplifies the operation.

Output control/microphone amplifier for the stereo-converted Uher 4000-S. By C. G. McProud. The follow-up on the conversion article in this issue.

PROFILES

Viking 96RMQ Tape Transport and RP-120 Record-Play Amplifier.

Mattes SSP/200 Power Amplifier.

Hartley 220-MS Loudspeaker System.

In the November Issue

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

AUDIO CLINIC

Joseph Giovanelli

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

Reducing Automotive Ignition Radiation

Q. I wish you would at some time or other, discuss the problem of ignition interference in FM car radios in AUDIOCLINIC. *Many stores are more than eager to sell FM car radios or converters to the unsuspecting buyer, carefully avoiding all mention of this problem which has to be dealt with squarely before any kind of success can be hoped for. What exactly must be done to the engine of a car which has only an AM radio in order to make it interference-free for FM? John Kellner, Boston, Massachusetts*

A. This problem is very common. Mobile telephones, police radios, and business radios for mobile use have all been subject to this kind of trouble because they, like the FM band, fall within the VHF range of frequencies. This range is susceptible to ignition pickup.

Sometimes the following methods of treating the vehicle itself are sufficient to eliminate radiation from the ignition system.

1. The motor should be grounded to the frame because sometimes it is mounted on shocks and no ground provision is made.

2. The tailpipe should be grounded, Failure to ground this tailpipe will result in its radiating a signal.

3. The hood should close properly. The Contact surfaces should be electrically conductive so that the hood can act as a shield.

All ground wire should be heavy. No. 12 gauge is a good choice of wire for ground straps. Flat copper braid about ½- to ¾-in. wide is even better.

The motor itself may require quieting by putting suppressors on center pole of the distributor. If this does not result in sufficient improvement, you will then have to add suppressors to the spark plugs. These suppressors of which I speak are designed to fit between the plug itself and the wire which connects to the distributor. Suppressors are nothing more than resistors whose terminals are designed to accept the appropriate automotive fittings. They have a drawback in that they make it slightly more difficult to start the engine in cold weather.

The generator is often a problem. You can take the "hot" lead from the generator field and bypass it ground by a coaxial capacitor which is available for this purpose. Sometimes, however, all you need to do is run this lead in braid. Of course, the braid must be grounded to the car frame.

The suppressors and capacitors are availble in a package designed to reduce automotive radio ignition radiation.

Recording Level and Record Speed

Q. When playing 33 1/3-rpm microgroove discs, I get exceptionally clean sound with hardly any noticeable distortion. However, when I play 45's, I notice a breakup of the high frequencies. The stylus shows no sign of wear and the amplifier contains an electrical mixing system to combine the two stereo channels of the cartridge for monophonic use. What causes this breakup at the high frequencies?

I notice that when playing both 45's and 33's that the recordings sound too fast when compared to the same recordings played on a certain New York radio station. To reduce the speed of my changer I hooked a Variac line transformer between the changer and the a.c. 60-Hz line. To drop the speed of the changer down to that of the radio station, I have to set the transformer at 70 volts. This is almost half that at which the changer should be operated. Will this hook-up damage the changer's motor or internal mechanism? Who is right on the record speed, the manufacturer of the record changer or the radio station: Martin Ruszala, South Amboy, New Jersey

A. The recording level is very great on many 45-rpm recordings. It is high enough on 33's, Heaven knows, but the makers of 45's really want to supply their customers with "loud" records.

You can track the 45's a little heavier than you are at present. This may help to relieve the condition to some degree.

Before making any adjustments to the changer, you should determine whether the changer is really running fast, regardless of the speed accuracy of the radio station to which you have been comparing your changer's performance. This can be done by means of a stroboscope. A stroboscope is a little disc which is placed on the turntable. There are dots or radial lines on this disc, possibly three rows of them, corresponding to 33 1/3, 45- and 78-rpm record speeds. The 33 1/3-row is usually nearest the outer adge of the disc. The 16 2/3-speed is exactly half the 33 1/3-speed. Therefore, the 33 1/3-row can serve to set both speeds. To use the stroboscope, you merely set the changer to the speed under test and scan the dots or lines corresponding to that speed. Shine a light on the dots. The light cannot be a flashlight; it must be fed from an a.c. power line. While an ordinary incandescent lamp can be used,

How great is the LAB 80?

the experts praise it...

Audio March 1965

"... This Garrard does a lot, and it does it amazingly well ... looks professional. [Four control levers] are carefully linked and we found it easy to effect a mode change while a record was playing without any jarring ... Cartridge mounting was easy and conventional. There is more than enough room to hold any cartridge ... The Lab 80 acquitted itself admirably on the test bench ... Speed accuracy and constancy in the face of charging voltage were outstanding ... Bearing friction is very low both in vertical and lateral motion ... the Lab 80 will perform well with any cartridge currently available (or on the horizon) ... may well be the automatic turntable which can satisfy both the decorator and the music lover ..."

High Fidelity April 1965

"... a superior record-playing device well worth the attention of serious listeners as well as those seeking primarily convenience of installation and operation ... attractively styled and very well constructed of high-quality parts showing precision workmanship ... should need little maintenance care over its useful life ... performed beautifully both as an automated turntable and as a manual combination ... Wow and flutter were very low ... completely inaudible ... Tracking is well nigh perfect ... can handle cartridges of all weights, including the lightest, and of all compliances, including the highest."

Hi/Fi Stereo Review May 1965

"... the only automatic turntable I know of that has an adjustable bias compensator for overcoming the side thrust inherent in any tone arm with an offset head ... quite effective ... distortion was very low even at the highest velocities ... The arm-raising and lowering mechanism worked perfectly with impressive smoothness and silence ... The effectiveness of this system is indicated by the fact that the change cycle will trip with tracking forces as low as ½ gram ... very low rumble level ... better than most manual turntables I have measured ... this handsome and smoothly performing record player is fully compatible with the highest-quality high-fidelity components."

Popular Science July 1965

"You can team this automatic turntable with the highest quality hi-fi stereo components with complete confidence ... you can play your stereo records indefinitely with almost no perceptible wear ... Rumble is less than with most professional turntables ... Wow and flutter are imperceptible even on sustained piano tones ..."

...the owners love it!

Electronics World July 1965

"In addition to being one of the most attractive record players we have seen, it meets the highest performance standards for home high fidelity equipment."

"I consider the LAB 80 a remarkable achievement. The arm tracks perfectly at pressures ¼ to ½ gram lighter than the excellent (DELETED) arm I had before ... The cueing device is a delight to use ... May I again compliment you ..." ***ALAN GOLDFINGER, Calif.***

"As a previous owner of a Garrard AT-6, I expected quality products from Garrard—but the Lab 80 has surpassed all my expectations ... My unit arrived in perfect condition and operated flawlessly ... Thank you for ... giving me an opportunity of owning the finest automatic turntable available today." ***DAVID F. DUNSON, Florida***

Garrard®

IMPORTANT READING: The Lab 80 and the other three new Garrard models are fully illustrated and detailed in the 32-page Comparator Guide. For your complimentary copy and reprints of the magazine reviews, write Garrard, Dept. GR-15, Westbury, New York 11591.

LAB 80—$99.50 less base and cartridge

CIRCLE NO. 103 ON READER SERVICE CARD

better results can be obtained by using a neon lamp connected through a suitable resistor. Some lamps have the resistor built into them. If the dots appear to be stationary, the motor is running at the correct speed. If the dots appear to be moving, the table is moving too fast or too slow, depending on the direction of the motion of the dots. A clockwise motion indicates that the table is running fast. A counter-clockwise motion of the dots or lines indicates that it is rotating too slowly.

Assuming that the strobe tests indicate that the changer is running fast, you must slow the changer down. I do not recommend that you do this by the method you are now using because that method will give rise to wow and flutter, even though it will do no damage to the changer. Motors of the type used in record changers are frequency sensitive rather than voltage sensitive with regard to speed. The correct method of changing the speed of rotation of such a motor is to change the frequency of the a.c. supply line. Reducing the frequency of the power source will reduce the speed of motor rotation, and vice versa; increasing the frequency of the power source will increase the frequency of rotation of the motor. This could be accomplished via an oscillator-amplifier combination but there are other ways of accomplishing the adjustment of *turntable* speed as will be seen.

Reducing the voltage will not cause any decrease in motor speed until a point is reached where the motor is very much under-powered and is on the verge of being unable to pull its load. The speed may vary, depending upon the number records in the stack. In this under-powered condition, the motor may not have sufficient power to pull the machine through the change cycle.

The only thing to do is to have the motor shaft ground down so that it will have the proper ratio between itself and the turntable rim. Of course, if the table is running slow, a collar must be placed around the shaft to give it a larger diameter. These three factors determine the speed of turntable rotation: the size of the motor shaft, the size of the driven portion of the turntable and the speed of rotation of the motor. The size of the idler wheel makes no difference in determining the speed of turntable rotation. The diameter of the idler wheel does not change the ratios between the motor shaft and the driven portion of the turntable.

If you are careful and use fine emery and crocus cloth, you can grind the motor shaft yourself. However, if you are afraid to undertake this job, the machine should be returned to the manufacturer or some reliable service shop.

While you are making the tests, you should determine the accuracy of all speeds. Then, everything can be taken care of at the same time when the machine is on the bench.

A final thought: Is it possible that you are using a 50-Hz model? (If it was procured outside the U.S. it probably is.) If so, obtain the 60-Hz motor pulley from the manufacturer or importer. Æ

After two months of what **Popular Science** described as "the most extensive listening tests ever made by any magazine," a panel of experts chose components for stereo systems in several price categories. The components in the highest rated system were to be the best available no matter what the price.* "Where there was a more expensive component that produced a detectable improvement in sound," stated **Popular Science** authors Gilmore and Luckett, "it was chosen."

AR-3 speakers and the AR turntable were the choices for **Popular Science's** top system.

The **Popular Science** panel was not alone in its findings. Two other magazines — **Bravo!** and **Hi-Fi Tape Systems** — selected components for the best possible stereo system; AR-3 speakers and

THE AR-3's WERE CHOSEN AS BEST.

Two of **Popular Science's** five-member panel check speakers.

the AR turntable were the choices in each case. **Gentlemen's Quarterly** chose the AR turntable for its top ($3,824) system, but relegated AR-3's to its "medium-cost" ($1,273) system. (The complete lists of selected components, as they appeared in these four magazines, are available on request.)

The AR turntable by itself has been reviewed by leading authorities as the best in the entire field regardless of price.

Yet you can spend many times the price of these AR components. AR-3 speakers are $203 to $225 each, depending on finish (other models from $51), and the two-speed AR turntable is $78 including arm, base, and dust cover.

*Speakers limited to "compacts" for reasons of practicality in the home.

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

Circle 106 on Reader Service Card

LETTERS

Recording Speed Inaccuracy

SIR:

This will be the *second* magazine on audio subjects which I have corrected in this mistake. Please, please, divorce yourselves from this strange notion.

I refer to a recent PROFILE on a tape recorder which mentions a speed inaccuracy of +2%. You indicate, quite correctly, that (pre-) recorded tapes played on this machine will be slightly sharp. Then you boo-boo in "Tapes made on this machine, of course, would be pitch-accurate on playback."

An error in recording speed of +2% gives a tape with a rate of 102%. Played back on the same machine, the error is 102% +2%, or 104.04%. (*Should be stated as 102% × 102%.* ED.) In other words, the rate is about 4% fast.

This inaccuracy is quite common, and 2% inaccuracy is, by current technical practice, acceptable, and would not be noticed on speech. However, on the basis of 25 years of listening to good music, I would consider it to be of great magnitude. A difference of 4% in interpretation is considerable. I should regard as acceptable a regulation of around 1½ to 2%.

Name Withheld

(*We disagree. In the first place, a tone recorded on a machine which is 2% fast will play back on a standard machine which is exactly "on speed" at 2% slow instead of fast. On the same machine, it will reproduce properly. Consider, for example, a 7½-ips machine which records 50% slow—that is, at 3¾ ips, played back on the same machine at the same 50% slow, which is still 3¾ ips, the recording will come out exactly on-frequency. As long as recording and playback are done on the same machine and it maintains the same inaccuracy all the time, the playback will be identical to the recording, and this condition will obtain at 1 ips or at 60 ips, or at any speed whatever. This overlooks the difference in frequency response at the various speeds, of course. But a given tone will reproduce exactly the same, so long as the recording and playback speeds are identical.* ED.)

Disc Quality

SIR:

Recently in a discussion of the quality of stereo and mono LP records, an interesting question was raised—Can a superior-quality recording be obtained from a legitimate record store by paying the full price, as opposed to buying the same record in a discount house for approximately half the price?

Three out of five of us said there was an audible difference in quality, while the others agreed to investigate the issue.

The reasons given pro and con were: 1). A discounter buys quantity. Therefore he can operate on a lower profit per disc. 2). A discounter makes "deals" with the distributor, and therefore buys the records cheaper. 3). The first "clean" pressings from the stamper may go to the record store at a premium price, while the hundredth or thousandth pressings may go to the discounter at a lower price. 4). A discounter may buy audibly imperfect records for practically nothing and mix them in with the good discs.

Whether or not there is any truth in this question should affect the buying public. Please advise us with your opinion and the facts.

ROBERT SINGER,
25 Melissa Road,
R.D. 2, Kingston, N.Y.

(*We like to think that our opinion and the facts are identical. In the first place, we must accept the fact that the "discounter" is just as legitimate a business as any other. If a given store can sell ten times the number of products as another of the same size and probable overhead, he can exist on about one-tenth the profit on each item. Considering the mechanics of manufacture and distribution, we doubt if it would be possible to separate the "audibly superior" records from the "seconds." When a discounter orders 1000 records, it is likely that they are simply taken from stock and shipped, just as an order for two or ten would be. Certainly not every record is actually listened to—probably not more than 1 in 100. The only 100% inspection is a visual one.*

Furthermore, "deals" for records are not very legal—though differing prices for quantities are, of course. The big price reductions usually are given only for "remainders," large lots of records which were poor sellers. ED.)

Audio Engineering and Recording Education

SIR:

I am at present enrolled at San Antonio College and have had two years of basic engineering courses. I am interested in the field of Audio and Recording Engineering but have found it difficult to locate colleges offering a program in this field. Would you please help me in finding the educational institutions (or recommend any particular colleges or universities) offering courses in this particular field?

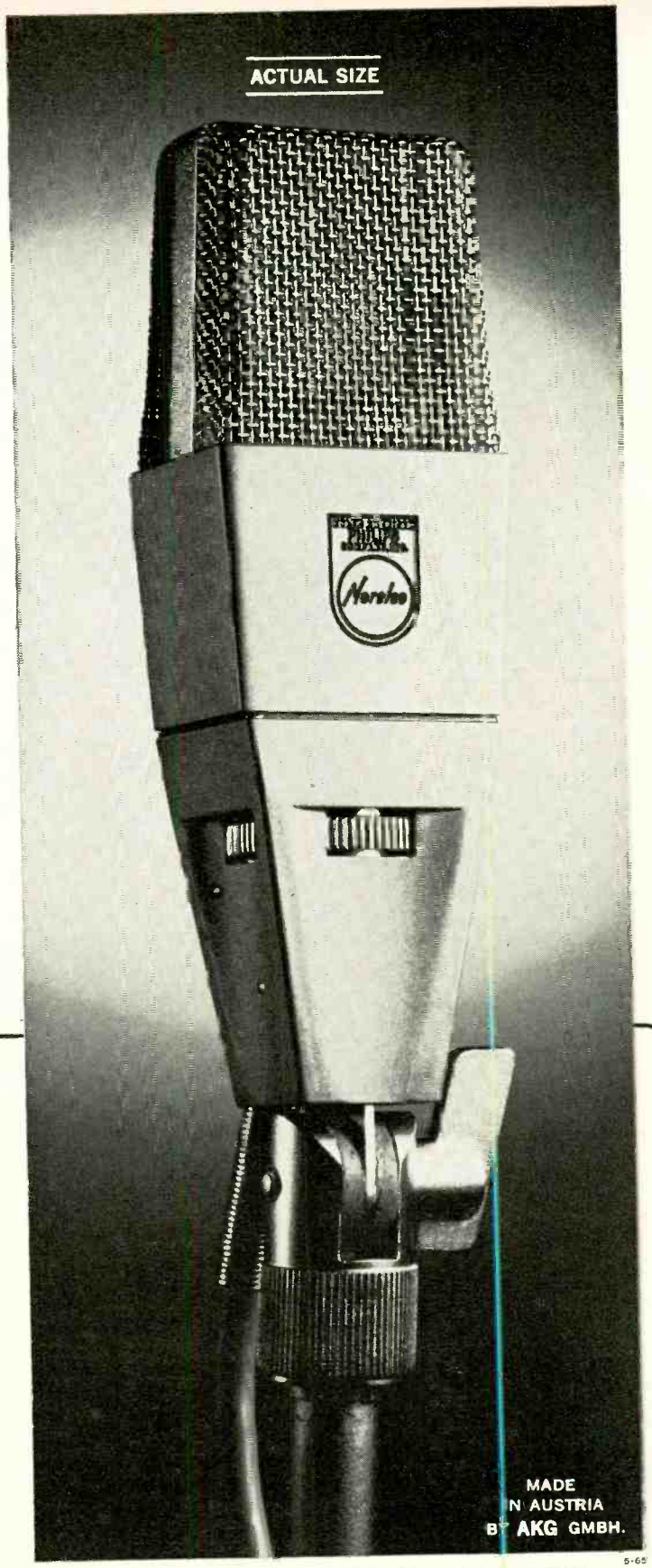
I would certainly appreciate your assistance or any information you may have that would help me plan for my future education.

VAN C. EDWARDS,
315 Williamsburg,
San Antonio, Texas 78201

(*We'd really like to help, but we don't know of any colleges or universities which offer such over-all courses. We would be pleased to publish a list of any that do, along with their curricula, if any of them are now offering such courses.* ED.)

C-12A

The C-12A condenser microphone represents a significant advancement in microphone design; its development has been based upon the experience and requirements of professional sound recording studios. ■ Twin diaphragm, mylar foil ■ Exceptionally low distortion due to nuvistor low frequency circuit in the pre-amplifier ■ Nine variable patterns may be remotely selected ■ ±2.5 db deviation from frequency response curve ■ Bass attenuation: 0, −7 db, −12 db

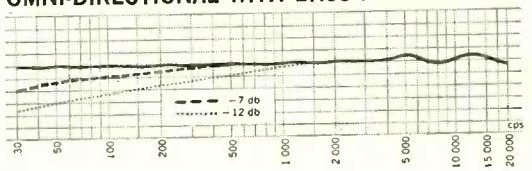


SPECIFICATIONS

Type	Pressure gradient, mylar foil capsule
Frequency range	20-20,000 cps ±2.5% (related to published curve)
Sensitivity	−46 db (1 mw/10 dyne/cm²) at 1,000 cps.
Directional characteristics	Cardioid, omni-directional, figure-of-eight, plus intermediate positions.
Nominal output impedance	200 ohm or 50 ohm
Sound pressure level	At a distortion of 0.3% 150 μbar at 40 cps, 1,000 cps, 5,000 cps.
Plate voltage	110 V
Filament voltage	5.2 V ±5%
Complement	Nuvistor
Temperature	−14° to +150° F
Relative humidity	90%
Bass attenuation	0, −7 db, −12 db in Power Supply
Connectors	Cannon, entire system

POWER SUPPLY

OMNI-DIRECTIONAL WITH BASS ATTENUATION



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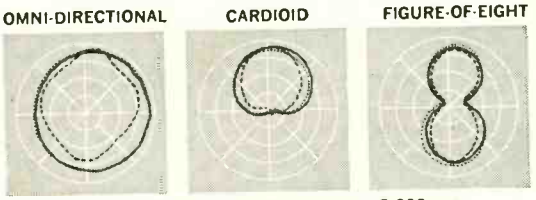

—— 125 cps - - - 1,000 cps ···· 8,000 cps

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Professional Products Division, 100 East 42nd St., New York, N.Y. 10017

Circle 109 on Reader Service Card

LIGHT LISTENING

Chester Santon

Robert DeCormier Singers: Heritage
Command Tape RS 884

Is it true that record and tape companies try to produce their best work in time for the autumn High-Fidelity Shows? If such is the case, Command Records has succeeded here beyond expectations. Cataloging the exceptional features of this four-track tape (not necessarily in order of importance), the signal-to-noise ratio is about one-third better than the present average. The sound leaps out into a room where most four-trackers take a bit of coaxing. The tone controls, believe it or not, can be set in a flat position and the frequency range goes considerably beyond the current run-of-the-mill. Don't miss this reel if you're even mildly interested in what four-track tape can deliver today under optimum conditions. As for the performance, it is also no slouch as Robert DeCormier leads his mixed chorus and not quite an orchestra in rousing songs and ballads popular in this country between the years 1750 and 1840. These are crisp and alert re-creations of a variety of Colonial and Revolutionary tunes that reflect a basically optimistic era. "The Riflemen of Bennington" and "Yankee Doodle" provide a brisk workout for the instrumental ensemble. "I Been in the Storm So Long" is a forerunner of the Negro spirituals that flourished after 1840. The humor of the times is to be found in "When I First Came to this Land." Command's separation of male and female voices is on the extreme side, so much so that the two female leads occupy the same ground at the far left end of the stereo listening area. In this case, you're sure to overlook the positioning of the artists as soon as you sample this sound at more than one listening level. This is an outstanding tape.

Melachrino Orchestra: Something to Remember You By

RCA Victor LSP 3398

The death of George Melachrino last June in London affects the situation of background music in more than one country. Anyone who has followed the rise of this orchestra since the days when their first HMV 78-rpm shellac discs appeared in the U.S.A. will hardly need reminder that an outstanding artisan in light music has left the scene. To say that Melachrino raised the standards in his field doesn't mean too much unless the point is stressed that much of the pioneer work in mood music was his. Since the vaults of any major record label can hold quite a bit of unreleased material at any given time, it may be premature to call this Melachrino's last album. If it is, it's a representative example of what he could do with class material. Here he reviews the great songs of Arthur Schwartz and Howard Dietz written for Broadway shows and revues from 1929 to 1963.

Boston Pops: Music from Ship of Fools

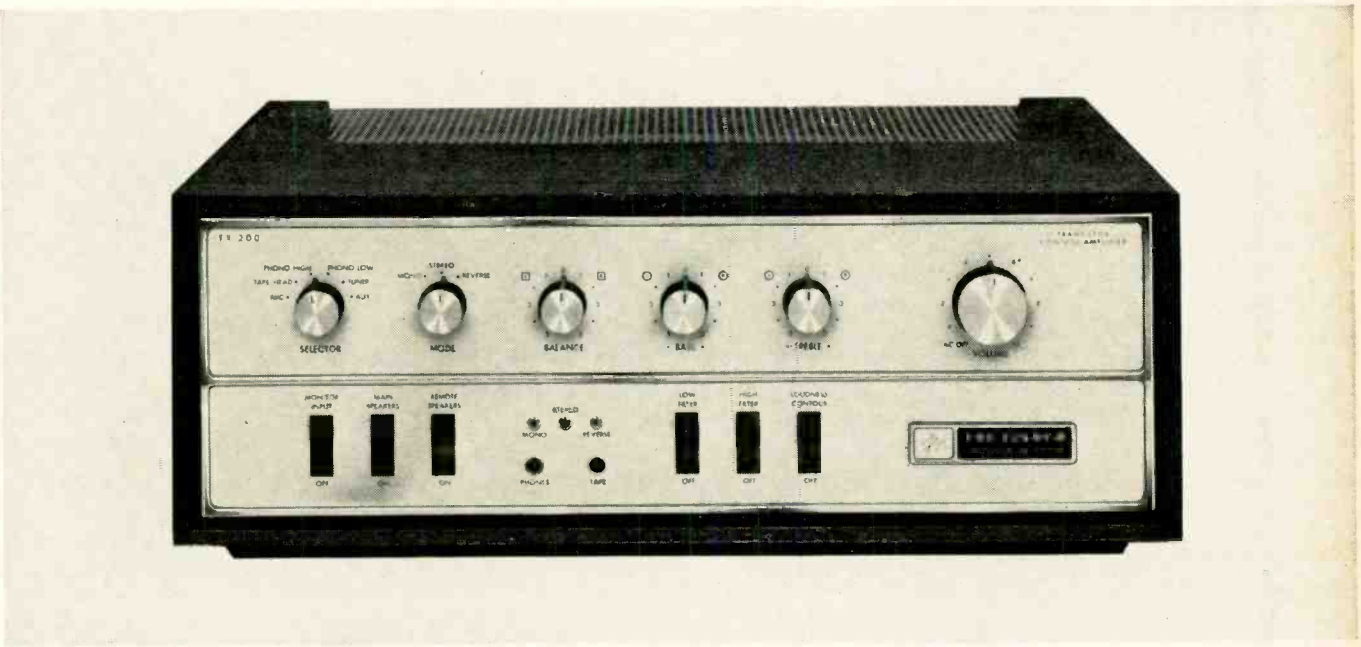
RCA Victor LSC 2817

Quite apart from its literary attainments, Katherine Anne Porter's lengthy novel of a few years ago drew a lot of attention because it took so long to write. Stanley Kramer's motion picture version of the novel, with production costs what they are nowadays, could not rely on longevity in the creative process to set it apart from other films. There are several indications that this is a major movie, not the least of these being the choice of background-music composer and the subsequent corraling of the Boston Pops Orchestra to perform the finished product. Ernest Gold, whose music had so much to do with the success of "Exodus," was the logical man to provide the score for this unsettling story of the giddy Thirties. The action takes place aboard a German passenger boat sailing from Vera Cruz to Bremerhaven with a heavy cargo of problems belonging to a richly assorted group of passengers. Unlike most motion picture soundtrack albums this release required a "translation" of the music before the public could be expected to buy it for home listening.

The original score had to be tailored to fit the limited resources of the ship's ensemble heard at meals and dances as the vessel plies the Atlantic. Only a violin, cello, and piano were available to Gold for the waltzes, fox trots, and light classical numbers he was to devise to recall an era of Central European music. A Viennese by birth, Gold has provided a score that sounds familiar yet reasonably fresh in special arrangements he had to make before the music could be played by the nearly-hundred-man Boston Pops. The hit of the album and without doubt the leading inducement to record sales will be the lush love theme called "Ship of Fools." It seems to have everything needed to make the hit charts. Listeners familiar with the perky music making of Mexican Mariachi street bands will certainly get a kick as the Boston Pops rips into the first selection on the record. Stereo throughout is very convincing as a major film gets the Big Treatment. *Æ*

12 Forest Ave., Hastings-on-Hudson, N.Y.

At last! A solid-state amplifier as great to listen to as it is to talk about.



The relatively young technology of transistor circuits has resulted in quite a number of solid-state amplifier designs that sound better on paper or in conversation than in listening tests. It seems that producing a no-compromise transistor amplifier which equals or surpasses the performance of comparable vacuum-tube models demands a special kind of engineering ability and experience. The Fisher kind.

Fisher solid-state amplifier design begins with the elimination of the output transformers. Thus, the bass performance and transient response of the new Fisher TX-200 stereo control-amplifier are not limited by transformer characteristics. And instead of the conventional two output transistors per channel, Fisher engineers put in *four*, to give you conservative operation at high power.

Not only can the rated power of 90 watts (IHF Standard) be obtained at 8 ohms, but almost as much power is available at 4 or 16 ohms, via the special impedance-selector switch. The IHF power bandwidth (half power at low distortion) extends from 12 to 50,000 cps!

As for preamplifier and control features, the TX-200 provides 16 inputs and 12 outputs to accommodate every type of program source, recording instrument, loudspeaker or headphone – plus 16 controls and switches for total control of the sound by the listener.

And, unlike certain hastily engineered transistor amplifiers, the TX-200 works equally well after three hours, three months, or three years. That's Fisher reliability. And that's *really* something to talk about.

Size: 15-1/8″ x 4-13/16″ x 11-7/8″ deep. Weight: 24 lbs. Price: $279.50. Cabinet: $24.95. (The Fisher TFM-200, a transistorized tuner designed to match the TX-200, costs $229.50.)

FREE! $2.00 VALUE! Mail this coupon for your free copy of *The New Fisher Handbook*. This entirely new, revised and enlarged edition of the famous Fisher high fidelity reference guide is a magnificent 80-page book. Detailed information on all Fisher components is included.

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The Fisher TX-200

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ABOUT MUSIC

Harold Lawrence

Two-Gun Percussionist With Jangled Nerves

The recording sessions described by the author took place at Watford Town Hall outside of London on August 4-6. The Mercury record in which Satie's *Parade* will appear is part of a program including works by Milhaud, Auric, and Françaix to be released early next year.

"Apart from the percussion, we should have no special problems with *Parade*." So Antal Dorati assured me a few days before we began to record. There was no reason to doubt him. The music in question was a ballet score by Erik Satie (1866-1925), the eccentric French composer who dressed in grey velvet from head to toes, lived in a poor workingman's suburb of Paris, and represented for composers like Ravel and others the new post-impressionist movement in French Music. Satie's ballet is 'easy' to perform. The 15-minute work, composed for Diaghilev in 1917, moves along at an unvarying metronomic rate of 76; the thematic material is uncomplicated to the point of naiveté; and the orchestration is lean, despite the large forces involved. In fact, for some players in the London Symphony, it was perhaps too easy. Remarked Barry Tuckwell, the orchestra's superb first hornist: "When are you going to give us some semi-quavers to play?"

But James Holland, the principal percussionist, was not so complacent. It was his job to assemble a battery of seventeen instruments, most of which belonged to the traditional percussion famiy. They included snare drum, bass drum, cymbals, tam-tam, tambourine, woodblocks, small drum, lottery wheel, xylophone, triangle, sirens (high- and low-pitched), revolver, *flaques sonores*, and *bouteillophone*. First, Holland tackled the *bouteillophone*.

As its name implies, the *bouteillophone* consists of tuned bottles, fifteen of them, whose range extends from D above middle C upwards for two octaves — a typical Satiesque 'instrument' "I've never heard of bottles actually being used in a performance of this score," explained Holland. "The vibraphone is the closest we percussionists can come to the sound of tuned bottles. But we'll try."

The manager of the Watford supermarket began to fill two "shells" (English for "cases") with empty ginger-beer bottles. "What do you plan to do with these?" he said as he lifted them onto the counter. "Why, I'm going to 'prepare' them for a recording session," Holland replied; and he placed his strange purchase in the trunk compartment of his car and drove to the Town Hall. In the kitchen, he and his assistant poured varying quantities of water into the bottles, carried them into the auditorium, and began hitting them with mallets.

With the vibraphone standing by, Holland began to 'build' the required scale. He tapped, listened, poured off water from one bottle, added some to another. Finally, the percussionist had to admit defeat. Standing in a puddle and grasping his wet mallet, he reported that the bottles could not encompass the entire range. The vibraphone was rolled into position and the bottles put back in their shells.

For the second time, water was to spell frustration for the percussion section. In the movement, *Prestidigitateur Chinois* (Chinese Conjurer), Satie scored a brief passage for "flaques sonores" (literally translated: "resonant puddles"), which are written to resound 15 times. When asked which instrument he planned to use for this, Dorati skirted the puddle and asked me to conduct an investigation into the exact nature of the composer's 'instrument.'

I first discussed the problem with Felix Aprahamian, music critic of the Sunday Times and an expert in French music. "I haven't the slightest idea of what Satie could have had in mind," he protested. "But why don't you contact Rollo Myers. He's written a book on Satie. He's your man." I phoned Myers in Sussex. "Flaques sonores! (Pause.) Probably one of Satie's jokes. He liked to invent instruments, you know." *Editions Salabert*, Satie's publisher, was no more helpful. Apparently the choice of instrument is left to the percussion player, I was informed.

Holland and I put our heads together. What would most resemble a resonant puddle? "A small cymbal might do it," Holland said, whereupon he jangled through his trunk of small percussion instruments and came up with a cymbal which he struck several times. The sound of metal was too dominant. "Choke it this time and use a different stick," I said. After some experimentation, Holland achieved exactly the right fortissimo splash.

On hearing it, Dorati agreed that the effect was correct, but he said: "Look, gentlemen, why don't we try to simulate the sound of a *real* puddle? We have nothing to lose; if it doesn't work, we'll return to the cymbal."

Within minutes, a large roasting pan was located in the Town Hall kitchen, filled with water, and brought into the auditorium. While the recording staff listened in the control room upstairs, the percussionist slammed his cymbal into the "puddle." The sound of water being agitated was plain, but no splash. Dorati suddenly hopped off the podium, rolled up his sleeves, and, his eyes gleaming with boyish delight, slapped the water vigorously. A dozen first violinists were instantly splattered with the flaque. Over the microphones it sounded as if someone had plunged into a large bath tub. Much laughter. It was decded unanimously that, in this case,

(*Continued on page 88*)

Antal Dorati rehearses the typewriter sequence in "Parade." Note the roasting pan in the foreground. (Photograph by the author).

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Until now, a pair of good speakers alone could cost you $200, $300, even $400 or more. And they were much too big for most rooms. Not any longer. Now you can get a superb Maximus speaker system for only $59.50.

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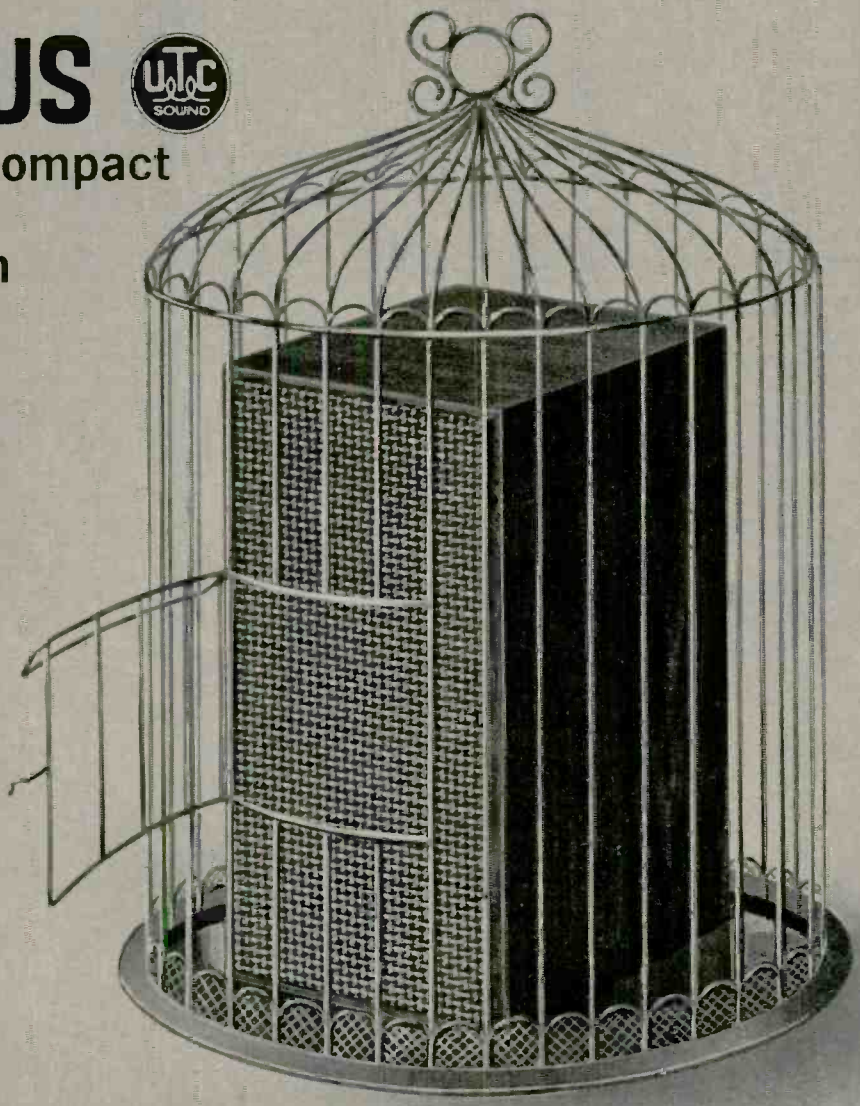

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AUDIO ETC.

Edward Tatnall Canby

TV TAPE. WHICH WILL IT BE?

I'm back again on a warm subject, growing hotter. Not in terms of the moment, I'll admit. But definitely for the future. Home TV on tape.

This is my third effusion on that subject, which might seem one too many—except that since my last installment the whole area has blown sky high with a brand new home TV recorder launched and on the market. And it's a different kind.

I'll admit, Ampex had me fooled. Back only months ago when they launched their first *linear* TV recorder for standard-size quarter-inch tape I couldn't have guessed that they already had a very different recorder practically ready for the home market. It isn't linear, it doesn't use quarter-inch tape. It is of the moving-head type, like the big commercial TV recorders (but ingeniously using only a single head). And its tape is no less than one inch wide, moving at slow speeds. Highly incompatible with present home audio recording, it would seem.

And so it might look as though my idea of audio-video compatibility, in one and the same recorder, were knocked for a loop. *One-inch* tape! Phew! So it'll be audio tape recording on one machine and video on another, and that's that.

But don't jump too quickly to conclusions. I'm not giving up the idea—not without some further speculations.

Admittedly I was "wrong" in suggesting that Ampex might aim the next-generation linear recorder at the home market, or the generation after that. Wrong for the moment anyhow. But put "wrong" in quotes because, remember, I didn't state that as a fact, but as a hypothesis. I made a projection, based on a whopping and arbitrary assumption, just for the argument: that refinements in heads and tape would make slower linear speeds possible than the presently necessary 90-plus ips. IF speeds could be slowed, perhaps to a practical 15 or 20 ips for acceptable linear home TV, then what?

The audio-video recorder, of course. Inevitable. No question about it at all.

But now we have a *de facto* home TV recorder of a radically different sort. And it's obviously not planned to be compatible in any way with audio tape recording.

Right now you can have this new deck in your living room for a mere $1000-odd, which is a reasonable first-model introductory price. (Remember the $13 ballpoint pen from Reynolds?) It works. It has two speeds, "hi fi" and "compact" (my own terms). It's easy and convenient to use, even if a two-hour (slower speed) reel of the one-inch special tape does cost a mere $65. In many ways this is a sensible and logical machine, under *present* conditions, avoiding some of the really serious drawbacks of *present* linear TV recording—the excessively high speeds, from 90 to 120 or so ips, and the horribly dangerous and tricky tape drive and control system that is required to roll ultra-thin half-mil tape at these outrageous speeds without snafus. The new one-inch tape moves sedately and slowly, as safe as a church. Its two speeds are 4.8 ips and 9.6 ips. An immense advantage, outweighing—*as of now*—all possible advantages of the linear system in respect to compatibility. So why argue further?

But let's argue, just the same. The big question still remains, and it is still hot: HOW in the future will video recording fit into the present home gadget picture (or the future picture)? It is short-sighted to imagine that it will remain wholly independent, quite removed from all the other systems in the home and around it. It isn't independent now. You have to hook it into your TV set. It certainly will *somehow* affect our two major areas of home gadgetry, one of them being our own: the home hi-fi system, and the home picture system, both movies and TV, not to mention still color slides.

I pointed out in my last installment that the all-over gadgetry in these two areas is already intricately interconnected in many ways and is likely to develop new interconnections. With TV recording's appearance on a large scale, these new interalignments may become explosive.

Instant Gadgetry

All the home areas are now expanding and changing. Look for instance, at what Polaroid did to pictures. First — instant black-and-white photos. Then instant color. And in response from the rival companies we have seen home photography turned inside out—instant cameras, instant film in packs and cartridges and, now, a whole new instant-type larger-picture 8-mm movie system. (See *Sound and Sight*, AUDIO, August.) Things move fast.

If TV recording breaks into the home, will it have any less explosive effect? Where will it go? In what ways will it force violent changes—and in what areas? Hi-fi and tape recording? Or cameras and filmed pictures?

Instant TV pictures on tape, and play 'em right back—or erase them and try again. Will that make the Polaroid people sit up! And, Agfa and Eastman too.

But how about instant TV pictures on your hi-fi tape recorder? That is still an important possibility, whatever the new TV tape size. After all, "instant" sound recording began with us hi-fi people 'way back shortly after the war. We've been pioneers in our own area of sound, and it's only logical that the extension into pictures of the record-erase idea should be intimately tied in with what we already have.

Helical TV for Color

Let's glance at the new Ampex system, with its one-inch tape and rapidly moving "helical" recording head. First, its two speeds, while not unlike our common home-recorder speeds—significantly—are not the same. Our "hi fi" speed is 7½ ips in the home machine, the economy or "compact" speed is 3¾ ips. (Except in the Wollensak automatic stereo tape cartridge system, the 1⅞-ips speed isn't much good for music right now.) The "hi-fi" TV tape speed is 9.6 ips, the "compact" is 4.8, neatly straddling the audio speeds. So right there, we have four speeds to cope with (not even counting 1⅞) if we are to think of a combined audio-TV deck on these lines.

Now this implies that compatibility with home audio recording is *not* a present factor in home television thinking, or has been put firmly aside in favor of other considerations.

What other considerations? The biggest one, I think, is color. And they have a point. It is something to think about.

The key to the new one-inch TV tape speeds, if I'm right is (a) a minimum for good-quality black-and-white TV—at the slower of the two speeds, and (b), more important, a minimum speed for color, in the future—that's where the faster speed comes in. Ampex specifically chose it for future color recording, if and when. And thereby, we can see, this present TV recorder firmly ties itself—for the time being—not into the hi-fi audio system but into the complex of television-movie-still pictures, all of which are slithering towards color.

Remember that color slides are 100 per cent of the still-picture projection market. Nobody projects black and white slides, except in education and the like. Not at home. And the movies have gone over more and more to color, though black and white still persists. That leaves TV—and television is, slowly but surely, edging towards more color all the time. So Ampex is probably right in this particular respect. In the long run, the TV tape recorder, at least in fancy models, must make provision for recording color on its tape. The new Ampex system does. (Another significant note: for a reduced price you can have a one-speed TV tape machine, at the slower speed only. Black-and-white.)

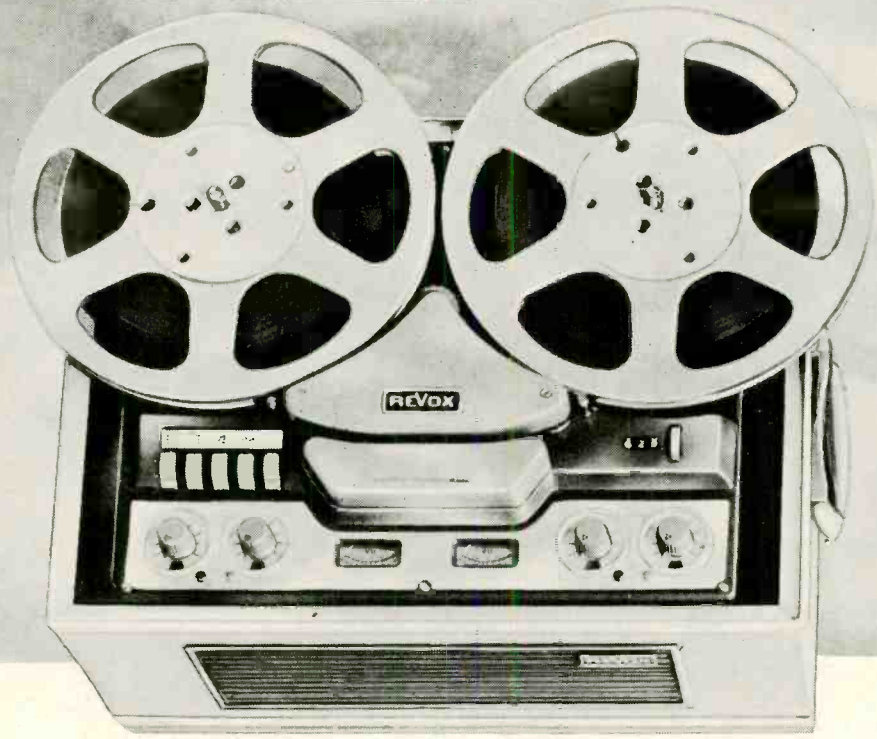
So it seems to be color at the expense of audio-video tape recorder compatibility.

Linear Advantages

Now why, I ask, did Ampex even bother to develop the admirable linear TV sys-

(*Continued on page 91*)

The Remarkable REVOX



has finally arrived in the U.S.

