AUDIO

FEBRUARY, 1961
50¢

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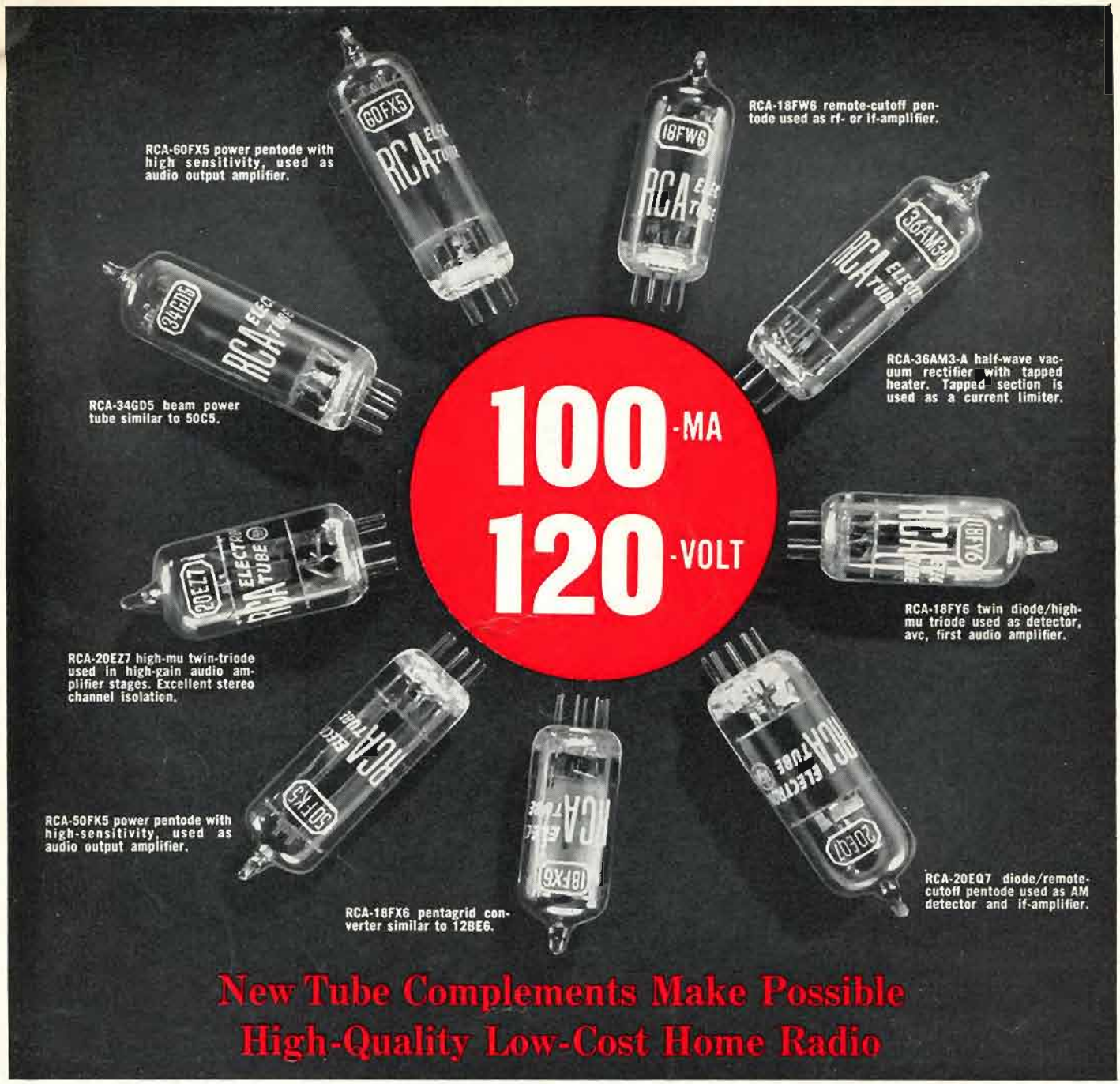

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FEBRUARY, 1961 VOL. 45, No. 2

Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

COVER PHOTO—Room-divider or wall-type decorator units serve as mounting for hi-fi equipment. An exclusive creation of Allied Radio Corporation, Chicago, the line of basic units includes an equipment or record cabinet, shelves and shelf backguards, and a speaker enclosure which will accept any 12- or 8-in. speaker and still provide for 30 to 50 LP records. Finish is oiled walnut veneer, with free-standing satin brass poles drilled every six inches for complete flexibility in assembling—and only a screwdriver is needed.

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RADIO MAGAZINES, INC., P. O. Box 629, MINEOLA, N. Y.
Postmaster: Send Form 3579 to AUDIO, P. O. Box 629, Mineola, N. Y.

AUDIO clinic

JOSEPH GIOVANELLI*

Head Wear

Q. Quite often we see tape head manufacturers include among their specifications an estimated life for their heads. For instance, one Viking head has a minimum life of 1000 hours according to the company. Since no tape speed is specified, isn't this statement incomplete? If we think of the wearing properties of recording tape as consisting of so many "grits per inch" of wear at the heads, then at 3.75 ips it would take twice as long to cause a given amount of wear than at 7.5 ips. Is this true, or have I overlooked something? Dick Dunham, Memphis, Tennessee.

A. The data for the life expectancy of a tape playback or record head must, of necessity, be incomplete. The manufacturer cannot know the speed with which the head is to be associated and hence, the number of abrasive particles which will pass over it. Also, he does not know what tape tensions and pressures the head will be subjected to.

I would say that tensions and pressures are more likely to contribute to the variations in head life than will the possible variations in tape speed. There is, of course, no doubt that the faster tape travel, the faster the head will wear. However, I am not at all sure that this wear is *directly* proportional to speed. As the tape speed increases, there is an accompanying increase of the number of abrasive particles which pass over the head during a given time plus an increase of tape pressure. Obviously, this tape pressure increase will result in the head being abraded more quickly than had the pressure remained constant. (You should remember, however, that tape wear does not consist only of the rapid passage of abrasive particles over the head. If these particles passed over the head with zero pressure, there would be no wear regardless of tape speed. Wear, then, is a combination of the abrasive quality of the tape plus the pressure with which this abrasion is applied to the head.) Both of these factors must be taken into account before we can estimate the life of the head. With some machines there may be no increase in pressure; in others the pressure may increase as the square of the speed ratios. This depends on the kind of tension-maintaining apparatus the machine employs.

As you can see, the manufacturer cannot take all of this into account. Therefore, the best he can do is to give you an approximation. If one head specifies 100 hours of life and another one 1000 hours you can guess with some certainty that the latter head is a better head from the life expectancy standpoint than the former. We cannot know, of course, whether this applies to all other performance data for the head.

To Play 78's

Q. I have, in addition to my regular record collections, several dozen old 78-rpm records dating from the early 30's. I am planning to tape the best of these. I would like to know the best method of getting them on the tape. Is it wise to play the records with a 1-mil or a 0.7-mil stylus in order to get below the worn areas in the Groove? John Wawzonek, Cumberland, Rhode Island.

A. To begin with, I do *not* recommend that you play your old 78's with a 1-mil or a 0.7-mil stylus. Either of these styli will sink to the bottom of the groove and will cut into the shellac, resulting in stylus damage and causing considerable noise in reproduction. Further, the narrow stylus will flop around in the grooves, leading to poor tracing.

Your best bet is to use either a 3- or a 2-mil stylus.

Since almost all 78's have no sound above 6000 cps, there is no need for full frequency response from your cartridge. Use a scratch filter set somewhere between 6000 and 9000 cps. If you have a rumble filter, it should be set to 50 cps. This will give you the quietest reproduction with little or no deterioration of the original sound quality contained on the records. Quieter reproduction could probably be gained if more of the highs were to be sacrificed, but it is my personal feeling that a little noise is not too much of a price to pay for the best sound.

Noise in Headphones

Q. I have been bothered recently by an increasing noise level from my stereo records, especially when played over headphones. The noise is a sputtering sound, present only when the channels are not in parallel. It was negligible in level at first, but has become objectionable lately. John Wawzonek, Cumberland, Rhode Island.

A. The sputtering noise of which you speak can have several causes. First, the stylus in your cartridge may be wearing

* *3420 Newkirk Ave., Brooklyn 3, N.Y.*

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KEY FEATURES	**The only dynamically balanced tone arm** on an automatic unit...with adjustable sliding counterweight, and built-in calibrated scale to set and insure correct stylus tracking force. Once balanced, this arm will track stereo grooves perfectly with precise specified pressure.	**Full manual position:** The RC88 is a single record player as well as an automatic changer. At the touch of a switch, the tone arm is freed, and individual records (or bands) are played by hand.	**"Slide/slide" controls**—Select manual (single play) or automatic operation on separate halves of the unitized panel. Instantly the 210 is ready to play. Clearest, simplest controls on any record changer!
	Full-sized, heavily weighted (6 lb.). Actually 2 turntables...a drive table inside, a non-ferrous heavy cast table outside; with a vibration-damping resilient foam barrier.	**The exclusive Garrard pusher platform**—remains the only automatic device that insures positive, gentle handling of all records, regardless of diameter or condition of center hole, or the record surface or edges.	**GARRARD's 4-pole shaded "Induction Surge" motor** with rotor dynamically balanced—a refinement not found in other record changers in this class. Insures constant speed with no hum or vibration.
	New exclusive, completely shielded 4-pole shaded Laboratory Series Motor...developed by Garrard especially for the Type A turntable system. Insures true musical pitch, clear sustained passages without wow, flutter, or magnetic hum.	**Interchangeable spindles** (manual and automatic). Have no moving parts to nick or enlarge record center holes. Records are lifted from turntable without interference, with spindle removed.	**Extra-sensitive stylus pressure control** through instantly accessible knurled knob built into the cast aluminum tone arm, insures precise specified correct tracking pressure at all times.
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and causing an increase in record scratch. This scratch can be eliminated when the cartridges are strapped in parallel since the vertical response is thereby eliminated. Second, it is also possible that there is a loose connection somewhere in the phono input circuitry between the cartridge and the preamplifier.

Much depends on whether the noise is always present or is present only when a record is being played. Of course, all tubes should be checked for shorts and microphonics.

Headphones are always more subject to noise than speakers are since they are very sensitive and are directly coupled to the ear. If you hear this noise with the preamplifier disconnected from the power amplifier, it is almost certain that this noise is generated within the power amplifier and that the sensitivity of the phones is allowing you to hear it. All you need do in this event is to reduce the sensitivity of the phones. This can be done by using an L-pad between them and the speaker.

Of course, I am only guessing that this is the method you are using to connect your phones. You could be connecting them directly to the preamplifier. If this is your approach, you will still have to reduce the sensitivity, but it can be done by means of a series resistor whose value depends upon the impedance of the phones and upon the degree of attenuation required.

These are but a few possibilities. Try them out and see what happens. If you still have trouble, please write to me. I'll try to figure out something else.

FM "drift"?

Q. My FM tuner, which does not have a metal cover, is located in close proximity to other equipment.

I am troubled by the fact that sometimes when I walk into the room containing the tuner, it suddenly goes out of tune. The degree of this is determined by my position in the room. Can you explain this phenomenon and suggest a remedy? Martin Hack, Kew Gardens, New York.

A. The fact that your tuner does not have a cover has nothing to do with condition of instability you have noted. What you are experiencing is not a matter of a change in turning with certain positions you occupy in the room, but has to do with changing signal strengths.

I would guess that you are using an indoor antenna in association with this receiver. Raise this antenna to ceiling height and place it in a spot where room traffic is at a minimum. If the final position of the antenna is near a window, enough signal strength to saturate the limiters will probably be gained. Once this has been accomplished, you probably can walk all over the room without noticing these unwanted signal changes.

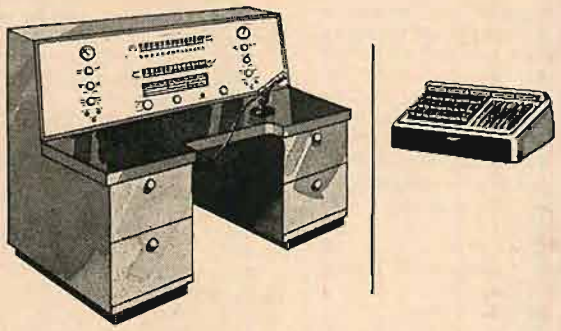
Three-Way Speaker System Balance

Q. Is there not some more exact method of setting the level controls of a 3 speaker sound system than just utilizing the way it sounds to the individual? I have a stereo sound system terminating in two sets of

(Continued on page 82)

Belden has it...