You've heard of the remarkable REVOX, of course. You've heard them rave about this recorder in London. Paris. Rome. Johannesburg. Everywhere. But you couldn't buy it in the U. S. until now. Now, finally, REVOX is ready for its American and Canadian debut. Is there another tape recorder anywhere that matches it, feature for feature? Decide for yourself:

Is the REVOX different? Consider these features, found only in the most expensive, professional tape recorders. Each of the two reels has its own Pabst motor. There is also a separate, heavy duty Pabst 6/12 pole hysteresis synchronous capstan motor that electrically changes the number of poles for the speeds. This is a direct drive unit assuring linear tape speed, whether at 3¾ ips or 7½ ips. Direct coupling eliminates wow and flutter; no belts to break or slip. Tension adjustment contrast assures use of any reel up to 10½ inches with assurance that tape will not snap or break. There are three ring-core heads, specially designed and manufactured by REVOX . . . each head performing its own function of record, playback and erase. Other features? All operating modes are switched electrically by push-buttons; you can use remote control on the REVOX; also a highly accurate tape counter; no pressure pads (for long head life); no need for hum-bucking gimmicks. Vertical or Horizontal Mounting.

EXCLUSIVE BENEFITS

The REVOX is the only recorder in its price category that takes a 10½-inch reel. You can record up to 4,800 feet of LP tape with unsurpassed sound quality. It's a complete 4-track stereo recorder. Exceptionally fast rewind. Oversized, solenoid-operated brakes assure quick and positive braking, even with extremely fast winding speeds. A microswitch senses the end of the tape and automatically stops the motor after a reel has been rewound or where a splice has opened. Tape breakage and tape spill are virtually impossible.

CREATING SPECIAL EFFECTS

With the built in mixing facilities of the REVOX, you can mix and record any two signals. You can also set one channel for playback, while the other is recording, and thus achieve all kinds of multiplay and duoplay effects — sound with sound — even sound on sound with echo.

PROFESSIONAL QUALITY FEATURES

The REVOX G-36 includes two VU meters, one for each channel, for accurate control of recording levels. All operating controls are electrically operated by pushbuttons. There are no gears, belts, levers or friction drives. In its smart gray, portable carrying case, with pockets for reels (reels not included), the REVOX is built for a lifetime of proud performance. Only $500.

AN EXPERT'S VIEW

Recently, British critic Geoffrey Horn wrote this about the REVOX: "One can record a piano at 3¾ ips, and if on listening critically to a held chord one detects the slightest waver, then it is likely to be the piano tuner you should send for, not the tape mechanic. This is a superlative machine, quite the best domestic tape recorder I have experienced, and so well worth saving and waiting for."

The REVOX is available only through carefully selected Franchised Dealers. Complete literature and Dealer listings are available upon request. Write Dept. A-10.

ELPA MARKETING INDUSTRIES, Inc.,
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ELPA REVOX

REVOX — another Elpa quality product distributed in the U. S., Canada and Puerto Rico.

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You can spend $99.50 for the or $129.50 for the even

(For the perfectionist, there are no other choices)

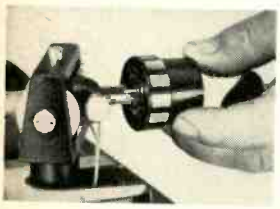
First, here's what the 1009 offers:

There's the advanced design, inspired engineering, superb performance and extraordinary reliability that closed the quality gap between the manual and the automatic turntable.

Then there's the confidence of owning the most highly acclaimed turntable in audio history . . . the first automatic ever awarded unqualified approval by high fidelity experts for use in even the finest music systems . . . including their own.

The very basis of this unprecedented critical approval is, of course, Dual precision performance. The kind that made possible flawless tracking at ½ gram, by an automatic tonearm that rivals the costliest manual arms . . . plus a host of engineering breakthroughs that raised every aspect of turntable performance to new heights . . . with demonstrable performance, not mere promise:

Precision Tonearm Balance



Lightweight tracking demands utmost perfection in tonearm balance. Dual achieves it with fine-thread adjust with nylon-braking, (no click stops) that takes full advantage of the virtually frictionless tonearm pivot bearing (under 0.1 gram).

A further refinement: complete isolation of the counterbalance in rubber, reducing tonearm resonance below 8 cps.

Stylus Force Applied Directly at Pivot

Tracking force is induced with the same high degree of precision, by a long, multiple-coiled mainspring, regulated by direct-dial stylus force adjust. The numeral readings are accurate to within 0.1 gram. And because the tracking force is applied around the pivot, the tonearm maintains its perfect balance in all planes.

DUAL 1009
Auto/Professional
Turntable

DUAL 1019
Auto/Professional
Turntable

world-renowned Dual 1009... more advanced Dual 1019

6% Variable Pitch-Control for All 4 Speeds

A valuable feature to any music lover, especially owners of old classics and foreign discs recorded at different pitch, and for playing solo instruments to recorded accompaniment. Dual's exclusive design varies turntable speed with no effect on either the motor speed or power. And once set, speed remains constant and accurate within 0.1%, with one or ten records.

Automatic Start in Single Play and Changer Operation

A great convenience feature is the 1009's fully automatic start in both single play and changer operation. And, of course, there is unrestricted manual flexibility as well. During play, the tonearm is completely free-floating and may even be restrained at any time during cycling, without concern for possible malfunction or actual damage . . . thanks to Dual's exclusive slip clutch.

Other exclusive 1009 precision features include: Elevator-Action™ Changer spindle that gently lifts all records, separating the bottom one so that no weight rests on it when it lowers; advanced Continuous-Pole™ Motor that maintains speed accuracy within 0.1% even when line voltage varies ± 10%; feather touch slide switches for effortless operation; built-in anti-skating compensation for one-gram tracking; massive 7½ lb. dynamically balanced, non-ferrous turntable.

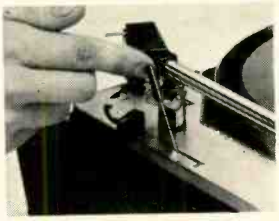
Now...why consider spending thirty dollars more for the 1019?

For still further Dual achievements of such significance that they enable the remarkable new Dual 1019 to close the gap with perfection itself. Many will feel that these advances are well worth the modest additional cost.

Direct Dial, Continuously Variable Anti-Skating Compensation

So accurate you can actually balance the stylus force in the groove: Result: complete elimination of distortion from unbalanced tracking at the program source itself. Even more important: an end to uneven wear, not only on the inner groove of the record, but on the stylus itself! Anti-skating is applied to the tonearm around the pivot and in the horizontal plane, directly counter to the direction of skating. There is virtually no increase in bearing friction . . . a phenomenally low 0.04 gram in the horizontal plane. Compensation is dialed, just as one dials stylus force, so that numerals on both direct-reading scales correspond exactly.

Feather-Touch Cue Control for Manual and Automatic Play



Cueing as it should be . . . precise and convenient . . . dead-center on the exact groove intended. Just a flick of the Cue Control lowers the tonearm smoothly, without a trace of vibration, no side shift of stylus anywhere on the record. When you stop on a note, you start again on that self same note! What's more, Cue Control also operates with fully automatic start for a slower-than-normal descent, as may be desired with high compliance styli, and automatically disengages. And cueing height is variable over a ⅜" range, to suit personal preference or to adjust for various cartridge heights.

Single Play Spindle Rotates with Record

The 1019's spindle actually locks into the platter and rotates with the record, exactly as with conventional single play turntables. Thus does Dual answer the purist's last remaining argument.

And there's even more! Cartridge holder adjusts for optimum stylus overhang; a "pause" position on the resting post for placing the tonearm without shutting off motor (very handy when flipping discs); concave platter mat to support records at their widest diameters (even badly warped discs won't slip), plus all the precision features of the 1009!

So . . . which Dual Auto/Professional turntable is for you? If you still can't decide for sure, we suggest you ask your authorized United Audio dealer to demonstrate both of these remarkable state-of-the-art instruments.

UNITED AUDIO Dual

12 WEST 18th ST., NEW YORK, N.Y., 10011

DUAL'S THE FINEST . . . THE RECORD PROVES IT SINCE 1900

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EDITOR'S REVIEW

COVER POLICY CHANGE

IT IS WITH CONSIDERABLE gratification that we note readers' comments on our return to the cover style we used for so many years, and which was practically an identification in itself. For those same many years, enthusiastic hi-fiers kept us supplied with photos of their respective "prides and joys" in the form of home installations. Deviations from this theme are possible, of course, but the basic subject matter must relate to audio. No reader is likely to get rich taking cover pictures for AUDIO, but each one accepted will at least provide the medium of exchange in sufficient quantity to pay for a new diamond-tipped stereo cartridge or a few reels of tape. In technical terms, we prefer 8 x 10's, glossy, and of good contrast and sharpness.

TWO-SPEED GEMINI TAPE RECORDER

Add to the already long list of tape speeds a new one—41¼ ips. This is the playback speed of the RCA-built miniature recorder used in the Gemini flights. Measuring only 10 in. square by 4 in. high, this device records continuously up to four hours at a speed of 1⅞ ips, using pulse-code modulation, then on command replays the information at the 41¼-speed in only 11 minutes, thus making it possible to record performance and physical-condition data throughout a flight, even when the spacecraft is not in touch with a ground station, and then transmit all the information to the ground when contact is possible—hence the high playback speed. It is said to record 67 million bits of information on each of its two tracks.

But when RCA showed its entire line of home entertainment tape recorders for 1966, this one wasn't included. Perhaps they are saving up the experience gained with the Gemini recorder to be used in their entry into the home video recorder field.

YOU CAN KEEP YOUR "OLDEST" PT6

Following Mr. Zide's mention, in the June issue, of the Magnecord contest for the oldest operating PT6, with the comment that it was doubtful if the owner of the oldest one would want to give it up, we were advised by Magnecord that they had a few brand new PT6's on hand and would trade a new one for the oldest, and would still give him his choice of the new 1000 series. Magnecord insists that the new 1021 is better than the PT6, modified thus: "with the possible exception of the ease of editing." Guess we should have *kept* our first PT6.

NEW SHOWINGS

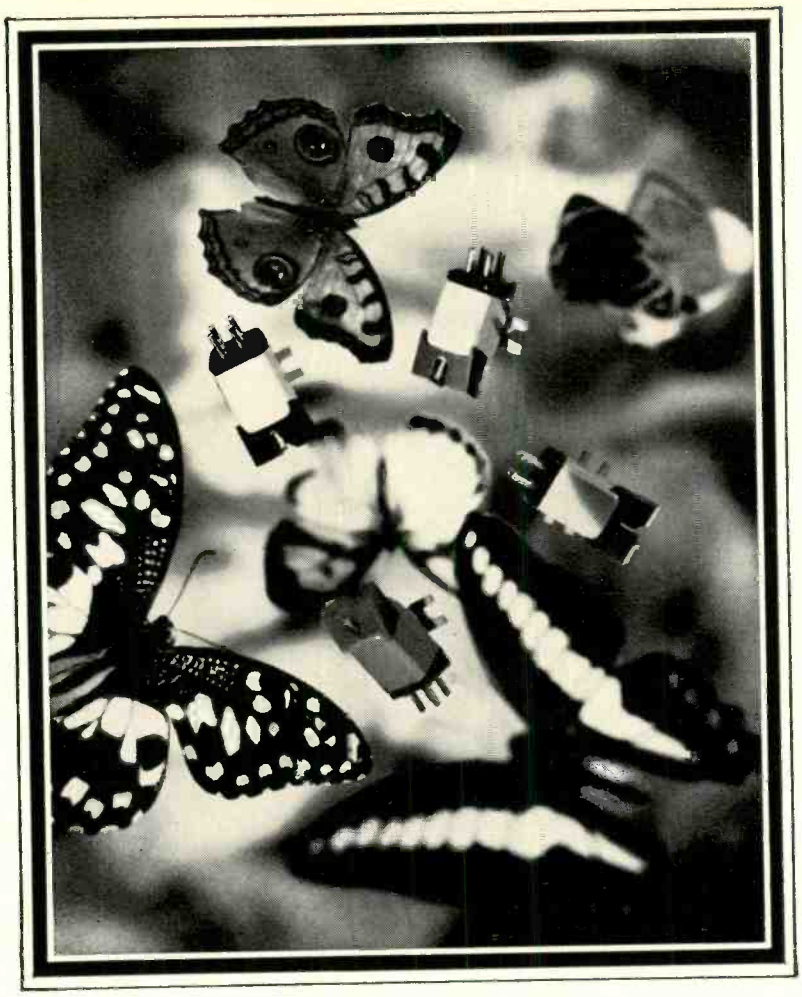
The month before the New York High Fidelity Music Show always brings forth a spate of new-product showings in a series of press previews and distributor-dealer meetings. These continue right up to the show opening, and serve to give us of the fourth estate some advance information. One of the greatest advantages of this custom is that it gives the manufacturer some idea of the acceptance by dealers of products which may still be in the "pre-production" stage. Another is that dealers can often be prepared with at least some stock of actual production items so that when the buyers begin to shop around for things they have seen at the show their orders can be filled without delay.

Thus over the past month or so we have been privileged to view the Norelco video recorder, and the Ampex, Matsushita, and Sony models, at progressively lower prices, so we are fully geared to accept home video in our province. We have seen the new and revitalized Acoustech line, RCA's tape recorders as mentioned above, and, going back to the Music Show, the Electro-Voice electronic line, which includes some surprises. As to the rest, we will let you find your own surprises at the N.Y. Show.

H. A. Hartley

It is with considerable sadness that we must chronicle the passing of one of audio's old timers, Henry Adair Hartley, one of the earliest speaker manufacturers in Britain, and long a high fidelity bulwark. His "215" loudspeaker found a wide acceptance in the U.S. following its introduction here by advertisements in AUDIO, and its purchasers ordered them in good numbers for several years direct from England. Mr. Hartley has often contributed to AUDIO, and to a number of other U.S. and British publication, and is also known for his "Audio Design Book," published by Gernsbach. His last contribution to AUDIO was an autobiographical sketch for the "Audio Pioneers" section of the May, 1962 issue. Mr. Hartley died of a heart attack on August 29, at the age of 65.

Because of his many visits to the U.S., beginning with his appearance in the 1951 New York audio show, and occasional visits of the writer to England, there was more than an editor-writer relationship between us—in fact, a real friendship. We shall all miss his wit, charm, and occasional Scottish cantankerousness.



Capture natural sound with Pickering.

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

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

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

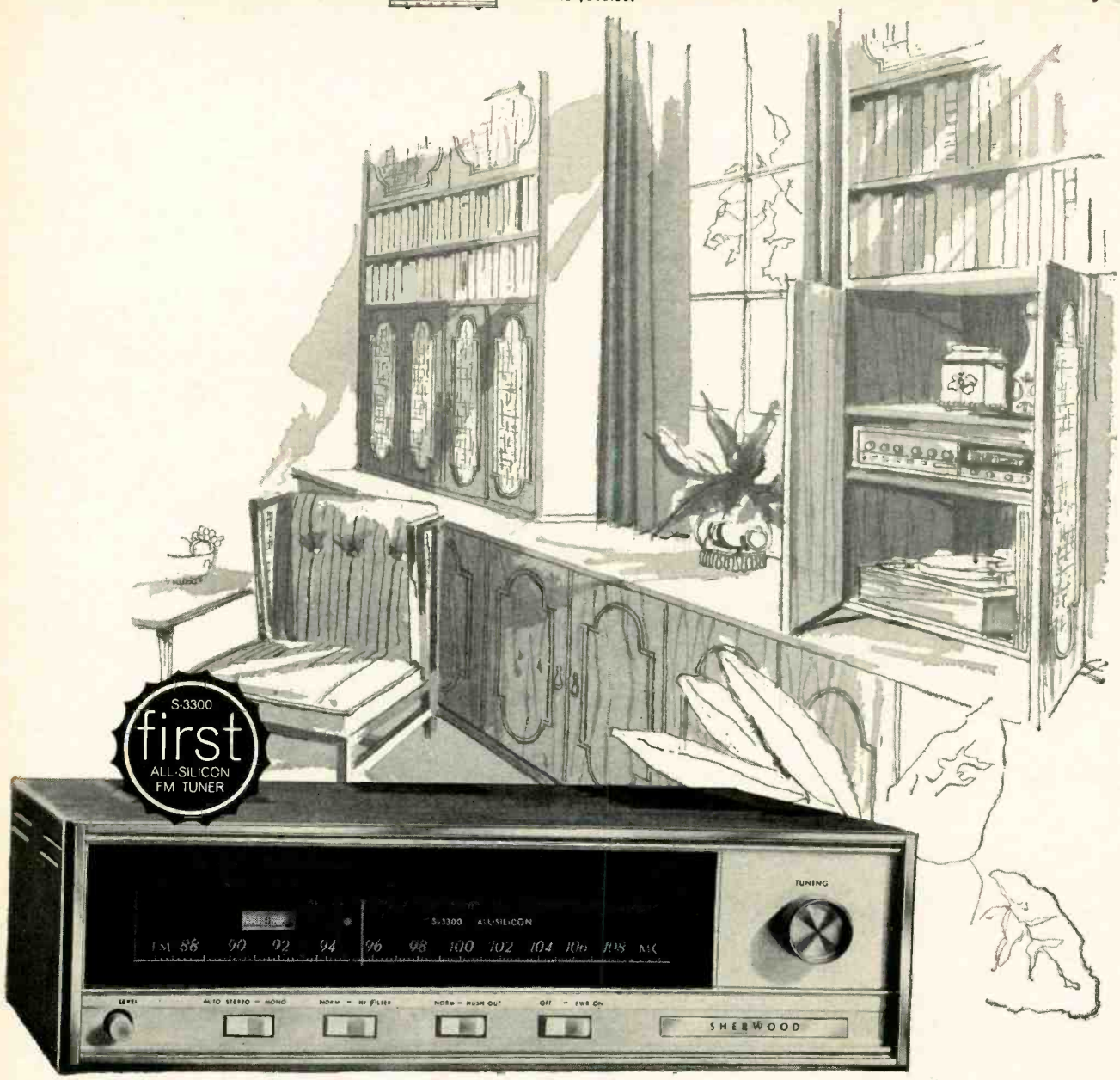
No other pickup design is quite like the Pickering V-15. The cartridge weighs next to nothing (5 grams) in order to take full advantage of low-mass tone arm systems. Pickering's exclusive Floating Stylus and patented replaceable V-Guard stylus assembly protect both the record and the diamond. But the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

PICKERING—for those who can hear the difference.

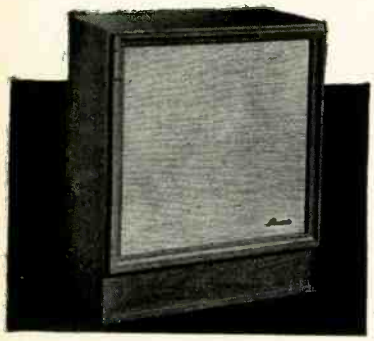
Pickering & Co., Plainview, L.I., N.Y.

Circle 115 on Reader Service Card

Compare these Sherwood specs! S-3300 IHF sensitivity 1.5 μv (30 db quieting), Stereo frequency response 20-15 kc ± ½ db., Capture ratio 2.4 db., Drift ≤ .015%, Hum and noise −70 db, 16 silicon transistors plus 15 silicon diodes, $167.50. Companion ALL-SILICON Solid-State amplifiers S-9900 90 watts $229.50, S-9500 50 watts $179.50, S-9000a 160 watts $309.50.



WHY DID SHERWOOD SAY "NO" TO GERMANIUM



Another first from Sherwood: The Tanglewood II 4-way speaker system features Sherwood's revolutionary omnipolar* high-frequency radiator with 160° dispersion to 22 kc. A pair of 10-inch woofers extends response to 24 cps @ −6db. In oiled walnut: $219.50.

No germanium transistors or nuvistor-tube hybrid designs for Sherwood! Instead, Sherwood insisted on the acknowledged reliability of ALL-SILICON Solid-State circuitry to make the new Model S-3300 the industry's **FIRST** ALL-SILICON Solid-State tuner. The S-3300 achieves the pacesetting sensitivity of 1.5μv (IHF) with newly developed circuits that are immune to overloading. Sherwood's engineers even included an amplified dual automatic-gain-control system to maintain proper selectivity under the strongest signals, automatic stereo/mono switching, and silent-action interchannel hush. All reasons why we dare to say, "Sherwood ALL-SILICON Solid-State High Fidelity is the best."

Sherwood

Sherwood Electronic Laboratories, Inc., 4300 North California Avenue, Chicago, Illinois 60618 Write Dept. 10A

Circle 116 on Reader Service Card

Convert the Uher 4000 Report-S to Stereo Playback

C. G. McPROUD

When a compact stereo playback tape machine is needed and only a mono record-playback machine is available, convert it yourself—as the author did.

A FEW MONTHS AGO, the writer was invited to address a group of engineers on the subject of stereo and high fidelity (what else?) in a city some 500 miles from home base. While this was not unusual, it was the first time that such a trip had to be made on "public transportation," meaning, in this case, by plane. Heretofore, such trips had been made to locations not over 200 miles from Mineola, which is close enough to use an automobile to eliminate the logistics problem of transporting a heavy tape recorder—and, in some cases, amplifiers and speakers—over the required distance. From previous experience in driving to the remote city, it was clear that it would require almost twelve hours of driving, since much of the journey was through mountainous country. Hence the trip by air.

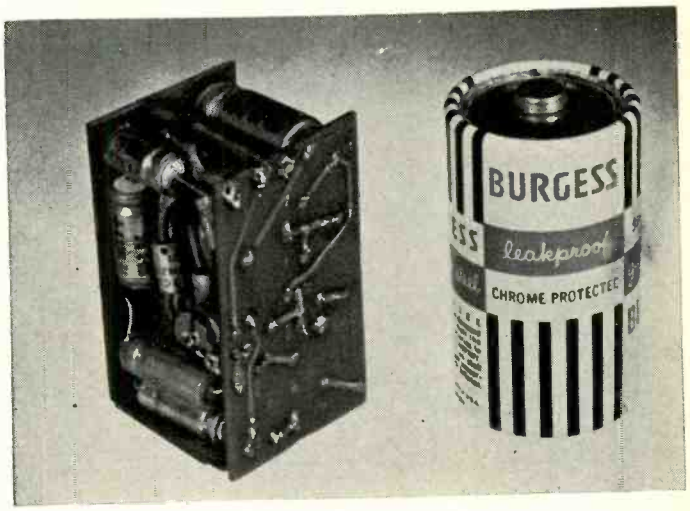


Fig. 2. New right-channel amplifier compared to a "D" cell in size. Amplifier fits into space intended for fifth cell.

Arrangements were made to have both amplifiers and loudspeakers furnished locally. Now a talk about hi fi and stereo should be accompanied by some demonstration material, which was prepared—or available from previous appearances of like nature, so a tape recorder was inevitable. The only *stereo* recorder available was an early Sony 555-A4, still a superb machine, but rather bulky and weighing 57 pounds—an unlikely candidate for air travel with a baggage allowance of 40 pounds.

In spite of the difficulties, the trip was made, recorder and all, and the portering job at our destination was sloughed off onto our hosts—who took it graciously. No sooner were we on the way back than the wheels started turning to figure out a more practical way of giving stereo lectures in distant locations without excess baggage charges.

Fig. 1. Converted Uher 4000 Report-S, with output coupling unit/microphone preamp at the right.

The Solution

Amongst the writer's stable of tape recorders was a compact little Uher 4000 Report-S—a battery operated gem weighing about eight pounds ready to go. It had, however, one drawback—it was a mono machine. Could we—our thinking went—convert this handy unit to stereo without too much trouble? Assuming that the head could be changed easily enough, where would we put the amplifier? How would we make external connections to it?

Now it just happens that the Uher 4000-S was designed to work from a variety of power sources—a 6-volt dry storage battery, an a.c. power unit which fits into the same space as the battery, which is exactly the same size as four "D" cells, or from *five* "D" cells, since their power capacity is not as

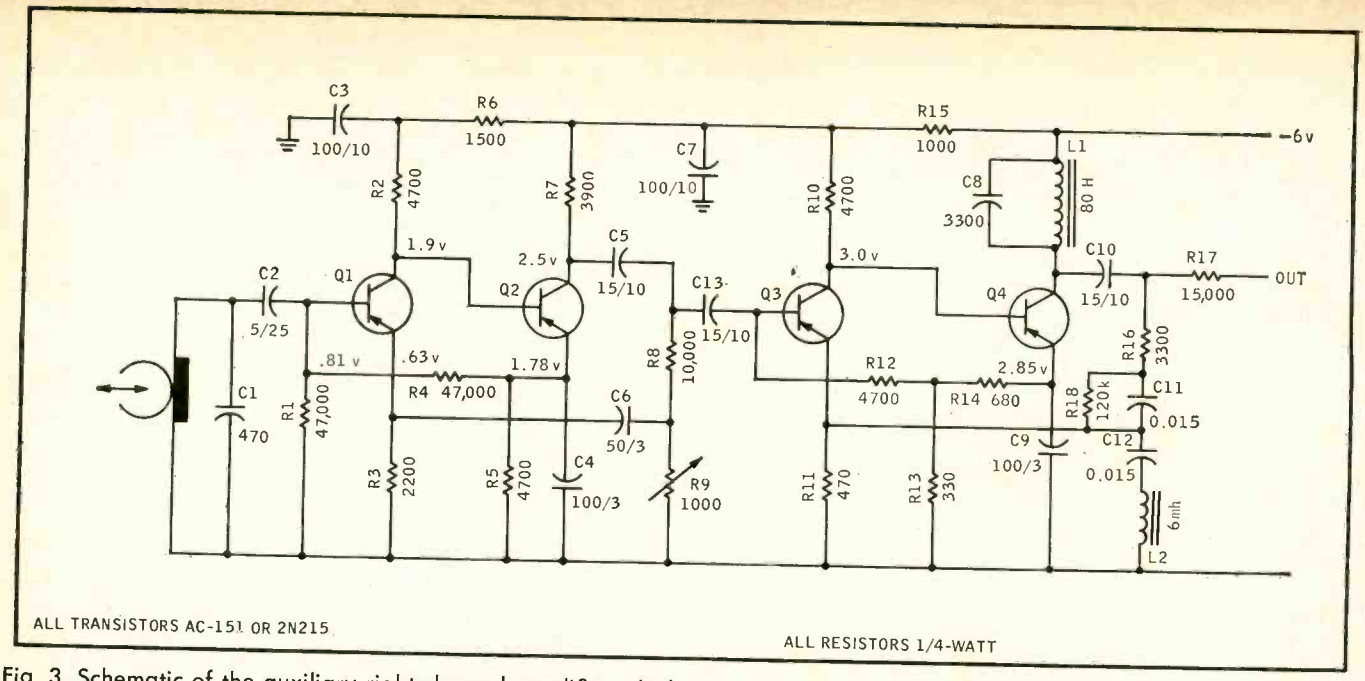


Fig. 3. Schematic of the auxiliary right-channel amplifier which is constructed on a printed-circuit-board "chassis" to fit into space required for a "D" cell.

great as the storage battery. Therefore, there is another compartment to hold the fifth cell, and when using the storage battery, this compartment is empty. *Voila!* we said—we'll put the amplifier in the compartment for the fifth cell.

This all sounds perfectly simple, but some complications crept in. In the first place, a "D" cell measures only 1 5/16 in. in diameter by 2¼ in. long. In the second place, the amplifier already in the Uher is a four-stage device, using, among other things, an 80-Hy choke as the collector load on the output stage. It is quite possible that a two-stage amplifier could have been designed to do the job, but we reasoned that the two amplifiers of a stereo machine should be identical, so we worked it out the hard way. It took a number of tries—like a dozen or so—before we finally succeeded in getting all the parts into a rectangular package—shown in *Fig.* 2 along with a "D" cell—which would fit into the fifth-cell compartment.

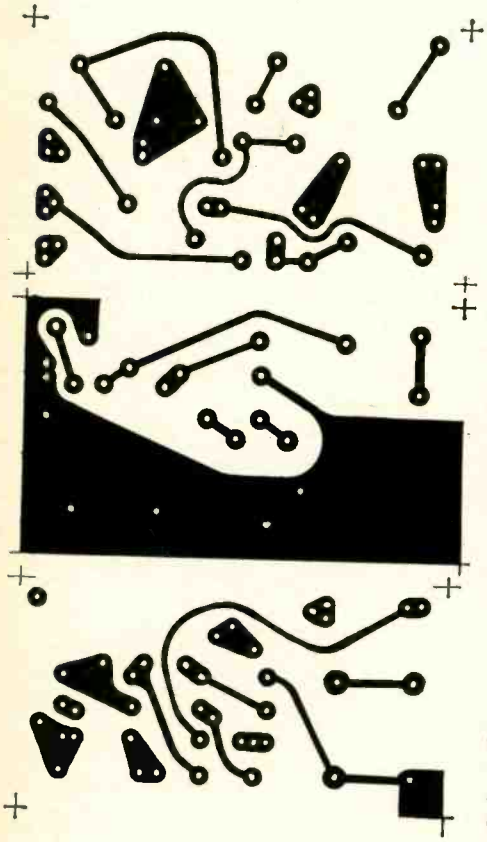


Fig. 4. Layout of the three printed circuit boards in the exact size required. Boards are identified from top to bottom as 3, 2, and 1.

One of the features of the Sony recorder which we had previously built into the case was one which we consider important for lecture work—a microphone amplifier. We had developed a configuration which put the output of the three-stage microphone amplifier equally onto the two stereo outputs, so that the lecturer would appear to talk from the center position directly between the right and left speakers. This also had to be incorporated into the package, although not necessarily into the recorder itself. It is shown as an outrigger on the recorder in *Fig.* 1. Note that it has two knobs—the lower one controlling microphone level, as well as switching the internal mike amplifier on; the upper knob controls the recorder output. Hence the auxiliary unit was also planned—a "microphone amplifier and coupling unit." It will be described in a succeeding article next month.

Circuit Arrangement

The amplifier circuit is essentially identical to that of the normal channel in the 4000-S. It is *not* identical in but one particular—one capacitor is only 50 μf instead of 100 because the larger one simply would not go into the space. There is only the minutest difference in performance, however. This amplifier is constructed on three printed-circuit boards, step by step, and as one proceeds, these boards are cemented together with epoxy. Construction must follow a certain order, however, and even now we haven't figured out what one could do if the unit didn't work after completion—one would almost have to destroy it to change some of the parts. Actually, the transistors can be changed, if necessary, but we have come to the belief that low-level transistors *never* fail.

The "chassis" thus consists of the bottom printed circuit board on which some parts are disposed; a vertical circuit board on which the 80-Hy choke, the four transistors, and some other parts are mounted; and the top circuit board, with the remainder of the parts. Bear in mind that there are—in addition to the 80-Hy choke and four transistors—13 capacitors (of which ten are low-voltage, high-capacitance electrolytics) 18 resistors including a variable, and a little 6-mH inductance used in the equalizing network. The unit operates on 6 volts, and draws about 2.5 mA. All input, output, and supply connections are made on the top circuit board. The three circuit boards are shown in *Fig.* 4, actual size. Most of the large electrolytics are suspended between the top and bottom boards, to conserve space. The small inductance is cemented with epoxy to the top plate.

The circuit *Fig.* 3, consists of four stages, with feedback around the first two for stabilization and to serve as

the gain control when in the recording mode, which does not concern us in this case. Playback equalization is provided by feedback around the last two stages, with the high inductance in the collector circuit of the last stage providing most of the low-frequency boost. In the normal amplifier, capacitors are switched in the playback equalization circuit to accommodate the four speeds, but since we expected to use the machine only at 7½ ips for stereo, the switching was not deemed necessary. Note that no playback gain control is provided in this section of the amplifier. In the normal unit, the playback gain is controlled after this four-stage amplifier, and just preceding the output amplifier.

Construction

The amplifier is constructed on three printed-circuit boards, shown actual size in *Fig.* 4. These could be made for you commercially, but we made our own, using photographic printed-circuit materials obtainable from jobbers, or by mail from Lafayette Radio. All three boards can be made on a single 3 x 4½-in. piece of laminate (Lafayette part no. 19R6805). A suitable negative can be made from Fig. 4 on high-contrast film at a 1 to 1 ratio, or you can have a suitable negative made by any letter shop or offset printing house. Clamp the negative over the sensitized laminate in a printing frame and expose it to an intense light. Direct sunlight, for example, should take about two minutes. We used a Sylvania Sun Gun at 18 in. away from the printing frame and exposed it for four minutes.

Now place the laminate in the developer (Part No. 19R6802) for three minutes, then drain for five minutes more. The laminate is then placed in the etchant (Part No. 19R6809) and left for 20 to 30 minutes, agitating gently every few minutes. Heating the etchant slightly speeds up the process. When the entire pattern is etched, wash the board thoroughly. Cut the board into three parts as indicated, and trim to the corner marks, filing the edges smooth. One other piece of laminate is required for the end. This is necessary so the spring in the battery compartment will have some flat surface to bear against, and also as an aid in construction. This piece is exctly 1 5/16 x 1 3/16 in. We cut a notch ⅜ in. wide and 1/16 in. deep along the center of one of the longer sides, as shown in *Fig.* 5, which serves to accommodate a finger nail when removing the amplifier from its compartment.

After the boards are made, drill all the holes in the centers of the pads with a #58 drill, except for the four which accommodate the four terminals of the 80-Hy choke, and indicated as

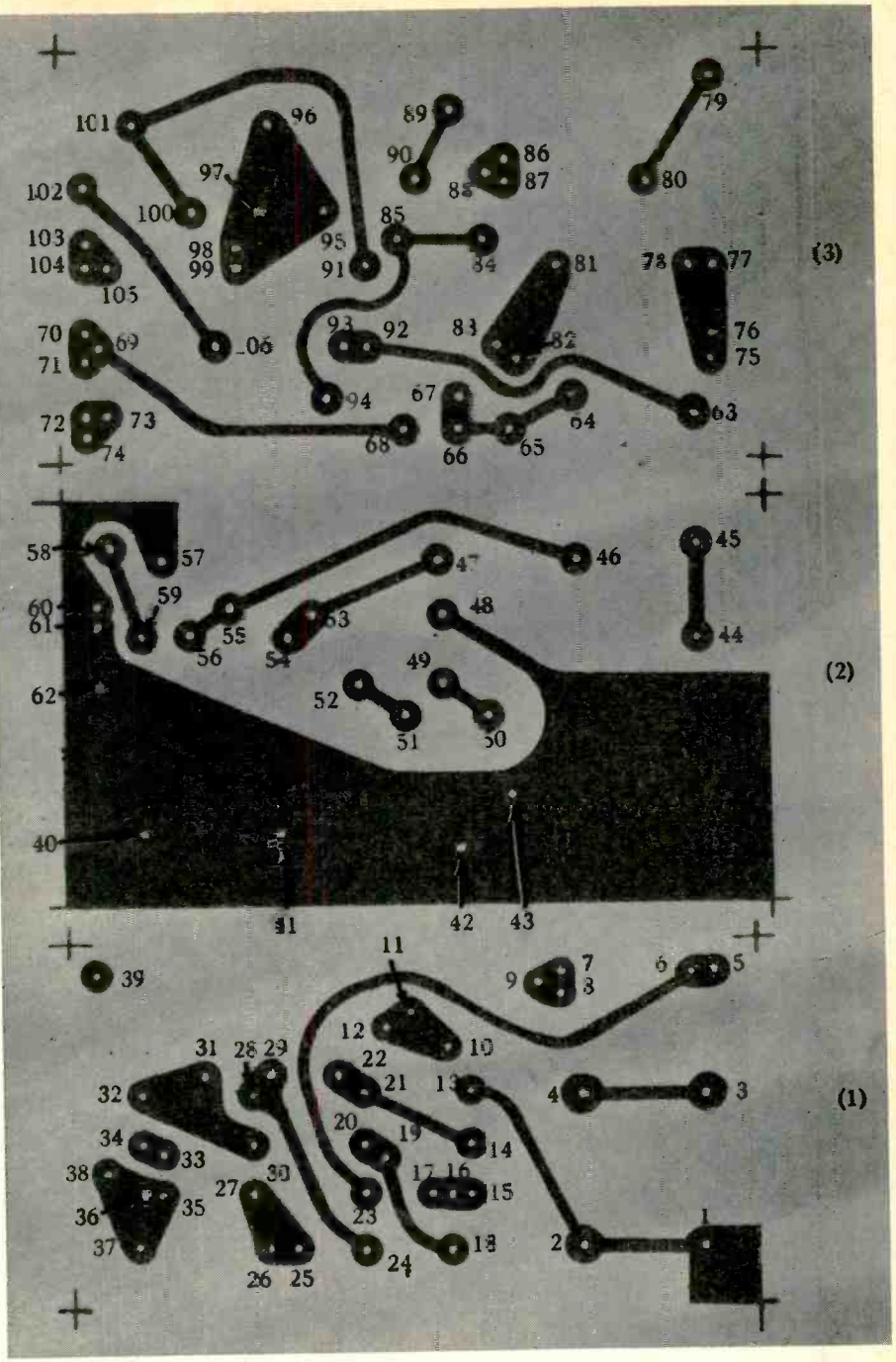


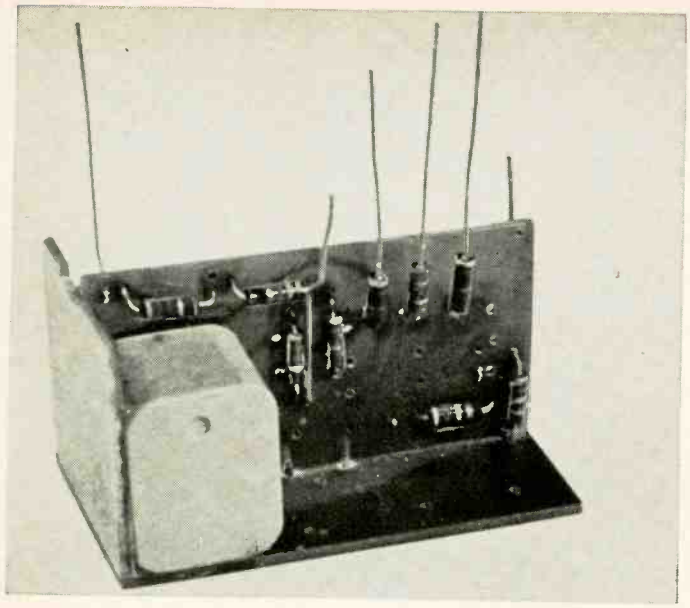
Fig. 5. Enlarged layout of printed circuit boards with the holes indentified by number.

No's. 1, 2, 3, and 4 on *Fig.* 5. Use a #45 drill for these.

Assembly

In the following description of the assembly of the amplifier, we will refer to the three boards as 1, 2, and 3. The end board has no components mounted on it, and is therefore not numbered. Holes 1 to 39 are on board No. 1; holes 40 to 62 are on board No. 2; and holes 63 to 105 are on board No. 3. No. 1 is the center board—the vertical member of the "I-beam" chassis. No. 2 is the bottom, and No. 3 is the top board.

The first step in the assembly is to install the 80-Hy choke L_1. This part obtainable only from Martel Electronics as part #2503 is an important element, as is L_2, (part #2505-3) also from Martel. Push the four terminal leads through holes 1, 2, 3, and 4 from the plain side of the board, and solder 1, 2, and 3 carefully, being careful not to use too much heat nor too much solder. Leave hole 4 unsoldered for the moment. Then apply epoxy cement (the two-tube combination obtainable from jobbers works well) along the bottom and left side (as viewed in *Fig.* 6) of the choke, and along the bottom and left end of the board, and attach to board No. 2 and the end piece, which is also epoxied to board No. 2 along its bottom edge. The



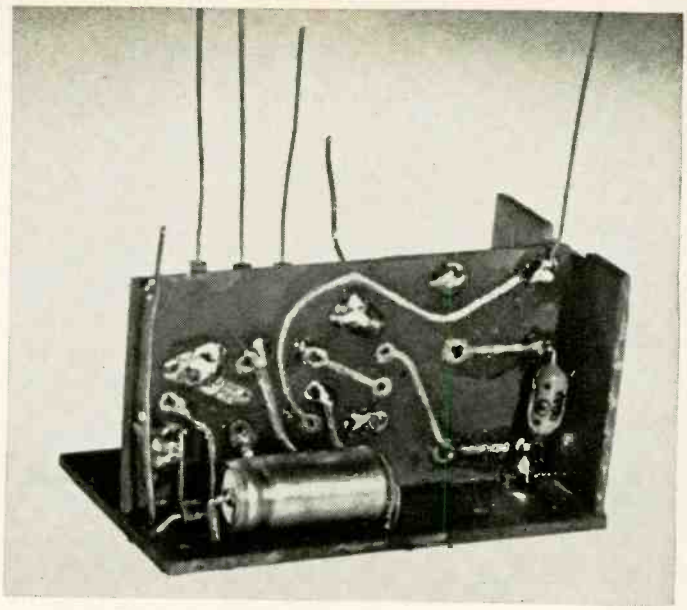


Fig. 6 (left). Initial step in construction with L_1 and several of the resistors in place. Note end board, flush against L_1 and the center board (1). Fig. 7 (right) earlier steps in construction as seen from the opposite side.

top of the choke—the side opposite the terminals—is to be flush with the side of board 2, and the end piece also. This should result in a unit like that in *Fig.* 6, except that the resistors are not yet in place. Clamp the assembly in a vise and let set overnight.

Since this is a relatively complicated assembly for amateur hands, with a high density of parts, it is necessary to mount parts on the "chassis" gradually, and in a certain order. Thus many resistors and capacitors are mounted at one end only, with their leads sticking up in the air and apparently going nowhere. The final step of assembly is to thread board 3 down over all of these upstanding leads, epoxying it to the center and end boards, and then soldering the leads to board 3.

To achieve the appearance of *Fig.* 6, mount the following resistors from the back (unprinted side) of board 1: R_{11}, 470 ω, from holes 6 to 8; R_{13} 330 ω, from holes 9 to 11; R_{14}, 680 ω, from 10 to 16; R_{12}, 4700 ω from 12 to 19; R_4, 47k ω, from 26 to 37; R_5, 47k ω, from 38 on board 1 to 62 on the bottom board, No. 2. The next three resistors should have one lead bent 90 deg. close to the body of the resistor and mounted as follows, with the remaining lead projecting upwards: R_6, 4700 ω, in hole 31; R_7, 3900 ω, in 29, and R_{10}, 4700 ω, in 22. Solder a 2-in. wire on the circuit side of Board No. 1 in hole 5, and position it upwards, as shown. Solder a 1-in. wire in hole 7, and allow it to project along the choke, perpendicular to the board. Solder a 2-in. wire in hole 16, leaving it projecting up on the non-printed side. Dress this wire close to the board, and put a ¼-in. "step" bend in it about ¼ in. from the top of the board. The wire shown at the extreme right in *Fig.* 6 will be installed later.

Next, turn the unit around, and install C_8, 3300 pf, between terminals of the choke, holes 1 and 3, extending the lead from hole 1 through the bottom board in hole 44. Similarly, connect short pieces of wire between holes 35 and 59, between 33 and 56, between 25 and 54, between 24 and 52, and between 18 and 49. Then install R_3, 2200 ω, between 55 and 60, and R_9, 4700 ω, between 48 and 53, and C_4, 100 μf, between 47 and 57, with the positive end in hole 57. Then solder a 2-in. piece of wire in hole 61 and leave it projecting upward. The result should look like *Fig.* 7 at this stage.

Mounting the Transistors

The next step is to install the four transistors. In the original circuit, AC-151's are used—Siemens transistors obtainable from Martel. Almost identical performance is obtained with 2N215's, an RCA product which are more easily obtainable and considerably less expensive—$1.73 each compared to $3.50 for the AC-151's. Make four pieces of colored "spaghetti" of each of three colors by stripping ½ in. of insulation off hookup wire. We used red, green, and brown, with red for collector, green for base, and brown for emitter. Slip these pieces of insulation onto the indicated transistor leads, and cut the leads off ⅛-in. beyond the insulation. Then bend about 1/16 in. at right angles. Starting with Q_1, insert the collector lead into hole 32 from the printed circuit side of board 1—the vertical one—and solder gently; Similarly, solder the emitter lead in hole 34, and the base lead in hole 36. Q_2 is then mounted, with the collector in hole 28, base in 30, and emitter in 27. Q_3 is next, with the collector in hole 21, base in 20, and emitter in 23. Q_4 is installed with the collector in hole 13, base in 14, and emitter in 15.

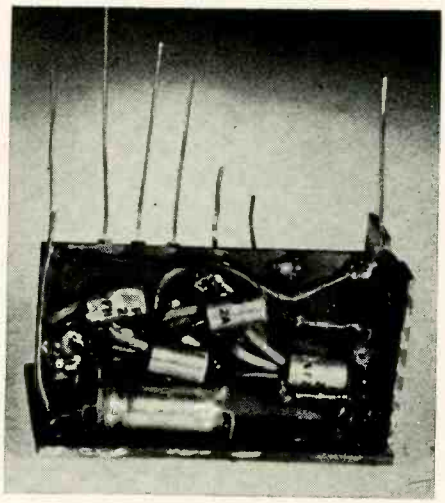


Fig. 8. View of the right side of the amplifier after further steps, including mounting of the transistors.

On a piece of hookup wire 2½ in. long, strip the insulation off the ends leaving 1⅝ in. of insulation on the wire. Wrap one end around the choke terminal at hole 4 and solder. Dress the wire upward and toward the left, and pull the other end through hole 39 and solder. The extending wire is then bent upward. Now, starting with Q_4, dress the transistor back over its leads until it lies flush against the board; then follow with Q_3, Q_2, and Q_1. The assembly will now look like *Fig.* 8. Insert the positive lead of C_6, through hole 46 and solder, leaving the body of the capacitor about ⅛ in. above the board. Similarly mount C_{10}, in hole 45, and C_2 in

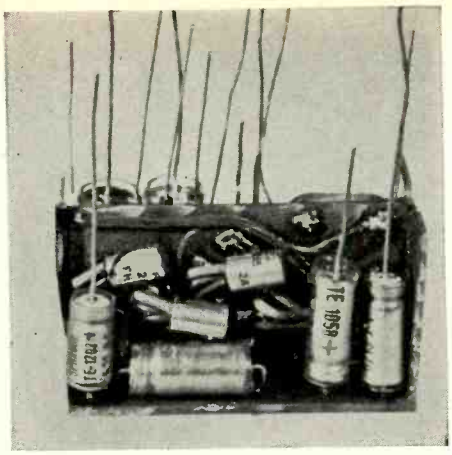


Fig. 9. View of the right side of the amplifier after all parts have been installed.

hole 58, both with negative leads in board 2. Dress the upper leads straight upwards. This side of the amplifier should now look like *Fig.* 9. Now turn the amplifier around and in the same fashion mount the positive leads of C_5 in hole 51; C_{13}, in hole 50; C_3, in hole 40; C_7, in hole 41; and C_9, in hole 42. Solder one end of a 2-in. wire in hole 43 and dress upright. Place a 1¼-in piece of spaghetti over the wire extending upward from holes 42 and 61. The unit should now look like *Fig.* 10.

Next take board 3—the top—and install R_{15}, 1000ω, from the underside (unprinted side) of the board and solder in holes 105 and 99; R_6, 1500ω, between 98 and 91; R_8, 10,000ω, between 94 and 67; R_{16}, 3300ω, between 92 and 83; R_{17}, 15,000ω, between 93 and 106; and R_{18}, 120kω, between 78 and 81. Then mount C_1 between 71 and 72; C_{11} between 75 and 82, and C_{12}, between 77 and 79.

To mount the equalizing choke, L_2, make two "J" shaped hooks which fit over the choke bobbin as shown in *Fig.* 11, and epoxy them in place. After setting, wrap the choke leads around the wires and solder; apply more epoxy to the coil, insert the wires into holes 80 and 87, and solder. This completes the preparation of the top board, No. 3.

To facilitate the threading of the upright leads into the top board, it is desirable to cut them at different lengths. From the longest upstanding lead, cut them one after another progressively shorter, leaving the shortest one about ½ in. above the top of board. Then start to feed the leads into the holes in board 3 as follows:

From C_{10} into hole 63,
C_6 into hole 64,
C_2 into hole 73,
C_5 into hole 85,
C_{13} into hole 84,
C_3 into hole 101,
C_7 into hole 96,
C_9 into hole 89,
wire from hole 5 into hole 75,
wire from hole 39 to hole 104,
wire from hole 61 to hole 69,
wire from hole 7 to 88,
wire from hole 43 to 86,
R_2 into hole 100,
R_7 into hole 97, and
R_{10} into hole 95.

This is an operation requiring some patience, but it is not difficult—only a bit exasperating occasionally. Before pushing the top board down firmly against the vertical ones, apply epoxy to the top edges of the center and end vertical boards. Then bring the top down firmly against the other two and bend over all the leads, making sure to keep the top and bottom boards parallel. Then solder all the leads, again using only as much heat and solder as necessary to make a smooth connection.

The final step in completing the amplifier is the installation of potentiometer R_9, which adjusts the gain of the amplifier. It will be necessary to enlarge the three holes into which the leads are inserted by running the drill

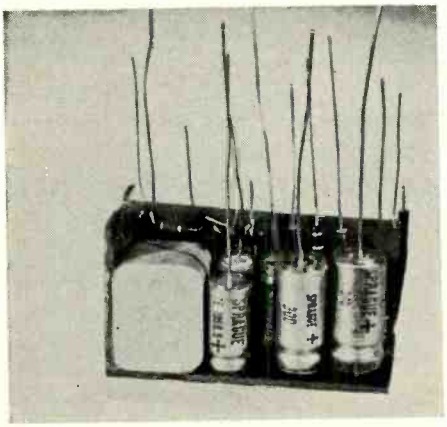


Fig. 10. Final view of left side of amplifier before putting top board in place.

through them again and tilting it from side to side. The potentiometer is mounted with the rotor slot to the outside to permit adjustment. Solder these three leads, and the amplifier is finished.

Head Change

To take out the old head, remove the azimuth-adjustment screw and the mounting screw, both of which are accessible to the left and the rear of the head respectively. Unsolder the leads from the vertical ceramic terminal strip and lift the head and its mounting plate out. Removal of the two tiny screws from the bottom of the plate releases the head. The 4-track stereo head used is Nortronics 1202, which approximates closely the electrical characteristics of the original. It is a "no mount" head, however, so it is simply epoxied to the mounting plate. *Fig.* 12 shows the correct position on the plate, with the left side of the head flush with the side of the plate, and the corner of the head flush with the corner of the plate.

When the cement is thoroughly dry, replace the plate with the same screws, using the coil spring under the plate at the azimuth adjuster, and the V-shaped spring under the mounting screw.

Prepare a 1½-in. twisted pair of hookup wire, with the head connecting clips on one end. Solder the other ends of the pair to the ceramic terminal strip from which the original leads were removed. Then prepare a 6-in. length of thin shielded lead, with the shield to one clip and the center lead to the other. Feed this wire through a hole in the chassis adjacent to the head. Slip the clips onto the head terminal pins, with the twisted pair leads on the upper pins, and the shielded lead to the lower pins. Make sure that the two ground terminals are at the same side of the head. With this head, which has a hyperbolic metal face, it is not necessary to use the pressure pad, so this entire assembly can be removed. Depress the pressure pad so the two C-washers are accessible, and remove them from the pins on the back of the pressure pad assembly. *Figure* 13 shows the new head in place.

On the underside, thread the shielded wire from the hole near the head around under the equalizer switch plate to point "A" of *Fig.* 14. Insert the amplifier into the opening for the fifth "D" cell, as shown in *Fig.* 14, with the end plate at the rear. It is recommended that the amplifier be wrapped in a piece of plastic such as Koroseal before installing. Leave enough to fold over the top plate. Connect the "hot" lead of the shielded cable to hole 74 of the top plate, and the shield to hole 71.

External Connections

To provide access to the normal output of the recorder, a three-hole Hirschmann socket is employed at the position nearest the front of the recorder on the right side. This socket must be changed to a 5-terminal socket, Hirschmann No. MAB 5S, obtainable from some jobbers, or from Rye Sound Corporation, 125 Spencer Place, Mamaroneck, N.Y. 10544.

Carefully unsolder the leads from

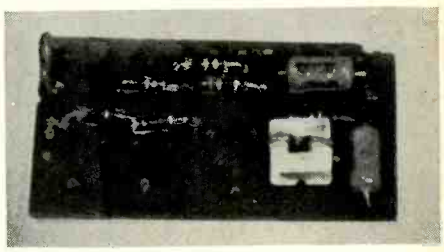


Fig. 11. Underside of top board showing position of L_2 and related resistors and capacitors.

terminals 1, 2, and 3 of the three-terminal socket, and remove the socket. Install in its place the five-terminal socket, and reconnect the leads removed from the original socket to the corresponding terminals of the new socket. Connect the shield of an 8-in. shielded lead to terminal 4 of the new socket.

Terminal 2 is the usual ground terminal on all Hirschmann plugs and sockets, but we are using the wiring to this socket as an on-off switch for the new amplifier. The 6-volt supply is connected permanently to the amplifier, but the ground return lead is connected to terminal 4 of the socket. The connecting plug is then wired from terminal 2 to terminal 4 internally. Thus, whenever the unit is to be used in the stereo playback mode, this plug is used, thus turning on the amplifier. There is no other ground to the amplifier, and the shield on the head leads is grounded only when the plug shorted from 2 to 4 is inserted. Since the other output is not used unless the stereo mode is employed, this works quite satisfactorily, and saves the need for a separate switch. With the shield of the 8-in. lead connected to terminal 4, connect the "hot" lead to terminal 5. This serves as the right-channel output lead. This is also the standard connection for the 5-hole socket, with right channel on terminal 5, left channel on terminal 3, and ground on 2. (In this unit, terminal 1 is used as a high-level input.) Dress the lead around the front panel and connect the shield to hole 70, and the "hot" lead to hole 102. The final connection to the amplifier is the –6-volt lead, which is brought from the point marked "B" in *Fig.* 14, where it is soldered to the printed circuit panel, to the amplifier, and connected to hole 103. Replace the fibreboard insulation on the bottom of the recorder as shown in *Fig.* 15, fold the insulating plastic amplifier wrapping over the top board and secure in place with a strip of cellophane tape. This should complete the construction and installation.

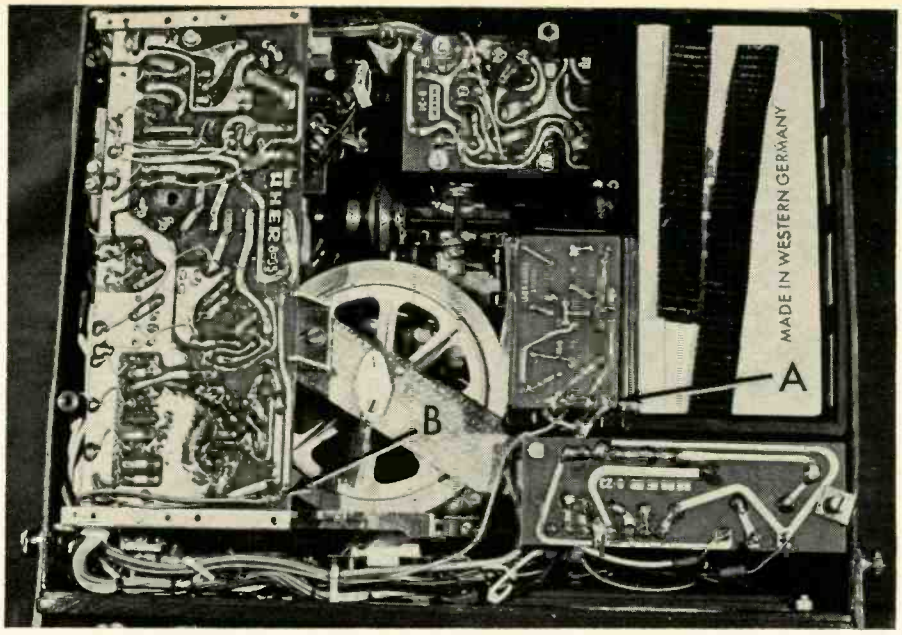


Fig. 14. Underside of Uher 4000 Report-S with new amplifier in place. Point indicated by "A" is where head connection is made. "B" shows where —6 volts is obtained from printed circuit of the recorder.

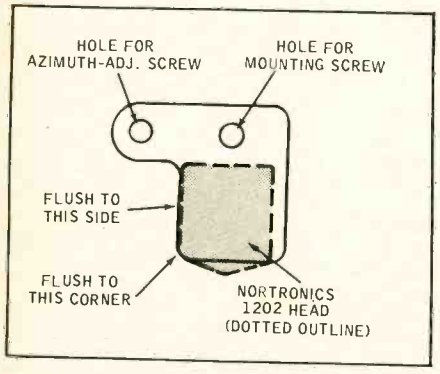


Fig. 12. Sketch of Nortronics 1202 head mounting on the head plate to indicate location. Head is epoxied onto the plate in the position shown.

Fig. 13. New head in place. Note that pressure-pad assembly has been removed as not necessary with the Nortronics 1202 head.

Head Adjustment

Usual head adjustments must be made. Using a piece of four-track tape, raise or lower the head to obtain maximum output from terminal 3 of the output socket. Tentative azimuth adjustment can be made on program material. Following this, put on a full-track test tape and adjust the potentiometer for equal output on terminals 3 and 5 of the output socket, shorting terminals 2 and 4 to turn on the amplifier for the right channel. After the gain is balanced, adjust azimuth in the usual manner with a high-frequency tone. Frequency response for the two channels should be within ±0.5 db from 50 to 20,000 Hz. and should conform to the NAB curve.

(*Continued on page 80*)

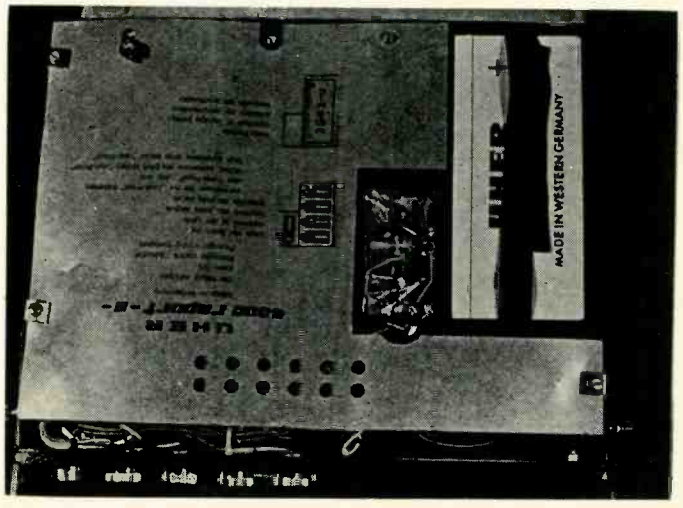


Fig. 15. Underside view of recorder with fibreboard insulating card in place, and showing the location of the new amplifier.

THE COMPLEAT AUDIOPHILE

The intrepid angler without a tackle box? The mighty hunter with no gun case? The philatelist without a stock book or stamp album? The artist without his taboret? The chef without a pantry? Never. *Never.* Never!

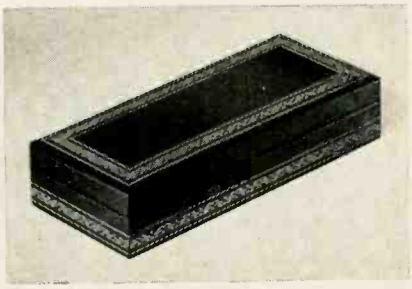
The fact is you enjoy an avocation more fully with the right accoutrements for the task at hand—and, inevitably, this leads to the need for a place to store the many small and delicate items comprising your collection.

Cartridges, for example. The true audiophile invariably owns more than one. He chooses the correct cartridge for the record—and for the occasion. Keeping them safe and handy is a problem that Shure has undertaken to solve. Voilá!

the SHURE CARTRIDGE CADDY

Exclusive, custom-designed, handsome 12" x 5¼" x 2½" black simulated leather box with gold leaf tooling. Compartmentalized and fully lined. Holds up to 4 cartridges and 6 extra styli —or 3 cartridges and 6 extra styli, with room to spare for your pressure gauge, brush, etc. Simply send $4.95 and proof of purchase of any Shure Stereo Dynetic cartridge to the address below.

(Value? Name your own price—the Shure Cartridge Caddy is unavailable anywhere else at any price!)



. . . the Shure Cartridge Caddy only $4.95

IT'S YOURS FOR ONLY $4.95 WITH THE PURCHASE OF ANY SHURE STEREO DYNETIC® CARTRIDGE

(Offer available in U.S.A. only)

V-15

THE ULTIMATE! Literally handmade and inspected in accordance with the stringent standards of the Shure Master Quality Control Program. Features bi-radial elliptical 15° stylus. Reduces IM, harmonic and tracing distortion. A purist's cartridge throughout. $62.50.

M55E

MODERATE PRICE. Compares favorably to the V-15, but produced under standard quality control conditions. Features elliptical 15° stylus. Will improve the sound of any system (except those using the Shure V-15). $35.50.

M80E

THE "FLOATING" CARTRIDGE. M55E type, spring-mounted in head-shell for Garrard Lab 80 and Model A70 Series automatic turntables. Bounce-proof and scratch-proof. Cartridge retracts when pressure exceeds 1½ grams. $38.00.

or the Shure **M3D** at $15.75; **M7/N21D** at $17.95; or any of the Shure M44 series cartridges at $17.95 to $21.95.

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

Circle 117 on Reader Service Card

Licensing of Television Servicemen

ALBERT WOODRUFF GRAY

Two State Supreme Courts have held licensing of servicemen to be legal. The rulings imply that any servicemen dealing with the public may be licensed.

STATE AND LOCAL governments are exercising an increasing surveillance of the business activities of television service and repairmen. Under its police power the state may regulate trades, occupations, and professions for the protection of the public welfare. That power in turn may be, and is, delegated to cities and other types of municipal organizations.

Some time prior to July, 1960, an ordinance was adopted by Kansas City requiring television and radio servicemen to secure a municipal license for the conduct of their work. That ordinance was held unconstitutional and another ordinance adopted. Concurrently with the adoption of this second Kansas City ordinance, the city of Detroit enacted an ordinance directed to the regulating, licensing, installing, and servicing of television equipment in that city, with a preface to that ordinance, commenting that the public had suffered great abuse in "being victimized by irresponsible sales methods, unethical and financially irresponsible service organizations and inferior installation, maintenance, and repairs."

The Detroit Ordinance

The Detroit ordinance established a nine-member board appointed by the mayor, consisting of four service dealers, a staff member of a television school licensed by the Michigan Department of Public Instruction, a television engineer from a local service station, a representative of the Detroit Department of Buildings and Safety Engineering, a communications officer in a city division, and a resident of the city.

The ordinance stated, in part: "It shall be unlawful for any person to engage in the occupation or trade of a certified technician without a license therefor as hereinafter provided; provided that the provisions of this ordinance shall not apply to any employee of a licensed service dealer performing services with his approval under the direction of a certified technician, nor to a student or apprentice when accompanied and supervised by a certified technician.

"All such employees shall carry official identification cards of such form and style as the Board of Examiners shall prescribe, to be issued by the service dealer, identifying them as authorized employees of said service dealer and bearing the license number of said service dealer, which shall be displayed upon demand to the customer."

The Supreme Court of Michigan, in its conclusion holding this ordinance to be a valid exercise of the police power of that state, said:[1]

"The service dealer did not have to be a skilled technician but, if not, the dealer must have a skilled technician among his employees. All who service television receivers are not required to be skilled technicians.

"The corporation counsel asks us to take judicial notice of the fact that the television receiver is a piece of complicated electrical apparatus; that television is a comparatively new field with a limited supply of highly skilled servicemen; but many are as yet apprentices; that much of the service requires comparatively unskilled operators such as the replacement of tubes; that to require a high degree of skill in all servicemen would be difficult to achieve, resulting in increased costs to the householder; that for these good reasons the ordinance permits identified employees to perform repair service under the direction of a certified technician."

Apparently at the time this decision was rendered by that Michigan court no other licensing statute or ordinance had come before any of the courts for review. However, the Kansas City ordinance adopted in 1961 came for review before the Missouri Supreme Court a short time ago, and that law was also held valid and constitutional.

The Kansas City Ordinance

The preamble of the Kansas City ordinance states: "Whereas the business of selling radio and television service contracts and servicing and repairing radio and television receiving apparatus have become a subject of great abuse with the result that the public has been and is being victimized by irresponsible sales methods, unethical and unstable service organizations, and inferior installations, maintenance and repairs."

This preface was followed by the ordinance making it illegal to engage in the business of servicing radio and television receiving apparatus without a license and providing for the issuance of such licenses to service dealers and certified technicians. By this ordinance the service dealer was defined as a person engaged in the servicing of receiving equipment at an established business location.

The licensee must either be a certified technician or have in his employ a certified technician in personal charge of servicing receiving equipment. For recognition as a certified technician the applicant must have passed an examination conducted by a five-member board which had investigated the training and fitness of applicants as well as preparing examinations that should be practical in character and relate to those matters which fairly test the capacity of the applicant to engage in the business within the scope of the license applied for. Separate licenses were authorized for the servicing of both radio and television receiving equipment, servicing television equipment only, and servicing radio equipment only.

It was further provided that this board was authorized to conduct hearings to determine whether or not a licensee has complied with the provisions of this ordinance and with the rules and regulations promulgated

(*Continued on page 86*)

The **new Sony 500-A:** A magnificent stereophonic tape system with the amazing **new 2.5 micron-gap head** that produces a flat frequency response from 40 to 18,000 cps ± 2 db:* A remarkable engineering achievement; a complete four track stereo tape system with detachable speakers** and two new award winning F-96 dynamic microphones. **All the best from Sony for less than $399.50.**

Outstanding operational features distinguish the amazing new Sony Sterecorder 500-A: ■ Two bookshelf type acoustical suspension speaker systems combine to form carrying case lid ■ 4-track stereo/mono recording and playback ■ Vertical or horizontal operation ■ Special effects with mike and line mixing and sound on sound ■ Two V.U. meters ■ Hysteresis-Synchronous drive motor ■ Dynamically balanced capstan flywheel ■ Pause control ■ Automatic sentinel switch ■ Multiplex Ready with FM Stereo inputs. ®

*Rave Review: "The NAB playback characteristic of the 500, as measured at USTC, was among the smoothest and closest to the NAB standard ever measured." — High Fidelity Magazine, April 1964. ■ **Rave Review: "One of the striking features of the TC 500 is the detachable speakers, ...they produce a sound of astonishing quality." — Hi Fi/-Stereo Review, April 1964. *Available* now: A sensational new development in high quality magnetic recording tape, SONY PR-150. Write today for literature and your special introductory bonus coupon book allowing a substantial discount on 12 reels of PR-150. Superscope Inc., Sun Valley, Calif. Dept. 17.

SONY SUPERSCOPE *The Tapeway to Stereo*

Circle 118 on Reader Service Card

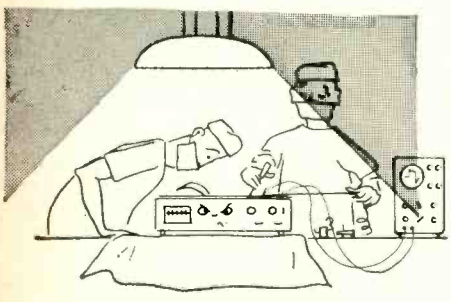
Hi-Fi and the British: Exhibitionism

ALAN WATLING

Those about to attend the annual ritual called the High Fidelity Show may derive some comfort that the British do as we do, or vice versa.

THERE'S no doubt about it—1965 will be *the* year to redesign our entire hook-up completely. Just how complete this operation will be depends on: (a) the bank manager; (b) the wife; and (c) the Audio Fair. On second thoughts, reverse (a) and (b). . . . To give (c) its full and grandiose title, the International Audio Festival and Fair has become a pivot around which the audio year turns. It is a sort of an Annual General Meeting of the trade and the customers, with the additional attraction of the people who actually design the stuff. Roll up, roll up and see the Bearded Genius who set fire to your cabinet. . . .

The time is the end of April, the place is the Hotel Russell. Albeit rather old-fashioned by American standards, it still has the advantage that separate, domestic-sized rooms are used for demonstrations and the great disadvantage that four hundred and two people try and get in each one at the same time. It is frantic, extrovert, technical, commercial, professional and amateurish all in the same breath. The salesmen slap each other's backs, the Seekers after Truth probe mercilessly into the misprints in the specifications and the naive newcomer gapes helplessly at the electronic entrails of Hi-Fi. It's noisy, too. The watts come out of the doors like summer tempests. The more musical of the demonstrators let in their queues, close the doors and give a balanced program, but, oh dear, the others. . . .



Fg. 1. Electronic entrails.

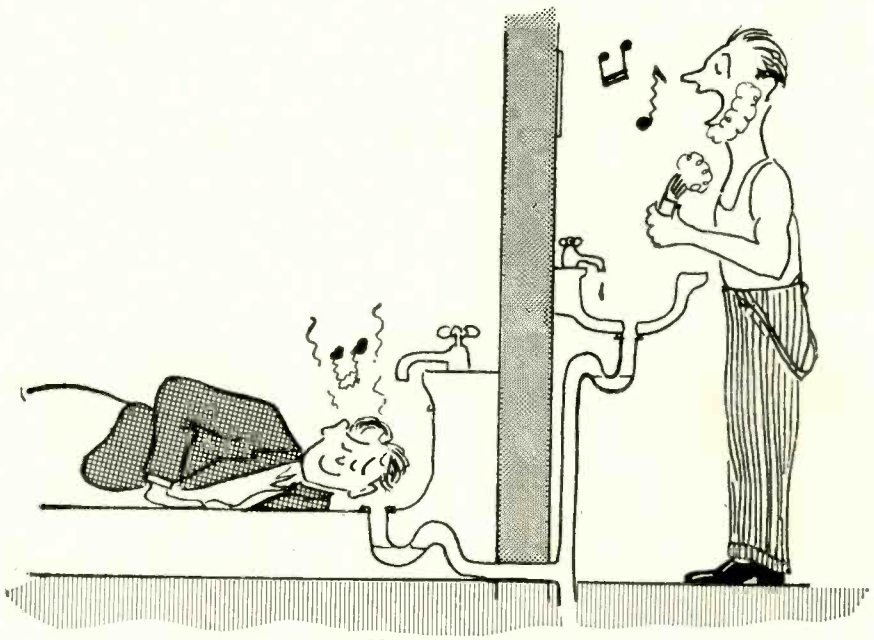


Fig. 2. Plughole monitoring.

In spite of the unhappy, questing look of the crowd, humour abounds. One stand boasts a six-foot-high photo of the underchassis wiring. "Are all your amplifiers like that?" "Every one, sir." "Shame," says the lad with the armful of leaflets, and points to a dry joint the size of a melon. . . .

"The equipment you can't afford to miss!" shouts the banner over an otherwise empty stand. . . .

"Rachmaninoff never heard it like this!" (They were dead right, too. . .)

Now and then one glimpses the frantic endeavours of a specialist caught on one foot trying to be a salesman, or vice versa. The trade is not always rich enough to be as functionalized as the automobile market, so the microphone designer battles nobly with someone else's disc unit and mixer, ending with a creditable imitation of Edison Bell singing in the bath.

One exhibit always fascinates me. A recorder spins majestically on an immaculate dais. Two impeccable speakers gently bathe you in massed strings, translucent as the dawn. And there's not a soul in sight, the tape never runs out, the fuse never blows, and no rough salesmen shout above the lovely sound. I think the man in charge hides in the bathroom and monitors through the plughole.

(*Continued on page 90*)

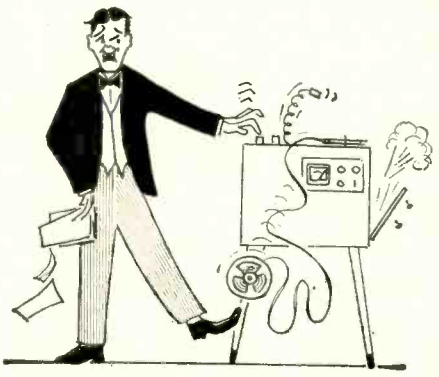
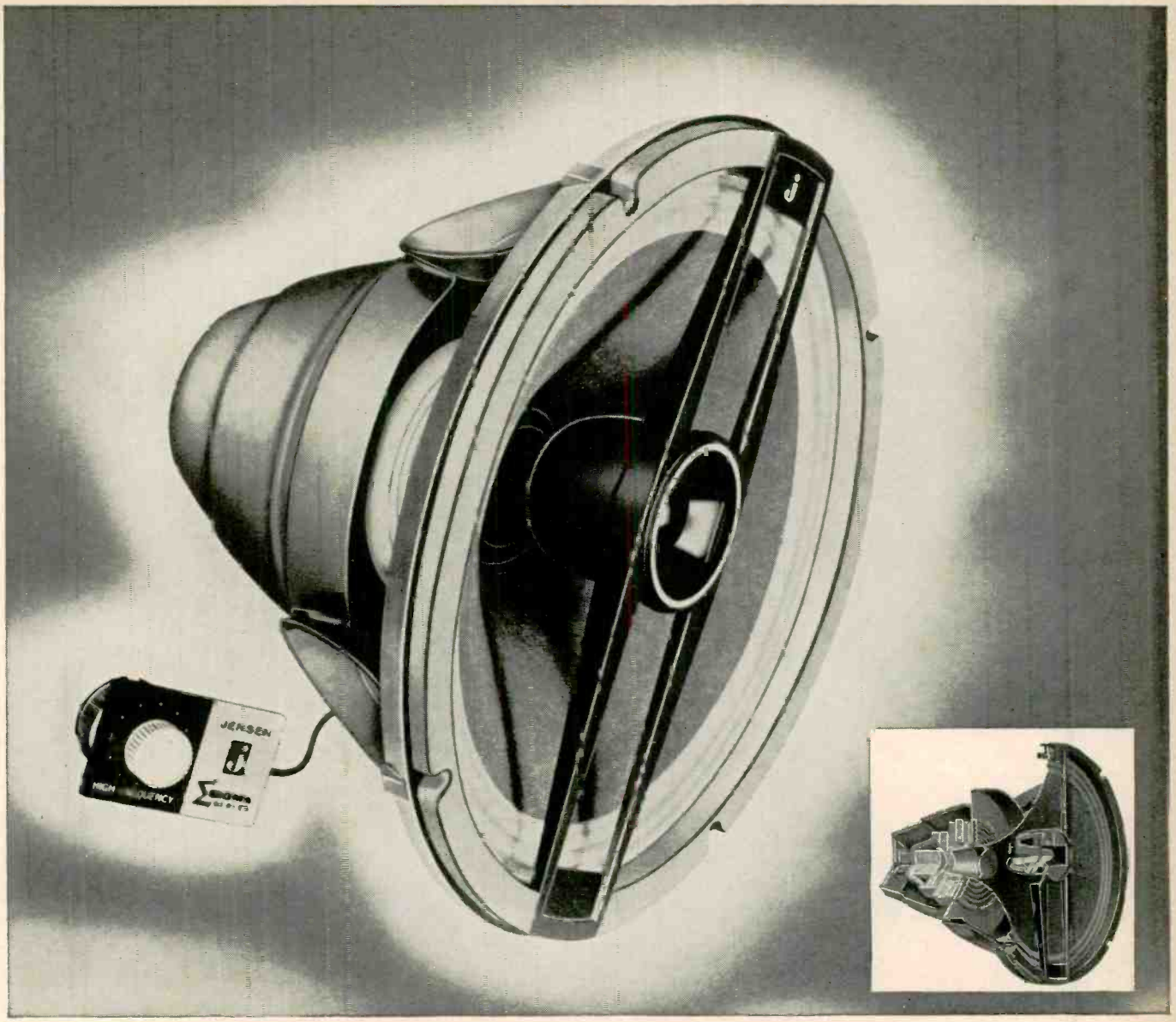


Fig. 3. Catastrophic failures.



Now JENSEN brings you an advanced 12″ version of the famous TRIAXIAL® loudspeaker

Fourteen years ago Jensen introduced the G-610 TRIAXIAL® 3-way loudspeaker . . . three acoustically and electrically independent loudspeakers in one unitary assembly. It made history as the first 3-way system and embodied the first horn-loaded compression driver supertweeter to be used in a commercial high fidelity loudspeaker. When this 15″ speaker was installed in a large enclosure, the sound was truly awe inspiring. We still make the G-610.

Now Jensen has created the SG-300 TRIAX®. It is scaled down in dimensions and will go in a compact shelf-size enclosure. It retains all of the important original concepts . . . is even more advanced in its use of the FLEXAIR® high-compliance long-travel surround and SYNTOX-6® magnetic structure in the woofer. Covers 20-20,000 plus cycles with outstanding smoothness and clarity. Forty watt program, eighty watt peak rating. Especially convenient for built-in systems. The SG-300 may well be the ideal speaker for you. Write for Catalog 165-L. See your dealer. $109.50

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JENSEN LOUDSPEAKERS

This product carries The JENSEN FIVE YEAR WARRANTY

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Argentina: Ucoa Radio, S.A., Buenos Aires • Mexico: Fapartel, S.A., Naucalpan, Mex.

Circle 119 on Reader Service Card

We just developed a sound tape so sensitive that

you can now cut recording speed by half, yet retain full fidelity. You can actually record twice the music per foot. Your budget will applaud. Start savings with this new box. ☞

SCOTCH® Brand "Dynarange" Series Recording Tape is the name. And this one makes all music come clearer, particularly in the critical soprano range. Reason: This tape cuts background tape noise in half. With this result: You can now record at 3¾ ips all the finest fidelity that before now your recorder could only capture at 7½.

Your dealer has a demonstration tape that lets you hear the excellence of this new tape at slow speed. Costs a little more. But you need buy only half as much—and can save 25% or more in tape costs. Or, if you use this new tape at fast speed, you'll discover fidelity you didn't know your recorder had.

Other benefits of new "Dynarange" Tape: Exceedingly low rub-off keeps recorders clean. The "Superlife" coating extends wear-life 15 times over ordinary tapes. Lifetime Silicone lubrication assures smooth tape travel, protects against recording head wear and extends tape life. Comes in new sealed pack, so tape is untouched from factory to you. Reasons aplenty to see your dealer soon, hear a demonstration. Then try a roll on your own recorder.

Magnetic Products Division 3M COMPANY

Development of Pulse-Modulated Audio Amplification

In Four Parts—Part 2

NORMAN H. CROWHURST

In this installment, the author first covers the relevant parameters, then considers switching characteristics and drive requirements. Economics of the circuit design and components chosen are of practical importance.

When we used to design tube amplifiers, the requirement for successive stages was merely that the plate voltage swing of one stage be enough to drive the grid circuit of the stage that followed it. Even for "plain" audio amplification with transistors, it's a little more complicated than this, and when we move into the new pulse modulation we find even more parameters crop up. Let's start at the output end, because our first job will be to find suitable output transistors for whatever power level we want to produce as output.

Most transistor specification lists include maximum collector voltage and current. If we're not concerned with frequency, the product of these two figures represents the maximum power the transistor can be used to switch. So a pair of 50-volt, 10-amp transistors should provide switching for 500 watts peak, or 250 watts average (maximum sinusoidal power). But at what frequency can we switch them?

Some specifications list a cutoff frequency, but this uses one of two terms of reference and thus is difficult to correlate: one way of giving cutoff frequency is to state the half-power point, operated as a grounded emitter;

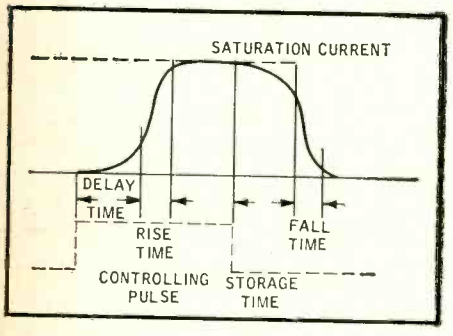


Fig. 2-1. A sample of the kind of output pulse generated by one type of transistor, to illustrate the meaning of the four time constants associated with transistors operating in switching mode.

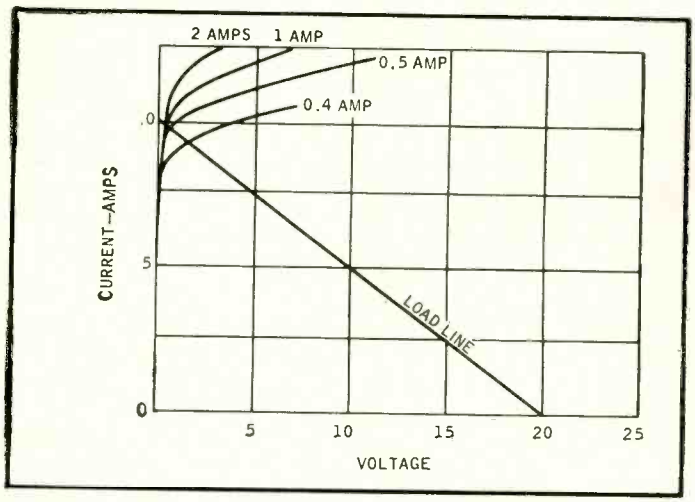


Fig. 2-2. Load line showing how saturation may sometimes be a somewhat vague quantity.

the other way gives cutoff operated as a grounded base stage, which is related approximately to the first figure by the current gain of the stage, working grounded emitter. If the current gain is 50, then the cutoff frequency may be listed by one method (grounded emitter) as 5 k Hz, and by the other as 0.25 M Hz.

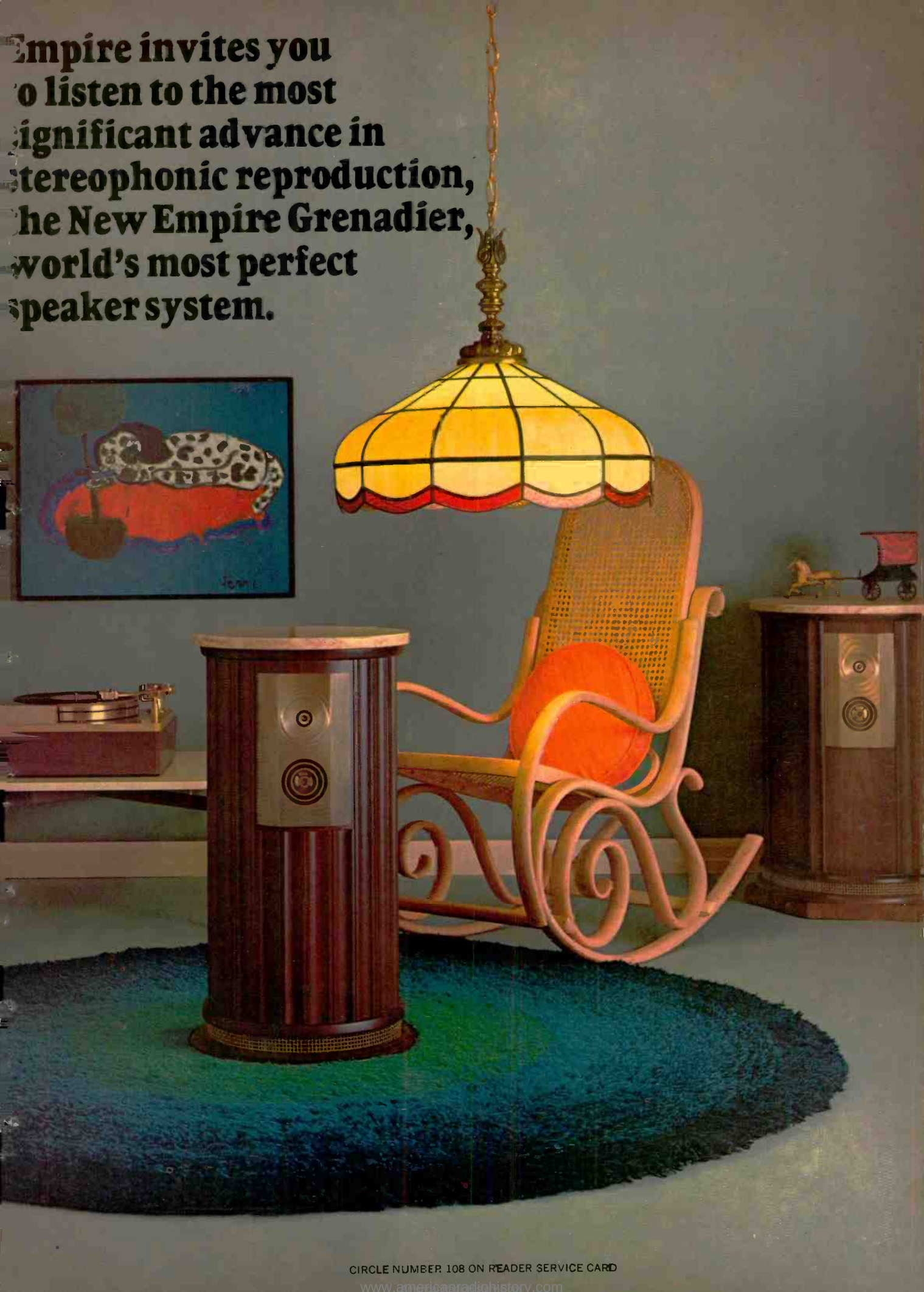
A third method of listing is coming into prominence: the gain-bandwidth product. If frequency is multiplied by gain at any point where the slope is 6 db/octave, this gives the gain-bandwidth product. The figure is similar to the grounded-base cutoff frequency. Its advantage is that it is equally applicable to either method of operation.

If you teethed on tube designing as I did you'd expect there to be some convenient correlation between cutoff frequency and the maximum usable pulse frequency. Of course, you'd also expect that this might be a matter of compromise: using a pulse frequency appreciably lower than cutoff should enable bigger relative spaces between pulses and thus improve efficiency. Broadly, these expectations are in the right direction, but when you start to try and nail down some figures, you find it's not as easy as that.

If you're amplifying sine waves, cutoff frequencies are fine. But when you're handling pulses, that's a different kettle of fish. Actually, exploring transistors with pulses tells much more about their characteristics than can be done with sine waves. Two transistors may end up with the same cutoff frequency, yet have quite different transient switching qualities. So, even when working on a design *based* on sine-wave amplification, mere specification of cutoff frequency does not tell the whole story, because the transistor is likely to encounter other forms when it handles musical signals.

Switching Characteristics.

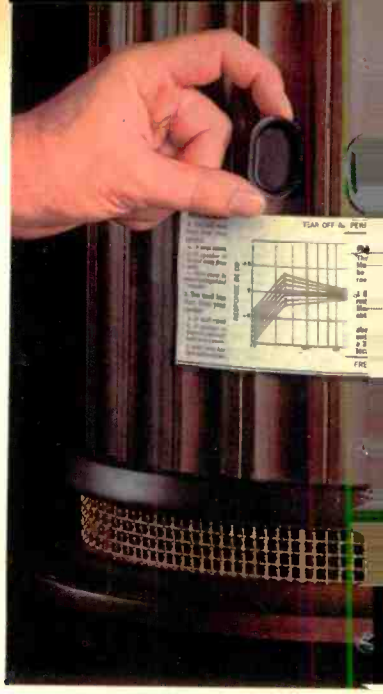
It turns out, when subjected to switching transients, that a transistor has, not one time constant, as would be implied by a single cutoff frequency, but four time constants. When, from being cut off, it is suddenly switched on by applying a base current that results in full conduction current, there is first a delay time before the current really starts to rise; then there is a rise time, defined in the usual exponential terms; then, when the base current is switched off, there is a storage time, followed by a fall time. *Fig.* 2-1 shows all these quantities, for a possible transitor. We can-



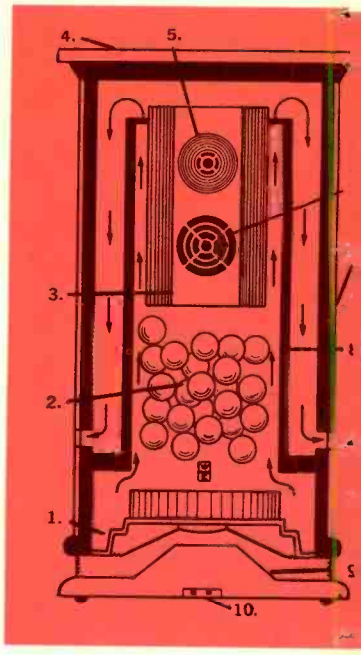
CIRCLE NUMBER 108 ON READER SERVICE CARD

Feature by feature the Grenadiers take you into a new world of sound. Listen for a moment.