Every wire and cable you need for sound and intercom service and installation



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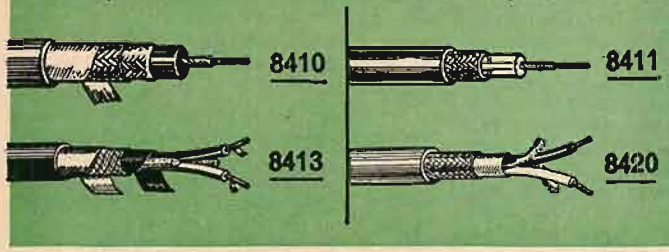
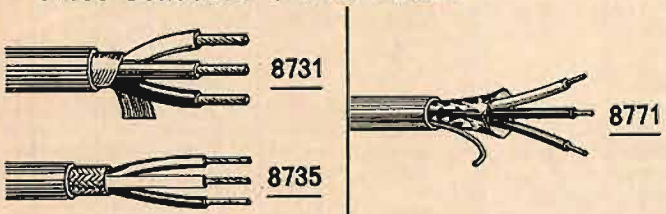


8410 8411 8413 8420

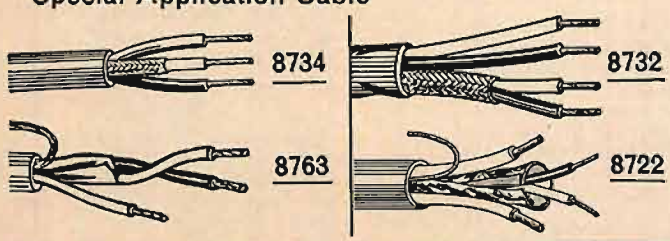
Three Conductor Shielded Cable



8731 8735 8771

8753 Multiple Pair Unshielded Cable ..1 to 51 pairs

Special Application Cable



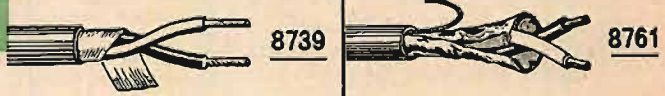
8734 8763 8732 8722

Hi-Fi Connecting Cable 8421

Miniature Broadcast Audio Cable

8450

Two Conductor Shielded Cable



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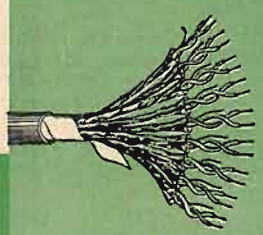

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8-8-0

LETTERS

Mystery of the xx's

SIR:

Just a line to thank you for the accurate and full review of the Patrician 700 and Stereon 200 loudspeakers in your January issue.

One unfortunate point of the review is that page 40 has a paragraph treating on the size of the Patrician but unfortunately the measurements were never entered before going to press. We hope you can do something to indicate that this apparently dimensionless speaker actually does have physical properties as well as ethereal ones. We want to ensure that your readers never confuse the Patrician 700 with the bookshelf models.

TERENCE E. FUREY,
Manager, Consumer Products,
Electro-Voice, Inc.,
Buchanan, Michigan.

(How right! Custom is to use xx's instead of some information not immediately at hand. Proper additional custom is to fill in the appropriate figures before printing. Herewith the corrected paragraph for the page 40 omissions:

"The complete Patrician 700 is not small by any means—obviously any enclosure which can accommodate a 30-in. cone speaker must be large. But the performance is also "big." The cabinet itself measures *54½* in. high, *33* in. across the front, and *28½* in. from front to back. The rear corners are cut off, and the cabinet is intended to be positioned in a corner with the cutoff corners 6 in. from the walls. Thus the front is *44* in. from the actual corner of the room, measured on the line bisecting the corner."

And we do not have any construction plans for it. ED.)

More Gremlins

SIR:

I have found Mr. Bosselaers' article, "Designing a transistorized preamp," (January, 1961), both interesting and informative. However, there appear to be several errors which need correction. They are as follows:

Page 26, third column—

$N = \sqrt{\frac{10\,V}{d_i^2}}$ should read $N = \sqrt{\frac{10\,V}{d_i}}$

$R_3 = (N-1)r_e = (N-1)(2/I_e)$ should read $R_3 = (N-1)r_e = (N-1)(26/I_e)$

$\frac{R_3 + I_e}{2200} \times 100\ mv = \frac{680 + 52}{2300} \times 100\ mv = 33\ mv$

should read $\frac{R_3 + r_e}{2200} \times 100\ mv =$ etc.

$I_e R_2 + 120\ mv = 460\ mv$ should read

$I_e R_2 + 120\ mv = 460\ mv.$

$R_1 = 6.6\ R_2$ should read $R_1 = 6.6\ R_2$

Resistors should have been marked on the drawing in *Fig. 3*. R_3 is 56k and R_2 is 9100 in base circuit of upper left transistor. R_5 is 680-ohm resistor in emitter circuit. R_1 is 680k resistor from ceramic input. Capacitor values associated with the ceramic input and with the two high-level inputs should be in micro-microfarads (picofarads) instead of in farads as shown.

Page 62, second column—

In the second line, the equation should read

$$\left(\frac{2}{0.1} - 1\right) 36{,}000 = 684{,}000$$

In the appendix,

$$kT(m \cos \omega t - \tfrac{1}{4} m^2 \cos 2\omega t)$$

should be divided by "q".

The last formula on the page should read

$$d_i = \frac{qV}{kT} \times \frac{1}{4N^2} = \frac{10\,V}{N^2}$$

I am also puzzled by the author's high-frequency corrections at the ceramic and high-level inputs. He states that $R_1C = 7$ microseconds; and thus he gets $C = 10$ picofarads for $R_1 = 680{,}000$ ohms. Since 7 microseconds corresponds to about 23,000 cps, I fail to see a reason for making $R_1C = 7$ microseconds.

DON G. DAUGHERTY,
6E University Houses,
Madison 5, Wisconsin

(We agree that 23,000 cps seems like too high a frequency to compensate for, and we have asked Mr. Bosselaer for further comment. ED.)

More XX's

(It seems as though our finger got stuck on the "X" key during the preparation of the January issue. On page 54, third column, fifth line they appear again. Please cross them out. That's why they are there anyhow—we tried to cross out something else. ED.)

Reverberation

SIR:

Will you please advise me or print an article in regard to the new reverberation units?

I am starting to convert a rather large system to stereo and do not want to slip up on any possibility. I happen to be a pipe organ fan, and it would certainly seem that of all music this type would be helped most by such an addition—a reverberation unit, that is.

G. W. MCELHINNY,
603 Sixth Avenue,
Havre, Montanqa

(See EQUIPMENT PROFILE, *page 48 this issue, for some information on the newer reverberation units. A more complete article is scheduled for the April issue.* ED.)

Editorial Needs

SIR:

As a regular subscriber of AUDIO, I do not remember seeing an article on the construction of a Hi-Fi TV tuner for the sound channel only.

Of course, most of us take the sound off the TV set. I would like to build a separate tuner for TV, since there are many programs I listen to rather than watch (for example, the Bell Telephone Hour).

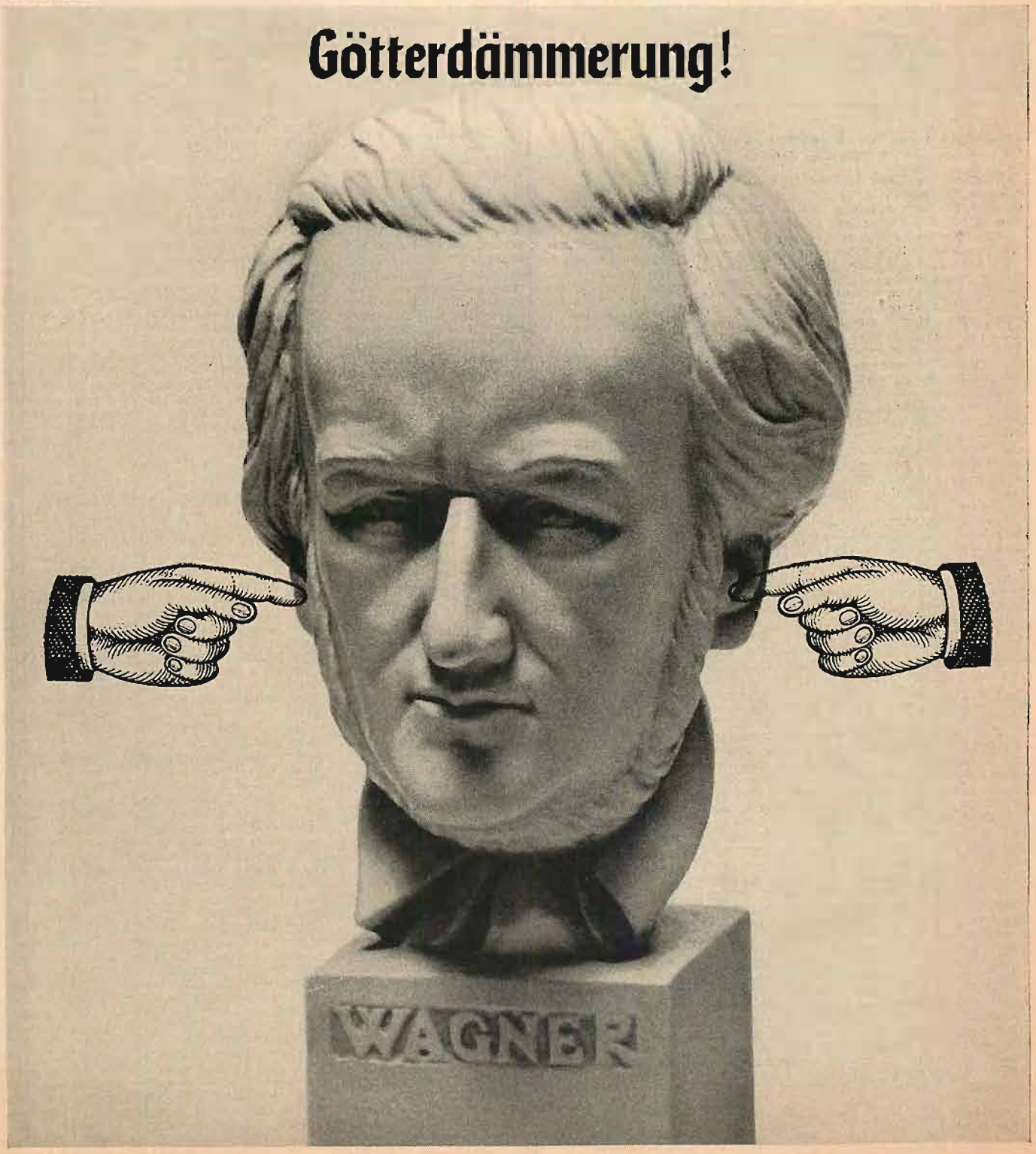
Can you provide me with a construction article if there is one. If not, perhaps you can make suggestions and furnish a block diagram for such a unit. My thought is to use a TV tuner unit, change the oscillator coils and bring the i.f. to 10.7 mc, and feeding it into the FM tuner i.f. strip. The other possibility is to use the FM tuner as an 88-mc i.f. amplifier.

MORTON J. SAVADA,
Sunny Ridge Rd.,
Harrison, N. Y.

(Like most inventions, the problem is practically solved when the need is determined. The TV tuner feeding into an i.f. strip—and why not use a 21-mc i.f.?—is a fairly simple solution. The 88-mc i.f. is likely to cause trouble with two high-frequency oscillators in the same room. We would welcome a construction article on this item, even though the demand for such a tuner is apparently not great—at least two have been offered commercially built, but none seems to be at the present. ED.)