Take a good look at the statuesque originality of this wide angle speaker system. Note its hand rubbed walnut finish, its imported marble top. Now, hear it perform. The new Empire 8000P is truly the most significant advance in stereophonic reproduction.



Empire's exclusive "Dynamic Reflex Stop System" allows you to adjust the bass and treble response to suit your individual room acoustics



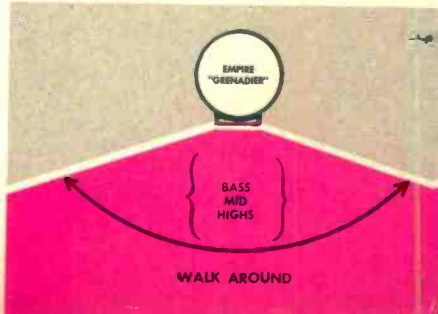
Irresistible beauty from any angle. Captivating sound from any position!

Empire's revolutionary die-cast divergent acoustic lens assures fuller frequency and separation, plus broader sound propagation. Lets you sit anywhere—hear everything.

Grenadier placement is non-critical. Phenomenal Stereo Separation and the highest fidelity of music is assured from any area in the listening room. Try this simple test! Walk around the Grenadier. You will experience no change in sound level of the bass, mid-range or highs. Full frequency and separation is assured by Empire's exclusive divergent acoustic lens system.

MODEL 8000P

Frequency Response: 25-20,000 cps.
Nominal Impedance: 8 ohms.
Power Handling Capacity: Music Power—Maximum undistorted 100 watts
Sine Wave Power—25-450 cps 60 watts
—450-5000 cps 40 watts
—5000-20,000 cps 20 watts
Components: Woofer—12". High Compliance with 4 inch voice coil.
Mid Range—Direct Radiator
Tweeter—Ultra Sonic Domed Tweeter
Both Coupled to Die-Cast Acoustic Lenses
Finish: Satin Walnut finish, hand rubbed.
Overall Dimensions: Dia. 16". Ht. 29".
Weight: 85 lbs. *List Price: $235.00 with imported marble top. $225.00 with hand rubbed walnut top.



EMPIRE

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The new Empire Royal Grenadier—classically designed, elegantly styled. Let the magic of this wide angle speaker system invade your presence with its majestic sound and richness of tone. Truly, one of the world's greatest speaker systems.

You're on the threshold of a new realm of excitement in music and sound. Empire has created for you, the worlds' most perfect high fidelity components. Combining unparalleled stereophonic sound with refreshing furniture styling ...the Empire Grenadier—projects a sense of presence never before achieved in a speaker system. Hear it! Compare it! Stare at it! You too, will be captivated by its greatness! The Empire Grenadier, first speaker system designed and engineered for stereophonic reproduction.

No less perfect than the Grenadiers are the Incomparable Troubadors —complete record playback systems.

High Fidelity reports—"... and what a speaker!" ...voices sounded quite natural with no coloration evident; orchestral music was balanced and full; transients came through cleanly; the organ sounded authentic. Overall, the sonic presentation was excellent; the speaker did not favor one type of instrument or any one portion of the spectrum and it never sounded honky or boxy."

OUTSTANDING FEATURES
1. 12 inch mass loaded woofer with floating suspension, four inch voice coil and world's largest (18 lbs.) speaker ceramic magnet structure.
2. Sound absorbent rear loading.
3. Die-cast acoustic lens.
4. Imported marble top.
5. Ultra-Sonic domed tweeter
6. Full presence mid range radiator.
7. Damped enclosure.
8. Dynamic Reflex Stop System.
9. Front loaded horn.
10. Complete symmetry of design with terminals concealed underneath.

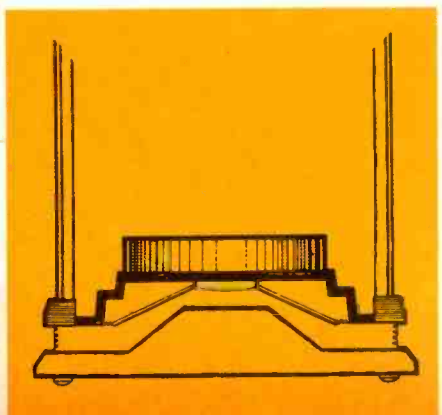
Technical Specifications: (Model 9000)
Frequency Response: 20-20,000 cps.
Nominal Impedance: 8 ohms.
Power Handling Capacity: Music Power—
Maximum undistorted 100 watts
Sine Wave Power—20-450 cps 60 watts
—450-5000 cps 40 watts
—5000-20,000 cps 20 watts
Components:
Woofer—15". High Compliance with 4 inch voice coil.
Mid Range—Direct Radiator
Tweeter —Ultra Sonic Domed Tweeter
Both Coupled to Die-Cast Acoustic Lenses
Infinite baffle system.
Finish: Satin Walnut finish, hand rubbed.
Overall Dimensions: Dia. 22", Ht. 29".
Weight: 120 lbs. List Price: $285.00 with imported marble top. $275.00 with hand rubbed walnut top.

The famous Empire 398—outstanding! too perfectly engineered for even a whisper of distortion...to handsomely finished to hide behind cabinet doors.

The Empire 498—no larger than a record changer—tailor made for console or equipment cabinets.

The Troubadors consist of the Empire 3 speed professional "Silent" turntable....Empire 980 dynamically balanced arm with sensational dyna lift...and the new Empire "Living" cartridge, featuring the exclusive magnetic cone stylus. No other cartridge can reproduce the entire musical range as precisely and with such clarity.

The woofer faces downward, close to the reflecting floor, surface, feeds through a front loaded horn with full circle aperture throat. This provides 360° sound dispersion and prevents standing waves from developing in the room.



Decorator designed to complement any decor. Engineered to outperform any other speaker system. Truly the ultimate in sound and styling.

Hi Fidelity reports: "The Troubador represents a precision engineered product of the highest quality...the finest, handsomest, record player available."

Hearing it all—a little better than it was intended to be heard. You, too, can enter Empire's new world of sound.

Just go 'round to your Hi Fi dealer for a sound demonstration of the world's most perfect High Fidelity components....Empire Grenadiers, Troubadors and "Living" Cartridges.

The Incomparable Troubadors. World's most perfect record playback systems.

The Famous Empire 398. Outstanding! too perfectly engineered for even a whisper of distortion...to handsomely finished to hide behind cabinet doors.

The new Empire 498 no larger than a record changer—tailor made for console or equipment cabinets.

Both Troubadors set a new standard in playback equipment. In fact, more Empire Playback equipment is used by FM Stereo Stations than any other brand. No wonder equipment reviewers, professionals and audiophiles the world over acclaim the Troubadors as the best money can buy.

(1) Audio Magazine: "Precise performance...an excellent buy for those who want the quality...we tried to induce acoustic feedback by placing the turntable on top of our large speaker system and turning up the gain—we were unsuccessful."

(2) American Record Guide (Larry Zide) "I found speed variations—that is, flutter and wow—to be inaudible...vibration extremely low....Total rumble figures have not been bettered by any turntable I have tested."

(3) Don Hambly, station mgr. KRE AM-FM, Berkeley, Calif. "We have long realized that belt driven tables would be the best to use, but had not been impressed with those on the market. The Empire tables, however, have all the basic requirements of design and simplicity of operation and maintenance that we have sought."

Only Empire makes a completely intergrated 3 speed "silent" record playback system.

INCOMPARABLE TROUBADORS TABLE OF CONTENTS:

Highly accurate Fine Speed Control. Push button power control with on-off light. Optimum distribution of turntable mass; 6 lb. heavy machined aluminum, individually balanced to precise concentricity; machined heavy aluminum base plate.

Safety suspension rubber mat. Retractable 45 RPM adapter. Rumble better than 65 db. Wow and flutter less than .05%. Power: 117 volt, 60 cycles AC, 30 watts.

980 dynamically balanced playback arm with Dyna-lift; 888P Living Cartridge with exclusive magnetic cone stylus.

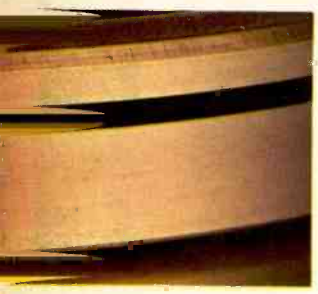
398 complete in handsome walnut base measures 17"W x 15"D x 8¾"H. Without base: height above mounting board 4" depth required below turntable baseplate 2½".

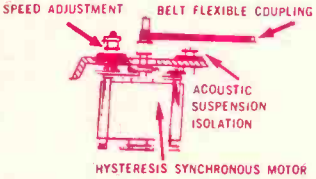
498 Troubador, complete in handsome walnut base, measures 16"W x 13¾"D x 7½"H.

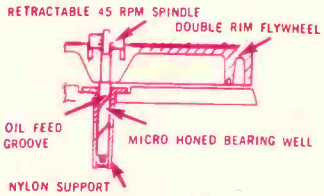
488 Troubador, complete with walnut mounting board, measures 15⅞"W x 13¼"D. Height required above mounting board 2¾", depth required below turntable bass plate 3½".

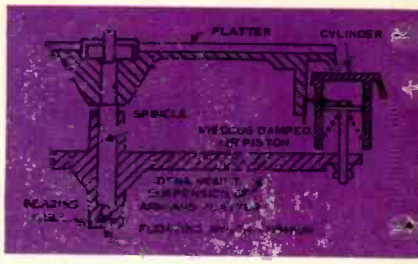
List Price: 398 Troubador with walnut base $185.00.
List Price: 498 Troubador with walnut base $170.00. Less base $155.00.

Its massive turntable is driven by a heavy duty hysteresis-synchronous motor that provides a constant speed regardless of current fluctuations. Only two moving parts, resilient nylon "seat" supports and cushions the rest of the main bearings. A continuous flexible belt (perfectly ground to a ±.0001 inch thickness) also contributes to its flawless performance.









Another impressive feature is Empire's sensational "Dyna mount" (vibration absorbing multiple-floating suspension system found only in the 498 and 488) virtually assures stability under any conceivable situation.

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not say typical, because almost every transistor type varies from other types.

This is not quite all, as regards the basic parameters related to switching. We speak of full-conduction, or saturation current. But this may not be easy to nail down specifically. At the end of the approximately linear range of the transistor's load line, where it runs into saturation, there is invariably some curvature. Current is usually controlled by the load line and the applied voltage —we're familiar with that from tube technology. But the final *voltage* drop across the transistor depends on the base current, although the collector *current* may not be changing appreciably beyond a certain point (*Fig.* 2-2).

Thus, if this transistor uses a 2-ohm load line, so that a 20-volt supply will result in 10 amps at short-circuit, we may find that 0.5-amp base current results in 9.5 amps with 1 volt across the transistor; 1-amp base current may result in 9.7 amps with 0.6 volt across the transistor; 2-amp base current may result in 9.8 amps with 0.4 volt across the transistor. But quite likely 2 amps would be beyond the rating for maximum base current, if 10 amps is the maximum collector current.

Another transistor may reach its minimum voltage drop much more definitely, at a certain current, following which the drop does not reduce appreciably, however much base current is increased.

Next, in combining these two characteristics—saturation currents and switching times—the four times shown in *Fig.* 2-1 are all subject to change with other parameters. The controlled collector current will change all of them. The times will be different if the maximum current is limited to 2 amps from those given at 10 amps. But let's assume we decide on a maximum current for the time being.

Delay time can be shortened, more with some transistors than with others, by surging the base current, so its initial value is higher than the steady value for the rest of the pulse. If the base is fed through a resistor, bypassing this resistor with a capacitor of suitable value, as in *Fig.* 2-3 can thus shorten delay time.

Rise and fall time vary with the (collector) current used, but beyond this dependence, are virtually invariable. There is no way of "speeding up" the rise and fall times at a given current value for a particular transistor. However, storage time can be shortened or lengthened. Where a higher current is used to achieve better saturation, or to speed up the delay time, storage time is usually lengthened (*Fig.* 2-4).

Some transistors will show an unduly long storage time (compared to other

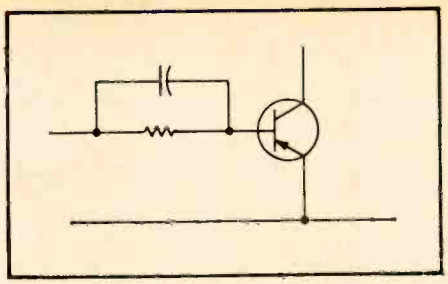

Fig. 2-3. A bypass capacitor can sometimes shorten either delay or storage time, or both.

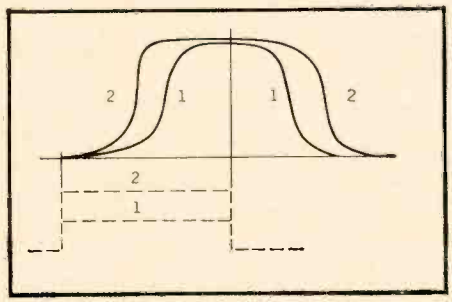

Fig. 2-4. Increasing base-drive current usually shortens delay time but lengthens storage time (curves 2 as compared with curves 1).

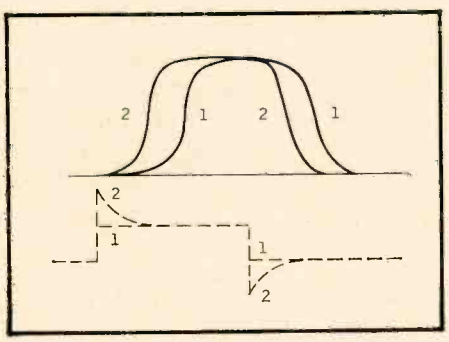

Fig. 2-5. How the bypass capacitor (*Fig.* 2-3) helps.

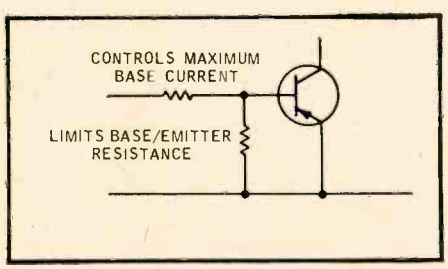

Fig. 2-6. A base-to-emitter shunt (resistor) can speed the delay due to storage time, in some transistors.

time constants) even when the controlling base current is not excessive. Then the storage time can usually be shortened by applying a reverse voltage (and thus current) at switch off. Instead of merely cutting off the current to the base at switch off, reverse it in a slight pulse. Thus the same capacitor that shortens delay time can also shorten storage time, in some instances (*Fig.* 2-5).

It would seem, from the circuit behavior of transistors, that storage time may have one of two causes: in some instances, it is the time taken for an excess charge to leak away; in these cases, reducing the base current at the peak of the pulse, or applying a reverse current momentarily at the moment of switching off, will reduce storage time.

In other instances, it seems as if the transistor "wants" to become self-supporting, so the collector current maintains the emitter current, which maintains the collector current, without any help from continued base current; this does not quite happen with junction transistors, but for a moment, known as storage time, the transistor "hangs on" before its current starts to fall. Where this appears to be the case, a reverse-current pulse is not necessary. It is sufficient to provide a relatively low-resistance path between base and emitter (*Fig.* 2-6).

Transistors with the latter form of storage characteristic, or where the operation current makes it dominant, will often maintain some current, after being switched to full conduction, if switching off is achieved by opening the base connection (physically). Thus, if the drive is derived directly from another transistor that merely ceases to conduct at the end of a pulse, the driven (output) transistor may have an exaggerated storage time—or even may not switch off completely at all.

One cannot generalize. The only thing to do is to check out the kind of transistor you think of using in simulated circuit conditions, and see how it performs. Best thing is to set up a drive circuit, such as that developed in the first part of this article, and try driving it. We have given this description of behavior as background for working on circuits to produce optimum performance.

Drive Requirements.

After selection of output transistors comes the question of how to drive them: in grounded emitter or common collector (emitter follower)? This involves choice of a drive transistor capable of sufficient collector current to switch the output transistor, with a collector voltage rating that will meet requirements, according to the way it drives. If the output stage uses a grounded emitter, a small base voltage will drive it, provided the current swing is there, so if it is any advantage the drive transistor can use a lower collector-supply voltage than the output stage (*Fig.* 2-7).

If emitter-follower action is required

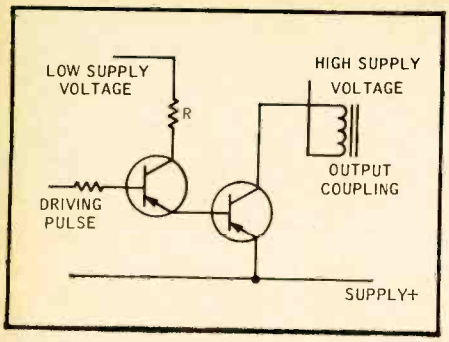

Fig. 2-7. Use of different supply voltages, when the output stage is collector coupled (grounded emitter). Resistor R limits drive-stage collector current, which is essentially output-stage base current.

—as we shall see presently where four transistors are operated in bridge, two common emitter and two common collector—the stage to drive it must have the same voltage swing as the output, with enough collector current to produce the output base current drive. In this case, as in some other positions, the choice may prove to be between an expensive silicon transistor that will fit the bill exactly, or a build-up of lower-voltage germanium types that will save on over-all cost and yield essentially the same performance (*Fig.* 2-8).

Economics.

In making this kind of decision, don't forget the fact that the cheaper transistors, which have usually been available longer, and thus have had more price reductions since their introduction, will not become much cheaper in the future, while the higher priced ones will probably come down in price more, as demand production increases in the future.

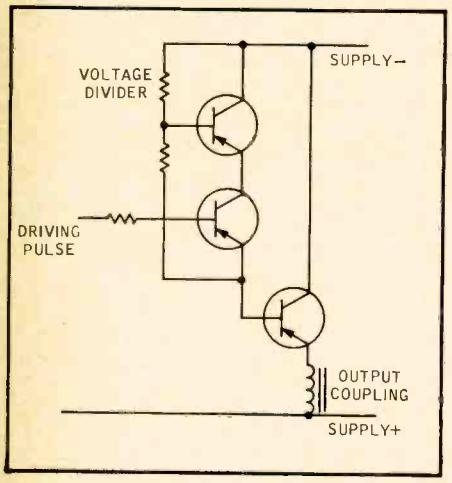

Fig. 2-8. Using two lower-voltage-rated transistors to serve on higher voltage by series connection. The two drive transistors shown here can withstand the full supply voltage needed to drive the output as an emitter follower, although their individual voltage rating is not high enough.

If you build up a single effective transistor stage from two or more actual transistors, to stand a higher voltage, work out the relationships at both extremes of the switching operation, and at a suitable point in between, to verify that the transistor's ratings are not exceeded.

Modulation.

Now we come to the provision of modulation. As we saw in the previous article, the output delivered by the capacitor and discharge resistor fed by the diode from the multivibrator, is a sawtooth, both in voltage across the capacitor and in current through the resistor. If the resistor is connected to the same base as another resistor carrying a steady current that saturates the transistor, except at the peak of the sawtooth, the sawtooth will switch that next transistor off (*Fig.* 2-9). Reducing current from the other source (which is audio plus bias) will cause this transistor to be cut off for longer, or the output transistor to be conducting for longer.

When you come to set this circuit up, you will find that precise setting, to get a pulse of minimum width, is quite difficult. Change bias a little bit and the pulse width will either disappear or become too wide. To aid in controlling this, the discharge current can be given a sharp-pointed start (*Fig.* 2-10) by bypassing part of the discharge resistor with a small capacitor. An alternative way of viewing this is that the capacitor and resistor are inserted in series with the existing discharge resistor.

If the bypass capacitor is small compared with the storage capacitor being discharged, the initial discharge current will be the same as if neither the capacitor nor its parallel resistor were inserted. But the discharge rate quickly changes to that which would occur if the total resistance were used for discharge. Suitable choice of values will achieve the desired curve. *Fig.* 2-10 shows values suited to a 60-kHz pulse frequency.

Thus the design of the multivibrator and its feed to the modulator stage follows the outline: the period of the multivibrator is determined by the time constant of the base-feed resistor and the collector-to-base coupling capacitors. When the multivibrator switches, it pushes the base of the transistor that is momentarily cut off positive by a voltage that would equal the negative supply voltage, if part of the charge were not passed through the diode to the output circuit—the storage capacitor.

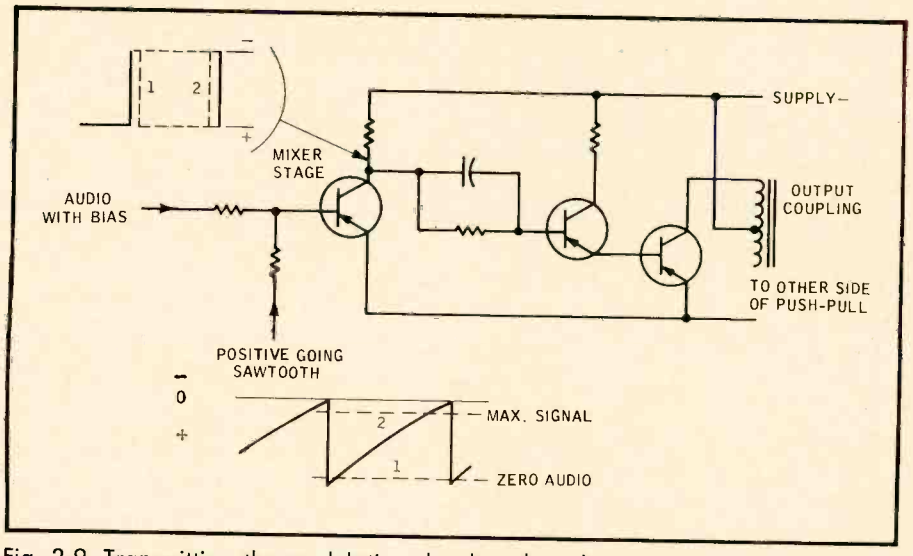

Fig. 2-9. Transmitting the modulation developed at the mixer stage to the output stage. The mixer stage (left) is normally conducting, saturated, and cuts off for pulses. The drive and output stage are normally cut off, pulse on to saturation. Variation of audio, combined with multivibrator pulses, varies the duration of the pulses transmitted.

As part of it is passed through the diode to this storage capacitor, the voltage is reduced by the ratio between these capacitances. An important feature here is to select high-speed, low-forward-resistance diodes. If the diode fails to charge the capacitor across the output at the same time it switches the multivibrator through the larger capacitor, it will not give the correct output waveform: it will have a slow rise and a rounded instead of a pointed top (*Fig.* 2-11).

To make the leading and trailing edges of the pulses as sharp as possible, especially the trailing edges, some positive feedback is needed. Without this, the mixer stage merely reproduces

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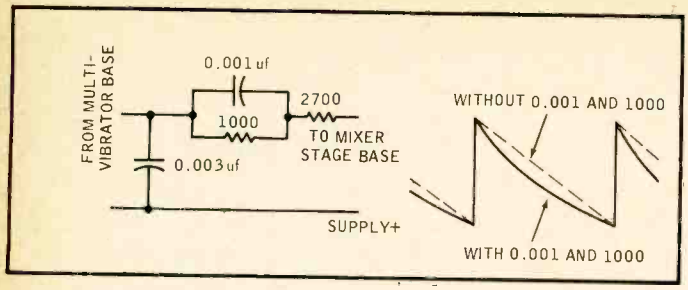

Fig. 2-10. Shaping the multivibrator pulse output to get sharper point, to better control the minimum pulse duration, at quiescent.

an amplified section out of the sawtooth. The leading edge is close to vertical, but its trailing edge has a definite slope (*Fig.* 2-12). The mixer stage only steepens this slope by its gain as a stage. This could be accentuated by applying it to another stage, biased so the mid-section of this stage's transfer flipped it from conduction to non-conduction and *vice versa*, but the simpler and less troublesome way is to boost the gain of the stage, over its active region, with positive feedback.

This is taken over two stages, to get the correct positive phase relationship. In *Fig.* 2-12, two possible feedback paths are shown in dashed line construction. Each has a capacitor and resistor. The resistor, where used, is chosen so the change of current at the base of the transistors to which the feedback connects is almost sufficient to support the change. If the stage were critically biased to this point, it would almost oscillate. But it only passes through this condition twice (once for on and once for off) for each period of the ultrasonic frequency. So it serves to accelerate the flip action.

This is further accelerated by using the capacitor. In some circuits the capacitor is all that is needed. These values are related, not so much to the switching (ultrasonic) frequency, as to the switching time constant of the transistors involved in the loop.

The mixer stage (middle one of *Fig.* 2-12) is coupled to the base of the drive stage, which in this instance is emitter coupled to the base of the output stage. As the output stage is collector coupled (grounded emitter), only a small base-driving voltage is needed so the resistor shown as 50 ohms in the collector of the drive stage is needed to limit drive-stage collector current, which is output-stage base current. This resistor can be common to the two drive-transistor collectors, because they never "fire" together. When one is conducting, the other one isn't and, for most of the time in quiescent, neither of them is.

To get the circuit working without danger to the output transistors, which are more costly than those used in the rest of the circuit, the emitters of the drive stage can be grounded, and the waveforms examined at the common collector, which we shall show in the next part of this article. It was found that, although the mixer stage put out a good negative-going pulse at its collector (current going off, with the supply negative), the drive stage failed to follow it adequately with its current-on pulse. Apparently, at this current level, the drive stage will not handle sharp pulses, without help. The method adopted was to bypass the coupling resistor from the collector of the mixer stage.

This posed a problem in capacitor choice: a small value would sharpen the leading edge, but the trailing edge remained poor; a larger value sharpened the trailing edge, but deteriorated the leading edge to a greater extent than with no capacitor at all. Finally, a successful combination was evolved (in dashed line ellipse in *Fig.* 2-12): the capacitor has a resistor and diode in parallel connected in series with it. The resistor limits the capacitor action on the leading edge and in this direction the diode is non-conducting. But during the pulse the capacitor acquires sufficient charge through the resistor so that for the trailing edge the diode conducts, providing reverse current to sharpen the trailing edge cut off.

Actually, a later change made this little assembly unnecessary. But this was a step in the development and it may have use in some circuits. Now we're ready to add the amplitude-controlling negative feedback and then the output stage. But those steps introduced further problems, so we'll reserve that for a further installment.

(To be continued)

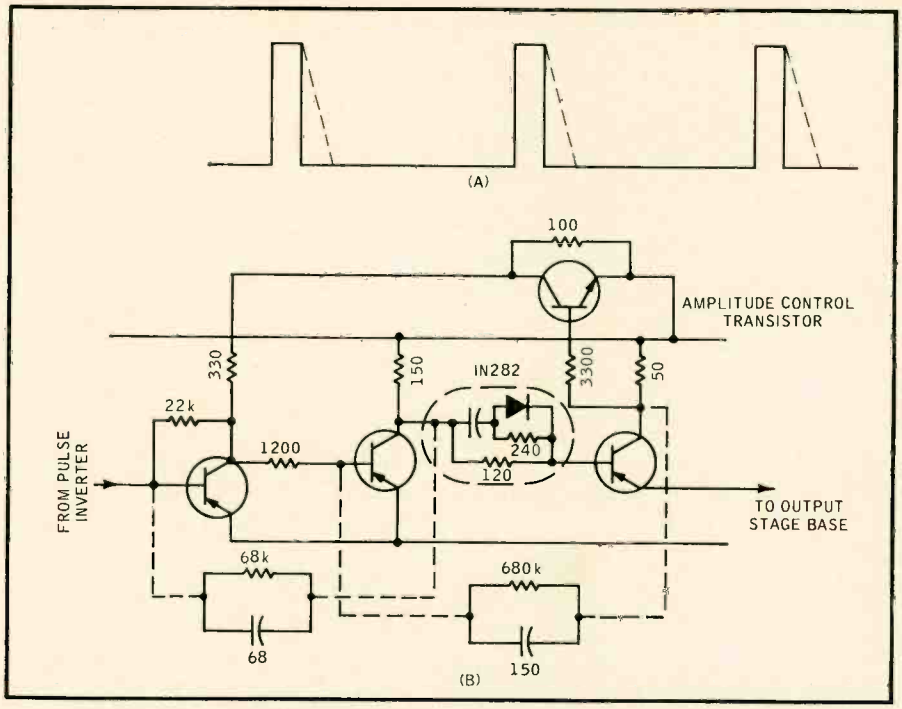

Fig. 2-12. Some details in development of satisfactory pulses: a. sloping trailing edge that occurs with no positive feedback to sharpen switching (dashed line); solid line shows effect of positive feedback; b. alternative ways of connecting positive feedback (values are those successfully used in those locations); in dashed ellipse is modified coupling between mixer and drive stage, to sharpen trailing edge of drive-stage pulse.

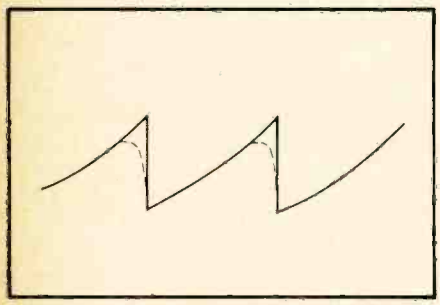

Fig. 2-11. Effect of using coupling diodes, in multivibrator output, with inadequate forward conduction (too high forward resistance): solid line, required pulse shape; dashed line, result of high forward resistance in diodes.

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PLANNING for a high-fidelity system (stereo) that culminated in almost three years of work before completion, we took a conservative approach in attempting to achieve the accurate reproduction of sound. By "the conservative approach" I mean: The use of components of the highest quality that would afford the least (or less) chance of *not* achieving the goal of true high fidelity. We could for instance, have employed much lesser equipment and tried the "curve matching" technique (combining a piece of equipment with, say, a 4-db peak in a certain frequency range, with another unit having a 4-db dip in that same range). However, this is rather chancy, and unless we had a practical means of testing components under the *same* test conditions, the results would be questionable. Hence, the conservative approach, using equipment components with very flat response over their range, and combining them in a system.

The design philosophy behind the equipment cabinet, which was built by A and O Custom Furniture Co. of New York City, was to combine the operational advantages of a studio-type control console, with the looks and finish of a fine piece of custom furniture. The cabinet is teakwood with a hand-rubbed satin finish. Because of the nearly 600 lbs. of weight, special care was used to make the cabinet as strong and rigid as possible. The bottom, or backbone of the unit, is stiffened with two 25-lb. carbon-steel plates which "bridge" each of the heavy 2" X 5" legs and are bolted to the inside of the bottom. In addition, the center portion of the bottom is braced by a ⅞" slab of solid marble and held firmly in place by concrete screws. This provides adequate rigidity. All this is long-term insurance against the slow warpage which takes place when even fairly heavy wood is subjected to a constant weight of this proportion and supported at only two points.

Instead of using a closed back for the cabinet, which would limit the air circulation, we left it open, (except behind the drawers), and installed a custom-made polished and lacquered brass grille at the back of the power amplifier compartment. This provides ample ventilation with the aid of three small fans—one for the power amplifier compartment, one for the tape deck compartment above, and one for the tuner-preamp compartment. These are fully foam rubber mounted and balanced to avoid cabinet resonances.

The equipment

At the top left is a Fairchild 412-1AA single-speed (33 1/3) which uses the high-torque hysteresis synchronous motor. The tonearm is an SME-3012 with bias adjuster, and the cartridge an ADC-1 using the standard stylus.

The turntable at the top right side of the cabinet is a four-speed Fairchild 412-1A-E.D. This uses a Papst motor

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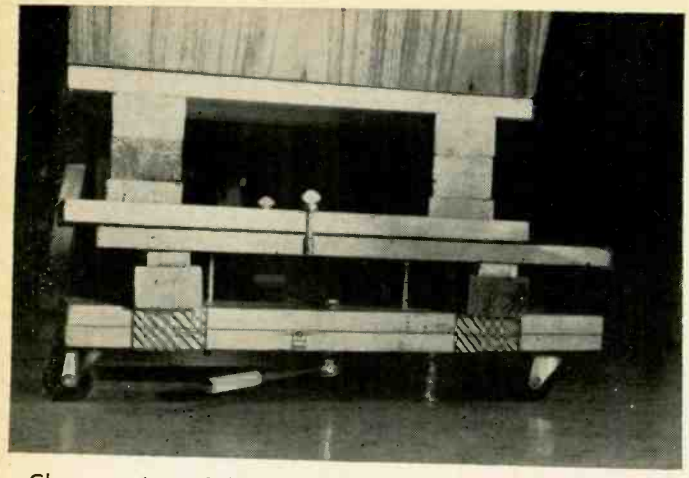
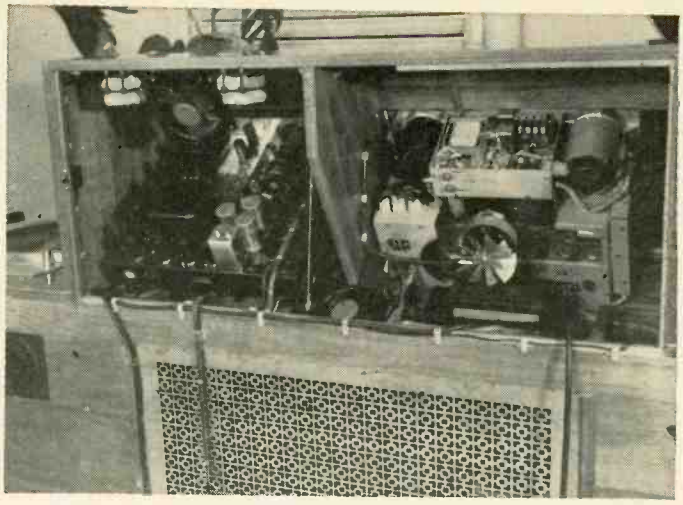


Close-up view of the ratchet roller-lift showing its application. The cabinet is raised sufficiently to permit placing wood blocks on the lift, holding it clear of the floor with complete safety for moving.



Rear view of the tape recorder-and-tuner panel. The smaller preamp is completely obscured by the tuner.

The tuner is located on the upper right side of the sloping center panel, and is hooked up to an attic mounted highly directional Yagi antenna with rotor.

Directly below the tuner is the Marantz model 7 preamp, so well known as to require little comment.

The power amplifier, a Marantz model 8 dual-30-watt unit, is located in the center of the large lower compartment of the cabinet.

Speaker Systems

Last, but by no means least, is the speaker system—a horn-loaded James B. Lansing D 44000 Ranger-Paragon, a single cabinet that is over 8½ feet wide, and weighs somewhere in the neighborhood of 700 lbs. (850 lbs. shipping weight). This massive unit stands near the equipment cabinet, and at right angles to it, so that its sound front is projected into the length of the 26-ft. basement music room, directly into the seating area located at the opposite end.

Essentially, it consists of two full-range speaker systems, each using identical elements, separately baffled and loaded, and arranged physically in such a manner as to provide a "curtain of sound" that seems to encompass an area beyond the confines of the enclosure in which individual instruments, seem to emanate from different localities within the "wall wide" sound front. This is accomplished by a combination of both direct and indirect radiation of sound—direct, from the two 075 tweeters located in the back curved walls of both serpentine low-frequency horns, and in a position that allows them to radiate directly out of the horns into the listening area, and indirect, from the two 375 mid-range drivers which are coupled to two short exponential horns. These radiate their sound waves against the large convex front surface of the enclosure, which by arcuated reflection, disperses the sound waves evenly throughout the listening area. The mid-range units are visable mid-way between the top and bottom of the mouth of the bass horns—resting against the edge of the curved front panel. These mid-range drivers are probably the largest of their kind in the high-fidelity field, employing huge magnetic assemblies, with each driver weighing around 30 lbs. And, also indirect, from the two model-150-4C 15" low-frequency drivers located deep within the large curved section of the enclosure. These radiate their sound waves into two large S-shaped folded horns whose mouth openings are to either side of the convex front surface.

The efficiency of the system is high. Two crossover networks are provided for each side of the system, with crossover points at 500 and 7000 Hz.

While a wider sound spread is easily possible with three separated speaker systems, (one for center fill), it is not applicable in this case, inasmuch as the wall along which the speaker system is located is only 11½ feet wide, and in our considered opinion (for what it's worth) three separate units would present little, if any, advantage. If space were available, this three-source arrangement, in many cases, would be definitely advantageous.

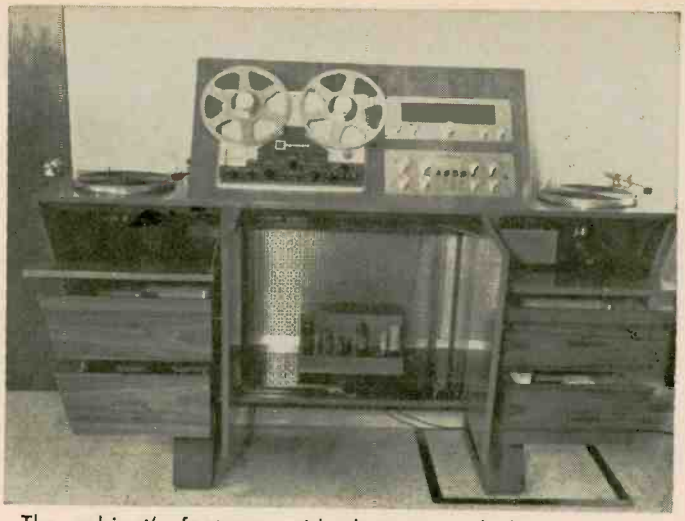
MISCELLANEOUS

The immediate problem facing us after installing the system was how to move the nearly 1300 lbs. of cabinets and equipment without strain. The upper left figures shows the ratchet roller-lifts that were devised and built by the writer for this purpose. The principle is very simple—On each lift a ratchet is permanently connected to a rather long bolt which in turn "works" (screws) in a fixed nut that is attached to the center of the roller base. The tip of the bolt contacts the bottom of the upper movable portion of the lift. Rotating the bolt one way lifts the cabinet up; the other way lowers its ratchet, brings the cabinet down. When the cabinet is lifted up to a certain level, wooden blocks are inserted between the movable and stationary portions of the lift, front and back of the lifting bolt, and actually support the cabinet. After the cabinet is lifted and blocked up it can be rolled out from the wall by one person. The wheels are "fixed position" types. Swivel casters do not work well with heavy weights. We have a second base with the fixed wheels at 90 deg. for moving the cabinets sideways, instead of forward and backward. The lifts were designed to be used with both the speaker and equipment cabinets.

Wiring—After all the equipment was installed in the equipment cabinet, there was a fantastic tangle of wires at the back of the cabinet. Special attention was given to eliminating this amateurish condition. First, we obtained special "openable" harnesses that would not only hold the wires neatly in place along the back and inside of the cabinet, but would allow easy removal of the wires in the event a component had to be removed for maintenance or servicing. Apparently no such clamp is commercially available.

Special care was also administered in "dressing" the wires for minimum hum and noise. Wherever possible, we

The modern design of the equipment cabinet sets off that of the loudspeaker and provides convenience and accessibility.



The cabinet's features, with drawers and doors open to show its many good points.

Close up of the control panel which accommodates the tape recorder, tuner, and preamp.

For servicing—and the initial construction—the cabinet is rolled away from the wall on its "ratchet roller-lift" which was developed by the author for this purpose.

for electronic-drive operation. Beneath the turntable is a slightly modified Fairchild Electronic Drive unit. This is actually a self-powered oscillator-amplifier (40 watts), capable of furnishing power at four different frequencies. Different taps on the output transformer are used for each of the four speeds. This arrangement causes less electrical power to be fed to the motor at lower speeds so that proper power and torque conditions are always maintained. Hence, the arrangement differs from the conventional, in that the speed changes are made electronically instead of mechanically by supplying four different fixed frequencies to the turntable motor making the *motor itself* revolve faster or slower at the flick of a rotary switch. Vernier speed controls are provided for precise adjustment of each of the four speeds.

The tonearm/cartridge arrangement is also unconventional. It consists of a slightly modified SME series II tonearm, and the Weathers PS-11K pickup system in which a lightweight armature assembly is connected through a soft elastometer to a pair of ceramic capacitor elements by a polarizing supply. As the stylus flexes, it stresses the capacitor elements, modulating the d.c. charge. Each element is connected to an amplified bridge-feedback circuit, incorporating a pair of low-noise transistors, and equalization and pre-amplification are added to provide the proper output voltages and frequency-response characteristics.

This dual record-playing setup has one main advantage besides the obvious ones of having a "spare" playback unit in the event something goes wrong with one, or halving the wear factor by alternating between the two. Incidentally, we use the "Dust Bug" for keeping records dust-free as the are playing. Instead of using the rubber suction cup pivot holder that comes with the unit, we fabricated permanent holders from an Empire tonearm rest base (one for each turntable), and installed them on the two Fairchild instruments. They make a much better appearance than the rubber suction cups, and they don't wiggle. (They're located on the left side of each of the 412 cover plates.)

On the left side of the sloping center panel, is a Magnecord 728 Professional 2-speed tape deck; (7½ and 15 ips) with three motors, separate record and playback amplifiers, separate VU meters, and separate erase, record, 2-track and 4-track sound heads. The machine records 2-track and plays back 2- and 4-track. This unit is, of course, my best source of playback fidelity. Most of my tapes consist of 2- and 4-track recorded material which I splice together and store on 10½-inch reels, requiring less space. Besides, the big reels work better on the machine (I get from four to six recorded tapes on one big reel). My home-recorded tape collection will now probably expand quite rapidly since I recently installed a Marantz model 10B FM multiplex tuner which held up the completion of my system for a year and a half.

(*Continued on page 85*)

Of the 3 automatic turntables priced at 99.50 only one offers all these features.

Look into it.

a. Hysteresis Motor. The 40H is the only automatic so equipped. Maintains accurate speed even with extreme voltage variations. Uses famous Papst motor, found in professional turntables and tape transports.

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e. Time-Tested Mechanism. The same basic internal mechanism which gave the Miracord 10 and 10H their reputation for trouble-free reliability. Assures smooth, quiet operation even with extended bass response.

The Miracord 40H operates at 4 speeds: 78, 45, 33 and 16 rpm, and handles 7, 10 or 12" records. It plays single records manually or automatically, and stacks of up to 10 in automatic sequence. It is a modern instrument for modern stereo systems.

See it at your hi-fi dealer, or write. Benjamin Electronic Sound Corp., 40 Smith St., Farmingdale, N.Y. 11736.

The Miracord 40H

The Wooden Monster

C. WILLIAM PHILLIPS*

Years ago we presented to the audio world the "Concrete Monster," a massive low-frequency horn completely external to the owner-builder's home. Now comes a wooden one which can be built inside the home—if you can find the space

The true audiofan is a restless creature who is never content merely to sit back and enjoy listening to his audio system. (*Bless his heart.* ED.) He must have new horizons to aim for in the audio world. In the early days of high fidelity the predominant goal of most enthusiasts was achievement of wider frequency response and lower distortion from speakers, amplifiers, and so on. Today the jaded audio buff yawns at advertisements of tweeters that respond to nearly two octaves beyond audibility, and amplifiers flat to one M Hz. Distortion in high-quality amplifiers has been reduced to such a level that values quoted are mostly zeroes. Audio equipment is growing ever more sophisticated, making it increasingly difficult for the technically inclined audio buff to make individual improvements, either by modifying commercial equipment or building his own. What, then, is left for the enthusiast to do for himself other than inserting and removing phono plugs? Fortunately, there are still plenty of rewarding projects remaining for the adventuresome do-it-yourself audio man. What I am going to describe is such a project; it has been on my "must-do-someday" list for years. The execution of it was an experience which could not be equalled by buying a carload of commercial equipment.

*Spaco Inc., 3022 University Drive, Huntsville, Alabama

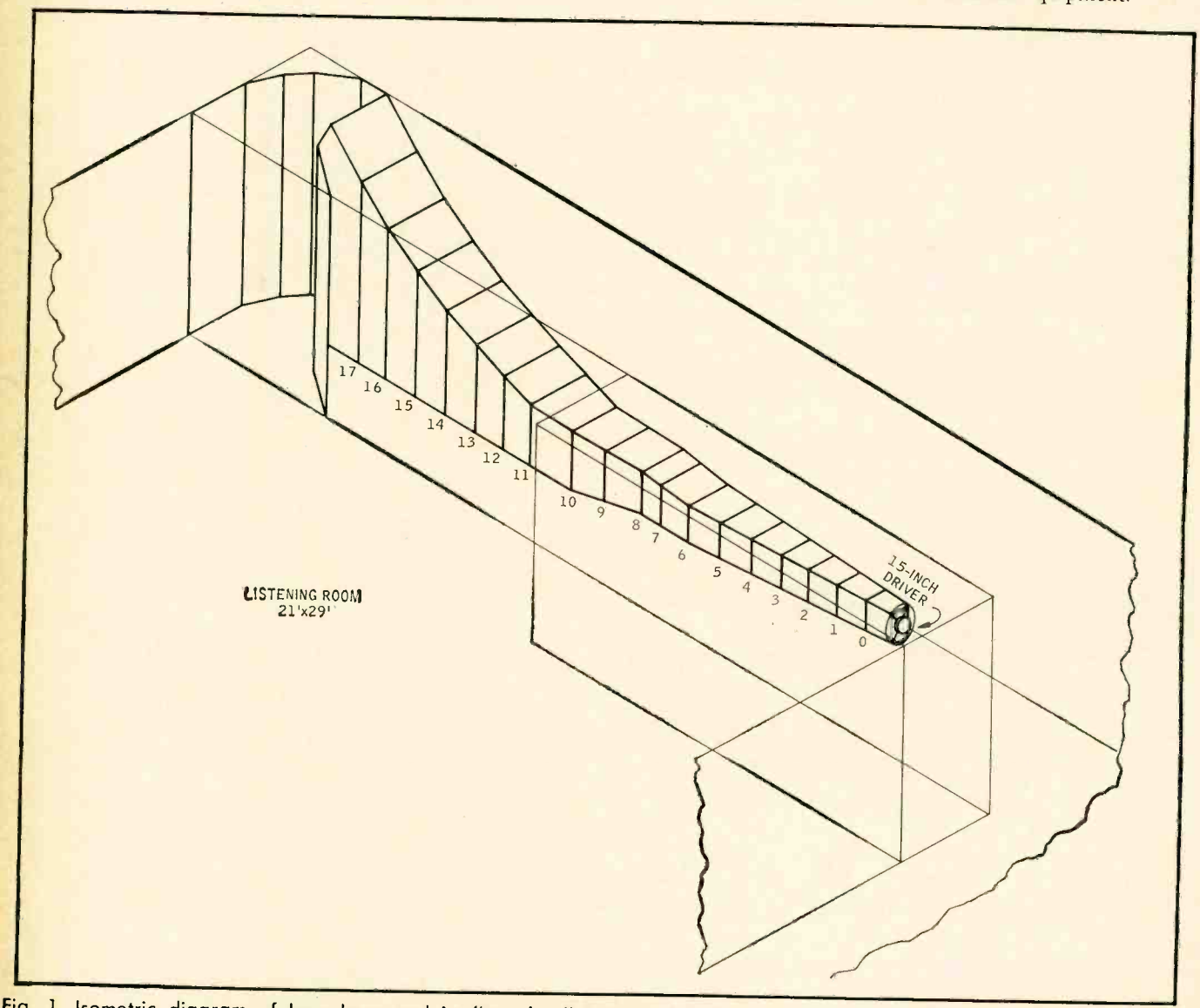
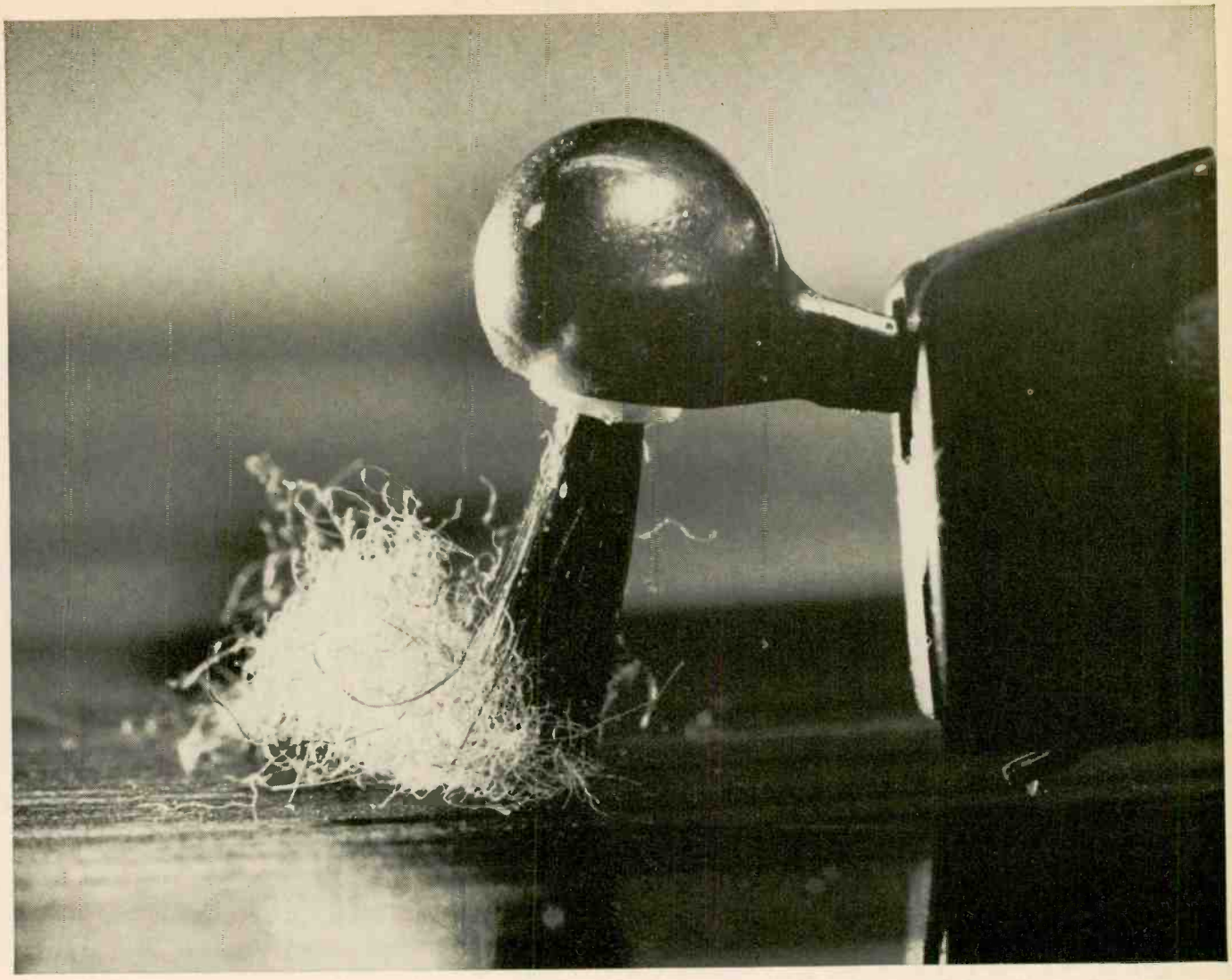


Fig. 1. Isometric diagram of bass horn and its "coupling" into the listening room. Note the 1-foot sections, each of which is a simple conical section, but together forming a hyperbolic horn.



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

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

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

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

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

Stanton

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Fig. 2. The throat end of the horn, showing the 15-in. driver.

With the great strides made in many areas of equipment design, it appears that the reproduction of sounds in the very-low-frequency end of the audio spectrum has been relatively neglected. Loudspeakers which operate beyond audibility at the treble end are commonplace. Ones which do this at the bass end are nonexistent. The air suspension type of speaker has advanced the state-of-the-art in recent years, but today you still cannot go out and buy a speaker system that will radiate a usable amount of undistorted power below 20 Hz. The first audible octave from 15 to 30 Hz is virgin land, waiting to be claimed by people with ideas. Some writers dismiss this range as unimportant because very little musical sound falls within it. This cannot be done any more than ignoring the 10- to 20-k Hz range for the same reason. Anyone who has witnessed a demonstration of quality reproduction including this octave will affirm its importance.

After giving consideration to many ways to approach the problem of bass reproduction in my home, the use of a large horn appealed to me as the most practical solution with the greatest chance of success. Space limitations normally prohibit such things, but I was fortunate to have room to build one large enough to do the job.

Design

After deciding to build a big horn, one of the first questions to arise was what type of horn would be best. There are numerous horn shapes to choose from, including those in which the area expansion is conical, exponential, parabolic, hyperbolic, or catenoidal, with infinite variations between. Various types of horns of identical size differ primarily in performance characteristics near the cutoff frequency. Since bass horns are generally required to operate *near* the cutoff frequency, performance in this area is important. At frequencies greater than about ten times the cutoff frequency all horns of comparable size perform similarly. In this range the specific throat resistance is equal to unity and the reactance is zero. At lower frequencies approaching cutoff, the reactive component of the throat impedance will increase, and the resistive component decrease at a rate depending on the type of flare. Conical horns, which have a uniform taper from throat to mouth, will begin becoming reactive at a relatively high frequency, and increase slowly with decreasing frequency. The resistive component, which indicates how well the horn will transmit energy along its axis, will decrease slowly down to zero frequency. A horn of the same over-all size but with a slow taper rate near the throat, and increasing to a high rate near the mouth will remain functional down to a lower frequency, with a rapid deterioration near the cutoff, and will be completely reactive at the cutoff frequency. An example of an extreme case is the catenoidal horn which has a zero taper rate at the throat, increasing to a high rate at the mouth. The throat resistance of such a horn actually increases near cutoff. The exponential horn, which is the most often used design, is a good compromise between the two previous extremes. Its throat resistance is about 87 per cent of maximum at one octave above cutoff. The cutoff frequency of all horns is determined by the rate of area expansion. Using a general equation for the area expansion of hyperbolic horns, the equation for all types of horns can be obtained by proper substitution.

$$S = S_o[\cosh (x/h) + T \sinh (x/h)]^2$$

Where:

S = area at distance x from throat
S_o = area at throat
h = flaring constant (determines rate of flare and cutoff frequency)
T = shape factor (determines rate of flare near throat relative to flare near mouth)

When T is greater than zero and less than 1, the flare is hyperbolic. When $T = 1$, the flare is exponential. When $T = 0$, the flare is catenoidal. The cutoff frequency is given by:

$$f_o = \frac{c}{2\pi h}$$

where: f_o = cutoff frequency
c = velocity of sound

To get the best performance in the space available, and to get the smoothest transition where the horn enters the room, a hyperbolic flare was used in this design. It corresponds to a T of 0.5, with a flare constant h of 10.0, resulting in a nominal cutoff frequency of 17.5 Hz. The actual cutoff of the horn appears to be slightly more than one octave below this. Many texts agree on the definition of cutoff frequency as given above, but one source gives a method of calculation that results in a cutoff of 8.95 Hz for the flare in this horn. The test results seem to indicate that this comes closer to being correct. Compared to an exponential horn of the same size, the flare rate of

Fig. 3. Interior of listening room, showing mouth of horn. Grille discourages walking into the horn.

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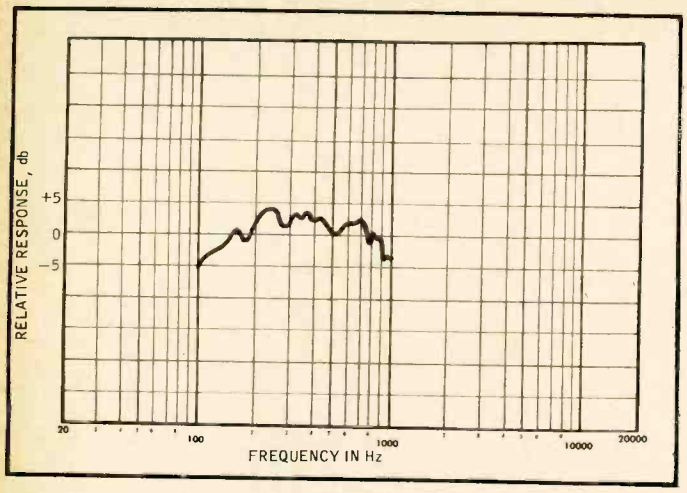

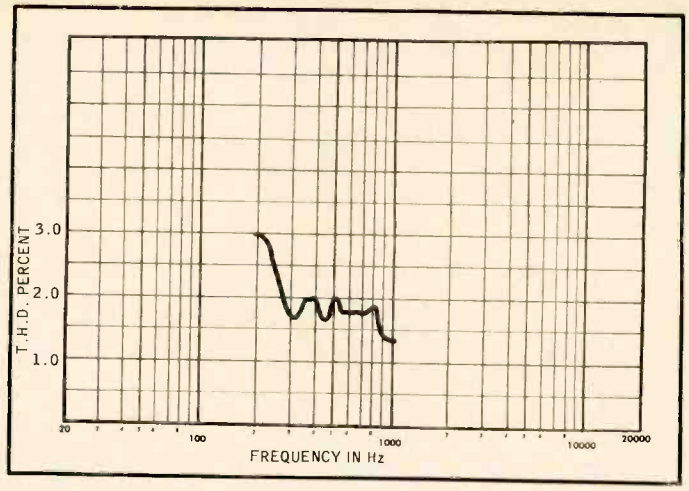

Fig. 4 (left). Averaged frequency response of bass-horn measured at a number of points in the listening room. Fig. 5, (right). Curve of harmonic distortion with 10-watt input.

this horn is smaller near the throat and greater near the mouth, which gives superior performance in the first octave above cutoff. This type of flare is not good for horns which must operate over a wide frequency range, because the slow taper near the throat tends to increase the non-linear distortion at high power levels. In this case the horn covers only two octaves, and this flare is ideal. In the final design a throat area of 0.5 sq. ft. was used, which is about half of the cone area of the 15-inch speaker used to drive the horn. This is common practice, and is done to further improve the impedance match between the driver and the air load.

The main part of the bass horn is built in a four-foot-wide tunnel in the basement of my home. This tunnel extends from floor to ceiling and runs the entire length of the house, although only about a third of the length is used for the horn itself. It also contains several large air ducts which had to be avoided when designing the horn. Fitting it all in was almost like trying to get six elephants in a Volkswagen. *Figure* 1 shows its location with respect to the listening room. The horn axis runs parallel to the partition and turns to the left to enter the room. At the point where it enters the room the area is about 5 ft. wide by 7 ft. high. The final section of the horn is the room itself, in which the two adjacent walls, floor, and ceiling form a conical section with a cross sectional area of about 200 sq. ft. at the largest point. The listener is, in effect, sitting in the mouth of the horn, reminiscent of a cartoon appearing in AUDIO several years ago.

Several compromises were necessarily made in the design, one of which was using a series of 1-ft. conical sections to approximate the horn flare. If an all-concrete construction were used, a curved horn would be quite practical, but when plywood is used the problem becomes difficult. Another simplification was the assumption of a plane wavefront inside the horn, which is not strictly correct. In the critical section nearest the throat, the flare rate is low and little error would result from this approximation. Near the mouth the error becomes greater, resulting in an actual flare rate greater than calculated.

The problem of insufficient mouth area in low-frequency horns is universal, with the inevitable compromise resulting in erratic response. The use of the room corner as a conical terminating section is the salvation of this horn, just as it is for many others. The room is large enough so that the effective mouth width is about one half of the cutoff-frequency wavelength. This is ample for a good approximation of an infinite horn. If this horn could be moved outside without the room, it would have pronounced resonances in the operating range.

Most low-frequency horn designs include techniques to offset the increase of reactance in the throat impedance near the cutoff, to prevent complete unloading of the driver at the cutoff frequency. Here this is not essential, because the cutoff frequency is below the operating range, and the amplifier will not deliver sufficient power at these frequencies to damage the driver.

Construction

The basic frame of the horn is constructed of 2 x 4 lumber, with spacing between frames of one foot. The concrete block foundation wall of the house is used for one side of the horn, and the concrete floor forms the bottom. The frames were anchored to the foundation wall with lead plugs and lag screws, which can be reached for an occasional tightening if necessary. Studs were driven into the floor with a .22-cal. stud gun to secure the floor plates. Additional bracing was obtained by tying into an existing partition to remove tensile loads from the wall anchors. An essential supporting column of the house structure was unfortunately located in the path of the horn, so the horn had to be detoured slightly to get around it. Concrete was used to make the transitions in this area. All other walls were made of ¾-in. plywood. With the 1-ft. frame spacing, the resonant frequency of all panels is well above the range of the horn. Both wood screws and nails were used to secure all frames and panels. The first eight feet from the throat is built entirely of wood. *Figure* 2 shows the appearance of the rear of the horn. The taper takes place in one plane at a time, except where it passes the support column. Starting at the throat, it flares first in the horizontal plane, then changes to the vertical plane, then changes back to horizontal for the remainder including, of course, the room walls.

The joints in the horn were made air tight with caulking compound, especially in the critical section near the throat, where pressure is greatest. To detect small leaks, the speaker was mounted on the horn and driven with a high-level subsonic signal. Leaks could then be found by listening for the sound of rushing air. The air from large leaks could be easily felt on the hand. To complete the construction the visible part of the interior was painted flat black, and a decorative grillle was built and installed. Instal-

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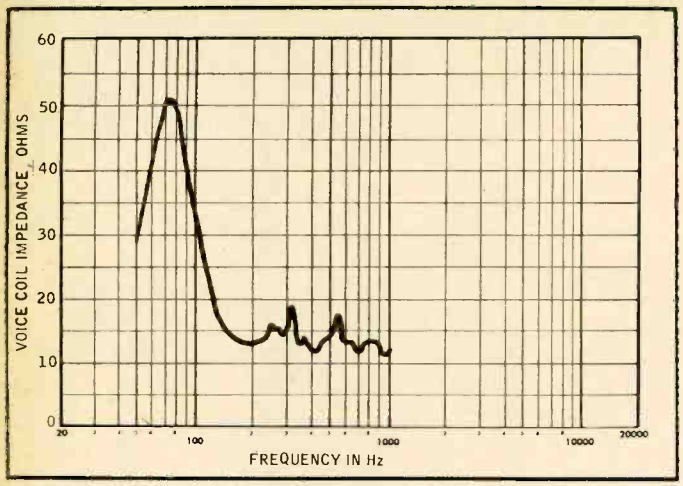


Fig. 6. Voice-coil impedance of bass-horn driver.

lation of the grille ended a favorite pastime of friends and pets of walking into the mouth and leaving footprints in the flat black paint. The appearance of the completed structure from the listening room is as shown in *Figure* 3.

The speaker originally used to drive the horn was a Stephens 103LX 15 inch woofer borrowed from another system. It served well until an Electro-Voice 15W-2 woofer of about 1952 vintage, (later updated) was obtained. The rebuilt unit had a long linear throw, and the unmounted resonant frequency had dropped to about 20 Hz. This speaker has been in use since, with excellent results.

Test Results

Measurement of the frequency response of the big horn proved to be quite difficult because of standing waves in the listening room. Since the thing could not be moved outside for testing, the only alternative was averaging the measurements from several locations in the room. Readings were made at 1-Hz increments from 10 to 100 Hz. The curve in *Fig.* 4 is an average of readings at 33 locations in the room. There are some peaks in the curve even after all of that averaging, but the response is relatively flat over the entire range. Most of the irregularities in the response curve are not generated within the horn itself, but are the result of spacing between reflecting surfaces in the room which promote standing waves. These spacings are those between the ceiling and floor, and between opposite walls. Also, the transition where the horn enters the room and changes to a conical flare is not perfectly smooth, causing a reflection back down to the horn throat. Because the mouth looks into a wall of the room rather than an infinite space, a resonant peak will be caused by reflections from this wall.

One criticism which might be made of this system is the large phase error caused by the difference in distance between the horn driver and the other speakers. At the crossover frequency of 50 Hz there is a phase lag of better than one complete cycle, which would undoubtedly alarm the purist who thinks in terms of a few degrees. Fortunately, it doesn't seem to make any difference to the ear, because no one has yet been able to detect the delay of the sound from the horn.

The total harmonic distortion of the horn was measured at several points in the room from 100 Hz down to 20, the limit of my distortion meter. *Figure* 5 shows the measured distortion with a 10-watt input to the driver. This is an extremely high sound level which cannot be tolerated without protective ear pads. Measurement at this level was complicated by extraneous noises generated by rattling windows, doors,

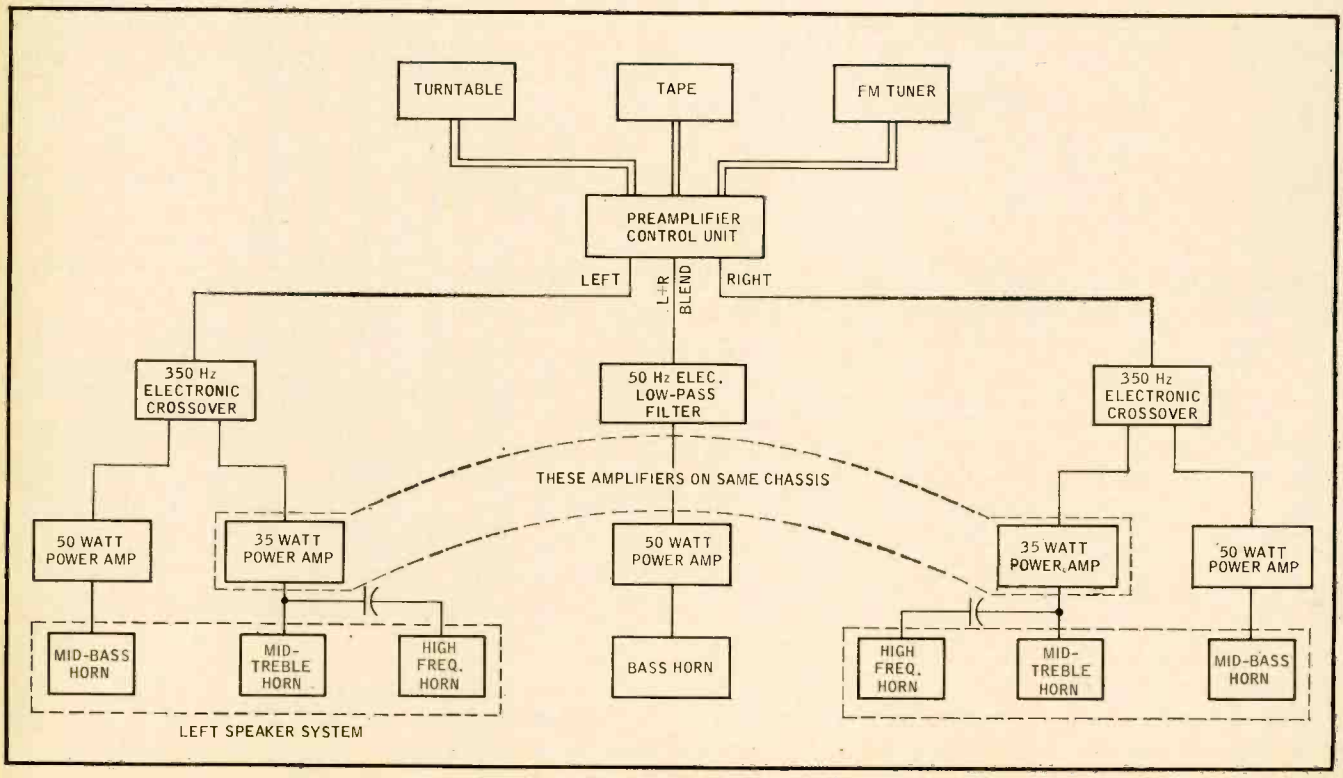
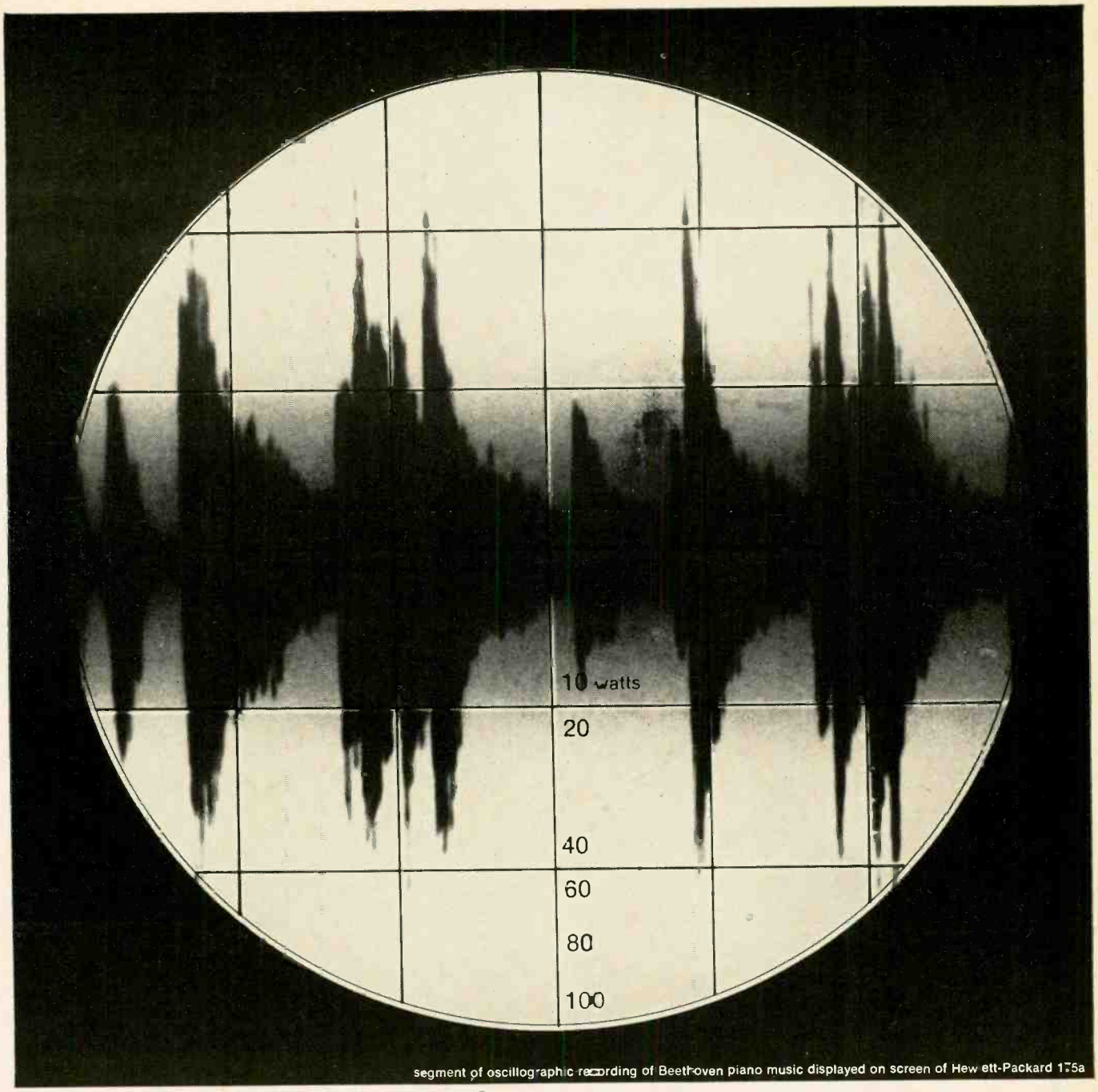


Fig. 7. Block diagram of complete audio system.



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

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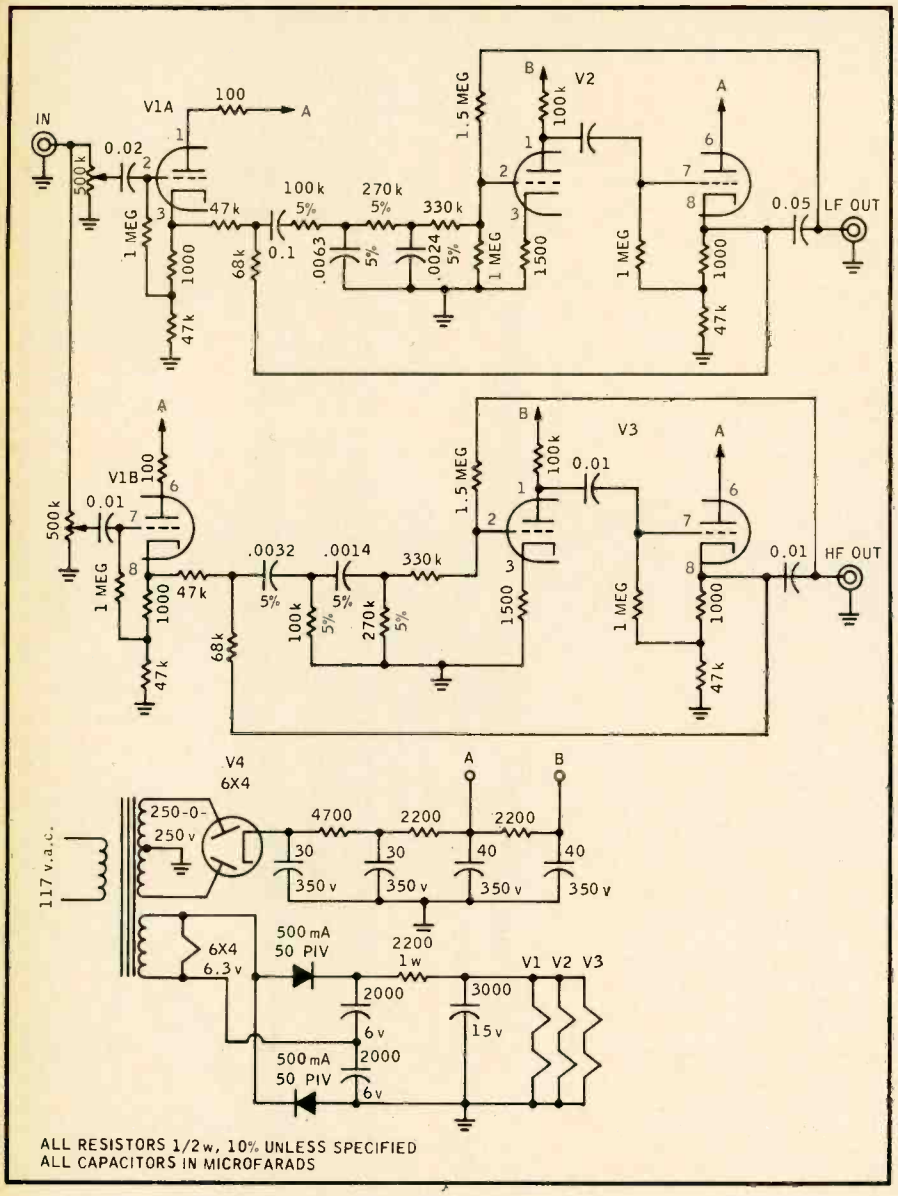


Fig. 8. Schematic of 350-Hz electronic crossover.

and pictures on the walls. At a power input of one watt rms, which is more representative of maximum listening level, the distortion drops to below 1 per cent. The values in the curve were at favorable locations in the room. At other parts of the room the distortion varied up to as much as twice those in the curve. While no data are shown on distortion below 20 Hz, the output viewed on an oscilloscope is essentially distortion-free down through 13 Hz, with a strong but distorted fundamental output to 9 Hz. Below this the distortion rises very rapidly, and the horn will produce practically no fundamental output.

One easily measured characteristic of a horn loudspeaker which tells much about its performance is the driver-voice-coil impedance at different frequencies. *Figure* 6 shows the impedance for this horn with the Electro-Voice 15W speaker, which has a nominal impedance of 16 ohms. The impedance is fairly constant down to about 14 Hz, below which it begins to rise rapidly. This rise is indicative of the cutoff of the horn. At the 7-Hz peak the horn is completely inoperative, and will radiate nothing but harmonics of the signal frequency.

Listening Evaluation

Measurements are very necessary, but listening tests are sometimes just as revealing and certainly more enjoyable, even with program sources other than music. With a sine-wave generator driving the bass horn amplifier, it is possible to produce unbelievable sound levels at low frequencies. At around 16 Hz, for example, the horn will radiate enough undistorted power to modulate your voice audibly as you speak, which is quite an experience if you've never tried it. The pressure can be felt on your chest, and your trouser legs will vibrate, as well as every other loose item in the house. It is impossible to tell where the sound originates unless you are standing near the mouth.

Listening to loud sine waves grows dull quickly, however, and is certainly no substitute for music. As one might expect, there is extremely little program material on which the bass horn can really shine. On better than 90 per cent of all musical recordings it adds nothing to the reproduction and might as well not exist. On those few recordings when it does function, it adds a precious realism which more than justifies its existence. The major source of music with content below 30 Hz is from pipe organs which have a rank of 32-ft. pipes, the first octave of which has a fundamental pitch between 16 and 32 Hz. Many recordings of such organs contain nothing in this octave because of low-frequency rolloff in the recording equipment. Many people feel that these frequencies are more trouble than they are worth and intentionally roll them off. Consequently, when you do get a recording with a good clean lower bass, you are lucky. An example of a commercial recording where the low end has been retained is the Saint-Saens Symphony No. 3 in C, on an RCA Victor recorded tape No. FTC 2029. The low C note of a 32 ft pipe in the organ at Symphony Hall in Boston is sounded several times, and in some places the intensity of the note is at maximum program level (0 VU on the meters).

Aside from musical material, there are quite a few recordings of outdoor sounds with considerable content below 20 Hz. When the fad of recording steam locomotives was going strong a few years ago, a lot of good demonstration material for the frequency extremes was created. Heavy moving objects such as trains and trucks generate low-frequency ground vibrations which are as much a part of the sound picture as the whistle or horn. An example of a commercial recording which contains these vibrations is Audio Fidelity AFST 1843, "Railroad Sounds." The re-creation of the sound of a passing train is not complete unless your chair shakes a little when the locomotive goes by. Thunderstorms are a fine source of very-low-pitch sounds at very high intensities. Thunderstorms recorded with top notch equipment can be overwhelming when played back on a system with adequate bass reproduction.

Along with the desirable sounds, there are some occasional unwanted

(*Continued on page 94*)

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

Like the KLH Model Eighteen.

It's a solid state FM stereo tuner.

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

Can something like that perform miracles?

We have witnesses.

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

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

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

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

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

Who said that? We did.

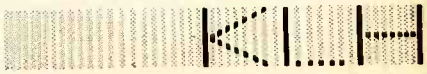
Is that witchcraft?

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

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

We'll bet our broomstick on it.

For more complete information on all our miracles, write The KLH People, 30 Cross Street, Cambridge, Mass., Dept. 112.



30 Cross Street, Cambridge, Mass.

Circle 130 on Reader Service Card

Transistor Output Stages—Distortion and Driver Impedance

GEORGE FLETCHER COOPER

Any design of transistor output stages involves a number of compromises—low- or high-impedance drive, operating bias, quiescent current, and so on. Even if you are not a designer, this article will give you an understanding of the problems involved.

Mr. W. Barry Clark of Ontario, who wrote to the Editor recently, has forced me to think very hard about output stages. He was concerned with the use of low drive impedance to get an extended frequency response from common-emitter stages, and I have already explored this question and have suggested that it does not work out quite so satisfactorily as it seems at first sight. In order to get the extended frequency response we must have available enough power to drive a grounded-base stage during the diffusion interval. A way of making the driver stage give the best compromise for this rather awkward two-faced look in the output transistors is to use a split-load stage as driver and an examination of this cricuit has been made although I do not know (since I have not yet mailed it) whether it has been published before this article.

We must also choose our driver impedance to keep the distortion low. An equation which we can make is that doubling the distortion costs us an octave in frequency response. I cannot remember even seeing this point of view expressed and it may look a little surprising. The background is quite simple, however. We have a performance specification and for a given amount of distortion we know that we must put on a certain amount of negative feedback. We exclude some of the professional jobs where the feedback is used to standardize the gain or an impedance because in a really-low-distortion system these are held better than we need. If the distortion without feedback is doubled, we need, in very simple terms of a single step circuit. This pracus back where we want to be. One of these days I shall explain why this is not strictly true. In order to add 6 db to our feedback we must modify the Nyquist diagram and, if we have pushed our design hard we must shift the response cut-off sideways. I know that ideally we shall have a 10 db/octave slope, but practically we shall probably think in terms of a single step circuit. This practical circuit will only give us an extra 6 db if we move the response corner, the characteristic frequency, in towards the band center by an octave.

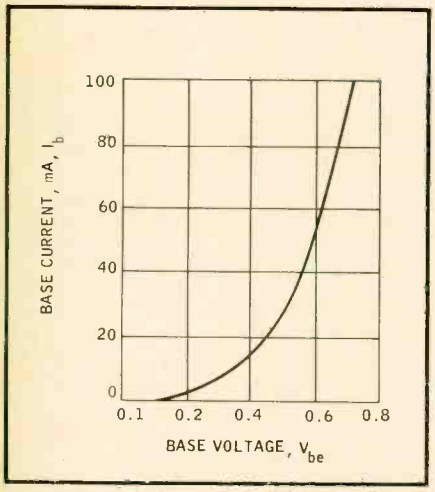


Fig. 1. Typical power-transistor characteristic in which slope becomes essentially constant at maximum signal.

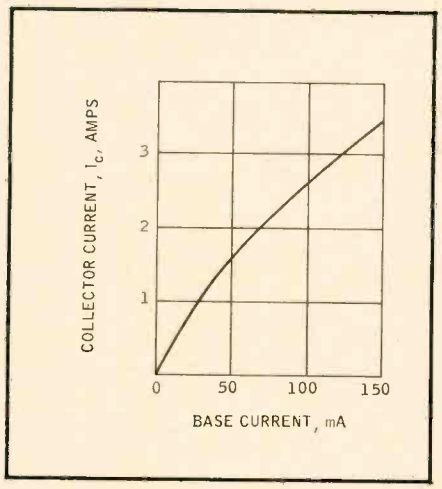


Fig. 2. Characteristic showing variation in small-signal current gain likely to cause excessive intermodulation.

There is a second equation which follows from this. If we have bandwidth to spare we can trade gain and distortion. We know this in one way, because we know that by increasing the feedback we cut both gain and distortion. The point which is often overlooked is that if we can double the gain for only 50 per cent increase in distortion we are making a profit on the deal, provided always that we have the band-width to throw away. In assessing the best conditions for low distortion we may wish to keep this aspect of the problem in mind.

Fortunately we do not need to think about the problem of the right sort of impedance to use. There are plenty of textbooks. Taking one at random I find (and for reasons which will become apparent I am not going to tell you which book says what): "In general, the common-emitter class-A stage will require a low source impedance compared to the transistor input impedance, corresponding to a voltage drive, if the distortion is to be minimized." And later, "The effect of source impedance on the distortion of a class-B stage is similar

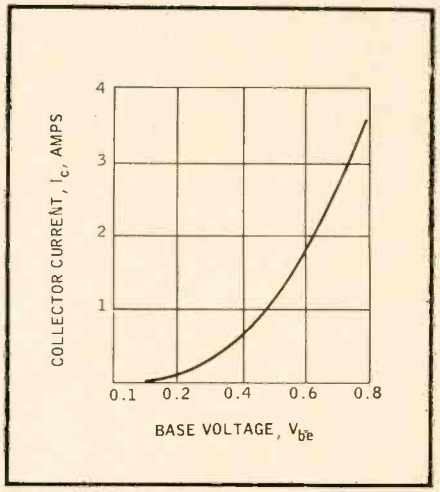


Fig. 3. Transistor similar to that of Fig. 2 driven by a high-impedance source results in this type of curve.

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AMAZING VERSATILITY!

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▣ The SX-1000T has a built-in highly sensitive protective circuit—a "must" in transistorized sets—made up of a transistorized switch and relay. Damage to the transistors, such as in the case of overloading due to a short circuit of the speaker terminal, are prevented with this protective circuit.

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▣ As for versatility, a full range of inputs and outputs is provided. These include those for tape head, tape line, magnetic or crystal phono, stereo headphones and for tape recording. If your tape recorder has a DIN connector socket, then all you need for stereo recording and playback is a single cable for all connections.

▣ Other features include: a precision tuning meter for pinpoint tuning, replacing the conventional tuning eye; a cascode front-end for the FM tuner section using space-age nuvistors for super-sensitivity: 2 microvolts for 30 db of quieting at 30% modulation; completely independent tone controls for each channel, to provide the exact shades of tones you want; a muting circuit for elimination of annoying between-station noises; a large stereo indicator lamp for quick recognition of stereo broadcasts.

▣ The handsome exterior design features a brand-new, attractive satin-silver and dull-black finish to match any decor; and controls and switches are laid out for maximum ease in handling, another point bound to please the non-mechanical-minded. For further details, contact:

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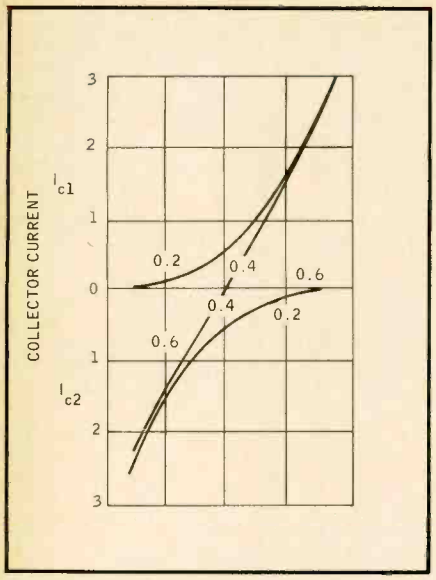


Fig. 4. Push-pull stage improves linearity by complementary matching of curves.

to that obtained with a class-A stage . . . to minimize distortion, a common-emitter output stage should be fed from a low source resistance."

So now we know. However, the same name appears on the spine of another text, where I read, "The grounded-emitter class-A stage normally has an optimum value of generator impedance which provides the best compromise between non-linearity at one end and at the other end." And later "To eliminate cross-over distortion in class-B stages, use sufficiently high generator impedance." Later again, "There is an optimum generator resistance, too low a value producing discontinuity at the origin, too large a value exaggerating the high-current curvature."

It can never be said that I give up easily, though I must confess that in the past I have abandoned this topic as fast as I could. Now, however, I really want to know and so I turn to another text by a different bag of authors. "As mentioned in another section, linearity of class-B stages is somewhat improved by use of a low-impedance driving source." Fine, except that I have read that section six times and it is not mentioned at all. In another section, however, "rounding of signal peaks, which may approach clipping for very low-impedance driving sources" is mentioned in discussing the problems raised by the non-linear input resistance.

What else can we find? Discussing mismatch in input impedance, another source says "The amount of distortion is dependent also on the source impedance, high source impedances giving less distortion." Another text which comes from the same stable says "the effective drive impedance should be at least twice the input impedance of each output transistor to ensure essentially current drive and low cross-over distortion." This is a more conservative view than my next quotation. "In practice . . . as high a value of a.c. source resistance as is consistent with other requirements." My final quotation "a high source impedance is even more necessary for class-B."

It was said of one political leader that he had sat on the fence for so long that the iron had entered into his soul. We cannot sit on the fence, we must come down quite definitely for low, high, or medium impedance (We sat at a corner, in case you wonder why the fence has three sides). We could adopt the democratic approach and count blockheads, but nearly all the authors list friends who have helped and others (enemies?) who have encouraged them. We could adopt the totalitarian point of view and march off in the wrong direction after a chosen text, our beloved leader. It is folk who do that who make our taxes what they are now.

What is the Answer?

You may feel that in writing this article I am myself prepared to lead you to the promised land. I see myself as Moses, yes, but Moses in the bullrushes, up the creek without a paddle, letting out a squawk. The trouble is not so much the basic problem but the fact that responsible workers in the field came up with different answers. There must be a trap somewhere. It is rather as though you were to stand in the street offering to sell dollar bills for fifty cents: you would not find many takers. However, if I am wrong I shall be in good company.