Can that be my Ride of the Valkyries? I wouldn't wish such sound reproduction even on that Italian organ grinder—Puccini! Now try it through a Pilot 654 stereo receiver. Some difference. You can hear the rich resonance of every hoofbeat, the startling clarity of every shriek. The Pilot 654 is the only all-in-one stereo component with a harmonic distortion factor of only 0.5%. Just hook up a pair of speakers. The 654 supplies the rest: separate FM and AM tuners, a 60 watt stereo amplifier, and 16 different controls— all on a compact, cool-operating chassis. If you can't attend the Bayreuth Festival, get the Pilot 654. With enclosure, $299.50. See the Pilot 654, and the 30 watt 602 Stereo Receiver, $249.50, at your authorized Pilot dealer. Both are U.L.-listed. Write for literature to: Pilot FOUNDED 1919 Radio Corporation, 37-38 36th Street, Long Island City 1, N. Y.

Götterdämmerung!



CHESTER SANTON*

The symbol ✪ indicates the United Stereo Tapes 4-track 7½ ips tape number.

Tenderloin (Original Broadway Cast)
Capitol SWAO 1492

Boasting an album number that should be a cinch to remember, this Capitol recording deploys the season's first major Broadway musical. The lull that has separated the end of the '59 season and the resumption of activity in the Fall of 1960 demonstrates more than ever the importance of the musical stage in the plans of the record industry. Even on records, Tenderloin underlines the importance of theatrical know-how that only an experienced production team can bring to a show. The producers, Robert Griffith and Harold Prince, have already given Broadway such outstanding attractions as "Pajama Game," "Damn Yankees," "West Side Story" and most recently, "Fiorello." In their latest effort, which stars Maurice Evans in a singing role as a crusading minister, they reaffirm their faith in New York City as the plot center of their theatrical universe. This time they zero in on the area known as the Tenderloin in the 1890's—the favorite district of police captains, tabloids, and the more versatile funsters in the male population.

Some seven years ago, the producers began to plan a musical based on the famous anti-Tenderloin crusade of the Rev. Dr. Charles Parkhurst. The appearance of a Samuel Hopkins Adams book on the subject two years ago got the ball rolling in earnest. The entire "Fiorello" team—director George Abbott and his co-author Jerome Weidman, composer Jerry Bock, and lyricist Sheldon Harnick—went to work on this show a week after "Fiorello" opened in November, 1959. The rowdiness of the local color is best depicted in the choral numbers by the Tenderloin crowd. *Little Old New York* and *How the Money Changes Hands* are gas-lit endorsements of the status quo. The two best ballads in the score are *Artificial Flowers* and the haunting *My Gentle Young Johnny*. The first is a standard tear jerker but *Johnny*, as sung by Eileen Rodgers, has the appeal of the true folk ballad. Maurice Evans reveals a serviceable voice fully up to the demands of his crusade. Those who know him solely in Shakespearean roles may be surprised to learn that this is his second singing role in the theatre.

Capitol's stereo sound in this album rates a special word. Their miking theory in past show albums has aimed at spaciousness achieved in the simplest fashion. Instead of resorting to reverb units for illusion of theatre liveness, they have been soaking up a maximum quota of room acoustics by the simple expedient of refusing to crowd their performers. Compare this recording with the original cast production of "Music Man" and you'll note the same effective use of lively surroundings. The "Tenderloin" recording enjoys darn near 30 per cent increase in recorded level and a decided improvement in frequency response.

* *12 Forest Ave., Hastings-on-Hudson, New York.*

The Unsinkable Molly Brown (Original Broadway Cast)
Capitol SWAO 1509

Andre Kostelanetz: Unsinkable Molly Brown
Columbia CS 8376

You may detect traces of more than one rags-to-riches play in this saga of a mining town tomboy and her struggle to attain acceptance in Denver society. The line that best sums up her humble beginnings occurs in the program notes describing the start of Act I. It's a sentence that struck me as a new and delicious model for musicals of this type, "As the curtain rises, Molly and her brothers are rasslin' in front of their tumbledown shack in Hannibal, Missouri." Once that business is out of the way, accompanied by Meredith Willson's marches and saloon songs, Molly proceeds to fight her way up every ladder in sight. She walks from Hannibal to the mining town of Leadville, Colorado. After a brief career as a saloon entertainer with a one-song repertory, she marries Leadville Johnny Brown who soon becomes the wealthiest miner in Colorado. Her saucy struggles in Denver and European society take up the rest of the plot. Her refusal to sink with the Titanic explains the title of the show.

Tammy Grimes, in her juiciest role so far, carries most of the show with such tunes as *I Ain't Down Yet, Belly Up To The Bar Boys*, and *Beautiful People of Denver*. Yet Miss Grimes would be the first to admit that her leading man, Harve Presnell, carries off top vocal honors in his first Broadway show. The 26-year old Californian should have no difficulty establishing a solid career on Broadway in view of the rich flexibility he brings to his three main songs. *I'll Never Say No* and the European-flavored *Dolce Far Niente* hold promise of the most frequent performance outside of the Winter Garden Theatre.

Hard on the heels of any major musical these days comes a batch of "cover" albums, non-cast recordings that use the score for their own purposes. The Kostelanetz instrumental version was early at the starting gate with eleven "Molly" tunes selected for their buoyancy in orchestral garb. His arrangers have had to struggle with a situation that other slick orchestras will face. The homespun sections of the score don't come over with very much conviction. Columbia's stereo gives a wide frontage to the orchestra's sound with good pinpointing of the violin and cello sections.

Margaret Whiting Sings the Jerome Kern Songbook
Verve ✪ VSTP 243

If your budget allows only fifteen tapes a year—make this one of them! It could be that only another reviewer exposed to an average year's recordings would join me in such a glowing estimate. Everything about this project is top drawer. Within the tape equivalent of two record albums are definitive vocal stylings of some of the greatest Jerome Kern hits. This release should return Margaret Whiting to the popularity she enjoyed when her version of *Moonlight in Vermont* was in the limelight. Only a naturally poised voice with genuine polish can do justice to songs such as *Smoke Gets in Your Eyes, Why Do I Love You*, or *Dearly Beloved*. Each tune has a fresh concept in the arrangements of Russ Garcia.

As for the stereo, the central location of the voice makes it easy to spot one of the best signs that miking was ideal at this session—the voice appears to originate in an area several inches in front of as well as behind the loudspeakers.

George Wright Encores
Hi Fi Tape ✪ R 702

George Wright Encores (Vol. 2)
Hi Fi Records R 711

Let the beginner demonstrate to his unsuspecting neighbor the agility of his new stereo record in making the sound jump from speaker to speaker. When I entertain an "oriented" friend and the shop talk turns to the investment required these days for really good bass reproduction. I dig out this recent pair of releases by Georgie Wright. The first, a stereo tape; the other, a mono disc of similar selections. If the comparison is confined to frequency response, a good mono disc and a four-track tape are a reasonably fair match. Both can operate in the region of the pedal notes on almost equal terms. Assuming that your amplifiers and speakers can deliver substantial output at 30 cps, the comparison is quite instructive.

Start with the mono disc and the bass sounds pleasingly plump—until you switch over to the tape. Then the pedal notes feel like the real thing. The difference is explained when you go back to the disc. Then what first seemed like authentic and robust bass is shown up for what it really is. The fundamentals are on the tape. The disc, in its low end response is merely pumping strengthened harmonics. Despite the fact that a mono groove can accommodate wider excursions with less risk of overcutting than a stereo disc, even this somewhat better-than-average mono Hi Fi record cannot match the tape's bass response. George Wright, in novelties or standards, is one of the very few organists with sufficient technique to encourage repeated listening and his roster of tunes in each of these releases is tops in diversity and showmanship.

Felicia Sanders: Songs of Kurt Weill
Time ✪ ST 2007

Time is one of the newer labels that wouldn't be caught dead in the market place with a gimmick-free recording. Knowing they were ardent proponents of ping-pongery, I had to suppress a qualm or two when I opened this tape reel containing show songs of the great Kurt Weill that have long deserved wider circulation. Surely they weren't planning to toss the voice of Felicia Sanders from channel to channel. I was relieved to discover that the major departure from normal procedure rested in the rather exotic reasoning outlined in the album notes that attempted to explain their placement of voice, rhythm section, and brass in the left channel—strings and woodwinds in the right. The first eyebrow lifter was this sentence in the liner notes. "There is so much musical logic in recording a vocalist in this fashion that one wonders why no one realized it until Time's experiments led the engineers to the inescapable conclusion that this was the way to do it."

My reaction was immediate. In fairness to other labels, it should be pointed out that this technique is hardly new with Time. I happen to have in my collection of stereo discs a recording called "Ruth Brown Late Date" (Atlantic S-1308). That disc is at least a year and a half in age yet it places the vocalist in the left channel and most of the orchestra in the right.

The other unusual claim on the jacket lends itself to more discussion. Some recording engineers are sure to question Time's implication that center placement of the singer in stereo inevitably leads to blurred reproduction. Even more difficult to fathom is the statement that placement of a vocal soloist in one channel means—in their own words—that "The voice does not come from the four walls and merge at some central point. "Given conditions sufficiently exaggerated, central placement—or any placement for that matter—can

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be made into a problem. The best proof that such a problem need not exist is Margaret Whiting's Kern tape on the Verve label. As a matter of fact, many of the Weill songs by Felicia Sanders will reveal miking difficulties quite unrelated to those outlined in Time's album notes. The mike selected for her use, however effective it may have been in brightening percussion sound in other releases, is merciless in its handling of sibilants and breath production.

Whatever reservations one may have about this album on technical grounds, thanks will certainly be extended to Time by Kurt Weill fans who have been searching for a truly comprehensive collection of his songs. Represented here are such shows as "Johnny Johnson," his first American production, with its flavor of the European music halls of the Twenties. The highlights of Weill's fifteen-year career in this country are covered by the great hits (*September Song, Speak Low,* etc.) and lesser-known excerpts from his last three shows—"Street Scene," "Love Life," and "Lost in the Stars." The only competition this release faces on tape is the Warner Bros. recording of Weill instrumentals entitled "Speak Low."

Jose Melis at Midnight/Many Moods of Melis

Seeco ✪ SEP 301

Those viewers of the Jack Paar show who have felt that the piano and orchestra of Jose Melis are not prominent enough in the proceedings, have a chance to indulge themselves now that the Seeco label is out on tape. As the key artist in their first release, Melis demonstrates in this Twin-Pak reel (tape talk for two record albums) that his popularity to date is not founded solely on proximity to famous personages. Some pianists achieve fame on the strength of a quirk in style. Others work hard to become background pianists devoid of style. Melis belongs to neither group. With only a small assisting group in some of the numbers—a full orchestra in the rest—he gets to the meat of the melody in commendably masculine fashion. The recording of the piano is business-like and the choice of tunes unhackneyed.

A Journey into Stereo Sound

London ✪ LPM 70000

Back in June of 1958, when some of us were wondering whether the stereo disc would make the grade, London helped to resolve the issue with the release of this recording. Virtually everyone with access to the best playback equipment available at that time immediately recognized the stereo disc version of this recording as the first example of impressive frequency response in a two-channel groove. The selections heard on this sampler were a hodge-podge of just about everything London had in stereo at the time; bits of symphonys, concertos, oratorios, pops and documentary sounds.

My favorite test bands featured a rehearsal sequence of a recording session (Ansermet leading the Suisse Romande Orchestra in Stravinsky's "Rite of Spring") and the distinctive sounds of a European train at its station. In the Stravinsky excerpt, just about every low voice in the orchestra was working to produce transients. In the train episode, the thud of the side doors being closed was recorded at frequencies that were low enough to show up differences in the response of a succession of stereo cartridges coming on the market at that time. Now that the same material is out on a four-track reel with little if any limitation in stereo separation, adequate tape playback facilities can bring the listener within hailing distance of the sound on London's master recording.