Let's Analyze the Stage

For analysis purposes we can do a lot of mathematics based on the exponential characteristic of the base-emitter diode and blind ourselves with Bessel functions. These will tell us just what we already know—that any diode characteristic can be linearized by means of an external resistance. Let us just look at a typical power-transistor characteristic: for our purposes the two most useful curves are those shown in *Figs.* 1 and 2, because we can usually ignore the feedback characteristic and the output impedance of the transistor. The characteristic in *Fig.* 1 is asymptotic to a slope of 100 mA/240 mV, or 2.4 ohms, but this region is reached only at maximum signal. For all normal signals we shall be down in what is presumably an exponential region. The characteristic in *Fig.* 2 shows that the small-signal gain varies from about 45 at $I_b = 0$ to about 17 when $I_b = 100$ mA. I always find it easiest to think of this effect in terms of intermodulation: a small signal riding on top of a large lower frequency will be very deeply modulated by this sort of range in current gain.

We can see the sort of distortion we shall get with a high-impedance drive directly from *Fig.* 2, but we must construct a graph of collector current against base-emitter voltage to see what a zero-impedance drive will do. This is a fairly easy operation and has been carried out in *Fig.* 3. An examination of this reveals that the characteristic is dominated by the input characteristic since the curvature is of the same kind.

Fortunately we are always concerned with push-pull stages, in which there is normally a balance in curved characteristics so that we do not need to proceed to the sort of linearizing operation described, for example, by Shea.[1] We can instead construct *Fig.* 4. Here we see that with a forward bias of just under 0.4 volts on each transistor we get a very good matching of the two characteristics and an over-all output-current *vs.* input-voltage characteristic which is quite linear. There is no point in trying to assess the linearity too closely, because we are dealing with the published characteristics of a so-called typical transistor. These are produced by drawing a smooth-looking curve in a cluster of data and are most unlikely to describe one particular pair of transistors.

If we take the result indicated by *Fig.* 4 at its face falue we see that we can obtain excellent results by operating a pair of transistors in push-pull from a

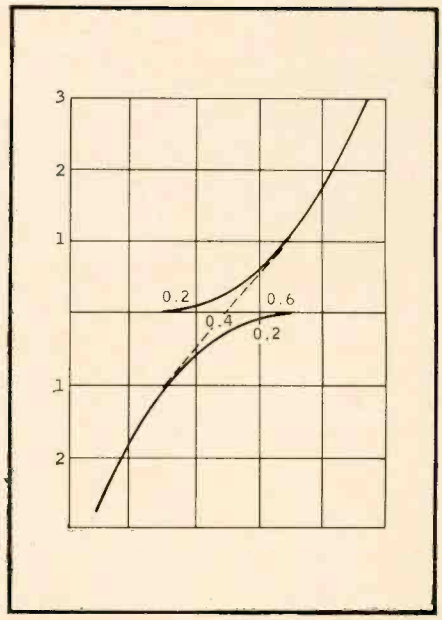
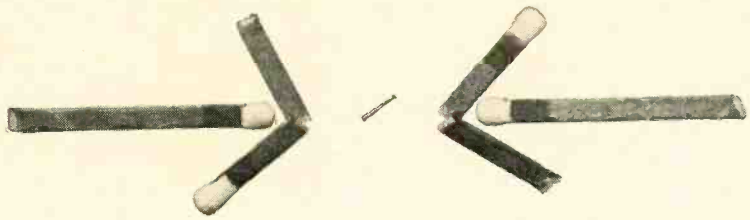


Fig. 5. Quiescent current (and dissipation) are reduced by lowering bias on stage of Fig. 4.



This is all that moves in the new ADC 10/E cartridge

We figure it costs you roughly $49,000 a lb.

You'll probably never buy anything man-made as costly by weight as this tiny, incredibly rugged moving stylus of the new ADC 10/E cartridge.

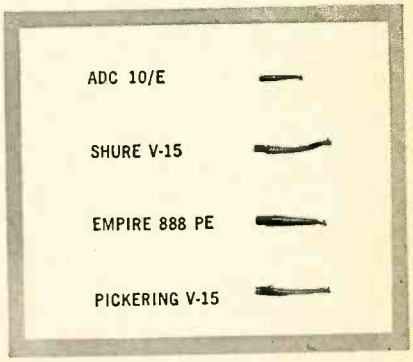
It reduces "moving mass" to about *one-third* that of the best magnetic cartridges.

Moving mass (the weight or inertia of the total moving system as felt at the stylus tip) is what your record has to push around. The groove must move it in one direction, stop it, then push it another direction—thousands of times a second.

Even a few milligrams of moving mass set up such tremendous forces that the record groove *yields* as the stylus passes. . . . So even on the very first play, you hear a distorted groove, not the groove that was pressed in.

Now, by a major jump forward in design, the ADC 10/E reduces moving mass well *below* the critical point of groove yield. Result: for the first time ever, you can hear the actual record you bought . . . on the first play, or the 500th. (Wear is negligible.) Listen to a complex passage, piano, operatic or choral selection, and you hear the difference. You get clarity, brilliance, reality and definition never obtained before. At long last, true "cleanness"!

How good is the new ADC 10/E? By any test, lab or listening, it is so perfect that any improvement would be pointless. For the first time it can be said: no one will ever make a cartridge that performs perceptibly better.



This actual photo of the moving parts of these popular cartridges contrasts dramatically the much lower "moving mass" of the new ADC 10/E.

SPECIFICATIONS—ADC 10/E

Type	Induced magnet
Sensitivity	4 mv at 5.5 cms/sec re-recorded velocity
Channel separation	30 db, 50 to 10,000 cps
Frequency response	10 to 20,000 cps. ±2 db
Stylus tip	Elliptical Stylus Contact radius—.0003" Lateral radius—.0007"
Vertical tracking angle	15°
Tracking force range	½ to 1¼ grams
I.M. distortion	Less than 1% — 400 & 4,000 cps at 14.3 cms/sec velocity
Compliance	35 x 10^{-6} cms/dyne
Price	$59.50

AUDIO DYNAMICS CORPORATION

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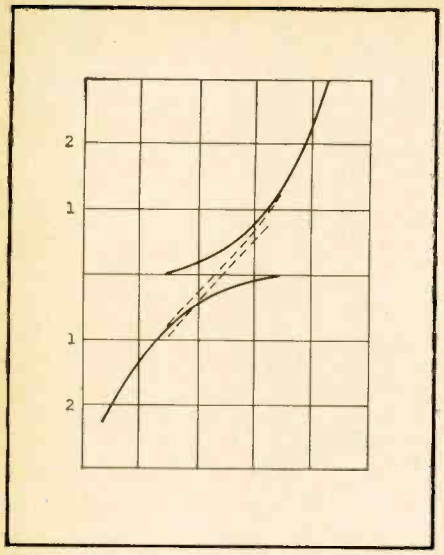


Fig. 6. Similar curve obtained with two actual transistors, in contrast to previous curves plotted from specifications for a "typical" transistor.

very-low-impedance source and that there will be some compensation for the fall in current gain at high currents of one transistor by the high current gain of the other at low currents. The over-all characteristic contains no sharp curvatures of the kind which can cause so much trouble when we are trying to get low distortion by using negative feedback.

A Practical Solution

For a practical designer, however, the answer may not be so simple. It is true that we need only produce about 0.4 volts peak and 100 mA peak to drive this push-pull pair and a very small driver power will therefore be needed. A low drive impedance must mean low-compared-with-2-ohms. A 10:1 step-down transformer from an emitter follower will give us about 0.25 ohms (if the transconductance of the driver transistor is 40 mA/V) and will demand that the emitter follower deliver 4 volts and 10 milliamps peak. The outlook continues cheerful.

I do not think I should be very happy with this design. The peak collector current is 2.8 amps, let us say, and let us assume that we are using a 14-volt supply. The maximum audio power available will be 20 watts and with an ideal class-B amplifier we should have an efficiency of 70 per cent and the dissipation in the transistors will be about 3 watts in each. For our working conditions, however, each transistor is passing about 0.5 amp under quiescent conditions, so that the quiescent dissipation is 7 watts per transistor. Although this is not an intolerable amount of loss for a line-operated unit it is on the high side and is a good deal higher than we should normally want to accept.

If we cut the forward bias to 0.3 volts we shall get the curves shown in *Fig.* 5. Cross-over distortion is beginning to show up but the quiescent current has been brought down to 0.25 amps per transistor. This is probably the basic design region which we should adopt if we were following along this design path.

I am not going to start worrying about the collector leakage current and all those problems for the present because I do not know how I am going to provide this 0.3 volt bias without introducing an appreciable impedance into the base circuit. A germanium junction diode is the sort of thing we shall need, but this will give us some 0.4-0.5 volts rather than the 0.3 volts we have decided is proper. We cannot easily use resistances, so we are stuck.

"*Transistor Audio Amplifiers*," New York: John Wiley & Sons, 1955; p 152.

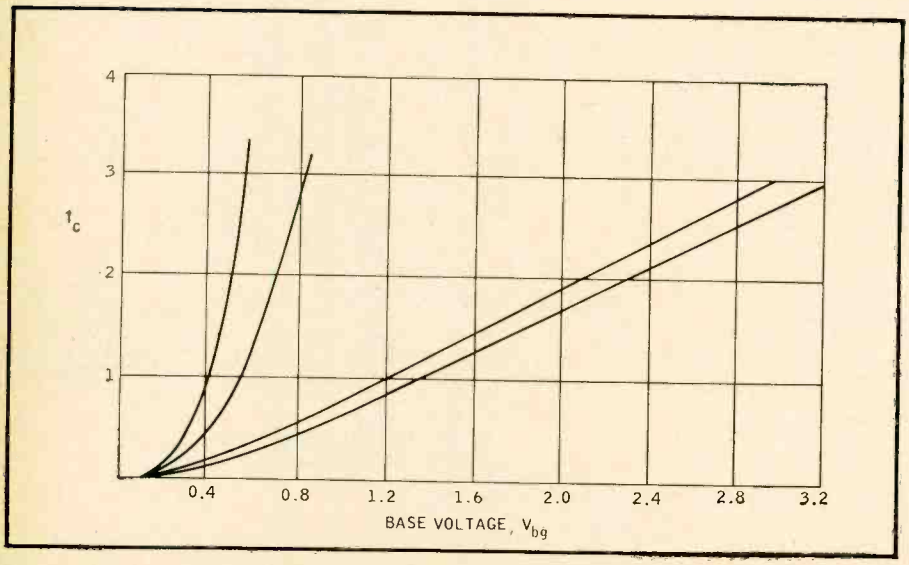


Fig. 7. Curves obtained with well-matched transistors.

This is not too alarming. The figures I have drawn so far show a pair of perfectly matched transistors, matched indeed as steadily as my hand can trace two copies of the same curve. As soon as we start to use two real transistors we shall get a result something like the form of *Fig.* 6, in which the upper transistor has rather more gain than the standard, while the lower transistor has rather less gain than the standard. This amount of mismatching is not very good, but it is sufficient to have two effects, both of which can be summed up by noting that the even-order terms are no longer balanced. We shall have some second-harmonic distortion and we shall have an unbalance in the quiescent currents. This last effect will be thoroughly inconvenient. If we are using the traditional form of transformer output we shall get some d.c. unbalance in the transformer: if we are using an output-transformer-less circuit we shall get a voltage unbalance at the capacitor. Even if we buy matched transistors they will not be perfectly matched: one manufacturer matches current gains only to within a ratio of 1.3 to 1 and I should think this was fairly typical.

The obvious thing to do is to match up the transistors ourselves. In *Fig.* 7 I have drawn the characteristics of two quite badly matched transistors, the pair of curves on the left, and added to them the effect of a 0.8-ohm resistance in each emitter lead to give the curves on the right. You see that, as you would expect, both transistors are now very much the same, because the transconductance of around 1 amp/volt is dominated by the resistance: we have in fact 0.8 ohms resistance and 0.1-0.2 ohms for the reciprocal of the transistor transconductance. Compared with our load of 5 ohms, this is rather extravagant amount of emitter degeneration but you can see that it enables us to fit the two characteristics together at a very low quiescent current. In fact we can use as a fitting guide the state where the transconductance is halved, which means for transistors without feedback where it has fallen from 5 amps/volt to 2.5 amps per volt, but here where it has fallen to 0.5 amps/volt for the over-all transistor-resistor combination, or 1/1.2 (2 ohms –0.8 ohms) it is about 0.8 amps/volt.

The price we pay is in drive power. We now need about 3 volts peak drive, but we still must produce 100 mA of peak base current: transformed back this might be 12 volts, 25 mA peak from the driver. Notice, however, that we now see something like 30 ohms looking into the bases. We must still have a low-impedance drive, but it must be low compared with 30 ohms. At the transformer primary this will

(*Continued on page 97*)

Some plain talk from Kodak about tape:

Noisemanship...modulation noise... and how to get extra dbs. of silence

Noisemanship is a very hip subject. The more noise your sound system has, the muddier your reproduced signal. Which brings up the subject of defining tape noises, how they occur, how they are measured, and what can be done to reduce them. Like at the start of Salome's dance, there's a lot to uncover.

Starting at the beginning

Kodak tape is mighty quiet when it leaves the factory. Because of special milling techniques and our now-famous "R-type" binder, the gamma ferric oxide particles are more uniform in size and shape and more uniformly dispersed than was ever before possible. Result: a superior degree of magnetic randomness, and thus, built-in quietness. To make sure that the roll of Kodak tape you purchase is as "quiet" as possible, we also bulk erase each roll. By "randomizing" the particles' polarity in *all* dimensions, foreign signals picked up during manufacture are eliminated.

This fairly pristine state doesn't last long. Once the tape has been subjected to the erase field and record bias from your recorder, a certain degree of randomness is lost. So-called zero-signal noise results because a recorder's erase system is not as efficient as a bulk eraser. Whereas bulk erasers cause 3-dimensional decay of the remnant signal, an erase head causes decay in one dimension only—along the length of the tape. This explains why zero-signal noise is always higher than bulk-erase noise.

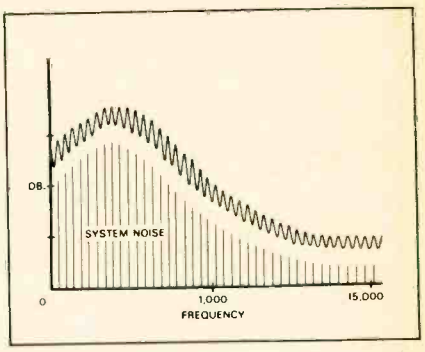
Blue plate special—noisewise

Noise in the presence of a recorded signal—modulation noise—is the real meat and potatoes of tape performance. Testing for modulation noise is a bit tricky, however, because both ac program and noise get mixed up in the amplifier. And if we are to determine the amount of noise in a system, it's imperative that we distinguish between one and the other. One way to do this is to use what our scientists refer to as a dc equivalent in r.m.s. milliamps of an ac signal.

Simply explained, we select the ac signal level that represents the practical limit for linear recording—2% third harmonic distortion. Then we apply a dc signal to the record head and increase the record current until it reaches the same level as that of the above ac signal. On the tape we have recorded a "zero frequency" program plus the modulation noise contributed by both equipment and tape. Since the reproduce amplifier filters out dc signals, only the modulation noise comes through, and this can be measured by an output meter.

Strike up the band pass

Final proof-of-the-pudding is to examine the total noise spectrum through band pass filters. Fun! One could, for example, measure the noise that comes through a 1-cycle band pass filter—even get a signal-to-noise ratio of about 115 db. But this really tells nothing about the tape's practical performance. For as the graph shows, there is much more noise in the lower frequencies than in the higher. For more meaningful evaluation, we specify two signal-to-noise ratios . . . one for the average low frequencies (20-1000 cycles at 15 ips) and one for the high frequencies (1000-15,000 cycles at 15 ips). We are happy to report that Type 31A (Kodak's general-purpose/low-print tape) rates as much as 6.5 dbs better in the low frequencies and 1.5 dbs better in the high frequencies. At Kodak, "shhh" is the word.



TOTAL NOISE SPECTRUM

KODAK Sound Recording Tapes are available at most electronic, camera, and department stores.

FREE. New, 24-page, comprehensive "Plain Talk" booklet covers all the important aspects of tape performance, and is free on request. Write: Department 8, Eastman Kodak Company, Rochester, N. Y. 14650.

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HERMAN BURSTEIN

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

Q. The service manual for my tape recorder refers to a solution called Magna-See that can be used for vertical alignment of the heads (by making the recorded track visible). I have been unable to find any dealer in my area who carries this. Can you please advise me where I can obtain it?

A. Magna-See is made by Reeves Soundcraft, 302 E. 44th St., New York City. They inform me that you can purchase it from Harvey Radio, 103 W. 43rd St., New York City

Q. I have read advertisments in which on 8-inch tape reel capability for a particular tape recorder is mentioned. I have not been able to find a supplier of such reels and would appreciate any information you may be able to provide.

A. Several inquiries I have made have proved fruitless. You might try writing to a European manufacturer of tape or tape machines; I am told that the 8-inch reel is popular abroad. You might try using 8-mm movie reels, which I am told come in 8-inch size.

*Q. I recently purchased a pair of stereo headphones and when these are plugged into my (self-contained) record player they sound fine. But when I use the headphones with my **** tape recorder the hum in the 'phones is shocking and makes reasonable listening pleasure hopeless. Please let me have your advice.*

A. A number of reviews of this particular tape machine, as well as my own experience with it, indicate a design fault that results in great hum. The resulting signal-to-noise ratio is less than 40 db, which is very poor (a good machine has s/n of at least 50 db and probably closer to 55 db). The hum does not show up too much when listening to a small speaker, such as the one in your tape machine, which cuts off sharply below about 80 or 90 Hz. But it shows up terribly on good speakers or good headphones. The only thing I can suggest is trying to get the manufacturer to remove the design fault or else trading in the machine for another make or model.

Q. I am wondering whether the Mylar base or oxide coating of the tape I use will be affected by use of a bulk eraser I have just bought.

A. To my knowledge, neither the base nor oxide of any kind of tape is adversely affected by repeated use of a bulk eraser.

Q. Will you please advise me of any information that I may be able to obtain on the practice of wire tapping?

A. Your question falls outside the scope of my column and knowledge, particularly since wire-tapping flirts with or oversteps the law. Perhaps you can augment your knowledge by visiting electronic houses that sell devices for tapping messages off telephones.

Q. I am interested in maximum quality and consider the new low-noise tape to be a major step forward not only because of the lower noise but because of the reduced likelihood of high-frequency distortion inasmuch as this tape requires less treble boost in recording. However, I have not seen any indication that tape recorder manufacturers are providing front panel selectable record equalization in order to facilitate use of the new as well as old tape. Have you?

A. I can only agree that it is desirable for the perfectionist to have variable record equalization (treble boost) available as a front panel control to accommodate tapes which differ appreciably in their equalization requirements. I would guess that the finest and most expensive machines will eventually incorporate such a control, while the majority of home machines will strive for a compromise among the requirements of the popularly used tapes, including low-noise tapes.

Q. What is the difference in the various equalization curves used by various tape recorders, such as NAB, NARTB, CCIR, and others?

A. The NAB and NARTB curves are the same. (The National Association of Radio and Television Broadcasters changed its name back to the original one of National Association of Broadcasters.) The NAB curve is a playback equalization characteristic consisting of about 36 db of bass boost, starting at 3180 Hz and ending at 50 Hz. The CCIR 7.5-ips curve, employed in Europe, consists of bass boost commencing at 1590 Hz and ending below the bass end of the audible range. Whatever playback curve is employed, the standard in question requires that record equalization be tailored to produce record-playback response flat within prescribed limits. In other words, you can get equally wide and flat response with either the NAB or CCIR curve. However, there will be some differences in terms of distortion and signal-to-noise characteristics. The CCIR curve tends to result in somewhat less distortion at the cost of somewhat poorer signal-to-noise ratio; it entails less treble boost in recording and therefore results in less signal and less distortion on the tape.

*Q. I have a **** tape machine, and my problem is that the takeup reel clutch does not slip enough and as a result there is too much tension on the tape, at worst stretching them and at best producing a horrible squeal. How can I take the turntable apart to change the clutch material? I can't see how to take it apart without wrecking it and cannot find directions in the machine's manual. My temporary solution so far has been to spray some graphite lubricant between the turntable parts. It works but only temporarily. I also used a wire a couple of times to scrape up the felt, and this too worked only temporarily.*

A. Unfortunately I cannot help you inasmuch as I have had no mechanical experience with your machine. I can only suggest that you place your problem at the door of your dealer and the manufacturer. Please understand that the TAPE GUIDE column essentially tries to deal with the basic electronic and magnetic aspects of tape recording, because here the various brands of tape machines are on common ground. But when it comes to mechanical performance, there are great differences among machines. Hence only a well-staffed service agency dealing intensively with tape machines can be in a position to answer a question such as yours.

Q. I propose to build a cabinet to house all my hi-fi equipment, including tapes. The tapes will be stored in a drawer immediately below the tape recorder and adjacent to the speaker system. Below the tape drawer will be a 1/15-h.p. blower fan. To the left of the tape drawer will be a TV set and a hi-fi receiver. If the magnetic fields of this equipment will have a harmful effect on my tapes, is there some way to shield the drawer, for example by lining it with galvanized iron sheeting?

A. To be safe, your tapes should be kept at least one foot from small motors such as those found in phonographs and tape recorders, and at least two or three feet from power transformers such as those found in power amplifiers and TV sets. I don't think that the magnetic field of the speaker extends far enough to present a problem. If your cabinet layout meets these requirements, your tapes appear safe. Should you nevertheless wish to line the tape drawer, I suggest that you use Mumetal or a much more workable material such as Co-Netic (made by Perfection Mica Co., 1322 N. Elston Avenue, Chicago, Illinois).

(*Continued on page 86*)

CONCORD "R" SERIES: FIRST TRULY NEW PROFESSIONAL TAPE RECORDERS IN 5 YEARS!

Several years ago, Concord engineers began design of a tape recorder to incorporate all the recent advances in electronic and electromechanical technology in a professional instrument without regard to cost.

The four basic considerations in the design of the "R" Series instruments were: 1. The recording quality, 2. The operating features, 3. The reproduction quality, 4. Rugged, reliable performance for heavy duty use. Here's how these objectives were achieved:

TAPE TRANSPORT MECHANISM: Three-motor design of the tape-transport mechanism provides fast tape handling (45 second rewind speed for standard reel).

Reliability: there are no rubber drive rollers or mechanical linkages which may be subject to deterioration. Reverse-play operation shows no measurable increase in wow and flutter.

All three motors are hysteresis synchronous, ensuring tape-speed accuracy regardless of line voltage fluctuations. The 24-pole slot-wound capstan-drive motor combines an electronically balanced rotor and newly designed double-thrust bearings to minimize motor end play and eliminate cogging.

The flutter-free performance of this new capstan-drive motor is in itself an engineering achievement of considerable magnitude. A dual winding allows the motor to operate at 3,600 rpm at 7½ ips and 1,800 rpm at 3¾ ips, permitting pushbutton speed change without mechanical rollers or idlers.

TAPE. Tensioning is achieved on the Concord "R" Series without pressure pads, using hyperbolically ground heads for maximum tape wrap. An electronic holdback tension circuit for each reel motor ensures optimum holdback in either direction of tape travel.

The tape path incorporates a precision-ground ball bearing flutter filter with a 30 oz. dynamically balanced flywheel. This system dampens minute amounts of mechanical flutter, preventing it from being recorded. The dynamically balanced 1.5 lb. capstan-drive flywheel is machined on a tape-controlled lathe for extreme dimensional accuracy. A special steel alloy (modified 17-4PH) was formulated to provide maximum flywheel mass and shaft strength as well as the hardness necessary for close-tolerance machining and grinding of the capstan.

The pressure roller consists of a precision-ground metal core with a molded-rubber facing designed for maximum tape friction and minimum wear. Pressure roller is easily removed for lubrication, cleaning, or special cueing.

"R" Series recorders feature automatic tape lifters, which remove the tape from direct contact with the heads in the fast-wind modes.

BRAKING. Solenoid-operated, self-equalized brakes gently but firmly stop the tape from the fast-wind positions without stretching or tearing. These self-compensating brakes do not normally ever require adjustment.

CONTROL FUNCTIONS. The transport mechanism controls are all-pushbutton and operate the mechanical functions electronically. In the R-2000, an electronic memory circuit permits the user to push the fast-wind or play button in sequence which causes it to fast-wind, stop, automatically pause, and proceed to the play mode without further attention, either at the recorder or at the remote-control station. In the record mode, the R-2000 provides an automatic rewind safety function at the end of the reel to prevent accidental erasure. The recorder shuts off automatically after completion of rewind.

In the play mode, "R" Series tape recorders automatically reverse at reel end, play the tape in the opposite direction, and then automatically shut off.

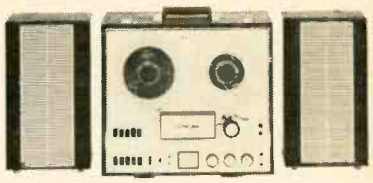
CONCORD MODEL R-2000 with full remote-control — under $800.

A remote-control console, included with the R-2000, provides full remote-control of all functions. R-1000 Series recorders have remote start-stop control for both play or record modes.

Cueing and editing is fast and convenient. The supply and take-up reels are readily rotated by hand with the recorder in the stop mode, and the heads are easily accessible for editing.

HEADS. All "R" Series recorders use professional low-impedance heads with laminated cores of a new mu-metal alloy, permitting minimum playback-head gap width and maximum frequency response. The record head has a wide gap for recording maximum signal. The erase head is of a new design, with a double gap and ferrite core to ensure maximum noise-free erasure.

"R" Series heads are selected in matched pairs with a tolerance of 1 db difference in channel output over the entire frequency range. A new, improved type of shielding has been developed, which reduces cross-talk to extremely low levels. The R-2000 has a plug-in head assembly, making possible use of ½- or ¼-track configurations.



CONCORD MODEL R-1100 with optional start-stop remote-control plus solid-state power amplifiers and speakers — under $500.

CONCORD MODEL R-1000 with optional start-stop remote-control — under $450.

ELECTRONICS. All "R" Series recorders contain four preamplifiers, two for recording and two for playback. This design permits monitoring from the tape while recording as well as separate equalization adjustments for each of the record and playback preamplifiers. Recording amplifiers are easily adjusted for optimum record bias for the particular tape and tape speed. Bias adjustments are readily accessible.

All components and electronic assemblies are equivalent to MIL Spec requirements. Advanced-design circuitry permits professional quality recording with superior signal-to-noise ratio and frequency response. The R-2000 has facilities for plug-in microphone transformers with −90 db shielding for either high- or low-impedance, balanced or unbalanced line.

ELECTRONIC CONTROL. Separate controls for both line and microphone permit mixing of line and mike levels. A monitoring control provides immediate source-tape comparison at the same sound level while recording. Recorders have front-panel provision for creating sound-on-sound or multiple recording by pushing a button or moving a knob. No need to change inputs or outputs.

Reverberation and echo effects are created similarly. Record levels may be adjusted without tape movement, and safety interlocks prevent accidental recording.

PRECISION MANUFACTURE. Produced on a custom basis (two R-2000's and six R-1000's a day), each recorder undergoes 68 inspection checks *during* assembly *before* final inspection. Every "R" Series instrument undergoes a 72-hour continuous heat-run test with all controls continuously operated by an automatic programming device. After successful completion of this severe test, each unit is again 100% inspected before shipment.

The "R" Series Recorders are available now at Concord professional audio dealers throughout the United States and Canada.

For Connoisseurs of Sound

CONCORD

CONCORD ELECTRONICS CORPORATION 1935 Armacost Avenue, Los Angeles, California 90025
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Audio Engineering Society

SEVENTEENTH ANNUAL CONVENTION

Following is a complete list of papers to be presented at the thirteen technical sessions.

9:00 A.M. *Monday, October 11, 1965*
ANNUAL BUSINESS MEETING

9:30 A.M. **MICROPHONES AND EARPHONES**
Chairman: **Donald W. Powers, Roanwell Corporation New York, N. Y.**

TWO-WAY DYNAMIC CARIOID MICROPHONE
B. Weingartner, Akustische u.Kino-Gerate Gesellschaft m.b.H., Vienna, Austria

A NEW LOW-NOISE CONDENSER MICROPHONE
Arthur R. Soffel, LTV Research Center, Western Division, Ling-Temco-Vought, Inc., Anaheim, California

AN INERTIAL, TISSUE-CONTACT-TYPE MICROPHONE-REPRODUCER UNIT FOR DEEP SUBMERGENCE COMMUNICATIONS
G. J. Sebesta, A. J. Mellen, A. Hofer and R. W. Carlisle, Dyna Magnetic Devices, Inc., Hicksville, New York

THE METHODS AND MEANING OF ACOUSTICAL MEASUREMENT ON TELEPHONIC TRANSMITTERS
Gaston A. Marchand, Roanwell Corporation, New York, New York

SELF-INDUCED NOISE IN CARBON MICROPHONES
Elaine Schiller, Roanwell Corporation, New York, New York

REAL VOICE MICROPHONE CALIBRATION AS A UTILITY LABORATORY METHOD
William B. Snow, The Bissett-Berman Corporation, Santa Monica, California

SPEAKER-MICROPHONE REVERSIBILITY CHARACTERISTICS
Abraham B. Cohen, LTV-University, Oklahoma City, Oklahoma

1:30 P.M. *Monday, October 11, 1965*
AUDIO AMPLIFICATION
Chairman: **George E. Owen, Motorola, Inc. Franklin Park, Illinois**

A POWER SUPPLY FOR TRANSISTOR-TYPE AMPLIFIERS
John P. Jarvis, Langevin Division of Sonotec, Santa Ana, California

FIELD EFFECT TRANSISTORS IN AUDIO PREAMPLIFIERS
Donald L. Wollesen, Motorola Semiconductor Products Inc., Phoenix, Arizona

TRANSISTOR AMPLIFIER DESIGN CONSIDERATIONS WHEN DEALING WITH MULTIPILE SOURCES OF SUPPLY
Stan R. Zachary, Zenith Radio Corporation, Chicago, Illinois

A NEW CONCEPT IN GAIN-REDUCTION AMPLIFIERS
John P. Jarvis, Langevin Division of Sonotec, Santa Ana, California

RECENT TRENDS IN AUDIO AMPLIFIERS
W. H. Heaven, Northern Electric Company Limited, Belleville, Ontario, Canada

DESIGN CONSIDERATIONS OF A SOLID STATE AMPLIFIER FOR USE IN HIGH QUALITY PROFESSIONAL STUDIO RECORDING AND BROADCAST CONSOLES
Arthur C. Davis, Altec Lansing Corporation, Anaheim, California

MICROELECTRONIC TECHNIQUES AND THEIR APPLICATION TO A FIVE WATT CLASS B AMPLIFIER
Edmund A. Karcher, Westinghouse Molecular Electronics Division, Elkridge, Maryland

7:30 P.M. *Monday, October 11, 1965*
MUSIC AND ELECTRONICS
Chairman: **Harold A. Johnson, Hammond Organ Company, Chicago, Illinois**

INTERESTING PROBLEM FOR AUDIO ENGINEERS IN THE ACOUSTICS OF VIOLINS AND VIOLAS
Norman C. Pickering, Astrosonics Incorporated, Syosset, New York

A VOLTAGE-CONTROLLED LOW-PASS HIGH-PASS FILTER FOR AUDIO SIGNAL PROCESSING
Robert A. Moog, R. A. Moog Co., Trumansburg, New York

REPORT ON A SEMINAR IN ELECTRONIC MUSIC COMPOSITION
Herbert A. Deutsch, Hofstra University, Hempstead, New York

REAL-TIME GENERATION OF MUSICAL SOUND ON A SMALL COMPUTER
Robert Clark, Argonne National Laboratory, Argonne, Illinois

AN ALL-FORTRAN MUSIC-GENERATING COMPUTER PROGRAM
Arthur Robert, Argonne National Laboratory, Argonne, Illinois

SOLID STATE AUDIO FREQUENCY SPECTRUM SHIFTER
Harald Bode, North Tonawanda, New York

DURATION AND/OR FREQUENCY ALTERATION
William S. Marlens, Contact Associates, Inc., New York, New York

9:30 A.M. *Tuesday, October 12, 1965*
MINIATURIZED AUDIO APPLICATIONS
Chairman: **Robert L. Geib, Dahlberg Electronics, Inc. Minneapolis, Minnesota**

MINIATURE BATTERIES FOR MINIATURIZATION APPLICATIONS
Joseph L. Dalfonso, Mallory Battery Company, Div. of P. R. Mallory & Co., Inc., Tarrytown, N. Y.

MINIATURIZED SEMICONDUCTORS
Frank M. Dukat, Raytheon Company—Semiconductor Operation, Mountain View, California

PERFORMANCE MEASUREMENTS ON EAR-LEVEL HEARING AIDS
Samuel F. Lybarger, E. A. Myers & Sons, Incorporated, Canonsburg, Pennsylvania

INTEGRATED AUDIO VOLTAGE AND POWER AMPLIFICATION—PROBLEMS AND SOLUTIONS
Robert A. Hirschfeld, Motorola Semiconductor Products Division, Phoenix, Arizona

HISTORY AND PROBLEMS OF HEARING AID CONTROLS
Henry J. Glueckstein, CENTRALAB—The Electronics Division of Globe-Union, Inc. Milwaukee, Wisconsin

THE APPLICATION OF TANTALUM CAPACITORS IN MINIATURE AUDIO AMPLIFIERS
William D. Hooper, Components, Inc., Biddeford, Maine

PROTECTION AGAINST SHOCK AND VIBRATION
Mahlon D. Burkhard, Industrial Research Products, Inc., Elk Grove, Illinois

1:30 P.M. *Tuesday, October 12, 1965*
LOUDSPEAKERS I
Chairman: **Adolph Morgan, Radio Corporation of America, RCA Laboratories, Princeton, N.J.**

A HIGH-COMPLIANCE LARGE-LINEAR-DISPLACEMENT LOUDSPEAKER
R. T. Bozak, The R. T. Bozak Mfg. Co., Darien, Connecticut

FLEXURAL BEHAVIOR OF A TAPERED HYPERBOLIC RADIATOR
Alfred H. Roberts, Gladwyne, Pennsylvania

A DUAL RADIAL HORN LOUDSPEAKER SYSTEM WITH CONGRUENT CYLINDRICAL WAVE FRONT RADIATION
John E. Volkmann, RCA Laboratories, Princeton, New Jersey, and A. J. May, RCA Broadcast & Communications Division, Camden, New Jersey

AN ULTRA-COMPACT, LIGHT WEIGHT SPEAKER SYSTEM
William Elliott, Sonocolor Corporation, New York, New York

ARTIFICIAL VOICE
Harry F. Olson, David Sarnoff Research Center, RCA Laboratories, Princeton, New Jersey

A SPEAKER SYSTEM USING DISTRIBUTED DRIVE
Victor Brociner, H. H. Scott, Inc., Maynard, Massachusetts

THE APPLICATION OF REVERBERENT FIELD MEASUREMENTS TO THE EVALUATION OF LOUDSPEAKERS AND MICROPHONES
Daniel Queen, Perma-Power Co., Chicago, Illinois

7:30 P.M. *Tuesday, October 12, 1965*
LOUDSPEAKERS II
Chairman: **Victor Brociner, H. H. Scott, Inc. Maynard, Massachusetts**

THE EFFECT OF COMMONLY USED BAFFLES ON THE SOUND DISPERSION OF TYPICAL DIRECT RADIATOR LOUDSPEAKERS
Robert C. Coffeen, R. C. Coffeen & Associates, Shawnee Mission, Kansas, and

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Circle 135 on Reader Service Card

Merrill K. Bauer, Graduate Student, Washington University, St. Louis, Missouri

MULTI-MOUTHED ADUSTABLE SOUND PROJECTORS
Abraham B. Cohen, LTV-University, Oklahoma City, Oklahoma

A REPEATABLE TECHNIQUE FOR LISTENING TESTS
Percy Wilson, "The Gramophone" Magazine, Middlesex, England

A SOLID STATE HIGH-FREQUENCY COMPRESSION HORN
Hugo Schafft, Motorola, Inc., Franklin Park, Illinois

A MATHEMATICALLY DEVELOPED LOUDSPEAKER —THEORY AND PRACTICE
Lincoln Walsh, Walsh Engineering Company, Millington, New Jersey

9:30 A.M. *Wednesday, October 13, 1965*
AUDIO INSTRUMENTS AND INSTRUMENTATION
***Chairman:* James W. Day, B & K Instruments, Inc. Cleveland, Ohio**

A SIMPLE, ACCURATE AUDIO METHOD OF BATTERY CONDITION MEASUREMENT
Yates M. Hoag, General Electric Company, Radio Receiver Department, Utica, New York

A SOLID STATE TRANSIENT TEST SIGNAL GENERATOR
Glen R. Southworth, Colorado Video, Inc., Boulder, Colorado

A NEW SOLID STATE OSCILLATOR FOR AUDIO USE
Robert E. Owen, General Radio Company, West Concord, Massachusetts

A PROGRAM DISTORTION MONITOR
Joseph H. Dessen, Audio Research Products Co., Blackwood Terrace, New Jersey

ENGINEERING CONSIDERATIONS IN AN EXPERIMENTAL HIGH FREQUENCY AUDIOMETER
Vincent J. Skee, Greens Farms, Connecticut

MICROPHONE CALIBRATION AT EXTREME FREQUENCIES AND SOUND PRESSURE LEVELS
H. E. Dahlke and J. J. Van Houten, LTV Research Center, Western Division, Ling-Temco-Vought, Inc., Anaheim, California

INSTRUMENTATION TRENDS FOR NOISE REDUCTION WORK, AS SEEN BY A MECHANICAL ENGINEER
Peter K. Baade, Carrier Research and Development Co., Syracuse, New York

INSTRUMENTING THE SUBJECTIVE MEASUREMENT OF PRODUCT NOISE
Elmer E. Rabek, B & K Instruments, Inc., Cleveland, Ohio

1:30 P.M. *Wednesday, October 13, 1965*
ELECTRONIC CONTROL OF AUDITORIUM ACOUSTICS
***Chairman:* C. P. Boner, Austin, Texas**

APPLICATION OF ELECTRONIC ACOUSTICAL CONTROL IN A LARGE MULTIPURPOSE AUDITORIUM
John W. Ditamore, Edward C. Elliott Hall of Music, Purdue University, Lafayette, Indiana

SOUND/COMMUNICATION SYSTEMS — THE SOUND CONTRACTOR'S VIEWPOINT
Milton A. Boom, Boom Sound Engineering, Inc., Chicago, Illinois

AN ACOUSTICAL TUBE SOUND DELAY SYSTEM
E. S. Seeley, Altec Lansing Division of LTV Ling Altec, Inc., Anaheim, California

DEMONSTRATION OF ELECTRONIC ROOM-ACOUSTIC CONCEPTS
John E. Volkmann, RCA Laboratories, Princeton, New Jersey

PASSIVE AND ACTIVE ACOUSTICS IN ARCHITECTURAL ENCLOSURES
Harry F. Olson, David Sarnoff Research Center, RCA Laboratories, Princeton, New Jersey

LIVE ANNOUNCEMENT RECORD-REPRODUCE FACILITIES FOR AIRPORT AUDIO COMMUNICATIONS SYSTEMS
Robert C. Coffeen, R. C. Coffeen & Associates, Shawnee Mission, Kansas

SOUND SYSTEMS FOR ORCHESTRA AND GRAND OPERA
Leo L. Beranek, Bolt Beranek and Newman, Inc., Cambridge, Massachusetts

NATURAL AND ARTIFICAL REVERBERATION
M. R. Schroeder, Bell Telephone Laboratories Incorporated, Murray Hill, New Jersey

7:30 P.M. *Wednesday, October 13, 1965*
SOUND REINFORCEMENT
***Chairman:* William B. Snow, Bissett-Berman Corporation, Santa Monica, California**

ACOUSTI-ARCHITECTURAL CONSIDERATIONS IN THE HARRIS COUNTY DOMED STADIUM
F. Talbott Wilson, Wilson, Morris, Crain & Anderson, Houston, Texas

ACOUSTICAL DESIGN OF THE HOUSTON ASTRODOME SPORTS ARENA
T. J. Schultz, Bolt Beranek and Newman, Inc., Cambridge, Massachusetts

EQUALIZATION OF THE SOUND SYSTEM IN THE HARRIS COUNTY DOMED STADIUM
C. Paul Boner and Charles R. Boner, Austin, Texas

THE NEED FOR COMMUNICATIONS TRANSMISSION PATH ANALYSIS IN MODERN BUILDING CONSTRUCTION
Werner H. Freitag, New York University, New York, New York

THEORETICAL AND PRACTICAL CONSIDERATIONS IN THE EQUALIZATION OF SOUND SYSTEMS
William K. Connor, TRACOR, Inc., Austin, Texas

"BEHIND THE ACTOR'S BACK"
David L. Klepper, Bolt Beranek and Newman, Inc., Cambridge, Massachusetts

9:30 A.M. *Thursday, October 14, 1965*
***Chairman:* Emil Vincent, Columbia Broadcasting System, Inc., New York, New York**

THE CBS 8A FIELD AUDIO CONSOLE
E. S. Raymond, Columbia Broadcasting Company, New York, New York

AUDIO CONTROL EQUIPMENT FOR USE IN STUDIO SOUND RECORDING
Robert C. Fine, Fine Recording Company, New York, New York

A NEW COMPACT STUDIO AUDIO CONSOLE
A. C. Angus, General Electric Company, Syracuse, New York

THE JETARAMA THEATER SYSTEM OF AIRBORNE ENTERTAINMENT
Robert E. Johnson, United Air Lines, Inc., San Francisco, California

AMERICAN AIRLINES IN-FLIGHT ENTERTAINMENT SYSTEM
Thomas E. Pierson, American Airlines, Tulsa, Oklahoma

DESIGN OF CONTROL CONSOLES WITH THEATER REINFORCEMENT SYSTEMS
David L. Klepper, Bolt Beranek and Newman, Inc., Cambridge, Massachusetts

NEW TRENDS FOR STUDIO CONSOLE DESIGN
William G. Dilley, Spectra Sonics, Ogden, Utah

BALANCE REQUIREMENTS OF EQUIPMENT CONNECTED TO TELEPHONE LINES
L. L. Swan, Illinois Bell Telephone Company, Chicago, Illinois

1:30 P.M. *Thursday, October 14, 1965*
DISC RECORDING AND REPRODUCTION
***Chairman:* Carl S. Nelson, Capitol Records, Inc. Los Angeles, California**

A LOW MASS, MOVING MAGNETIC CONE, PICKUP CARTRIDGE WITH ELLIPTICAL STYLUS
G. A. Morrell, Dyna-Empire, Incorporated, Garden City, New York

ABSOLUTE CALIBRATION OF PICKUPS AND RECORDS
A. Schwartz, A. Gust and B. B. Bauer, CBS Laboratories, Stamford, Connecticut

OPTIMIZING THE DYNAMIC CHARACTERISTICS OF A PHONOGRAPH CARTRIDGE
C. R. Anderson, J. H. Kogen, R. Samson, Shure Brothers, Inc., Evanston, Illinois

APPLICATION OF THE SILICON SEMICONDUCTOR PHONOGRAPH CARTRIDGE
John F. Wood, Euphonics Corporation, Guaynabo, Puerto Rico

STYLUS MASS AND ELLIPTICAL POINTS
John Walton, Decca, London, England

THE HAECO VARIABLE PITCH SYSTEM
Howard S. Holzer and James Gainsley, HAECO, Los Angeles, California

INSTRUMENTS FOR RECORD CLEANING
Percy Wilson, "The Gramophone" Magazine, Middlesex, England

CONTINUOUS DELAY REGULATOR FOR CONTROLLING RECORDING ERRORS
Duane H. Cooper, Coordinated Science Laboratory, University of Illinois, Urbana, Illinois

PERFORMANCE EVALUATION OF PICKUPS WITH ELLIPTICAL STYLI
A. Schwartz, A. Gust and B. B. Bauer, CBS Laboratories, Stamford, Connecticut

9:30 A.M. *Friday, October 15, 1965*
MAGNETIC RECORDING AND REPRODUCTION
***Chairman:* Rein Narma, Ampex Corporation Elk Grove Village, Ill.**

MODULATION NOISE IN TAPE RECORDING
Robert Z. Langevin, Ampex Corporation, Consumer and Educational Products Division, Los Gatos, California

(Continued on page 84)

RECORD REVUE

Edward Tatnall Canby*

Beethoven: Piano Sonatas Op. 31, No. 2; Op. 81a ("Les Adieux"); Op. 101. Wilhelm Kempff.
Deutsche Grammophon
138 942 stereo

This is one LP in the complete series, recording the entire set of Beethoven sonatas plus other piano works, by the great and now elderly German pianist Wilhelm Kempff. It "replaces" (or rather supplements) the much older complete set he made 'way back, once available here on early Decca LPs.