Patachou Sings Broadway Shows

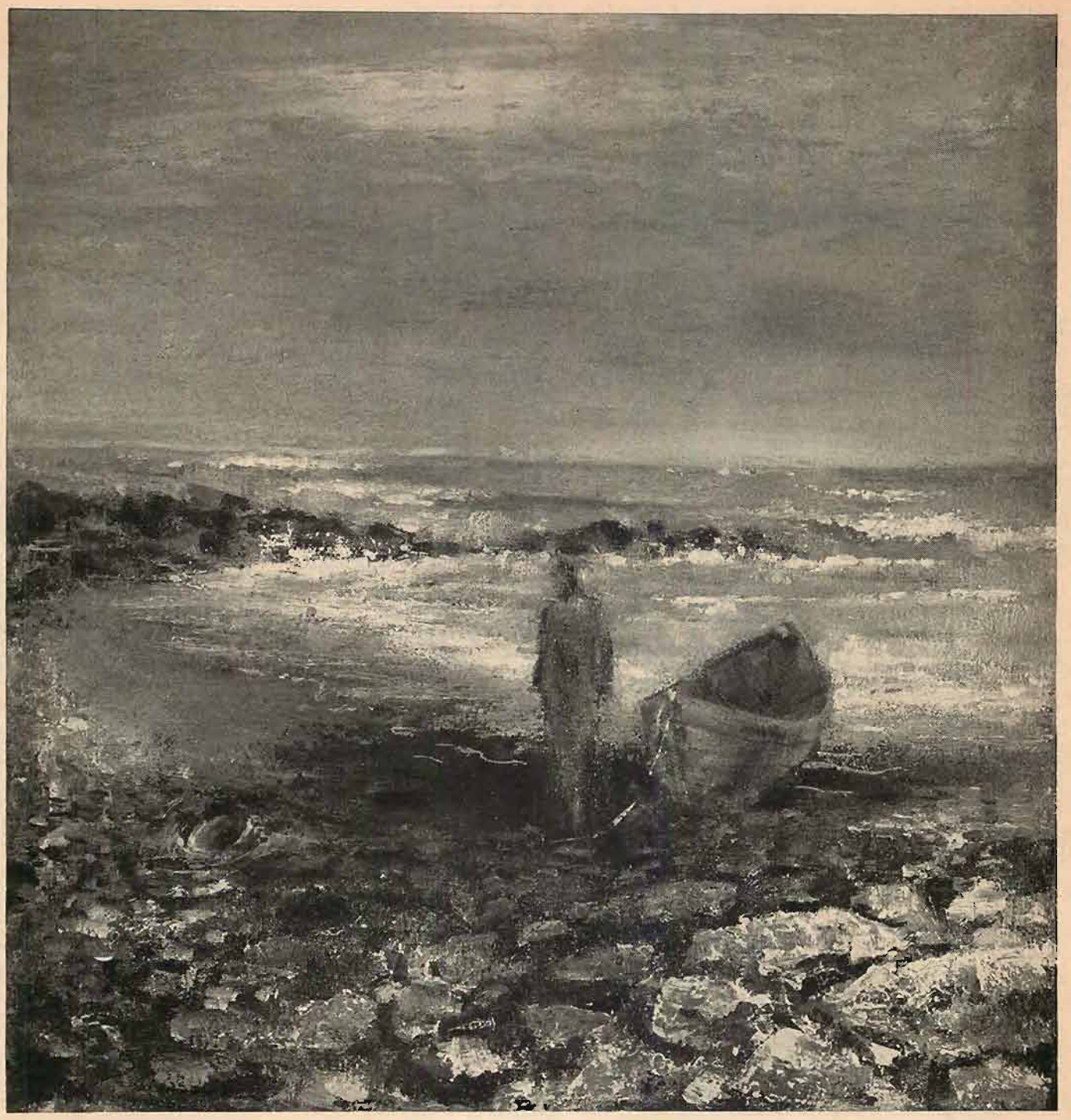
Audio Fidelity AFLP 1948

Les Grande Chansons (Vol. 1): Patachou

Columbia WS 318

In the course of her bilingual traversal of Broadway on the Audio Fidelity disc, Patachou works out a neat solution for the record buyer who would like to own the hit songs from "Irma La Douce"—in French. The show

(Continued on page 86)



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Edward Tatnall Canby

TWIN-CHANNEL HOME RECORDING

For the life of me I can't find the back issues of AUDIO, a couple of years ago, in which I described my experiments in home recording via stereo tape, two mikes in hand. But I do remember that I dwelt for a few lines on what seemed to me a quite remarkable and unforeseen discovery, that home amateur-type recording via two channels is both wonderfully effective and as tonishingly easy—far more versatile, more foolproof than one-mike, one-channel recording of the usual sort.

I put off detailed discussion at that point for the best of reasons. It was academic. Few people had stereo recorders to play around with. Stereo was to listen to, and we were fully preoccupied in those days with listening problems—how to get stereo from tape, then, soon, from disc. The market was beginning to fill up with so-called "stereophonic tape recorders," but virtually all of them were in plain fact mono recorders and stereo players. All except for a handful of imported models and a few tape decks of the Viking or Bell type that could be acquired, to choice, with dual-channel recording equipment.

The Mono Standard

It was obvious that the general public was first going to learn about "pre-recorded" stereo, on tape and disc. One thing at a time. Moreover, it was clear that the then-new "stereo recorders" were actually a familiar phenomenon, the transition model, and that real home recording via dual channels would have to wait until newly designed recorders came into production. The transition machines, originally intended for mono, didn't have room for home two-channel recording's bulkier components. Only the European makers resolutely went ahead with their honest but clumsy adaptations for full stereo recording on mono-type models, notably the Tandberg 5-2.

And so, right up to the present, the great bulk of our home tape recording has continued to operate on the well-tried mono standard. The machines may have been called stereophonic and they have become more versatile in many ways, playing all sorts of tapes, full-track, half-track, quarter-track, stereo, mono. But as recorders, they have remained flatly mono. I suspect that those relatively few recordists who have acquired Norelcos, Tandbergs, Uhers, or tape decks with stereo recording preamps, have not done very much as yet in the way of stereo recordings via mikes. It isn't in the air—not yet.

But now the moment has come. This season for the first time the "average" American tape buyer is going to run into two-channel home recording in earnest. The newly announced models, at last and inevitably, are true "stereo" recorders. Dual-channel recorders. And the great American public has another big entertainment question to face—shall I buy stereo recording (as well as stereo playback)? What good is it for *me*? Is home dual-channel recording worth the cash? What can you do with it?

After all, though we've actually had four-track stereo playback equipment on the market for many months, it's only now that one of the biggest of the U. S. popular big brands has come forth with twin-channel recording—no less than Webcor. And, if I may paraphrase, as Webcor goes, so goes the nation. Now it'll be full-page ads in *Life* and the *Post*, pretty models on TV with two mikes alluringly held in their lovely two hands. This is it! Two-channel home recording is here. Let's get on the bandwagon.

Mr. Snoozebury

Well . . . almost. Not quite. The new models are coming out, but the way most folks act you'd never know it. These words, I'll wager, are being printed comfortably ahead of the boom, maybe by a year or so as far as the well-known American small-town backwoods are concerned. Just ask your local dealer and see.

This last December, for instance, an ardent local lady called me up in our small town in Connecticut, she's head of the local music school, for advice on a new tape recorder. The school needed one for its teaching and she knew I knew all about such things. She would prefer, of course, a recorder that had no more than one push-button, for all control functions, and it shouldn't cost more than, say, forty-five dollars. This she implied in delicate language without saying so exactly—I got the idea all right.

This was a bit arch, on her part, for as it turned out she was going to pay a lot more and already knew it; but she had to test me out against her local dealer, just to be sure. I dutifully told her that tape didn't come as cheap as disc equipment and she'd have to pay more, if she wanted a really "good" machine; she replied she guessed as much, since she'd asked at the local hi fi and camera shop some twenty miles away—in fact, she added brightly, she was there right now and Mr. Snoozebury, the proprietor, had showed her some very interesting new machines though they were, indeed, dreadfully expensive.

You can picture my visions of Mr. Snoozebury listening a foot or so from the phone, but I manfully ploughed in and did my duty. I suggested flatly that before she bought anything she should consider a stereo recorder.

Long pause. A *what?* . . . I didn't quite hear what you said, Mr. Canby. Dreadful telephone service. . . . (She's slightly deaf, and never more so than when life offers her new complications.)

—STEREO, I repeated carefully. I could see the handwriting on Mr. Snoozebury's wall, but I had to go through with it. A stereo RECORDER.

—Wha . . . ? Well, Mr. Canby, we really *hadn't* thought about those new stereo tapes though I'm sure they're just lovely. Our little record player is quite adequate for our very modest. . . .

—No, I said patiently, I mean a stereo *recorder*. One that records on two tracks at once, you know, one of those four-track machines. . . .

—But Mr. Canby, we only need one recorder, not four. I'm sure that Mr. Snoozebury. . . .

I ignored this killing logic and continued doggedly. Yes, I know it will cost somewhat more, but in a music school, you see, a machine that will take down TWO recordings at once can be of invaluable help in all sorts of educational situations. Take, for instance, a violin and a piano. . . .

—But Mr. Canby, I'm quite sure we really can't afford even two recorders. One will be quite enough for the present. Though I am sure the piano department would be glad to. . . .

—Two microphones, you see, I interrupted. Both running into one machine. They make the same recording—I mean, almost the same. And with four tracks. . . .

—Four tracks? (A new idea was getting through.) You mean a machine that plays four different tapes? How interesting! But I don't really think we can afford anything quite like that right now. You see, we've raised only enough money for one tape—I mean one recorder. . . Oh dear, what DO I mean? Mr. Canby, do let me ask Mr. Snoozebury, right here, what he thinks about these four-tape machines.

I picked that up *very* hastily: ask him whether he handles the Norelco, or the Tandberg, or the Uher—they're all stereo recorders, imported from. . . .

—Mr. Canby, Mr. Snoozebury has the nicest tape recorder right here, and I just wondered what you thought of it. (The cat, of course, had been waiting all this time to get out of the bag. The lady had every intention of buying the one she'd long since decided upon. They always do.) It's a—(pause, muffled voices in background) he says it's a Wollysack, or is it a Gunnysack? And he'll give the School a very good price, since we do so dreadfully need a recorder for our work.

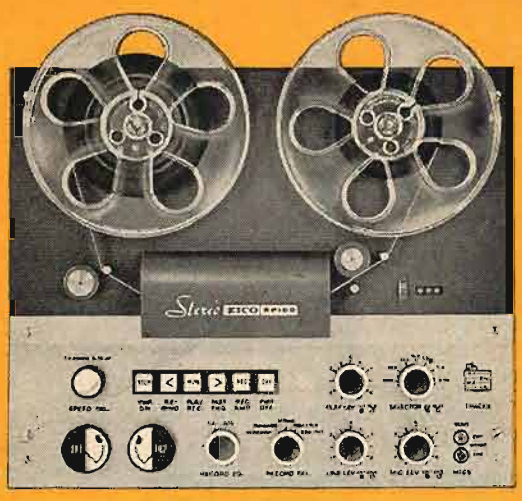
Well, I gave up on the spot, as you can guess. I enthused over the Gunnysack, alias the Wollensack, and opined that for her purposes it was an excellent buy. And which model was it—did it play stereo? She hadn't considered this, and acted as though I were bringing up a tired subject already well got rid of; so I didn't bother to find out whether this was the half-track mono model with 10-watt built-in power amplifier, or the modification that plays stereo but is minus the power amplifier. As for any thought of two-mike, dual-channel *recording*, I mentally chalked this conversation as Round One—a Total Loss. A rout. No, two-channel home recording was not here quite yet.

Mr. Snoozebury (his real name is only *slightly* different) evidently had never heard of two-channel at that point. Nor did he know about the assorted European imports I suggested. Nor any new Webcors or Reveres. If he did, he wasn't telling my lady friend. But as for the Wollensack, now *there* was a really fine little machine. . . . It is, too.

* * *

I'll admit that this is a somewhat enhanced transcript of the original phone conversation. But it does represent the gist of reality. If you doubt it, try your own

dedicated to perfection



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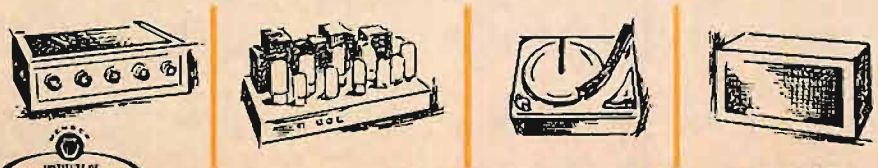

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local lady-prospect. I think you will have noticed, in any case, one thing of significance. This lady would not buy home two-channel recording, but she knew all about tape recording itself, and was eagerly and wisely ready to spend cash for it. What's more, she knows what to do with it when she gets it—mono-style, at least.

Now pause to remind yourself what a triumph of long-range education that is! Maybe a good ten year's worth.

It seems but a moment ago that other nice ladies were asking me about buying a new phonograph and didn't I think this lovely Hepplewait was just the thing? New speeds? You know, Mr. Canby, we have so many precious old records, we really won't be able to afford any new ones, and we do like those we have so much. . . . LP? What was that? Long Paying? You mean buying on the installment plan—dear me, I hadn't thought of that. I'll have to ask Mr. Snoozebury this very minute. He's just showing me some new invention, is it the Wire Brush? It plays jazz on picture wire, but I don't really think, for my purposes. . . . Mr. Canby, I *really* don't like all this noisy jazz music . . . do you?

That would have been around 1952 and I would not have then dreamed of suggesting a *tape* recorder to the lady. You can imagine how far I would have got! So, in ten more years, I'll bet, Mr. Snoozebury will have a storeful of dual-channel tape machines and the ladies will be calling me all over the place about them. No more wire recorders.

Therefore, let's anticipate. What has the dual-channel tape recorder to offer to the home amateur and semi-pro (schools, etc.)?

Semantics

First, you must untangle the semantics. No nice lady in her right mind can make head or tail of our present jungle of tape terminology.

It's not four recordings, you explain—merely four tracks on one tape. You don't use them all at once. You use two of them in one direction and two the other; it works exactly like the old system. (That's reassuring.) You run the tape through twice. Just pretend it's a regular recorder. (That's the solid approach.) Except that now you have two mikes instead of just one. One mike in each hand. (Who uses mike stands? If not in the hand, then on a table, or sitting in a chair.) When you play back, the sound comes out of two speakers. Simple. Easy.

That is the biggest point to get over in our coming missionary work among the mono tape heathen. Tell 'em it's just like it always was—you make a tape, then you play it. Aim and shoot. No special professional know-how for dual-mike recording.

In fact—and here is Point Two—it's twice as easy, twice as sure-fire. This is the big surprise, this is the honest plug that means what it says. It's the new sensation that's coming our way in home tape recording. It's the answer, every time, to the coming nationwide chorus of murmuring objections — home-stereo-recording-is-impractical-because-stereo-is-for-the-experts-and-who-wants-to-do-professional-studio-recording-in-the-home-and-anyway-it's-expensive.

Is it Stereo?

The fact is, as I have quickly found by home experiment, that two-mike home recording is very seldom stereo at all. It's dual-channel, all right, but not stereo.

Stereo is, indeed, a tricky technique that demands a professional sense of microphoning. It can be produced in the home, just as good pro-style mono recording occasionally turns up on a home recorder in good hands. Nine chances out of ten, though, your home recordist won't get real stereo sound in any proper sense at all; or his stereo will be bad stereo, as such. Instead—the thing to do is to forget all about stereo and concentrate on much simpler recording techniques.

The thing to do is to avoid the very term "stereo" in our whole approach to this new home two-channel recording. It doesn't apply technically, for the most part. It has too many wrong associations. It *is* difficult—when done in professional style. But good two-channel recording isn't difficult at all in the home situation, if you forget about stereo.

Dual-Channel

I propose, then, that as often as possible we refer not to *home stereo recording* but to *home dual-channel recording*. This avoids a whole series of confusions and says exactly what needs to be said, without dragging in complications. What's more, it makes talking about tape recorders a lot simpler.

Thus—your *four-track* recorder now can make a *dual-channel* recording. Your half-track recorder usually made a *single-channel* recording though a few models could record *dual-channel*. (NOT "two-track"!) Any old recorder can make a *single-channel* recording, whether full-track, half-track or quarter-track.

If for clarity we will confine "track" to its technical meaning, a recorded track or trail of information on a tape, and use "channel" in its proper sense, as the complete communication system from mike to track or from track to speaker (or both

simultaneously), we'll do much to help the public get itself clear on fundamentals, before taking the hoped-for plunge into dual-channel home recording.

Stereo, then, is a professional-type sound, as purveyed via commercial recordings, dual-channel recording is *any type* of recording via two channels, stereo included.

If you aren't going to stress true stereo, then what *do* you do with your home dual-channel machine?

Almost any old thing. In my somewhat randomly purposeful experimenting to date I've produced some wonderfully amusing, effective, slick, realistic, natural-sounding tapes, and most of my "technique" has been deliberately, absurdly crude, once I caught onto the fact that this is what works best.

The zanier your mike positions, given the all-important duality, the trickier are the results. The medium is astonishing. It untangles the nuttiest muddles, disciplines the undisciplined, makes neatly formal rows out of helter-skelter masses of people, reduces the wildest mike gyrations (via waving arms) to staid immoveability. . . . But let me pass onwards to several categories of zany simplicity that occur to me as helpful in dual-channel recording, though in practice they overlap more or less continuously.

The Two-Point Close-Up

The simplest and best home two-channel technique, the most useful of all and the most surefire, is that which I'll call the Two-Point close-up.

Pick up your two mikes and stick them as close as possible to two different sounds. Make sure they are *different*. (Allow for level, of course—close-up sound is usually loud.)

Put one mike three inches from a folk singer's mouth (amateur, of course—no Metropolitan Opera voices in this show); put the other a couple of inches away from the strings of a guitar. Keep them apart. Space your people five or six feet or more apart. (And space your playback speakers even further, for enhanced effect.)

Or set up an amateur Romeo and Juliet (again, serious but amateur) on two mikes, well separated. Or sit two of your small kids on two TV cushions and get 'em to talk—with giggles. Channel A: *"What's black and white and read all over?"* Channel B: "(Giggle) A NEWSpaper!!"

The palpable fact is that the question, on playback, is asked out of one loudspeaker and the answer comes, across the room, out of the other. That is the big new dramatic sensation. The spatial dialogue, each sound inside a different speaker (not behind it), makes for a lively, surprisingly engaging effect of "two-ness," much more attractive than the inflexible "one-ness" of the ordinary mono recording! Just watch the listening heads bob back and forth. Two-point commercial stereo is often pretty dull, ping-pong style. But in home recording it's something else again. Fun, effective, useful.

Almost any sort of duet or dialog is made much more interesting by this simple home technique. Ordinary conversations grow vivid when one person is in each speaker, instead of the usual situation where several voices are superimposed one on top of the other for a spatial monotone.

Absolute vs. Relative

It may occur to you that these dual recordings made close-up and excluding virtually all liveness or room-sound, are essentially absolute recordings. The two tracks

(*Continued on page 58*)

EDITOR'S REVIEW

THE "BEST" LOUDSPEAKER

REGARDLESS OF SOURCE MATERIAL, amplifier phono pickup, tape recorder, or microphone, the last link in the entire chain of any sound reproduction system is the loudspeaker. And no matter how good the rest of the equipment—including the original source—the loudspeaker is the one element most likely to introduce its own characteristics into the over-all sound quality.

Some audiofans, searching for the ultimate in a loudspeaker enclosure, take the viewpoint that sound should be reproduced by some device with "resonance." Their fundamental idea seems to come from the fact that a violin, for instance, has "resonance" and that therefore—since it is recognized as such a good sound producer—a loudspeaker should be designed like a violin. Others choose a different instrument to copy in order to make a loudspeaker cabinet, with no better results.

Sticking to the violin analogy, it must be recognized that its "frequency response" is not flat throughout the entire audio spectrum. Actually, it is frequency response primarily that makes the difference between a fine instrument and the poorest of fiddles. Suppose, for instance, that we had a violin which had a 10-db peak in its frequency response at 1400 cps—a not impossible condition. Let us suppose further that we had a loudspeaker built in the form of a violin just like our original so that there was a 10-db peak in the loudspeaker at 1400 cps. Then we play music on the original instrument and reproduce it on the violin-loudspeaker. We would have a resultant peak of 20 db at 1400 cps. This is not unlike the trouble in dubbing tape after tape in a consecutive pattern—that is, copy 1 from the original, copy 2 from copy 1, copy 3 from copy 2, copy 4 from copy 3, and so on. This is in contrast to the normal method in which copy 1, copy 2, copy 3, and so on are all dubbed from the original. In the consecutive pattern, a 2-db peak in the system anywhere would put an equivalent peak on copy 1; a 4-db peak on copy 2, a 6-db peak on copy 3, an 8-db peak on copy 4, and so on. This practice is not usual in commercial dubbing, but if audiofan A makes a copy from his original tape and gives it to audiofan B, and he copies it and gives it to C and he copies it and gives it to D who—and so on—the frequency response of the last copy will contain all the defects of all of the recorders of the system.

Thus what is needed is a loudspeaker that is entirely inert—it should not introduce any characteristics of its own into the reproduction. That is, of course, asking a lot, for there are no perfect loudspeakers. By the same token, if all manufacturers were able to make loudspeakers which were perfect, then all of the products of the various manufacturers *should* sound alike, and everyone knows that they do not.

Now it is to be assumed that every manufacturer strives to make a good loudspeaker—certainly the basic principles of craftsmanship as well as business demands that he do so. But he must also make a *salable* product if he is to stay in business. And this is where the differences come in. Those who have the responsibility of passing on the over-all sound quality of the product may have different tastes, and those tastes are certainly reflected in the speaker. The main problem in loudspeaker manufacture is to turn out a product that will appeal to a large enough segment of the listening public to make it economically successful.

We are so often asked, "What is the best loudspeaker?" or "What speaker should I buy?" For many reasons we cannot answer that question. First and foremost is the unfairness on our part if we were to tell enquirers that the product of one of our advertisers was better than the product of another. If we were to say that we like X's speaker (or amplifier or tuner or phonograph cartridge or turntable or what-not) Y is certainly not going to like us any more. Neither is Z nor A nor B nor anybody except X.

The most important (to the speaker buyer) is the fact that not everyone likes exactly the same type of sound. And since all loudspeakers do not sound alike—the biggest understatement of the year so far—the only logical answer is for the individual to hear as many as possible and then select the one that he likes best. To be sure this is difficult for the man who is not close to an audio salon or who must buy from advertisements alone. We feel that within the same price class there is not a *great* difference in quality. Common sense tells us that it is not likely that one manufacturer can make a loudspeaker for $19.85 that is just as good as another's unit at $495.00. Our advice, then, is always, "Choose the product of any reputable manufacturer in the price range you want" when you can't compare a lot of them. When you can, we say, "Choose from the products of any reputable manufacturer and pick the one that sounds best *to you.*" Even if we would, we could not say which loudspeaker you would like best, and anyhow you're the one who is going to listen to it and we don't want to "shoulder the blame" if you're not satisfied.

And as a final word, hear as many as you can at the Washington High Fidelity Show, February 10–12 at the Shoreham Hotel.

STANTON Calibration Standard: Model 381 – An ultra-linear professional pickup for recording channel calibration, radio stations and record evaluation by engineers and critics...from $48.00

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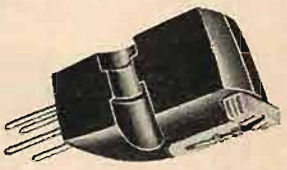

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A Case for the Custom Console

F. H. JACKSON*

A custom console to meet your specific equipment needs is relatively simple to construct and requires only the most basic hand tools. The approach described in this article makes it possible for anyone to produce a furniture-quality console.

TO PARAPHRASE THE noted sculptor's description of the genus homo sapiens' lifetime as the "Seven Stages of Man," one might as easily draw the simile anent the genus "audiofan"! Fortunately for the writer, and his acquaintances, fired with the desire for fine reproduction of music in the home, the stages are confined to three in number, whose total duration need not *necessarily* sum to a lifetime!

The first might prosaically be termed the planning stage, wherein the audio literature is combed not less avidly than are the shelves of the neighborhood emporium devoted to such wares (presided over by the ever-patient proprietor).

The second might be termed the stage of creation. Decision, ever procrastinated, has finally molded actions. Within short days passing our scrimped savings fast disappear into the maw of desire!

The third stage, for lack of more apt semantics, might be called the contemplative. This article is being composed at that most difficult of times. For the author, the planning and the creation are over. The satisfaction and enjoyment of a fine concert wafting through his home, is tempered by the gnawing query, "Has the final stage fulfilled the promise of the long past first?"

These stages through which the author's system developed are universal enough in nature as to cause the reader similar concern as he plods his way through that first stage!