The new Kempff seems to me a mellower, more human, great Beethoven player. The earlier performances were miracles of precise phrasing and balance, intense but rather taut, hard and dry. Musician's music, to an extent. The new playing is more human, more relaxed, though still with the wonderful clarity of phrasing and detail of the younger Kempff. A splendid series for the willing Beethoven listener, I'd say.

American listeners may have to adjust for a few moments to the characteristic European piano sound, primarily the piano itself with that somewhat woody tone and less sonorous bass that is preferred there to our Steinway-style sound. Also the recording, which matches it in its somewhat dry stereo (very likely via M-S mike technique) the stereo only subtly different from the mono. It soon begins to seem quite OK —and then quickly proves excellent for the music.

Beethoven: Complete Violin and Piano Sonatas
Zino Francescatti; Robert Casadesus.
Columbia D4S 324 (4)

It pays to keep re-checking. Those who have found Casadesus a tough, hard, professional in the past, and Francescatti a sometimes inaccurate and weak-willed virtuoso on the violin, may have to revise their ideas here, in the over-all if not in detail. I was, as the phrase goes, impressed in spite of myself. These two seasoned Frenchmen (Francescatti is a product of France) do have a natural affinity for each other and play together like old friends. And both can be inspired by Beethoven's vigorous music to produce a thoroughly professional French-style performance, dramatically up to everything the music has to offer.

This, in spite of some of the familiar faults of each player. Casadesus can bang unmercifully (and unphrasedly) in loud passages. Francescatti's violin line is still a bit flabby and occasionally out of tune. Some time ago I did a comparison of these players' recording of the most famous of the Sonatas, the "Kreutzer" alongside of the RCA Victor reocrding by Szeryng and Rubinstein in which RCA won hands down, for these very reasons.

Nevertheless, in the whole, Beethoven himself, or at least a convincing version of his musical personality, does get through abundantly, in most of these recordings. Somehow, the aggregate is more impressive than each of the ten sonatas on its own.

Vladimir Horowitz (Beethoven: "Pathétique," Debussy: Three Preludes; Chopin: Two Etudes).
Columbia MS 6541 stereo

Vladimir Horowitz Piano Recital (1932-37)
Angel COLH 300 mono

This is an extraordinarily interesting comparison—the same unique pianist, today and thirty five or more years back. Not many artists still active are to be found in Angel's famous COLH series of Great Recordings of the Century. As most readers are aware, the high-strung Horowitz virtually retired from pianism a good many years ago, but now he has made an unusual come-back, of which this Columbia record was one of the first fruits (with two others earlier, and a newer one of his recent concert re-debut in Carnegie Hall).

The musical story is quickly set down The newer record is far and away more impressive than the collection of old recordings—not on grounds of technique (the fabulous Horowitz technique seems to have been preserved intact over thirty years) but on sheer musical depth.

The old record is a typical late-Romantic-style concert program (in spite of Debussy and Poulenc), brilliant in execution, not really profound in meaning. It begins with the inevitable Bach-Busoni arrangement—every pianist used them!—in which Bach is rewritten into a cross between Chopin and Liszt; then a classical group, Scarlatti and Beethoven, followed by reams of brilliant Chopin, superb and yet, somehow, just a bit on the light, whimsical, virtuoso side. The big Beethoven, the "32 Variations in C Minor," is not convincing emotionally; somehow it seems shallow and misunderstood.

In the new recording, instead, we find a firm, enormously profound older Horowitz, probing to the deepest meanings of each of the larger works he here tackles, showing an extraordinarily perceptive new sense of style. This is a man who has lived, who has come to the final expression of his own gifts, who puts his superb technique to an ultimate musical task, every note counting its maximum. No waste, only extraordinary musical efficiency. No wonder they cheered him.

The "Pathétique" of Beethoven is just superb, a revivified warhorse marvelously balanced and styled; the Debussy is startlingly different, better than any since Gieseking and, before him, George Copeland. The Chopin works are of the biggest sort, and are played that way. Splendid. So is Columbia's Horowitz piano sound.

Artur Schnabel—Bethoven. ("Eroica" Variations; Vars. in F, Op. 34; Minuet in E Flat; Rondo in G, the "Lost Penny," in C, Op. 51, No. 1).
Angel COLH 65 Mono
(Great Recordings of the Century)

In its systematic way the British EMI company, granddaddy of many a famous recording, is reissuing quantities of its priceless earlier material transferred to LP. Because of their earlier connections, this company and Victor released much in common. Thus there is a curious duplication nowadays—when the two are no longer connected.

The famous Beethoven Sonata Society recordings by Schnabel were released, for instance, in a monumental RCA album that included the two fat printed volumes of the Schnabel edition of the Sonatas, the whole going for an absolutely fabulous price. Now, Angel (EMI's classical label hereabouts) is bringing them out again, but in separate single discs. Also some extra discs of the non-sonata piano music of Beethoven that were recorded by the great pianist, of which this is an example. A side dish to the sonatas.

I found this one disappointing in part. The Schnabel performance of the immense "Eroica" Variations (the earlier form of the Variations in the last movement of the "Eroica" Symphony) is so-so for Schnabel, both in concept and in finger-work—which seemed particularly messy. (Schnabel was no great finger-man, but we excuse it in favor of his musical penetration and understanding—when and if.) It was an off-day recording session for him, I guess. The other Variations, and the Rondos, are excellent, however. And that's a good half of the record. Especially the "Rage over a Lost Penny" — does *that* one fly! Object lesson for those who play it like a hurdy-gurdy.

We must always remember that Schnabel, who often made technical mistakes, is

(*Continued on page 80*)

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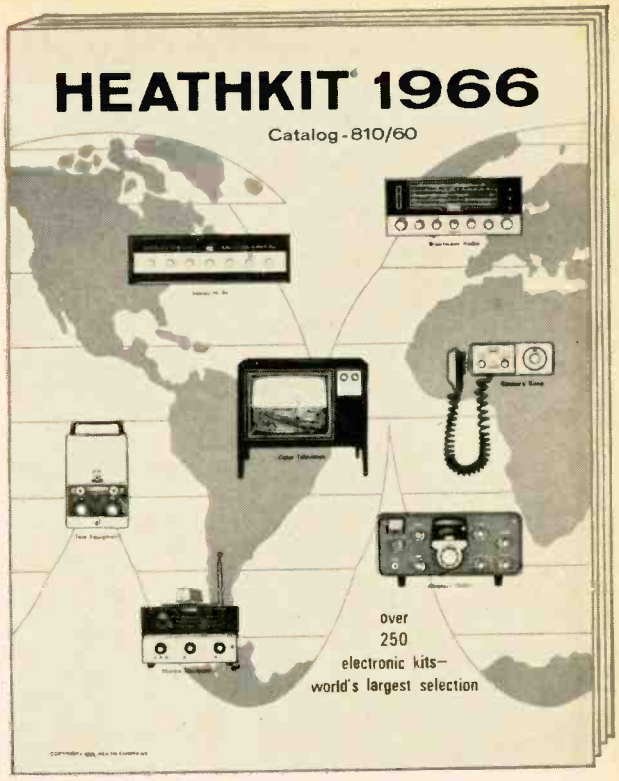

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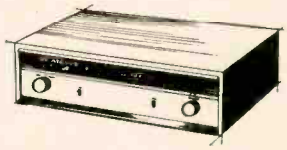

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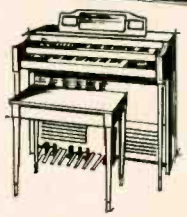

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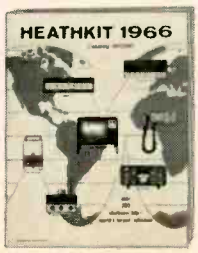

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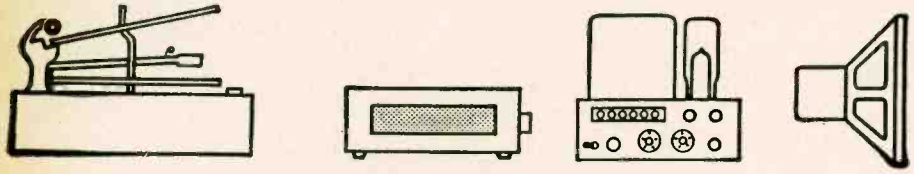

SONY/SUPERSCOPE MODEL 250A STEREO TAPE RECORDER

Precision of construction and attractiveness of design have been hallmarks of the Sony line of tape recorders ever since the first one was introduced here in 1959—the 555 series. During the succeeding years, the line has broadened widely until it now encompasses the entire range of types from the simpler monophonic machines up to the sub-professional models. There are, of course, a number of sophisticated professional models, including a few video tape recorders, but these do not generally appear on the "hi-fi" market, and only a few hobbyists that are well endowed with the coin of the realm are likely to have them in their homes. The newest addition—the home video recorder—will change that, however.

But that does not keep the rest of us from wanting a number of professional *features* in the machines we can afford, and the 250A certainly falls in this category—we used the term "sub-professional." Unfortunately, "professional" has been applied to too many products in the past years, just as many products are called "high fidelity" when their only claim to the term is the printing on the shipping carton or a decal on the front panel.

The Sony 250A appears to us to be an ideal machine for the hobbiest who wants to build it into his system, since it does not have its own loudspeakers, has no playback volume control, and is a relatively simple machine. It would be a perfect second machine for use in dubbing, for instance, since its low price, $139.50, does not present any great hardship.

The unit is entirely transistorized, and is arranged so as to record on either left or right channels independently, as well as on stereo. Operation is quite simple, with tape motion controlled entirely by one knob. This control has five positions—from the stop position the tape is placed in the forward mode, for either play or record, by a clockwise movement to the first position. The next step is pause, which moves the idler away from the capstan, providing an instant stop. The final clockwise position is fast forward. Thus when turning back from fast forward, the control must first go through pause before engaging the forward mode, which effectively prevents broken tape. Rewind is provided by turning the control one step counter-clockwise. In some machines, when the control is moved from fast to forward, thereby causing the idler to contact the capstan, the quick stopping of the tape often breaks it. With the 250A, however, it does not seem possible to move the operating control fast enough to cause this. Furthermore, the machine is "fail-safe" that is, in case of power failure it simply stops, without any tape spillage. A microswitch actuated by the tape when in the proper position across the heads controls the power, so that run-out or tape breakage shuts off the power.

Because there are no playback controls on the recorder, the external amplifier's controls select which channel is being played, or controls the level of the two channels in stereo.

In front of the two level-indicating meters is a lift-up cover at the left front of the panel. Under this cover are, two record-level controls, and a record push-button, and two microphone mini-jacks. At the extreme counterclockwise position of the record-level controls is a switch which cuts off the bias and erase for its related channel. When the record button is depressed, the meters are illuminated by red light. A.c. power for the entire machine is controlled by a push-on-push-off button at the right front of the panel. This button is illuminated when power is on. Auxiliary (high-level) input phono jacks and playback output phono jacks are located on a small recessed panel on the rear of the wood base. A digital counter is located just above the plastic cover for the recording controls.

The head assembly has two removable plastic covers which slip over split metal pins. The rear section of the cover provides access to the heads for cleaning, and with both removed one has access to the front of the heads for editing. Two heads are employed, the erase head, and the combined record-play-head—the latter being well shielded. In the record or play mode, hinged covers provide a completely closed shielding. Since there is no power amplifier in the 250A, monitoring can be obtained from the associated amplifier to which the unit is connected, as the input signal appears on the playback jacks (line output) during recording.

Each channel consists of four stages, with a total of eight transistors in the audio circuitry. Two more are used in the bias oscillator.

Measuring only 14½ in. deep by 11⅝ in. deep and 6½ in. high, the 250A is compact. It may be removed from its wood base and installed in the user's cabinet either vertically or horizontally, making it completely flexible in application.

Fig. 1. Sony 250A Tape Recorder.

Performance

Rewind and fast-forward time measured at 2 min 35 sec for a 1200-foot reel. Wow and flutter measured less than 0.18 per cent at 7½ ips, and just under 0.22 per cent at 3¾ ips.

Using a standard frequency tape, response measured −1 db at 50Hz, +1.5 db at 15,000 at the 7½ ips speed; −0.8 db at 50 Hz, +0.8 db at 7500 Hz at 3¾ ips.

When you're judging loudspeakers . . . consider *efficiency* . . . defined as "the quantity of sound obtained from a speaker system per amplifier watt."

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For Comparator Guide with full specifications, write Dept. WR-15, Wharfedale Div., British Industries Corp., Westbury, New York 11591.

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the owner with a reference point against which to adjust the mid and high ranges. The reference point is a tone lying well within the range of the woofer. Tones are presented in rapid order for first the mid-range against woofer and then the tweeter against mid-range; finally all three tones. With this tool, a high degree of accuracy is achieved, through purely audible means, in balancing the speaker against both its surroundings and its feeding components.

We tried the speakers in two rooms. In both cases the record resulted in a balance that we felt was completely musical. What proved more interesting was that several associates that used the record to balance the speakers in the same rooms came up with virtually identical settings. From these tests we conclude that this is indeed a useful tool. Limited tests indicate that the manufacturer's claim that this record is suitable with most any three-way system is probably accurate.

Measurement of the woofer, under outdoor conditions, showed smooth response down from the crossover point. There is a 3-db rise at 400 Hz but otherwise the curve showed a smooth decreasing line that indicated that there is good usable response to about 38 Hz. Measurement of the top end proved more elusive since on-axis measurements of the drivers had no relationship to the dispersion characteristics of the way they are used. Therefore we relied on our ears to tell us that over-all response is smooth, flat, and extends well beyond audibility.

Musical sound with these reproducers is quite neutral. This is neither a forward-sounding nor a rear-hall sounding product, though these qualities could be adjusted quite a bit one way or the other with the mid-range control. Bass response is good, too. It is certainly not a boom-box; quite the contrary the over-all bass response is perhaps just a bit *too* modest. Strangely though, the speaker does not sound thin. A tympani sounds much the way it does in a hall—full and vibrant, but not hollow.

We were curious to see just what musical effect the 360-deg. dispersion would provide. The results are more than interesting; they are, we believe, responsible for lifting this speaker into the forefront of reproducers.

For the first time we could shut our eyes and really feel as if there was an orchestra deployed against the end of our room. Sound did not come from the speakers; it was lifted above and behind the units. The total effect of this characteristic defies description—it should be heard!

We are of the opinion that no speaker can be, or will be, definitive. There is no standard against which to judge them. Unless you can call one's own memory of live sound a standard. Still, this speaker does not drive us into frenzies of dissatisfaction when it is played directly after a return from Lincoln Center's Philharmonic Hall. This, to us, is the mark of a really good transducer. The KSC-3 is in such a category. Perhaps it is outpointed by some others in ultimate bass response or in other characteristics, but taken as a whole, it is a *music* reproducer that belongs on anyone's listening itinerary when contemplating speaker purchases. The $195 price tag is one point in its favor. Circle 212

"OOO! AHH!" *chorused the scientists succinctly and the musicians mellifluously*

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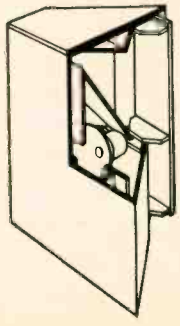

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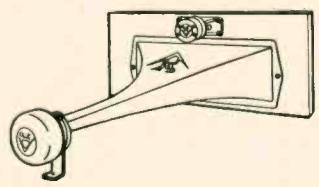

straight-axis design and is completely free of the irritating distortion which occurs in reflexed horns. The horn is mounted on a specially designed flange which effectively increases the horn's mouth area and adds measurably to its smoothness of response . . . less than 6 db variation from 400 to 5,000 cps.

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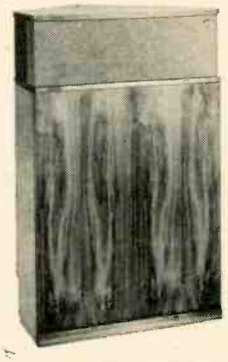

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SOUND AND SIGHT

HAROLD D. WEILER

THE PRIMITIVE visual techniques developed by Melies and Porter mentioned last month were combined and refined by a young man who was eventually to become the world's most famous and influential creator of motion pictures. His films became the blueprint for directors wherever films were made and still remain, to this day, the fundamental source of film knowledge. The techniques contained in just five of his pictures would provide a complete course in modern motion picture and video tape filming. D. W. Griffith's influence is present in every motion picture or video film you see today.

Most video or motion picture audiences are not aware of how mental impressions can be created and altered and how their emotions can be swayed, not by the actors and settings, portrayed alone, but even more drastically by means of various techniques employed during the actual filming and editing of the picture. The most commonplace object or concept may be glamorized, dramatized, made interesting and exciting through the application of these techniques. Conversely, and of equal importance, the exact same object or concept may be depreciated and demeaned through only a variation in the filming and editing techniques employed; both objectives may be achieved with equal ease without the viewer's sensing that their reactions are being manipulated.

We have thus far mentioned only the visual techniques employed in motion picture and video recording. The aural techniques are of equal importance in creating or changing impressions and swaying emotions. With rare exceptions, sound is not utilized to its fullest extent even today. From the earliest times of the film to the present, sound has been treated as a difficult, problem laden, stepchild. Thomas A. Edison, whom we shall discuss later, was the first man to realize the importance of combining sound and sight. Even he, however, did not realize its effect on our mental impressions and emotions.

Sound, to begin with, is not just a supplement to sight! It plays a much larger part in our lives than we realize. When you hear a bird or a plane you naturally look up. Before you sight the source of the sound you are aware of its exact position. Before your vision even begins to function the localization faculty of your hearing has already accurately computed the location, direction of travel, and approximate distance of the sound source and fed this information to your brain which then directs your sight. A person with normal hearing can accurately locate the source of a sound within two degrees, *without the aid of sight!*

From the beginning of man, sound and sight have thus functioned together, one complementing the other, but equally important! Prehistoric man depended as much upon his hearing for survival as he did on his sight. Heavy undergrowth or tall grasses limited his vision. If he was to survive, one of his other senses must react quickly and provide an "early warning system" for predator and prey. His hearing, because of its localization faculty, became his primary warning system.

The importance of sound in motion pictures and video recording becomes even more obvious if we stop to realize that a human being hears before he can see. The fetus during prenatal life is constantly exposed to the repetitive sound of the maternal heart beat. This earliest exposure to sound plays an extremely important part in our reactions to all sound in later life, as we shall show in a future article.

Before discussing the aural techniques employed in motion picture and video production, it would be well to explain something of their history: when, how, and why they were developed, and the purpose they serve.

For the earliest recorded attempt at combining sound and moving pictures, we must return to the evening of February 5, 1870, the place, the lecture room of the American Academy of Music, in Philadelphia. Henry M. Heyal is demonstrating his new "magic lantern" device which employs a number of slides mounted on a wheel. By rapidly projecting his series of posed still photographs on the wall he produces the illusion of motion. His most successful presentation is that of a couple waltzing. It is accompanied by a small group of musicians in the same room playing in synchronization with the projected images of the dancing couple. While this device of Heyal's was only an interesting novelty and never put to commercial use it is the first recorded attempt at combining sound and sight in the field of moving pictures.

For the next attempt we must go forward to the fall of 1887 in the laboratory of Thomas A. Edison. After Edison had completed work on his "improved phonograph," he returned to an early dream—"a device which would perform the same service in recording and reproducing motion which the phonograph performs in recording and reproducing sound."

From the December, 1933, issue of the Journal of the Society of Motion Picture Engineers (now S.M.P.T.E.) we find, "Edison's idea as disclosed to me in 1887 at the Newark laboratory was to combine the phonograph cylinder or record with a similar . . . drum on the same shaft, which drum was to be covered with pin-point microphotographs which of course must synchronize with the phonograph record."

On December, 1887, W. K. L. Dickson, assistant to Mr. Edison, who wrote those words, was sent to Scovill Manufacturing Co., a large photographic house in New York to purchase some "special equipment." The order was a large one, for the time, totaling $835.16, and Scovill Manufacturing Co. took the precaution of checking with Edison before making shipment. A letter to this effect is in the Edison Archives at the Edison National Historic Site in West Orange, New Jersey.

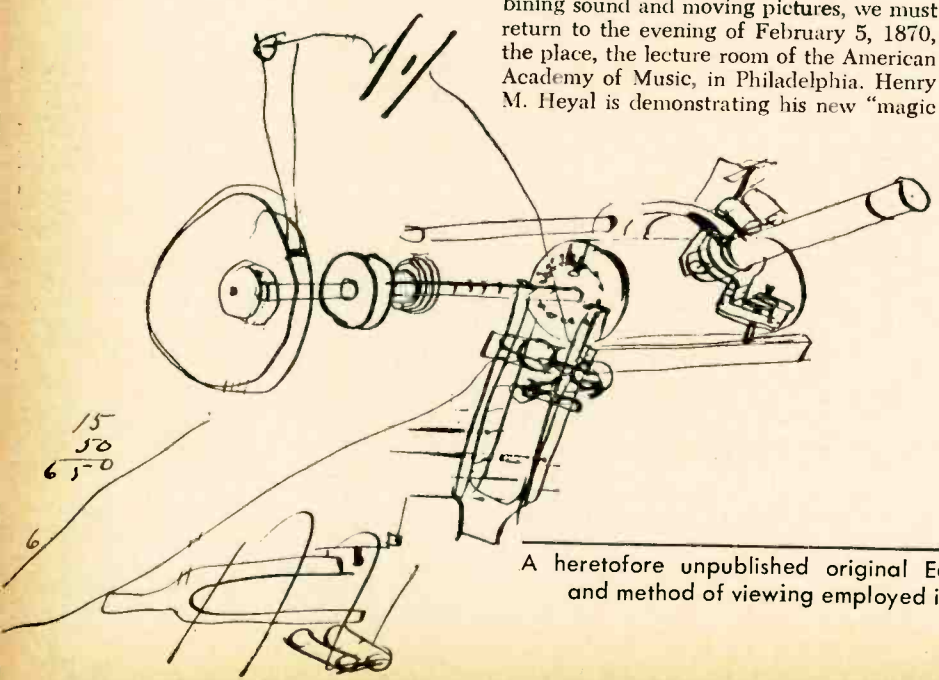
In an article also written by Mr. Dickson in Century Magazine, June, 1894, describing the earlier invention of the "Kinetophonograph" we find, "The initial experiments took the form of microscopic pin-point photographs, placed on a cylindrical shell, corresponding in size to the ordinary phonograph cylinder.

Mr. Dickinson continues, "These two cylinders (one for sound and the other for sight) were then placed side by side on a shaft and the sound record was taken as near as possible synchronously with the photographic image impressed on the sensitive shell."

In the 1933 J.S.M.P.E. article Dickson provides additional information on this early experiment, "Before making the drum, which was to fit over the phonograph shaft, I made a small micro-camera using various objectives or lenses taken from one of my microscopes to produce the pin-head pictures."

These early images were photographed in continuous spirals around the cylinder,

(*Continued on page 89*)



A heretofore unpublished original Edison sketch illustrating the construction and method of viewing employed in an early moving picture machine.

For only $3.78 per watt you can own the world's first all-silicon stereo receiver!

New PLAYBACK® series

It's completely new and way ahead of its time! The Altec 711 PLAYBACK receiver gives you an honest 100 watts in a rugged, trouble-free all-silicon design that's the best power-per-dollar value on the market!

SOME AMPLIFIER!

It provides 100 hefty watts of clean, undistorted power. The kind you can *use*, not just talk about! Turned up to a roof-lifting 70 watts, this fantastic amplifier has a total harmonic distortion of a mere 0.25%. Even at the full 100 watts, distortion is still only 0.5%!

Three Good Reasons Why You Need Such Power in an Amplifier. If you're lucky enough to own high-efficiency Altec PLAYBACK speakers, you can use your power to achieve concert-hall listening levels. Because Altec's FULL-SIZE speakers dissipate so little of your power, you can bring the full sound of the orchestra into your home!

On the other hand, if you have ordinary, low-efficiency speakers, you need the 711's power to coax a good listening level from them. And you'll still have enough reserve power to handle the sudden dynamic changes which are inherent to most music. In fact, the Altec 711 has enough power to help reduce clipping—even with very inefficient speakers!

Third, no matter what kind of speakers you have, an amplifier that's designed to perform so well at 100 watts provides a brilliant fidelity at lower listening levels that low-power amplifiers just can't match. It's like a fine motor car designed to operate at 120 mph. When you cruise at 65, you know you're just loafing along without strain. If your car had a top speed of only 80, however, then 65 mph would be close to the car's endurance.

Other Amplifier Features include frequency response of 20-20,000 cps ±1 db *at 100 watts*—and at lower power settings a fantastic 10-100,000 cps response / rocker panel switches / automatically resetting circuit breakers instead of fuses / and no transformers anywhere to cause distortion.

SOME TUNER!

The 711's masterful combination of sensitivity and selectivity picks up even the weakest stations—then hangs onto them like a bulldog. Drift is a problem of the past!

The 711 tuner is extremely sensitive, with a volume sensitivity of 0.9 μv and usable sensitivity of 2.2 μv IHF. Other specs that back up the superior performance of this years-ahead tuner include capture ratio of 2.5 db, stereo separation at 1000 cps of 40 db, and a power bandwidth of 20-20,000 cps ±1 db.

A unique 4-gang tuning condenser makes the 711's special sensitivity-selectivity combination possible. The fully neutralized IF uses the newest high-gain silicon transistors for optimum integration with the tuning gang.

WHAT THE 711's ALL-SILICON DESIGN MEANS TO YOU

Only silicon transistors have the inherent ruggedness, the ability to "take it," that ensures you years of trouble-free listening enjoyment. And by "take it" we mean that silicons can handle at least 200% more heat than germaniums!

The rugged reliability of silicon transistors is why military specifications for critical electronic equipment demand silicon instead of germanium transistors. This is the kind of reliability you get in the new Altec 711!

REALLY CONVINCE YOURSELF—COME SEE THE FANTASTIC ALTEC 711!

It's all silicon—it's all excitement! The 711 comes completely enclosed in a beautiful metal case (walnut case optional), thanks to its no-heat operation! Your Altec dealer is waiting to show you the new 711. Or, for complete information, write Dept. .

COMPARE FOR YOURSELF THE 711's POWER-PER-DOLLAR VALUE!

Make	Model	Price	Watts	Dollar-per-watt	All-Silicon Transistors
Altec	711	$378.00	100	$3.78	Yes
Bogen	RT 6000	359.95	60	6.00	No
Fisher	500 C	349.50	75	4.66	Tube
Fisher	600 T	459.50	110	4.17	No
Fisher	440 T	329.50	80	4.12	No
Harman-Kardon	SR 300	264.00	36	7.33	No
Harman-Kardon	SR 600	354.00	50	7.08	No
Harman-Kardon	SR 900	434.00	75	5.79	No
Scott	344	429.95	50	8.60	No
Scott	340 B	399.95	70	5.70	Tube
Scott	348	499.95	100	5.00	No
Sherwood	S-8000 IV	312.50	80	3.92	Tube
Kenwood	TK 80	339.95	80	4.22	No
Kenwood	KT 10	269.95	40	6.74	No
Kenwood	KW 55	219.95	40	5.49	Tube

Chart is a cross-section of comparably priced receivers available at the time this advertisement was prepared. Prices and wattage figures are based on information contained in advertisements of the respective manufacturers.

ALTEC LANSING
A Division of LTV Ling Altec, Inc.
ANAHEIM, CALIF.

©1965 AL

Circle 141 on Reader Service Card

CONVERTING THE UHER

(*from page 24*)

The output coupling unit shown in *Fig.* 1, with its self-contained microphone amplifier will be described next month.

To be continued

PARTS LIST

C_1 470 pf, disc, Sprague 5GA-T47
C_2 5 μf, 25 v., Sprague TE1202
C_3, C_7 100 μf, 10 v., Sprague TE 1119.3
C_4, C_9 100 μf, 3 v., Sprague TE 1059.5
C_5, C_{13}, C_{16} 15 μf, 10 v., Sprague TE-1116
C_6 50 μf, 3 v., Sprague TE-1058
C_8 3300 pf, Sprague 192P-33292
C_{11}, C_{12} .015 μf Sprague 192P-15392
L_1 Uher 80-Hy choke, Martel Part #2503
L_2 Uher 6-mh equalizer coil, Martel Part #2505-3
Q_1, Q_2, Q_3, Q_4 Siemens AC-151 transistors (or RCA 2N215)
R_1, R_6 47 k ω, ¼-watt resistor
R_2, R_5, R_{10}, R_{12} 4700 ω, ¼-watt resistor
R_3 2200 ω, ¼-watt resistor
R_4 1500 ω, ¼-watt resistor
R_7 3900 ω, ¼-watt resistor
R_8 10,000 ω, ¼-watt resistor
R_9 1000 ω, sub-miniature potentiometer, Lafayette part No. 99G-6142
R_{11} 470 ω, ¼-watt resistor
R_{13} 330 ω, ¼-watt resistor
R_{14} 680 ω, ¼-watt resistor
R_{15} 1000 ω, ¼watt resistor
R_{16} 3300 ω, ¼-watt resistor
R_{17} 15,000 ω, ¼-watt resistor
Three printed circuit boards (see text)
1 pc. laminate, 1-5/16 x 1-3/16 in. (see text)

RECORD REVUE

(*from page 70*)

particularly vulnerable today since he came before the age of tape editing and the consequent profound change in our listening ears. Today we cannot tolerate minor slips and inaccuracies—because we never hear them any more. In his day, listeners were more broad-minded, both at concerts and in record listening. They were right in a way. But, on the other hand, we can't dodge the impact of a mistake that, once repeated in a replaying, becomes an anticipated thing and therefore deadly. So the tape editors are right, too, in a way.

Beethoven: The Complete Sonatas (Beethoven Sonata Society). Vol. XII, Opus 101, Op. 109. Vol. XIII, Op. 110, Op. 111. Artur Schnabel (1932-1943).

Angel COLH 62, 63

Here are the last two LPs in the complete sonata reissue, with the last four sonatas, the famous and difficult late ones. Musically, they are superbly rewarding — for the later the Beethoven, the more does the musical mind behind the playing count, and that is where Schnabel was strong.

All but one of these, Opus 101, were recorded far back, in the early months of 1932. Opus 101 is two years later, 1934—and there is a noticeable difference in sound. The three earlier ones are both somewhat muffled and rather irregular in pitch; they have that curious quality of not being loud enough, no matter how much you raise the volume. Probably a result of poor transient recording as well as wobbly pitch. (None of this is enough to interfere seriously with solid listening.) Opus 101, two years later, seems immediately louder and clearer. The pitch is steadier, the percussives sharper, and hence piano realism begins to improve. Interesting commentary on recording, as of those very dynamic years in the early electrical era.

Beethoven: Trios for Violin, Cello and Piano, Vols I and II. (Complete.) Mannheimer Trio.

Vox SVBX 553 (3); SVBX (3) stereo

Vox really stakes its all on these immense collections — six records, twelve sides here, all the trios Beethoven wrote, including such lovelies as the big, violent "Archduke" and the superb set of variations on "Ich bin der Schneider Kakadu," a tune about a tailor.

Well, you can stake your all, too. This Mannheimer trio plays excellent Beethoven. It is a youthful group, full of zest and enthusiasm as well as good Beethoven style. The pianist, who is generally the leader in this kind of music, is a kind of junior Rudolph Serkin, here, with the live-wire, sprightly intensity that the music absolutely requires. Excellent! Buy the works!

MORE BAROQUE

Marc-Antoine Charpentier: Music for Port-Royal. Ceremonial Music of the French Baroque. Soloists, Roger Blanchard Instr, and Vocal Ensemble, Members Paris Conservatory Orch.

Nonesuch H 71037, 71039 stereo

I've thrown two discs in together here, both displaying French performances of French Baroque music out of the Seventeenth and Eighteenth centuries. No use trying to name the many assorted soloists, but all perform very much in the French tradition, singing gracefully through the nose or playing in a brisk if slightly out-of-date style tinged with leftover Romanticism. Doesn't hurt the music a bit.

The first disc, all-Charpentier, celebrates one of the chief "rediscovered" composers of the French Baroque in lovely music composed for the nuns of the celebrated nunnery of Port-Royal and for the Saint-Chapelle in Paris. The second has more Charpentier, an "Epithalanium" for the wedding of a South German prince,

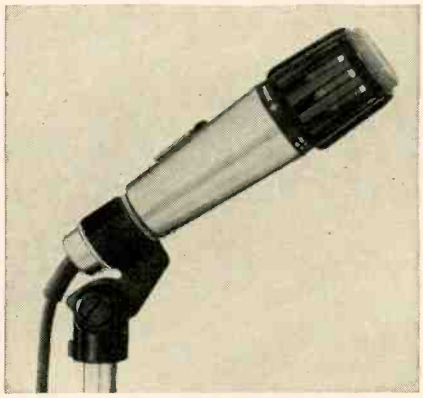
plus a splendid Latin piece by Lully, celebrating the Dauphin's baptism, and a work by the well-known Anonymous (attributed to Delalande), a "get-well" offering to Louis XIV after an illness. A great variety of strange music, a bewildering wealth of unfamiliar styling but, in the end, a worthwhile "new" sort of music for the inquiring listener.

ERRATA!

No issue of any publication is ever perfect, we believe. A comma is left out or put in, a price is wrong, an address is missing, or what not. We were no exception in the August issue. We *try* hard, but the errors do creep in. For example:

SHURE BROTHERS

On page 83 we showed a picture of Model 580 microphone, but labeled it



Shure 580

Model 545. The 545 is still the sleek model it has always been—and a right popular one it is, too. Apology No. 1.

McINTOSH

On page 38 we show the McIntosh line as having hum and noise figures ranging from 60 to 76 db, whereas most other good amplifiers appeared with figures in the 80's or 90's. We originally *asked* for hum and noise figures below 1 watt output, but practically everyone who responded changed the head of the column to "below rated output." This makes the McIntosh line look poor by comparison, although everyone knows is well up among the top few. Add about 20 db to the figures given. Apology No. 2.

SCHOBER ORGAN

The same thing applies to their TR-2 amplifier, which is listed as having a S/N of 67 db, also below 1 watt. Compared to others which use the "rated power" figure this looks bad. We are advised by Schober Organ that the correct figure should be 83 db under the commonly used rating. Apology No. 3.

NEW PRODUCTS

• **Ribbon Microphone.** The Professional Products Division of Shure Brothers has recently announced the availability of a rugged unidirectional ribbon microphone featuring wide-band response and a super-cardioid directional pattern. This is the model SM33, equipped with a rugged mechanical design and internal ribbon protection that assures reliable operation even under severe abuse conditions. The super cardioid character of acceptance ensures high rejection of unwanted noise and vibration. Frequency response

is 40-15,000 Hz; dual output impedances permit selection of either 30-50 ohms or 150-250 ohms. Output level at 1000 Hz; is −60 db at 30-50 ohms and −58.5 db at 150-250 ohms, where 0 db equals 1 milliwatt with 10 microbars. Features include a bass-tilt position for close-in miking and a self-adjusting swivel that allows 45 deg. of forward motion and 70 deg. backward. The microphone is finished in textured light and dark grey enamel and fits standard pipe thread. 20 feet of two-conductor shielded cable is provided; termination is with a Cannon XLR-3-11 Connector. List price is $129.00. **Circle 200**

• **Low-cost Amplifier Kit.** Lafayette Radio has just released a new unit designed to appeal to the need for a quality monaural control amplifier of modest price and medium power. The KT-615 provides 15 watts of output. It has three separate inputs: one for magnetic or ceramic phono, one for tuner and one for AUX—a tape recorder, TV sound or the like. Important specifications include: Harmonic distortion of 1.1 per cent; 15-60,000 Hz response ±2 db at one watt and 35-20,000 Hz response at full power; hum and noise is −45 db in phono and −75 in

the high-level inputs: input sensitivity is 1.5 mv in phono and 0.5 volts in the high-level positions. Features include separate bass and treble controls for full boost and cut; a hum-balance control and a push-pull ECL82 output. Outputs are provided for 4, 8 and 16 ohms. The tube complement is 2-ECL82/6BM8, 1-EZ81/6CA4 and 1-ECC83/12AX7. The kit comes complete with wire, solder, and easy-to-follow instructions. Dimensions are 11⅛" x 7½ x 4½". List price is $19.95. A matching grey case is available at $3.95. **Circle 201**

• **Speaker Kit.** This new kit system from Sonotone results in a two-way, high-compliance speaker system utilizing an acoustic-suspension woofer. The kit is complete with all necessary parts including crossover network, tweeter level

control, screws, nuts, and bolts. The speaker cabinet itself is constructed of unfinished non-resonant panels. Designated the RM-1K and priced at $35.50 suggested, the unit measures 14½" x 10½" x 7¼" deep when it is completed. **Circle 202**

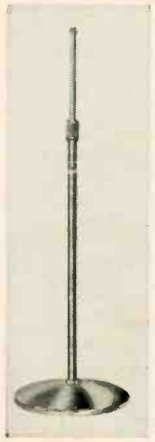
• **Solid-state Mixer/Preamplifier.** The McMartin LX-40 has an output level of +10 dbm at 600 ohms unbalanced. It features four microphone inputs and a separate program input—each of which is individually controlled. Also provided are a master gain control, tone control, and a cueing switch. A front-panel phone jack makes it easy to monitor program

material. Stable operation of the unit is assured by the use of silicon transistors throughout. Optional accessories include: three conductor microphone connectors male or female type; phono, program, and tape-head preamplifiers; universal microphone-line input transformer; VU meter and an 19-inch rack-panel mounting. **Circle 203**

• **Professional-type Tape Recorder.** European magazine readers are already familiar with the respected name of ReVox.

Their Swiss-made tape recorders will now be imported and distributed in this country by Elpa Marketing Industries. The illustrated ReVox Model G-36 combines professional characteristics in a machine that is listing at $500.00. Among these is an ability to handle 10½-inch reels, three-motor operation, solenoid-operated brakes, built-in mixing facilities, separate record and play heads and preamps, two VU meters and an automatic end-of-tape stop. Bias oscillator frequency is 70 kc. Operation is by a row of keys and is straightforward and logical. A digital counter allows the user to find portions of a tape easily. **Circle 204**

• **Microphone Stand.** Atlas Sound has just announced an attractive gold-finished microphone floor stand. Designed for special decor requirements, the MS-14G gold stand is also intended to complement both black- and gold-finished microphones. The low-profile base is inconspicuous and concentrates weight at



the outer edges for greatest stability. Self-leveling, shock absorbing base pads and anti-tipover construction are used. Height adjustment is from 34 inches to 62 inches, the base has a 10-inch diameter and the list price is $18.75. **Circle 205**

• **Capacitor Microphone System.** Vega Electronics has announced the availability of a new, miniature omni-directional microphone and separate a.c. power supply. Invented, developed, and manufactured in California, the Vega capacitor microphone system is claimed as comparable to the most expensive imported units. Characteristics include a 20-20,000-Hz response, less than 0.3 per cent distortion and excellent transient response. The miniature microphone head connects via a 20-foot cable to the a.c. supply. This cable may be extended.

if needed, to as much as 200 feet. The system also features switchable high- or low-impedance outputs plus a switchable low-frequency filter. The microphone has a low-noise Nuvistor as the only component in addition to the capacitor element. There are two versions of the system. The single-system Vega 20 is priced at $185.00 while a dual system Vega 22 at $315.00 offers two units for stereo with a dual power supply and two microphone heads. **Circle 206**

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AES CONVENTION LISTINGS

(*from page 68*)

FLUTTER PERCEPTIBILITY AND A NEW FLUTTER ANALYZER
George S. Bahrs, Bahrs Industries, Palo Alto, California and John G. McKnight, Ampex Corporation, Los Gatos, California

A FLEXIBLE SHEET MAGNETIC RECORDER
Erling Skov, Ampex Corporation, Video-Instrumentation Division, Redwood City, California

DROPOUTS AT LOW TAPE SPEEDS
Frank A. Comerci, CBS Laboratories, Stamford, Connecticut

A TRANSISTORIZED PROFESSIONAL RECORDER
Ben Oniki, Ampex Corporation, Video-Instrumentation Division, Redwood City, California

TRANSIENT RESPONSE AND CROSS MODULATION DISTORTION IN MAGNETIC RECORDERS
Keith O. Johnson and D. P. Gregg, Gauss Electrophysics, West Los Angeles, California

A NEW COMPATIBLE MASTERING TAPE RECORDER
George S. Bahrs, Bahrs Industries, Palo Alto, California and Walter T. Selsted, Hewlett-Packard, Palo Alto, California

1:30 P.M. *Friday, October 15, 1965*
SPEECH ANALYTICS
Chairman: Dr. Homer Dudley, Summit, New Jersey

HUMAN INTEGRATION OF CONCURRENT AUDIO AND VISUAL MESSAGES
Donald B. Devoe, Applied Research Lab., Sylvania Electric Products, Inc., Waltham, Massachusetts

MEASUREMENTS OF REACTION TIME IN INTELLIGIBILITY TESTS
M. H. L. Hecker, K. N. Stevens, and C. E. William, Bolt Beranek and Newman, Inc., Cambridge, Massachusetts

THE UNSCRAMBLING OF HELIUM SPEECH
Michel Copel, U. S. Naval Applied Science Laboratory, Brooklyn, New York

RESEARCH TOWARDS A HIGH EFFICIENCY VOICE COMMUNICATION SYSTEM
Harry F. Olson, Herbert Belar and Edward S. Rogers, RCA Laboratories, Princeton, New Jersey

MANIPULATED SPEECH
Franklin S. Cooper, Richard S. Music, and Norman B. Reilly, Haskins Labs., New York, New York

IMPLEMENTATION OF A DOUBLE-SPECTRUM-ANALYSIS PITCH EXTRACTOR
Cyril M. Harris, Columbia University, New York, and Mark R. Weiss, Federal Scientific Corporation, New York, New York

THE ANALOG CHANNEL VOCODER
Lawrence E. Cassel, Philco Corporation, Blue Bell, Pennsylvania

APPROACHES TO THE SYNTHESIS OF SPEECH
Ignatius G. Mattingly, Department of Defense, Fort George G. Meade, Maryland

COVER STORY

(*from page 46*)

separated power cables from signal cables and through careful positioning were able to reduce the small amount of remaining hum even further. The cumulative effect of arranging and rearranging electrical cables for greatest reduction of hum and noise and sometimes be quite rewarding.

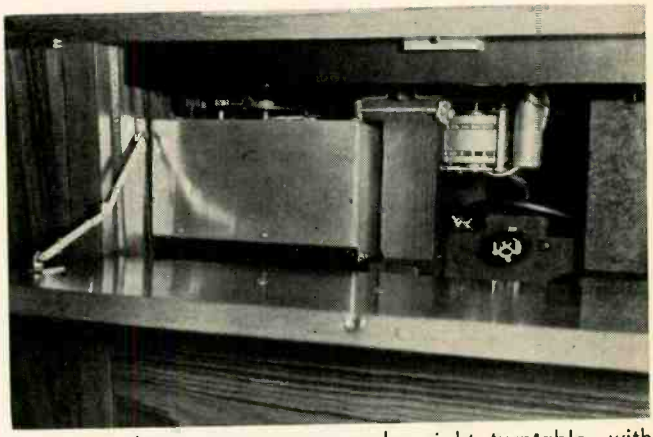
After the wires were fastened in their "best" positions we were left with a lot of excess lengths of cable. These were all promptly cut down to eliminate any excess (extension cables can easily be used if a piece of equipment has to be removed from the cabinet for servicing).

The results of all this is a safer, more professional looking, and even better performing, installation.

The room acoustics were a little on the "live" side. Large (6ft. high) artificial plants have been used effectively around the room to break up wall reflections. The plants were another "do-it-myself" project which was assembled from an assortment of "loose" stems and leaves (plus accessories) purchased at a local florist. The ceiling is covered with Armstrong acoustic tile (the type with the holes) and the floor with Armstrong vinyl asbestos.