* *6060 N. Brightview Dr., Glendora, California.*

One problem faced, and no doubt common to fellow devotees of the audio art, is the ever present problem of combining audio component quality with living room decor. Optimizing the equipment quality somehow always seems to outstrip the desires of the distaff side to decoratively house that which husband hath wrought!

Secondly, there is need for convenient access, coupled with easy component removability. Thirdly, it was desired to incorporate in the design the quality of adaptability, i.e., obsolescence conversion. Lastly, convenience features compatible with the design criteria were to be incorporated. How well the solutions to these problems wear is the continuing subject of both this article and the third stage of this audiofan's career in high fidelity.

The basic system chosen (see appendix) was to be that of a three unit stereo presentation of both high-fidelity broadcast and phonograph programming. The three units were to consist of separate left- and right-channel speaker cabinetry together with complete component console housing for all program and amplification sources. (*See Fig.* 1.) The cynic so easily states that given appropriate sums most problems are solved. To confound this crass viewpoint, the writer offers this system and in particular his solution to the task of creating a furniture setting for such a system at a total cabinet cost of under $100! This cabinetry cost was not predicated upon ownership of an extensive inventory of power tools. On the contrary, the author's sole claim to a power workshop is a vintage electric drill with a $12 sabre saw attachment!

How Were These Items Constructed?

At the risk of offending the power tool sellers, we must state that most local lumber yards, for a very nominal charge, will cut and mill any raw stock to your working drawings. On my unit the tolerances maintained were such that for ease of assembly, the method approached the so called "kit" type of cabinet construc-

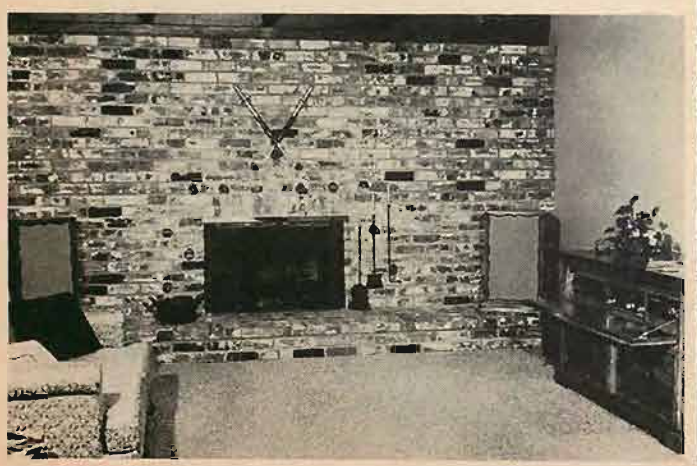

Fig. 1 (below). The complete system.

Fig. 2 (right). Exploded view of the laminated case construction.

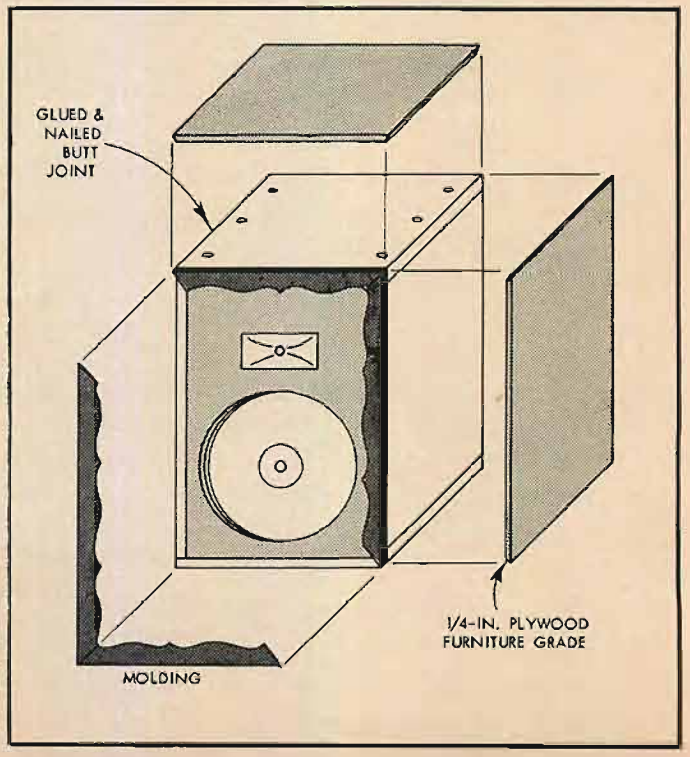

Fig. 3. Top edges of the console are covered with wood tape.

tion. The obvious advantage to this method is the wide latitude in design permissible, *versus* the justifiably limited number of styles available from kit manufacturers.

Another area of expense coupled with the construction of a console suitable for milady's living room is that connected with jointing and cementing of large scale furniture. Rather costly jigs and fixtures are usually required for such construction. Since these items were not readily available to the author, some substitution became a necessity. The resultant innovation, which is felt to be the prime one of these in this system, has been termed "laminated case construction". (See *Fig.* 2.) Cabinet makers may shudder within their professional stoicism to learn that this method uses common finishing nails and quick-setting casein cement! The method was first tried on the construction of the speaker cabinets and the encouraging results prompted the use of the same method, without modification, in building the console.

The procedure consists of two steps. Step one is to simply butt the sides and nail using casein glue (several national brands are available). Three-quarter-inch fir plywood is adequate. After counter-sinking the nail heads, the case is rough sanded to remove any gross irregularities on the surface. Previously cut and corner-mitered, ¼-inch, furniture-grade, plywood panels (again the friendly millwright at the local lumber yard was responsible) were coated on the underside with glue, as was the rough case. Carefully fitted, the panels were butted at all corner miters and weighted until the glue set. The end grain in this case was covered by the application of grille molding although an alternate method, easily applied, is to use plywood tape. This tape method was used extensively on the end grain covering of the console. Most observers believe the cases are of solid hardwood construction. (See *Fig.* 3.) This laminated case construction and the implementation of the Provincial motif in all three cabinets (which helped to create a unity of design) through use of ordinary builders molding, did much toward beautifying the ensemble. The grille frames are definitely enhanced by the graceful curves of the covering molding. The console inset doors and the drop front have that added touch of detail, which would be noticealy lacking were these panels of plain surface. Mention should be made at this juncture, that a contribution to the over-all effect was gained by the hand fitting and mitering of these moldings on assembly to comply with the final tolerances existing on the several mating items.

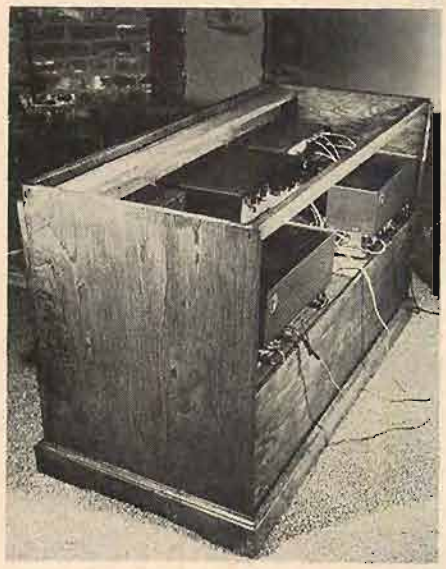

Fig. 4. The top is off! Note the laminated case construction in the end panels.

The second major problem to be resolved by our design was that of accessibility. It is only within the last several years that the ogre of maintainence accessibility has been given notice, much less resolution, by the commercial package interests, and that primarily by the television receiver manufacturers. It is to be seen (*Fig.* 4) that this problem was resolved most easily by the inclusion of a lift-off top in the console design. This feature greatly eases the disassembly breakdown of the system into units for repair or transport. In addition the preamplifier and tuners are so inserted into the control panel, that their removal is accomplished by simply sliding them on their base toward the rear of the console for an inch or two. This is possible because the normal bezel-type mounting was not employed. Insteal, a matching rectangle was cut in the panel for each of the three units to be mounted. As each unit face protrudes about ¼ inch from the panel face, it is difficult to tell whether or not they are permanently affixed. This feature has already proved of value in the case of some minor repairs to one of the panel units. The operation took less than a half hour, including repair of the unit.

The third criterion for our design, in which it was desired to create solutions amenable to our other goals, is that called adaptability, or obsolescence conversion. One area in which this attribute was incorporated was the design of the speaker enclosures. Close perusal of *Fig.* 5 will reveal the method used to allow for future horizontal placement of the speakers, should the need arise. The bases are entirely separate from the speaker enclosures, and the enclosures are finished on all four sides. They need only be lifted off their bases, placed on the side (after orienting the horn tweeter) for functional use as a bookshelf enclosure.

In line with solution to the problem

(*Continued on page 79*)

Appendix
System Parameters

Component	Function	Mfr.	Model
AM-FM Tuner	Right Channel Either AM-FM or FM-FM stereo (see below)	Pilot	FA-670
FM Tuner	Left Channel FM-FM Stereo	Heath	FM-3
Turntable	Record Reproduction	Fairchild	412
Tone Arm	Record Reproduction	ESL	S-1000
Cartridge	Record Reproduction	Shure	M3D
Preamp	Control Center	Dynakit	PAS-2
Amplifiers (2)	Left and Right Channel Power Output	Allied	83 YU 793
Speakers (2)		University	CUL 10 (kit form of 2 way SLOH system)
Cabinets (spkr)		Custom	To Univ. CUL 10 Specifications
Console		Custom	

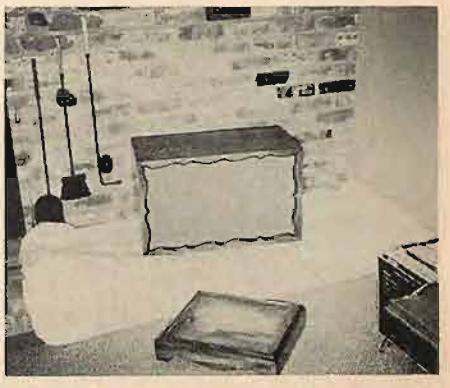

Fig. 5. The bases are separate and the enclosure finished on all sides to permit a variety of placements.

"Ersatz Stereo" Unlimited

C. H. MALMSTEDT*

A multichannel monophonic system that gives stereo some impressive competition.

IN A RUSTIC HOME in California there is a monophonic hi-fi installation that, in results achieved, matches the grandeur of the country around it.

"As good as stereo!" the system has been acclaimed. And, by a visiting symphony conductor.

"Magnificent! It is as though I were standing on the podium, the orchestra right here before me!"

Whether or not these accolades are extravagant, the fact remains that "monophonic" applied to this installation is as pleasantly deceptive as the name "Erosion Acres" is for the home and grounds that house this audio system created by its owner, Mr. Harwell Dyer of Carmel Valley.

"How," all ask, "do you get such marvelous sound from an installation that looks so simple?"

The answer is: growth, of more than twenty years' duration; growth born of a constant desire for improvement—of the technical facilities and of an understanding of music, a knowledge of the composition of the sounds that were to be reproduced with the best possible fidelity; things, in fact, that are not come by cheaply, in either time or money.

Considered by the standards of today's hi-fi, Mr. Dyer's beginning was, however, a modest one. A Gilfillan radio-phonograph with a Garrard changer handling only 78-rpm discs was, back in 1938, the first nucleus of the system. Today, the Carmel Valley installation consists of six speakers and twelve electronic units housed in five unit-locations

Fig. 2. The music corner, with part of the large library above and below the turntables. Note the home-built turntable on the left.

in and about the large living room, but so placed that, while everything is readily accessible, little is in evidence to mar the furniture grouping, the decor of the room, and the magnificient view from it.

Interestingly, the original heart of the amplifying system still serves as one of the power amplifiers—proving that the best is always in the long run the cheapest, and that modification intelligently applied can obviate the too-often-assumed necessity for discarding good units merely because of age. Designed and built in 1946 by Dyer and William Hilchey, this 300-watt amplifier utilizing 6L6 tubes feeding two 845's, in push-pull, employed the best components then available. Originally part of a 300-pound rack-mounted composite unit, this amplifier was later converted by James Meagher into a Williamson class-A amplifier of 150 watts full power and 75 watts distortionless output. Following the same desire to preserve and effectively use the worthwhile and the proven, an Altec 515 woofer also was salvaged from the earlier installation (where it had been in an infinite-baffle arrangement stabilized by a half a ton of concrete within a wall) for modification and use in the present system, as was an Altec 604-B coaxial speaker system, along with associated crossover networks.