I have found high fidelity to be an extraordinarily satisfying hobby, and while the system just described may be to many in the same wishful thinking category as a Rolls Royce or Cadillac to us it represents sort of a semi "design-it-yourself"—do-it-yourself accomplishment. It has been a gateway to the excellent sound that has filled our home ever since a memorable Saturday evening, nearly three years ago, when it first roared into full-throated operation.

View of inside of one of the drawers showing accessories—strobe, Dust Bug and fluid holder, stylus cleaning brushes, white gloves for handling records, and so on. All drawers are finished on the inside and lined with green felt cemented to removable board liners.



Electronic drive compartment under right turntable, with the drive unit shown at the left and the Papst turntable motor at the right.

TAPE GUIDE

(*from page 64*)

*Q. I purchased a **** tape recorder and hardly had it two months when I noticed considerable distortion when I recorded. The distortion seemed to increase according to the number of times the tape was used; it was virtually non-existent on virgin tape. And there was no problem with recorded tape, so the trouble apparently lay in recording. On a hunch I ran some of the distorted tapes past a permanent magnet several times, which partly reduced the distortion. Further running of the tape past the magnet brought additional improvement. I do not look forward to the prospect of running ten tapes past the magnet ten times apiece. Can you suggest a better alternative?*

A. I suggest that you erase the tapes in question with a bulk eraser, which takes but a few seconds.

Q. I have a tape recorder which does not incorporate tape lifters. I have been thinking of installing an "adjustable tape guide post" so that I can lift the tape off the heads while winding or rewinding. Please tell me if you recommend what I am planning to do.

A. If there is any contact between the tape and the heads during winding or rewinding, this accelerates head wear and it becomes desirable to lift the tape off the heads in some manner. Thus it appears worthwhile installing the tape guide post you speak of. The only possible disadvantage, and of course one that is far from certain to occur, is that the change in the tape path might result in the tape winding less smoothly on the reels; this would affect tape tension during storage and might result in tape deformation and consequent distortion upon playback.

Q. In order to improve the signal-to-noise ratio of my tape recorder, I plan to replace the resistors (mostly 5 per cent tolerance) with 1 per cent tolerance resistors. Do you think this substitution will improve the S/N appreciably?

A. You may get an improvement in S/N from 1 per cent resistors, not because of their more precise values but because usually they are made from materials that produce less noise. If you use deposited carbon precision resistors you may be disappointed. I suggest that you employ deposited metal film resistors. These are not cheap. They cost about $2 apiece. I cannot say how much improvement you are apt to get. Æ

TV LICENSING

(*from page 26*)

thereunder and shall report its findings and recommendations to the Commissioner of Revenue as to suspension, revocation or renewal of the license.

In addition the Commissioner of Revenue was authorized to suspend or revoke any license if the Board of Examiners find the licensee has violated any of the rules and regulations.

The main attack on the validity of the Kansas City licensing ordinance was that the ordinance violated both state and federal constitutional provisions respecting due process clauses, in that the conduct of the business of servicing television or radio receiving sets "does not intimately or directly affect the public health, safety, morals, or general welfare."

The ruling of the Missouri court[2] is worthy of note and will undoubtedly play a frequent role in the future litigation relating to the licensing requirements in the conduct of a television service business.

The court said: "The police power is such that any trade, calling or occupation may be reasonably regulated in the interest of the public welfare if the general nature of the business is such that unless regulated many persons may be exposed to hazards and misfortunes against which the legislative body can properly protect them.

"The preamble to the ordinance here in question recites that preservation of public safety and prevention of fraud upon the public are matters at which the ordinance is directed. The evidence showed that there is an element of danger involved in incompetent services, particularly of television receivers.

"Likewise it showed that fraud upon the public is particularly possible in such business because of the complex nature of the machines involved and the general public ignorance of their operations. Such considerations are sufficient to evoke a proper exercise of the municipal police power."

Another ground of attack on the constitutionality of this ordinance was that the singling out of television repairmen for regulation and licensing without administering similar restrictions on other repairmen, such as washing machine repairmen, automobile repairmen and similar business activities, was arbitrary and unreasonable.

"There is no constitutional requirement," said the court of this objection, "that legislation must reach every class to which it might be applied—that the legislature must regulate all or none. It is not unconstitutional because it is not all embracing and does not include all the evils within its reach."

The ordinance exempted the service and installation of: (1) industrial machinery; (2) mobile equipment; (3) any radio or television equipment used or furnished by a common carrier public utility; and also (4) any service or installation relative to which the State of Missouri or the United States Government assumes jurisdiction.

Objection was made to this exemption, which affected the reasonableness of the classification. The court commented:

"The ordinance was obviously designed for the protection of the ordinary householder unfamiliar with the competency and qualifications of the person whom he selects to make the repairs. The exemptions cover operations of the type in which the owner of the equipment often regularly employs persons to perform. Such employees are selected on the basis of their ability to perform the work after consideration of their qualifications. Such exemptions are reasonable and in accord with the purpose of the ordinance."

A further attack on the validity of this ordinance was that it was unreasonable and unconstitutional in that it failed to take into consideration the difference between "outside men" and "bench men" in the television and radio repair business.

"There is," said the Missouri court of this objection, "a general recognition of

two separate categories of service work. One performed by so-called 'outside men' involves testing and changing of tubes and making minor adjustments in receiving sets in the customer's house or repairs not involving charts and schematics.

"Major repairs, involving charts and schematics, are made at the service dealer's place of business by 'bench men.' These contestants assert that the degree of skill and knowledge required of an outside man is much less than that required of a 'bench man' but that the ordinance gives no recognition to this fact, subjecting all service technicians to the same examination.

"There is no constitutional requirement that the ordinance recognize the distinction in the category of work in the business regulated. The ordinance requires the examinations to be 'practical in character.' They are required to cover 'the theory and practice of service, knowledge of the provisions of this ordinance, interpretation of charts and blueprints and plans of such service.' We cannot say that the provisions of the ordinance regarding the examination to be given are unreasonable."

REFERENCES

[1]People, v. Murphy, 110 N.W.2d 804, Mich., Sept. 23, 1961

[2]McClellan v. Kansas City, 379 S.W.2d 500, Mo., June 8, 1964

ABOUT MUSIC

(*from page 10*)

imitation of life was preferable to the real thing.

The bottles and roasting pan were put aside, leaving the percussionist free to devote himself to a 'dry' *Parade*. He turned his attention to the six revolver shots in *Petite Fille Americaine*, the second and third of which were to be fired in rapid succession. After several ear-splitting rehearsals, Holland discovered that the trigger mechanism of his revolver would not allow him to fire off the two shots rapidly enough. He therefore assigned the third shot to an assistant. "Bang . . . *Bang-Bang* . . . Bang . . . Bang . . . Bang." Perfect!

Typewriters were now required for the same scene. A pair of office machines had been transported from the headquarters of the London Symphony early on the morning of the first *Parade* session, along with two typists, male and female. The typewriters were placed on a table near the first violinists, much to the distraction of the players (all male) who kept stealing glances at Sarah Park, the attractive young London Symphony secretary. Feeling that the typing should sound purposeful, Dorati instructed the typists to copy items from a daily newspaper, preferably one which

they had not yet read. Miss Park, however, alternated between the obituary page and a remembered lesson from typing school: "Now is the time for all good men to come to the aid of the party Cremation private no flowers please now is the time to come to the hospital but no flowers please, etc." The typewriters were to sound continuously for 16 bars, with a precise start and finish.

The other percussion effects posed no unusual problems, and the section as a whole was deployed in the following manner: bass drum, tambourine, snare drum, and cymbals were placed slightly to the right of center, between the woodwinds and trumpets; lottery wheel, tam-tam, revolver, xylophone, vibraphone, sirens, triangle, and woodblocks were arrayed along the outskirts of the violin sections from left to center; and typewriters and *flaques sonores* were located left of the podium.

As Satie's gently amusing score unwinds with clocklike regularity in the completed recording, with each percussion effect turning up at the appointed second, it all must seem so effortless to the listener. The chief percussionist, however, will always remember it as the time he was as busy as the sound-effects man in a *Gangbusters* radio serial.

SOUND AND SIGHT

(*from page 78*)

just as were the impressions recording the sound, and were exceedingly small. Mr. Dickson's Century article mentions that they had great difficulty getting the images large enough even for viewing through a microscope.

Their first problem, according to Dickson's Century article, was "how to secure clear-cut outlines or indeed any outlines at all together with the phenomenal speed." He continues, "The Daguerre, albumen, and kindred processes met the first requirements, but failed when subjected to the test of speed." We must remember the photographic cylinder was in continuous motion. To obtain even some form of vaguely distinguishable outlines, they evidentally had recourse to the method employed by E. T. Marey in 1888 in his "chronophotograph." Marey had his actors clothed in white and photographed against a black background, in order to indicate their movements more plainly. This, incidentally, provides us with the reason the first man to appear in motion pictures later wore a white sheet, in the now famous "first motion picture."

The aural results in these first experiments were excellent, for the time, as would be expected. However, because of the images, or more correctly, the lack of images, obtained with this first moving picture camera, we can only add that it is a tribute to Edison's dogged persistence that the experiments were continued at all. They did continue as we shall describe next month. We also hope to bring our readers complete information on a new historical discovery, "The first existing 'movie' to combine sound and sight made in 1893!" Æ

LIGHT LISTENING

(*from page 8*)

eter usually heard soaring with abandon over the strings of a Mariachi group. Other highlights almost equalling the first tune in effectiveness are a droll "Ric Rac Polka" and a lurching "Charleston for an Old Fool." Stereo throughout is very convincing as a major film gets the Big Treatment.

Anna Moffo: One Night of Love

RCA Victor LSC 2794

Television can be credited with an occasional constructive act in the development of recorded entertainment. Some months ago, the versatile Anna Moffo took time out from her many operatic appearances to visit the "Tonight Show" on NBC-TV. She happened to select for the occasion the great old song, "One Night of Love," long associated with Grace Moore. The combination of the smooth, easy-to-take Moffo voice and an elegant tune from Hollywood's golden age started the right wheels turning at RCA Victor. Skitch Henderson, the man in charge of music on "Tonight" and an RCA artist himself, immediately saw the possibilities for an album featuring more songs from the period, including the other Grace Moore favorite, "Stars in my Eyes." In arranging this attractive collection of songs for Miss Moffo, Henderson has more than earned the right to equal billing on the album cover. There are very few modern releases around that can boast arrangements in this class. Skitch Henderson can give the best of them pointers on how to support a melodic line while giving the maximum share of the spotlight to the fortunate vocalist working with him.

The Many Shades of Georgia Brown

Capitol T 2329

This new recording by the young lady introduced in the Broadway musical, "Oliver," is a good example of first-rate mono being turned out today. It happens to be Georgia Brown's first recording session at Capitol Records and the control room contingent has done everything possible to welcome her to the fold with proper sound. In a further show of good will, they've been careful not to burden her recorded voice with the sibilant edge found in other recent vocal releases from Capitol. The roster of tunes chosen for the debut Brown album reflects the variety of the artist's past engagements in show business. Prior to her American debut in "Oliver," Georgia Brown starred in th English production of "Three Penny Opera" and is currently the leading attraction in the London production of "Maggie May." The many shades of Miss Brown referred to in the title include several of a deep shade of blue. Duke Ellington's "The Blues" and "Mood Indigo" are gratifying items to encounter in any song album. They are delivered with suitable fervor in the lower regions of the voice.

HI FI

(*from page 28*)

As an exhibition, it shows in the flesh, so to speak, all the equipment you have heard about, dreamed about and secretly desired. It also shows the designers' latest brainstorm and a few of the things he hasn't even designed yet (all nicely done up in teak cases). A welcome addition lately is a sprinkling of the big American names, whose representatives can be recognized by their first-class suits and a slightly puzzled look. Case-hardened as they are by your own audio shows, it seems that the British enthusiast comes as a bit of a surprise. Firstly, because anyone who has the stamina to pound up and down three flights of stairs all day and still be keen on multiplex pilot filtering must be pretty dedicated, and secondly because we tend to be very frank in our comparisons between brands. "No fixed high-pass filters? Sonico have one on their *cheap* model." No diffident Englishmen here. . . .

The first half-day is reserved for the Trade (or anyone who can get hold of a white ticket). Euphemistically called a Preview, it allows the technical Press to observe the High Priests of Hi-Fi assembling the mechanics of the Oracle, always a fascinating process. It is evident that the experts are no more immune to catastrophic failures than we are, and no more averse to using string and Scotch tape, either. Those of the Press who have written their caustic reviews the day before retire to the bar and compare notes—on anything but Hi-Fi. Those who haven't, pound round the hotel rooms and try, as always, to invent new epithets for the sound quality that comes from smaller and smaller loudspeakers. Avoiding, of course, "muffled," "constricted," "lifeless," and so on. If anyone had said twenty years ago that all this expertise would be expended on the reproduction of sound, they would have been smartly reminded that this was the province of Voight and his associates and as such not to be treated lightly.

Just how lightly it has been treated can be judged from one almost unbelievable remark heard at the last Fair. 'Do you know what ———'s latest gimmick is? Using real musicians for comparison! They'll never swallow that." It might have been for my benefit, of course. Sheer exhibitionism. . . Æ

AUDIO ETC.

(*from page 12*)

tem launched only a few months ago, with its elegant high-speed drive, at 90 ips, and its quarter-inch tape? The alternative moving-head system, straight out of the various commercial generations of TV recorder, was already at hand and under development for home use. Why did they bother with quarter-inch tape recording at all? Why should an industrial firm now buy the 90-ips quarter-inch tape model at some $3000 when the newer slow-speed one-inch tape system is available for about a third as much?

Things get pretty technical here, but my best guess is that linear tape, for all its enormous speed (and serious transport problems) offers big advantages for recording precise information of a non-entertainment sort. At 90 ips, TV tape has a very wide "spread," a big-scale spatial rule. The bits of information are placed rather accurately on the magnetic ruler of the recording. In contrast, the slow-speed, moving-head systems—various related sorts—involve some very complex recorded tracks and a problem of synchronization that, I would guess, might be horrendous if one were after really accurate timings and placings of vital info. Imagine—instead of a single linear track straight down the tape, you have a rat's nest of millions of diagonal streaks, helices (in the helical type moving head system used for the Ampex home recorder), the information, so to speak, jumping from one streak to the next as the moving head speeds crosswise and the tape moves along endwise. Some geometry!

In the new one-inch tape TV recorder, the effective head-to-tape speed at 9.6 ips is 1000 inches per second. Phew! Even at the slower speed, 4.8, the head-to-tape velocity is thus 500 inches of diagonal cross-hatching per second. To retrieve accurately measured information bits out of that sort of trace would be like trying to plot a linear graph on the cross-shadings of an artist's pencil sketch!

So (I'm speculating) the linear TV recorder does have industrial and information usefulness, even at the prohibitive 90 ips, thanks to a straight-line, continuous, unbroken magnetic track, mile after mile.

But hold on. I haven't given up the idea of a home linear quarter-inch TV recorder, for two good speculative reasons. One is purely technical, the other circumstantial. Take the second one first.

Wesgrove

Circumstantial? Well, there *is* a linear TV home recorder for quarter inch tape on the market, more or less, right now. (Not counting the monster Ampex console that nobody is really expected to buy.) It is that curious British affair, the Wesgrove

VKR 500, recently somewhat available in the U.S. (Dunno about right now. Maybe the editor has some late info.) (*Nope*, Ed.) It runs on quarter-inch tape. And it comes in home kit form.

Curious, because that machine, a sort of prototype venture, sells at the absurdly low price of $392 for the basic kit, or $492 wired up. That's right down among the medium-price plain audio decks, which run tape at 7½ or 3¾ ips; and this baby eats it up at three alternative speeds—from 90 to 150 ips! Some hay burner.

Now I have my doubts about the practical commercial life of this particular linear TV recorder, as of all current accounts. Our friendly colleague mag, *EI*, (*Electronics Illustrated*), for instance, ran an amusing test on the kit which appears in the September, 1965, issue (available, after the fashion of such mags, around the 4th of July). They built it. To be succinct, they didn't get any picture. Though they might be wrong. They also note, incidentally, that the thing has no fast rewind, only a "fast" forward (about 100 miles per hour, I suppose), and no erase head, only a permanent magnet. Some economy! (P.S. Or was it a d.c. bias?)

But this isn't the point. What matters is that the Wesgrove *exists*, or existed. Somebody had the nerve and enterprise actually to develop a stripped-down linear quarter-inch TV tape deck, obviously banking on the *inherently simple* construction that the linear type of recording makes possible. That is important. It shows a significant line of thought that still isn't dead. For the *only* serious difficulty with the linear system is the presently necessary very high tape speed. (P.P.S. See another report in *Popular Science* for August.)

Speed reduction

If linear tape speed could be significantly reduced, by two thirds or so, the whole TV recording situation might look very different. *If* we assume, as now, that 90 ips is the minimum writing speed—forever—then Ampex's one-inch tape with the moving head is the only answer, and not compatible with audio tape recording. But who said nothing further could be done?

Can the speed be reduced, maintaining adequte frequency span? I'd say all signs point to a yes. And this strictly from an outside viewpoint. I have no inside info on actual tape experiments going on.

What it all boils down to is a combined factor, the optimum recording and playback head gaps, plus the optimum tape quality—graininess, uniformity of texture, magnetic characteristics. What gap width (and corresponding tape characteristic) is necessary to record a minimum TV top frequency at, let's say, 15 ips, which is a practically compatible speed for home linear TV tape? You'll need to accommodate something between 1.5 and 2 MHz (2,000,000 Hz), and that's a lot. Can it be done? Can tape be improved? Can gap width be reduced accurately?

In view of the dramatic advances of the last ten years, I'd say almost surely it can. Rumor tells me so, if vaguely. Common sense says so, too.

We've made huge strides in tape formu-

lations lately. Have we reached an ultimate barrier—like, say, tape granules of one molecule each? Probably not. (Find a smaller molecule, silly.) And what of heads? The potential of the "deposited gap" technique, I gather, allows head gaps to be laid down only a molecule or so wide. Nortronics, for one, makes heads consistently with gaps of 50 microinches. Other incidental problems being solved, would that do it?

Remember that only some fifteen years back our first home tape machines managed from 40 to 7000 Hz top at 7½ ips; yet now we get a good 10,000 commercially at 1⅞ ips in the Wollensack-3M type of cartridge. That's roughly an 8 to 1 improvement.

If we could just improve the tape vs. frequency factor by another 6 to 1 or so—we'd have it. Then, you see, our audio-video compatible recorder would be well in hand, if perhaps excluding color.

The Linear Deck

Let me reformulate the deck we might then build. One chassis, audio and video, one set of motors, one audio head assembly, one drive mechanism, etc. In addition to the audio heads, presumably quarter-track, for both directions, a TV head assembly, also used in both directions, as in the present Ampex linear recorder.

Three recording speeds, all usable for audio. 3¾ ips, 7½ ips and 15 (or maybe a special speed for TV a bit higher—30 ips would be feasible—for a better picture quality).

The highest speed would, of course, be for video. Might require ten-inch reels but, hopefully, there would be a medium-size reel, maybe 8½ inches, or the new Ampex 9½ inch size. Whatever the size of the reel for TV, the standard audio reels would also fit. And all would play—sound and picture.

For simplicity you could sacrifice 3¾ ips, leaving just two speeds, audio at 7½ and video at X ips, hopefully 15 or 30. That would do it. Given the wished-for tape and head improvements, this doesn't seem very difficult. And the resulting combo deck would be a versatile and efficient home unit with a maximum usefulness and a minimum of costly duplication.

Movies, color TV? A bit more improvement and you'd have your color all right. Might involve some sort of cartridge drive, dust-free and all that. But—with the requisite tape-to-head improvements, the linear system could do all that the helical one-inch tape machine can do and with a lot more versatility. Ah—but will the improvements come? Are they possible? I dunno. I expect they are, though.

Might add that a simple linear TV recorder could take many composite forms, combined not only with tape recorders but in other useful configurations — like radio tuners and amplifiers today. Why not? A very flexible device.

The Helical Deck

Briefly, to complete my speculations—suppose the one-inch helical TV tape does become standard and the linear TV tape dies away. Could the helical system be made compatible with audio taping? After a fashion, maybe.

The speeds are clumsy, straddling the audio speeds; but we might settle for three (allowing for color), at 4.8 (TV), 7½ (audio) and 9.6 (TV color). A dual reel system, of course. The machine would have to take both one-inch *and* quarter-inch tapes. Clumsy as all get-out, but possible, I suppose. Ugh. Not a very appealing idea. And think of the tape guides and the heads (especially that high-speed moving TV head)! AND helical editing! Could be done, but it would be a monstrosity.

But what really counts, I think, is cost. Can the present moving helical-head system be reduced in cost enough to make it practical in an audio-video combination? Right now, that type of machine might cost $1500 or more. Can the moving head and the one-inch tape ever get into a medium price bracket?

And so, back to linear. Linear is *inherently* simple in the mechanism. *IF* linear tape-and-head frequency response can be improved as I suggest, to make a 15- or 30-ips speed possible, or even slower, then the linear tape machine's utter simplicity will really begin to count. I suspect it would leave the one-inch helical TV tape far out on a cost limb.

It all depends! So, go study the latest top-secret reports (if you can get at them) on the latest tape research and head developments, home, industrial, space, computer and what-not. That's where we'll find the answer. *P.P.P.S. The Sony recorder, half-inch tape 7½ ips, helical was too late to include in the above. The stew is thickening fast!* Æ

WOODEN MONSTER

(*from page 56*)

vibrations and noises in recordings and playback equipment which are also reproduced by the big horn. Tape recordings sometimes contain transient low-frequency sounds, probably caused by irregularities in the bias waveform. These are usually inaudible, but now are not. FM broadcast stations sometimes use tones in the range of 20 cps for keying automatic programming equipment, which are now quite audible. You would probably expect turntable rumble to be a problem with this system, but it is very slight at worst. Addition of the bass horn increases the rumble level only by the amount that the main channel speakers were down at the rumble frequency. At the 30-Hz rumble frequency of my turntable, the speakers are down no more than 10 db. Turntables with 600-rpm motors and a 10-Hz rumble should not be a problem either, because the ear itself is down quite a bit at this frequency when the level is low. Dialing the FM tuner quickly through a station with the gain turned up will produce a thump which will flap your eardrums so that it feels as if they may touch each other inside your head. A slight exaggeration, perhaps, but it feels something like that. None of these extraneous sounds is really objectionable. They are simply part of the game.

Associated Equipment

The large bass horn I have been describing is used in my audio system by feeding it with a blend of both channels below 50 Hz. This means, of course, that no stereo information is reproduced below this frequency. This is really not a compromise, because sounds have very little directionality at these frequencies. The bass-horn driver is powered by its own amplifier, as are the other speakers in the system. The various amplifiers are driven by high-impedance "electronic" crossovers. The two main-channel speaker systems are home-built copies of the original University "Classic." They contain three horn-type speakers which cross over at 350 Hz and 3k Hz. A center fill (L + R blend) speaker with a conventional crossover at 800 cps was also used at one time, but was

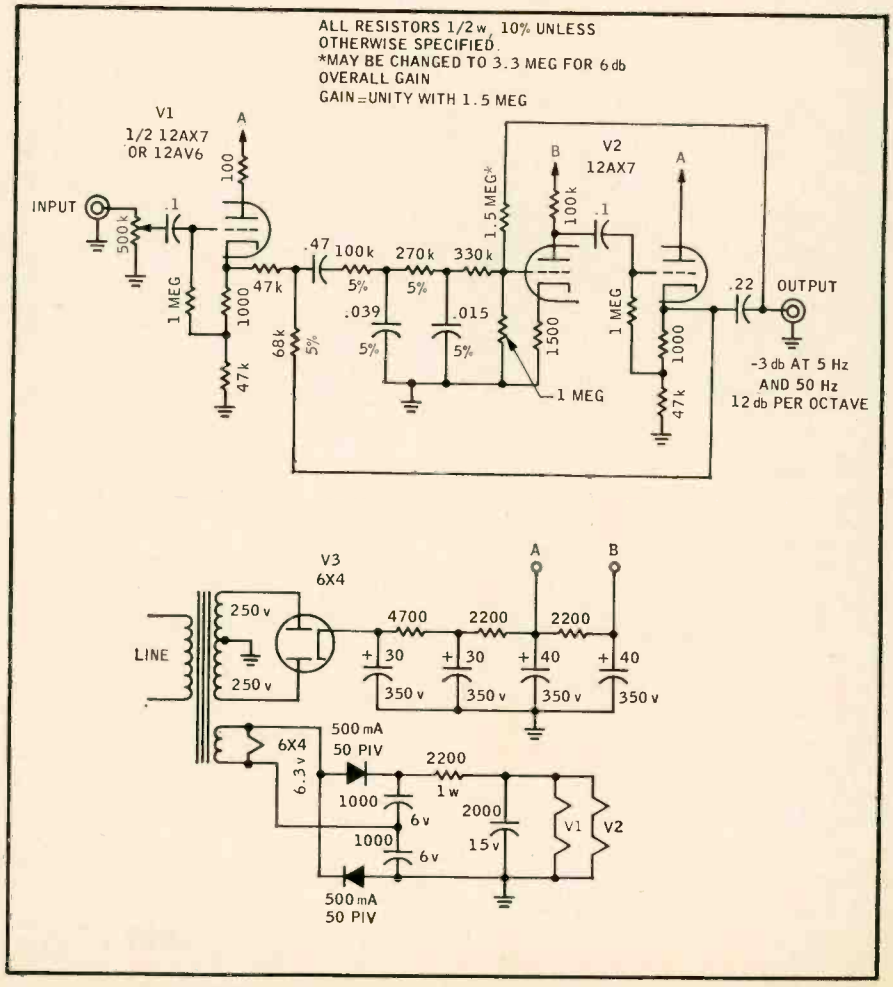
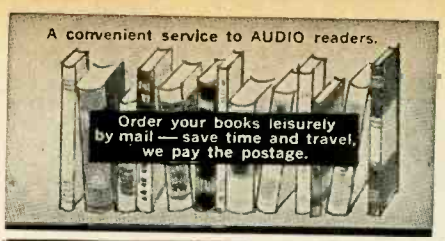


Fig. 9. 50-Hz low-pass filter in bass-horn circuit.

moved out to make room for a Hammond PR-40 tone cabinet. The Hammond speaker is used only for the organ, and is not connected with the main audio system. *Figure* 7 is a block diagram of how the components are arranged electrically. All of the electronic equipment is commercial with the exception of the electronic crossovers, which were designed for this system. They are conventional R-C units with 12 db/octave slopes, and have extremely low distortion and noise. For those who are interested, the schematic of the 350-Hz units appears in *Fig.* 8. The components which require constant access, such as the preamp/control unit, turntable, and tape recorder are mounted in a bookcase in the wall opposite the speakers. The bulky components such as crossovers and power amplifiers are mounted on a long shelf directly behind the bookcase.

One might well question the reason for such complexity in an audio system. The truth is, it just grew. The reason for the electronic crossovers originated eight or nine years ago when I used a "motional feedback" arrangement to reduce woofer distortion. It consisted of taking the 20 db or so of negative feedback for the power amplifier from a separate velocity-sensing coil in the speaker instead of the output transformer secondary. This allowed driving the woofer cone to the limit of its excursion without distorting. The difficulty in maintaining amplifier stability with a reactive crossover network between it and the speaker made an electronic crossover necessary. When stereo got into full swing, I was forced to double everything in order to keep up with progress. With the addition of the big bass horn, woofer distortion is no longer a problem, and the crossovers are merely icing on the cake. Generally speaking, performance of a good system with separate amplifiers for each speaker should be superior to a comparable system with conventional crossovers. If cost were no object, I would be inclined to go to the amplifier-for-every-speaker route. In the case of the bass horn the electronic filter is a decided advantage, because inductors and capacitors for a conventional network at such low frequencies are inconveniently large.

If asked if this "toy" is worth all the effort put into it, I would answer most emphatically yes. I haven't had this much fun with an audio project in quite a while. If you have a few hundred cubic feet of space to spare in your home, I would recommend horn-building as good recreation. If you build one and decide you don't like it, you can always build shelves in it and use it for storing fishing poles. *Æ*



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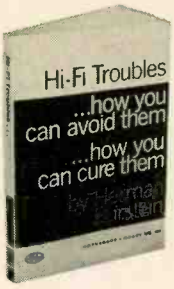

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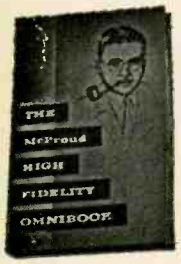

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TRANSISTOR OUTPUT STAGE

(*from page 62*)

be 480 ohms, a value which suggests that here we shall find the split-load type of driver stage very useful, for an emitter follower is a much lower impedance than we need use.

I cannot decide whether we should find it profitable to pick up a little power by using the split-load technique to give us the emitter degeneration in the output stage. We can do this even if we have what is basically an O.T.L. system, but I rather feel that the extra few watts are not worth the cost of a transformer. If the circuit is of interest it needs more space than I can devote to it for the moment.

We must now, however, think of what we have done. In very simple language we should expect to get the same result by putting 26 ohms in the base line of the transistors, which we can regard as operating them from a high-impedance source. The construction of the input circuit impedance with similarly mismatched transistors and a 26-ohm series resistance is shown in *Fig.* 8. Again we see how the resistance dominates the characteristic everywhere except at the low-current bend. Again we can fit these two characteristics together in the usual push-pull form and use quite a low current-matching point. The drive power will be the same.

The trouble with this is that although we have linearized the base current we have left the transistor current gain to look after itself. We still need to provide the forward bias to prevent cross-over drop-out, but the only thing we have made in the way of profit is the power we should waste in the emitter resistance. In the example, this was several watts and in a competitive design this might be serious. Are there any other considerations which must be taken into account? There is the question of thermal stability. It is certainly not inevitable that a high source impedance at signal frequencies should be a high resistance to the bias supply but the higher the source impedance the larger the inductance of the transformer must be and the more likely we are to get an appreciable d.c. resistance. As you know, resistance in the base lead reduces the thermal stability of the transistor and increases the possibility of a catastrophic thermal runaway.

The problem is beginning to settle into some sort of shape. If we consider the current-gain aspect of the transistors we must use some resistance in the emitter leads to match up the characteristics and to straighten them out. Having chosen a minimum resistance on this basis we can get some extra linearization of the $V_{be} - I_b$ characteristic by increasing the source impedance. The advantages of this are practical rather than theoretical: in theory, at least, the straightening out of the input characteristic reduces the compensation for the opposite curvature of the current-gain characteristic. However, most of the curvature is at the ends of the characteristic, and at opposite ends. so that balancing of the low harmonies does not improve the high harmonies.

I think that the problems of driver

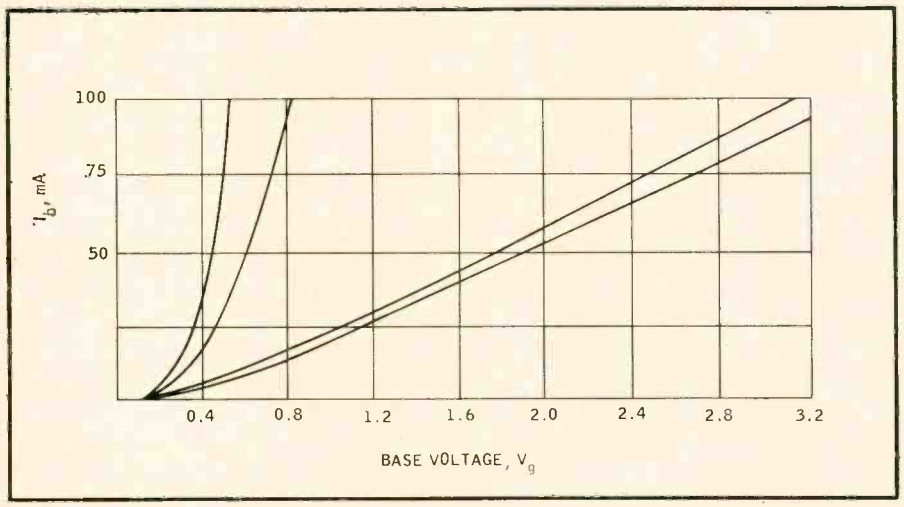

Fig. 8. By juggling source resistor values as well as emitter resistor, performance can be improved as in this set of curves.

design clinch the matter. In order to get the full benefit of a low-impedance drive we must have a large amount of available drive power and we should limit this demand by the use of resistance in the emitter circuit. We need this resistance anyway for matching, for thermal stability, and to adjust the bias conditions to match the bias regulator. We can then make the driver impedance as low as possible compatible with getting full drive even under transient conditions.

Conclusions

I started off this article by pointing out that the textbooks were divided in their stories and that we had a choice of two answers, one of which must be wrong. I think that the conclusion which we must reach is that they are all wrong. This may remind you of the story of the proud mother watching her son marching in the parade (they are all out of step but our Johnny). You may remember the fragment attributed to Ouida, "They all rowed fast, but none so fast as stroke." I feel that the writers of the textbooks have set themselves what the psychologists call a forced-choice question: do you prefer Picasso to Mozart?; if the house caught fire would you save your mother, your mistress, or your Manet? As designers we can ask for more information, about the quality of the Manet or . . . . . Æ

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FOR SALE: Compander by Fairchild. Brand new. Complete. $45. Dynakit Stereo 35 power amplifier. $40. Slightly used. Theremin 5 tubes, special 500-cycle xtal. Complete with schematic and directions. Value $85. Sell, $45. R. A. Love, 2314 Woodstock Ave., Pittsburgh, Pa. 15218.

WANTED: VARO FL3D flutter meter. Please state price, condition and age in first letter. N. Tonkin, Box 3-3844, Anchorage, Alaska.

Collector wants World, Associated, Muzak, MacGregor, Standard transcriptions, catalogs, ERPI-WE transcription player. Bob Nicholas, 4200 Blackthorne, Long Beach, Calif. 90808.

FOR SALE: Crown 714C 4-track stereo tape recorder, 10½ reel capacity, cost new $795. Will sell for $390. Tom Rose, 3410 Rockbluff, Dallas, Texas.

WANTED: Technical translators, free-lance assignments, also INTO foreign languages. State experience, languages, specialties. Box CL-1, AUDIO, P. O. Box 629, Mineola, N. Y.

Industry Notes.....

British Industries Corporation has moved its general headquarters, and its metropolitan area warehouse and service facilities, for the Garrard, Wharfedale, and Multicore Divisions to a new building on the Long Island Expressway

at Westbury, New York. The new BIC quarters combine the various departments and functions previously located in the Port Washington area.

A special stockholders' meeting of **Acoustech,** Inc., Cambridge, Massachusetts voted to sell controlling interest to **Rek-O-Kut Co.**, Inc., a leading producer of turntables, tone arms, and headphones. **John Koss,** President of Koss/Rek-O-Kut, said the acquisition of Acoustech, pioneer in the field of solid-state amplifiers, was part of his company's long-range expansion plans. **Morley Kahn,** founder of Acoustech, will continue as will all key management and engineering personnel. Acoustech will remain at its present location in Cambridge, Mass. Koss also announced that **Martin L. Borish** and **Leo J. Dunn, Jr.** had agreed to accept key positions with Acoustech. Dunn will serve as Vice President of Operations. Borish will be Vice President of Engineering. Koss indicated that the addition of Dunn and Borish will permit Morley Kahn, Acoustech's founder to devote his full efforts to sales and marketing.

Ben Selvin, well known to the music industry for more than half a century, will continue in his present post as music consultant for 3M Company's stereophonic tape albums. Selvin has spent the last two years in obtaining rights to music of all types for use in 3M's Wollensack automatic tape recorder system. During Selvin's active musical background, he has been a violinist, band leader, radio director, and recording manager. He received the industry's first Gold Record for his million-seller "Dardanella" recorded in 1919.

Sony Corporation of America, New York, has relocated its warehouse and service facilities from 514 Broadway, Manhattan, to larger quarters at 37-15 61st Street, Woodside, Queens. In addition to being headquarters for the warehousing and servicing of transistor radios and television sets, the Woodside facility will handle the recently introduced Sony home video tape recorder.

Alvis A. Ward, President of **LTV Ling Altec, Inc.,** a subsidiary of Ling-Temco-Vought, Inc., announces that they have acquired the former LTV University Division of Ling-Temco-Vought, Inc., from the parent corporation. This move will concentrate most of LTV's commercial electronic enterprises in one subsidiary. No changes in personnel or operations are contemplated. The University Division will continue to operate on an autonomous basis and to maintain its current marketing policies and distribution channels. **Haskel Blair** will continue as President of the University Division and will become an LTV Ling Altec Vice President. University will continue to headquarter at its new facilities, 9500 West Reno, Oklahoma City.

Roberts Electronics of Los Angeles has appointed Larry Winn Regional Manager of the New England states, operating out of Reading Massachusetts. Winn comes to Roberts with four years experience as Sales Manager of the Roberts division of Allied Appliance Company in Cambridge.

Members of the 1965-66 **Bell & Howell** Audio-Visual Advisory Council were announced by Everett F. Wagner, President of the Bell & Howell Photo Products Group. They are: Robert P. Abrams, chairman, Jasper Ewing, Jr., Robert Hiller, Joseph C. Meidt, and Albert F. Milliron. Stephen J. Bartha of Bartha Visual Education Service, Columbus, Ohio, chairman of the 1964-65 Council, will serve as advisor to the new panel.

Jack Kufeld, formerly of EMI Scope and Stromberg-Carlson has joined **Whitecrest Industries, Inc.** of New York as Vice President in charge of marketing. He is pleased to announce the appointment of the first representatives for the new line. L-C-A Sales, Inc. Lots of luck, Bob and Paul. Mr. Kufeld may be reached at 251 East 139 Street.

Tape Heads. The House of Wolfgang Bogen has been renowned for quality tape heads for almost as long as there has been tape. Bogen Tape Heads are now to be distributed in this country by **International Recording** Company, Inc., of New York. To this day, these heads are still manufactured under Wolfgang Bogen's personal supervision in a modern three-story building in West Berlin. Here, heads for magnetic sound and pulse recording are carefully made, tested, and released. It is understandable then to read in a recent press release that International Recording is pleased indeed to have secured this valuable line. The release goes on to say that this company expects to be representing more audio professional lines. Certainly, this is an auspicious start.

New Man at Oki. Mr. Joel Koenig, vp of Chancellor Electronics has announced the appointment of Mr. Alfred Torrisi as National Service Manager for all Oki Home Entertainment Products. Prior to this appointment, Mr. Torrisi had been the quality control supervisor of Oki tape recorders for Chancellor.

New Man at Benjamin. Peripetatic Joseph Benjamin, President of the firm bearing his name has announced the appointment of a Long Islander, Jerry Di Mucci as Plant Manager. Mr. Di Mucci is no stranger to this field. Prior to Benjamin Electronics he has spent 20 years in electronics. Included in his resume are the facts that he has been general manager of Cavalier Radio Company, plant manager of Shell Electronics Company and production manager of Electronic Creations. In his new post, Mr. Di Mucci will be responsible for all plant activities including production, shipping, and inspection. Benjamin Electronics is both manufacturer and distributor of high fidelity and stereophonic systems and components.

New Title at ADC. Milton Selkowitz, director of marketing for ADC of New Milford, Connecticut since September of 1963 has been raised to Vice-President, Marketing, for Audio Dynamics Corporation. ADC President Peter E. Pritchard, in making this announcement stated that "This appointment will strengthen our marketing organization and accelerate our company growth." Mr. Selkowitz is a graduate of Miami University, Oxford, Ohio, with a bachelor's degree in business administration and with a major in marketing. Judging by ADC's successes so far, he has used his education well.

Reps. In and Out. Harman-Kardon has informed one and all that the **Spivey-Cole Company** will represent its products in the lucrative Texas and Oklahoma areas. This rep team, just five years old, has already established a fine reputation as representatives in the Southwest.

Telex Acoustic Products, manufacturers of headsets, microphones and sound accessories has added three new reps. For Arizona, California and Hawaii they will be covered by the **Frank Kessler Sales Company** of Los Angeles. The Southeastern part of the country will be covered by **World Wide Products, Inc.** with home offices in Miami, Florida. Repping for Telex in eastern Pennsylvania, Washington, D.C., and Virginia is **Brothers and Conneen Associates** of Baltimore, Maryland. Telex Acoustic Products Sales Manager Don Rogers stated that the realignment of the national sales organization was necessitated by the growth of the Telex product line, and is expected to provide increased penetration in each of the markets involved.

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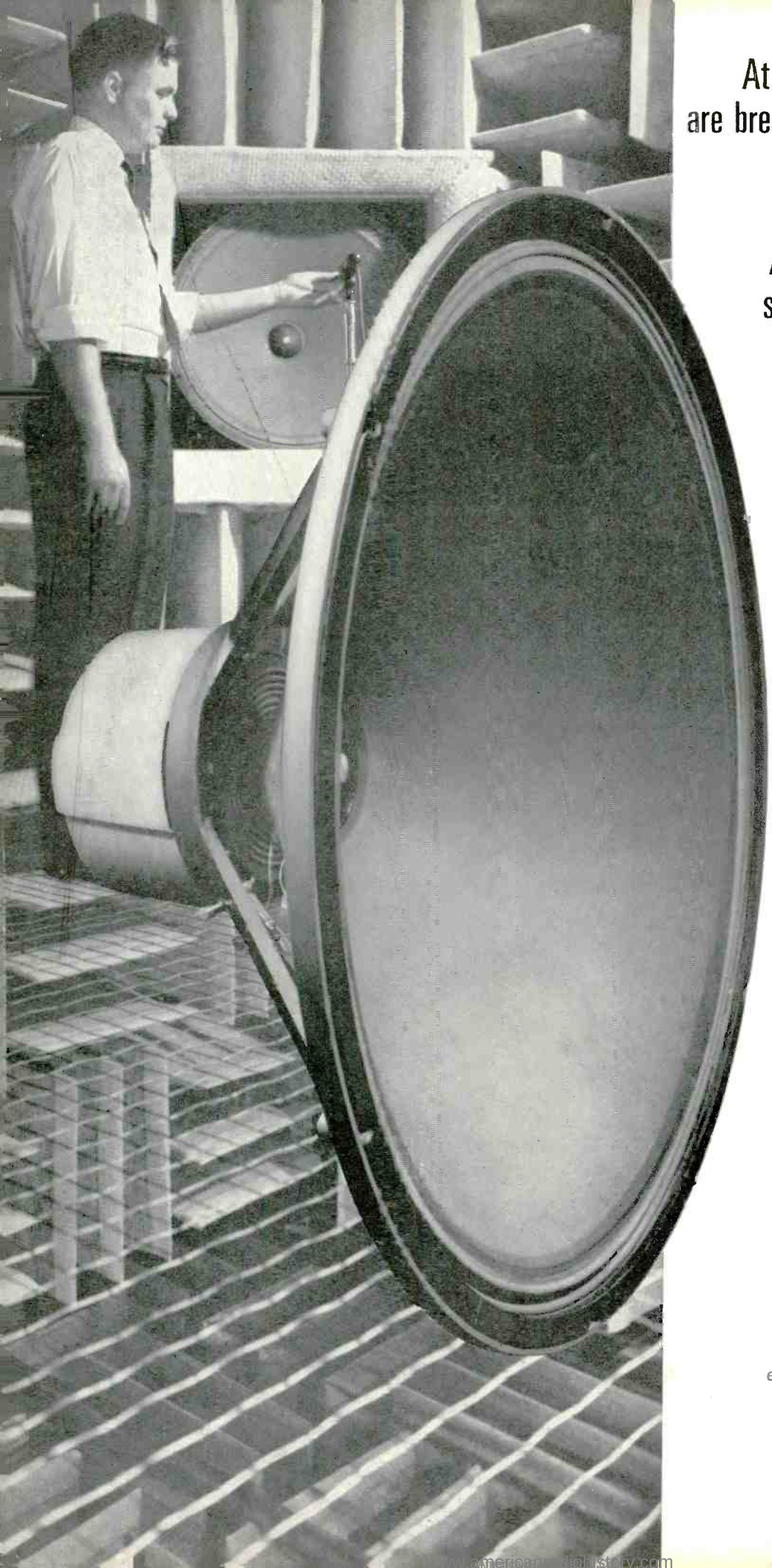

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