With these and other units as a starting point, the present unique installation got under way in 1951, many years before the advent of commercially available stereo. As with all lovers of fine music, the goal of the Dyers was not only high fidelity but as well concert hall realism. It soon became apparent that

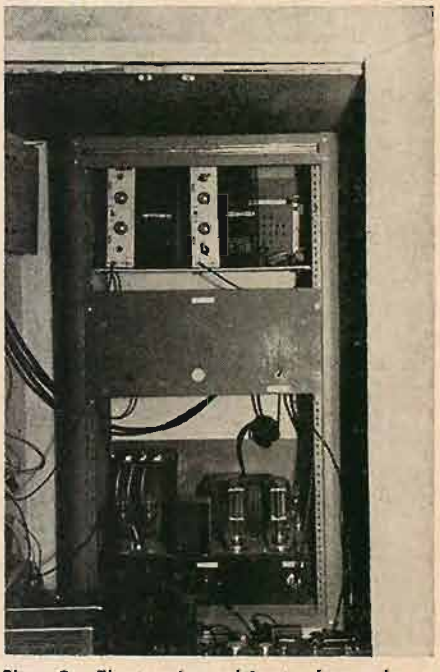

Fig. 3. Electronic cabinet, formerly a closet.

to get this realism, more was needed than a judicious placement of good speakers. Dyer went back to the first-things-first principle: he decided, first of all, to design and build his own turntable. The result leaves little to be desired, even in these days of many fine commercial turntables.

While few may care to go this far in a do-it-yourself endeavor, this home-made turntable is worth looking at before a view of the entire system.

Constant speed, free of vibration influences was the aim. Parts were picked up here and there. In a wrecking yard was found a 65-pound, 16-inch diameter,

* *Box 411, Windermere, Fla.*

Fig. 1. Not stereo—but magnificient music . . . a magnificient view . . . peace.

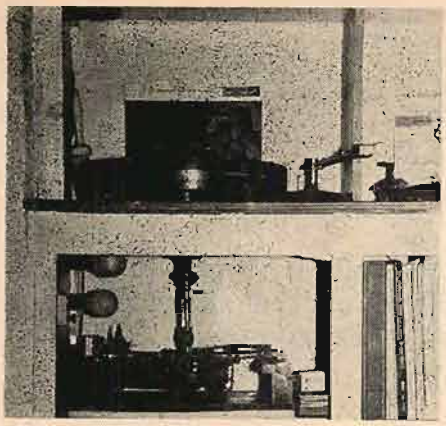

Fig. 4. Home-made 16-inch turntable.

two-inches-thick balance wheel once used in a saw-mill—massive enough and heavy enough to resist vibration. To one side of this wheel was bolted a ½-inch-thick disc of plywood. Over the plywood a ½-inch disc of neoprene was then glued. This combination became the turntable. The problem of a motor to turn this table was solved by a Green Flyer motor of the type used in broadcasting station transcription turntables. Set in an "H" saddle constructed at home, the motor was placed on a foam rubber pad within a cabinet under built-in bookshelves. To assure vibration-free drive of the turntable, sections of the drive-shaft were separated by Lord rubber couplings, with a free-wheeling device in one section of the drive-shaft. As a precaution against overheating of the motor during long use, a small rubber-bladed fan of the type used in automobile interiors was added to the motor compartment. To render its operation inaudible, its speed was reduced by the use of series-connected light bulbs, which also conveniently illuminate the enclosure during operational inspections. There was one problem: how to start this heavy turntable spinning without asking the motor to do it. Solution: to the drive-shaft was fastened a six-inch length of stiff wire protruding straight out; to the end of this wire a small magnet was attached; at one point on the travel-radius of this magnet a microswitch was so placed as to be actuated when the magnet passes it the first time. Result: manually start the turntable slowly—and within one turn or less the microswitch applies the current automatically, and the table smoothly works up to the speed it was set for—33⅓ or 78 rpm.

Both the construction time and the time required to attain full speed (about a minute) are more than amply justified by the performance. "If there is any rumble in evidence, it is inherent in the recording, not in the turntable."

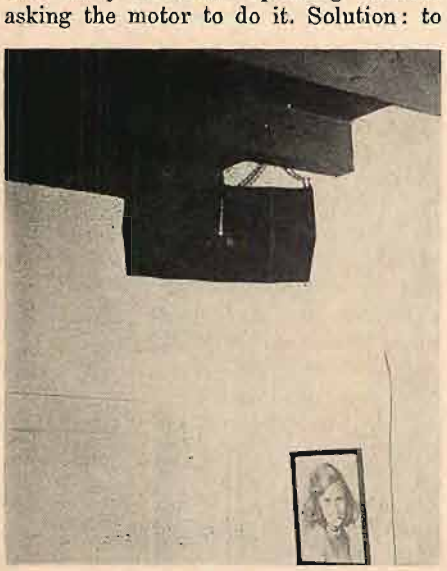

Fig. 5. Midrange horn disperses sound throughout the large room, augmented by a woofer at floor level.

More concerned with fidelity than efficiency, he decided to use the big home-made power amplifier to feed an AR-1W speaker in its infinite-baffle enclosure, placed on the floor at one end of the room. With the feed originating at the home-made turntable, the Garrard changer, or a Fisher FM tuner, the AR-1W woofer receives its input through a Grommes 212 preamplifier feeding a Heathkit electronic crossover, the Low output of which was set to decline at 100 cps.

With one bass-response channel thus established, another set of speakers—an Altec 604-B coaxial and a 515 woofer—were mounted on a common infinite baffle half the size of a large closet door. To accommodate this baffle, the door

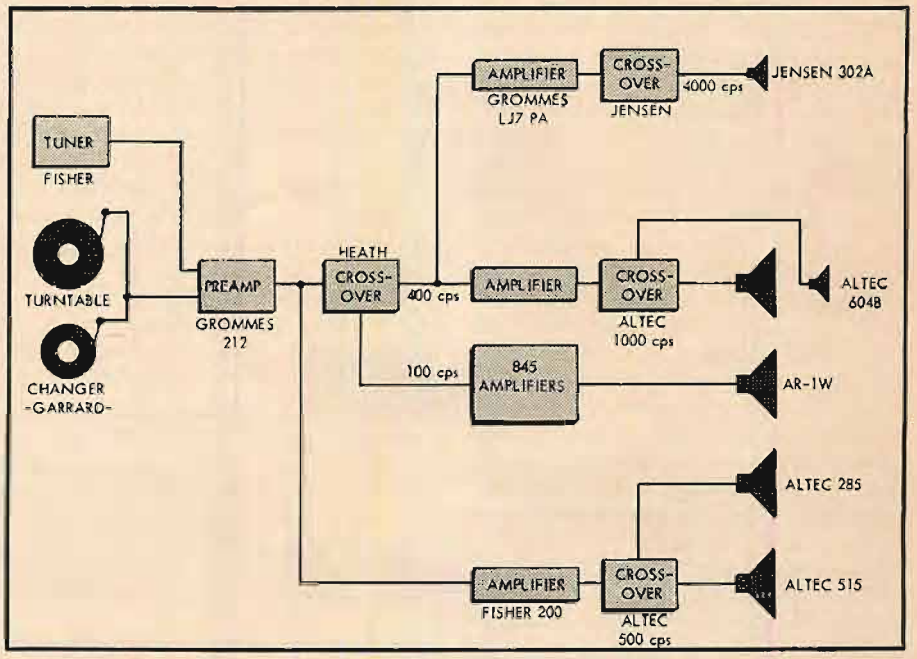

Fig. 6. Block diagram of the four-channel system.

With a GE magnetic cartridge and 16-inch transcription pickup arm on this turntable, it became again a case of one thing leading to another: where a good audio system had inspired the quest for a better turntable, the turntable thus developed now led the way to a demand for an even better audio system: "The best monophonic thing I've ever heard," said one listener.

But it was a desire for a stereophonic kind of realism that brought about the "unorthodox" use of crossover networks that is one of the keys to the success of this system. This, in turn, was brought about by the physical characteristics of the house the Dyers purchased in Carmel Valley. With walls of unsurfaced concrete block, a floor of smooth, waxed cement, and a large picture window in one wall, plus a rather high beamed ceiling, the living room was obviously a "live" one. A member of the infinite-baffle school, Mr. Dyer set to work accordingly—to assure, first of all, adequate but natural reproduction of bass.

was removed from a closet at the same end of the living room that holds the AR-1W. Bottom half of this 6-feet-deep closet was partitioned off as a housing for the rack of major electronic units and power supplies, with the lower half of the door cut vertically in the center to provide two flap doors that could, without jeopardizing appearance, be left ajar for ventilation. The upper half of the closet thus vacated was lined with absorbent padding and utilized as an enclosure for the two speakers. To the same baffle now was added a Jensen 302-A "bullet" tweeter, thus making this a four-speaker infinite-baffle enclosure about six feet to the left of and about five feet above the AR-1W on the floor.

Input to this speaker system was now arranged through individual channels to which only the Grommes preamplifier and equalizing system are basically common. To feed the 604-B coaxial, the High output of the electronic crossover, set to pass above 400 cps, was fed into

(*Continued on page 81*)

Computers in Audio Design

R. G. BUSCHER*

Through use of computers the audio engineer can materially reduce the amount of time he spends on routine computations and thus increase the amount of time available for handling design problems. Here is a description of the various computer types plus a specific audio design example.

In Two Parts—Part One

IN RECENT YEARS, names such as PACE, 650, MANIAC, REAC, 704, and ESIAC have appeared more and more throughout our society. These are the designations given to the computers which are used in the areas of accounting, engineering, and research. Through the application of computers, time- and money-consuming procedures are being simplified. Each year more people come into contact with these applications. Utility bills, bank accounts, savings bonds, credit cards, income tax, government checks, and the paper work of many other everyday activities are handled by some sort of computer.

In engineering, the speed of data processing is of extreme importance. By freeing engineers from routine complex calculations so that they may go into new endeavors, these machines are stepping up the rate of progress.

Complete models of complex systems can be computer simulated for engineers to study. In this way the cost of optimizing a design can be reduced.

If a new system were to be built for each design change, the cost of development would be many times what it is now. Each time a design error was made a new system would be required. Computers, however, allow quick and easy changes in design. On computers, "mistakes" are indicated by means of signal lights, horns, or other such means. A flip of a switch will return the problem to its original state. The engineer can then make the necessary changes and start again.

Even the field of audio can benefit through the use of computers. The design or optimization of audio systems can be done on computers more quickly and more accurately than by hand methods.

By introducing circuit equations into computers, the laborious task of amplifier design, for example, can be made easier. Tube characteristics can be placed in the computers in order to determine the amplifier tube operating points. A more complex design in terms of component aging effects is readily accomplished by parameter variation. Changes in resistor, capacitor, and voltage values can be programmed to study the tradeoffs between power, bias, and distortion.

Other audio areas such as speaker, cartridge and tone arm, and tone control design can be investigated in similar fashion.

While most of the computers in use today are built to perform a specific function, they all fall into one or the other of two classes: analog or digital.

While each class can do the problems handled by the other, there are basic differences which make necessary a choice of which type to use in a particular case. Such a choice is made on the basis of the problem and its requirements. Such factors as problem accuracy requirements, the number of parameters, and their changes enter into this choice.

The digital computer has its greatest use in numerical analysis work where precise bookkeeping-like routines can be set up. The analog computer has its application in the area of system analysis work where systems must be engineered and optimized.

In order to illustrate the differences between the two classes, each will be discussed in the following sections.

Since audio design work is of interest to the reader of AUDIO, the major emphasis will be on the analog computer.

* *36 Ray Street, Schenectady, N. Y.*

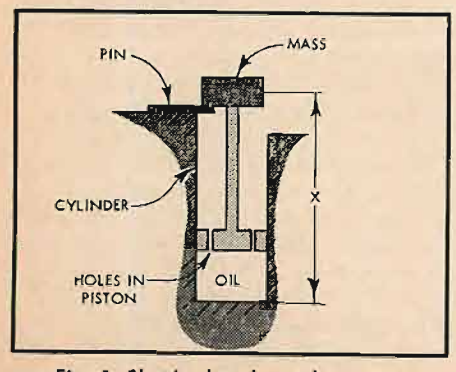

Fig. 1. Shock absorber schematic.

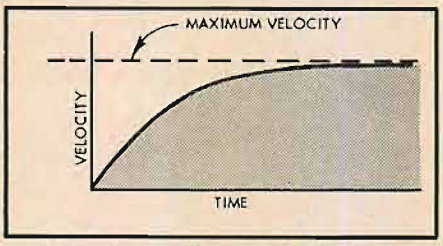

Fig. 2. Velocity of mass when the pin is pulled.

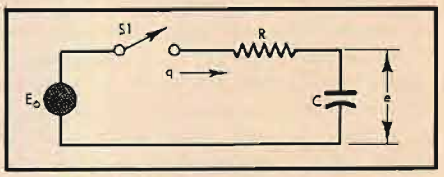

Fig. 3. Shock absorber analog.

The Digital Computer

The digital computer is a device that uses discrete steps to represent numbers while it performs mathematical operations. This is similar to the operation of an abacus. On the abacus, beads are used to represent numbers. Addition and subtraction are performed by the shifting of these beads. A similar procedure is used in electronic digital computers. In this case "bits" are used to represent the numbers. A number or quantity is changed to "bit" representation by the use of a code. The "bits" take the form of either the presence or the absence of a signal. The presence is denoted by the number "1" and the absence by the number "0" when setting up the problem. The over-all number or quantity is then represented by some combination of 1's and 0's, according to the code used.

By the use of Boolean algebra and other techniques beyond the scope of this article the various mathematical operations are performed.

The accuracy of these mathematical operations is limited only by the number of bits used to represent the quantity. Six decimal places of accuracy imposes no strain on a typical digital computer.

One of the main features of digital computers is the memory function. By the use of this memory a number can be stored in the machine until it is needed

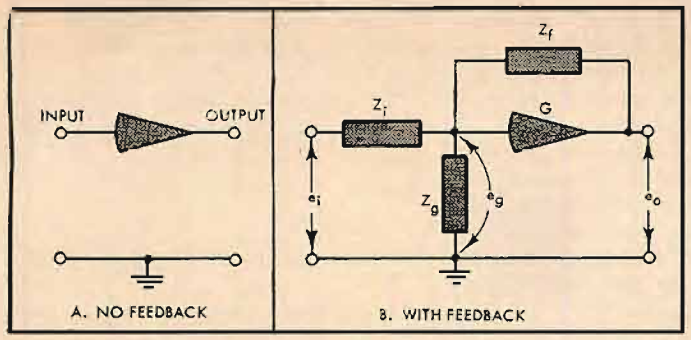

Fig. 4. Operational amplifier.

for computation. Upon being changed it can again be stored until further needed. For example, a bank account balance could be kept in a computer's memory. When the depositor makes a deposit, the teller, by pushing buttons, could call the depositor's balance from the memory. The new deposit could be added and the new balance put back in the memory where it remains readily available for future transactions.

These memories take three common forms: magnetic core, magnetic drum, and magnetic tape. The rate at which information is required in the computation determines which type of memory is used. The types are listed in order of decreasing accessibility. The core is the "fastest" memory. The bits take the form of a magnetized or unmagnetized core to indicate respectively the "1" or "0." The core memory immediately supplies the number it contains as often as desired. The magnetic drum is a metal drum coated with magnetic oxide. The bit is recorded as the presence or absence of magnetization in a particular area on the drum. The recording is done by heads similar to tape recording heads. The drum rotates at a high rate of speed. As the area passes under a fixed write-head a pulse is applied to magnetize or demagnetize the area as required. For readout, another head is used to detect the presence or absence of the signal as the area passes.

The information on the drum is available only once per revolution thus its "access time" is longer.

The tape storage is essentially the same as the drum except that a reel of tape is used. Some sort of searching technique has to be used to find the area in which the information is found, thus this is the slowest of the three methods described.

For such applications as missiles where high speed calculations are necessary, the core memory would be used. In the example of a bank account, the tape memory would probably be adequate.

The Analog Computer

The analog computer operates, as its name implies, by providing an analog of some physical process. One of the best examples of the analog computer is the slide rule. On the slide rule numbers are represented as lengths. The operations of adding or subtracting of lengths accomplish various mathematical operations.

In its engineering form the analog computer normally is used in the simulation of entire systems. While there are mechanical, electromechanical and electrical analog computers, this discussion will be confined to the electrical type.

In setting up an analog simulation the equations which represent the behavior of the actual physical system should be available. Electrical circuits are then made up which obey the same type or class of equations. Voltage and current variables within the electrical circuits

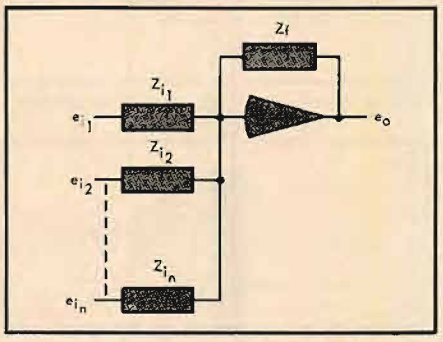

Fig. 5. General summation.

will behave in the same manner as do the variables of the physical system.

Changing resistors, capacitors, and voltages in the electrical circuit will then correspond to changing various physical parameters; mass, spring force, or length, for example. By making these circuit changes the engineer can easily optimize his design. The final circuit quantities can then be related back to the physical parameters.

The types of problem which are appropriate for an analog computer include aircraft simulation (of which the "Link Trainer" is a classic example), atomic reactor control, automobile suspension systems, and power transmission systems.

In order to show the theory of the analog computer it is necessary to have a problem. For the present, the problem to be discussed is that shown in *Fig.* 1. A mass is raised above some reference and held by a pin. The mass is connected to a piston which is immersed in a cylinder of oil. The piston has holes in it to allow the oil to flow through. This piston-cylinder combination is a typical shock absorber. What does the velocity of the mass become when the pin is removed? From experience it can be surmised that the mass will fall with increasing velocity until the oil is going through the piston holes as fast as it can. At this time the mass will have its maximum velocity and will keep this velocity until the piston strikes the bottom of the cylinder. The velocity will take the form shown in *Fig.* 2.

In order to set up an electrical analog of this problem it is necessary to write an equation of the system. Using conventional laws of mechanics this equation is:

$$M\ddot{x} - W + K_d\dot{x} = \Sigma \text{ Forces on mass} = 0 \qquad (1)$$

where

M = Mass of the body
W = Weight of the body = Mg
K_d = Damping coefficient due to the oil
$\ddot{x}$ = Acceleration of the mass
x = Velocity of the mass
g = Gravity acceleration

solving for $\ddot{x}$ and substituting Mg for W yields: (2)

$$\ddot{x} = g - \frac{K_d\dot{x}}{M}$$

Now if an electrical circuit can be determined which obeys an equation of the same form the analog is found.

Using "20–20 hindsight" consider the circuit of *Fig.* 3. Writing the charge expression for the voltage drops around this loop when S1 is closed we find equation 3,

$$E_o = R\dot{q} + \frac{1q}{C} \qquad (3)$$

where $\dot{q}$ is the current and q is the charge. Solving for $\dot{q}$ yields:

$$\dot{q} = \frac{E_o}{R} - \frac{1q}{RC} \qquad (4)$$

This equation is of the same form as equation 2. As $\ddot{x}$, the acceleration, is the time rate of change of $\dot{x}$, the velocity, so is $\dot{q}$, the current, the time rate of change of q, the charge.

The analog relationships of the quantities are given below with constants inserted to conserve units.

$$\ddot{x} = k_x\dot{q} \quad \text{where } [k_x] = \frac{\text{feet/second}^2}{\text{coulomb/second}} \qquad (5a)$$

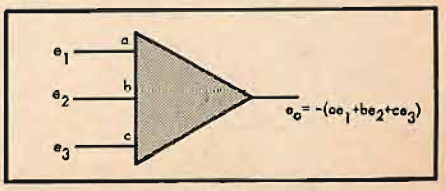

Fig. 6. Adder symbol.

$$\dot{x} = k_x q \quad \text{where } [k_x] = \frac{\text{feet/second}}{\text{coulomb}} \tag{5b}$$

$$g = kg' \frac{E_o}{R} \text{ where } [k_g] = \frac{\text{feet/second}^2}{\text{coulomb/second}} \tag{5c}$$

$$\frac{K}{M} = k_t \frac{1}{RC} \text{ where } [k_t] = \frac{1/\text{second}}{1/\text{second}} = 1 \tag{5d}$$

The small k constants are known as scale factors and as seen by their units are used to relate the various quantities of the actual and the analog system, k_t, is seen to be nondimensional. The numerical value of these scale factors depend on the expected range of the various variables.

It can be seen that the act of closing S1 in the electrical circuit is the same as the act of pulling the pin in the actual system. Further, it is evident that the actual system can be optimized by changing the electrical quantities until the desired operation is achieved. Then by using the scale factors the values of the actual system parameters that will cause the same response are established.

In analog computer work the basic building block is the operational amplifier. Through the use of RC networks in conjunction with the amplifier various mathematical operations can be formed.

The symbol most commonly used for the operational amplifier is given in (A) of *Fig.* 4. In (B) of that figure this amplifier is shown with an input impedance, Z_i, a feedback impedance, Z_f, and a grid impedance, Z_g. The amplifier gain is G. The input voltage is e_i, the grid voltage e_g, and the output voltage is e_o. An expression for the output voltage e_o will now be found by using Kirchoff's rule that the sum of the current into the grid point is zero. This leads to the expression

$$\frac{e_i - e_g}{Z_i} + \frac{e_o - e_g}{Z_f} - \frac{e_g}{Z_g} = 0 \tag{6}$$

The relation of the grid voltage to the output is given by:

$$e_o = -G\, e_g \tag{7}$$

$$e_g = \frac{1}{G} e_o \tag{8}$$

By combining equation 6 and equation 8 the output over input relation becomes:

$$\frac{e_o}{e_i} = -\frac{Z_f}{Z_i} - \frac{\frac{Z_f}{Z_i}\left(1 + \frac{Zi}{Zf} + \frac{Z_f}{Z_g}\right)}{G} \tag{9}$$

It is seen that if G is made very large, the second term vanishes leaving:

$$\frac{e_o}{e_i} = -\frac{Z_f}{Z_i} \tag{10}$$

This is the basic expression for use in analog computer work. The impedances can take various forms of RC networks giving a large variety of functional relationships between the input and the output voltages. These relationships are useful in complex problems.

The most common forms in use are the adder and the integrator. If more than one input impedance is added to the grid point as shown in *Fig.* 5, the output voltage will be the sum of all the inputs with gains determined by the impedance ratios as shown in equation 11.

$$e_o = -\left(\frac{Z_f e_{i1}}{Z_{i1}} + \frac{Z_f e_{i2}}{Z_{i2}} + \ldots + \frac{Z_f e_{in}}{Z_{in}}\right) \tag{11}$$

This addition applies regardless of the form of the impedance. If the impedances are resistors, the unit is an adder. For simplicity the adder is shown in *Fig.* 6 where gains a, b, and c are the respective ratio of the input and output impedances. (In this figure and from now on all voltages are with respect to ground.)

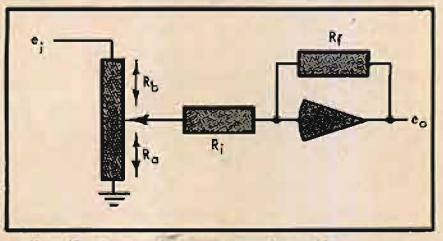

Fig. 7. Potentiometer gain adjustment.

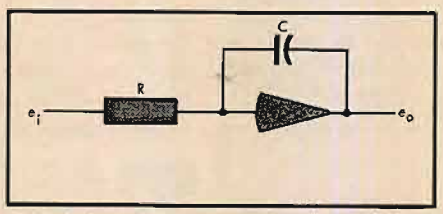

Fig. 8. Integrator operational amplifier.

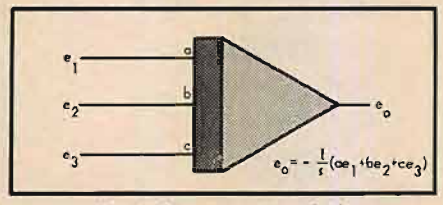

Fig. 9. Integrator symbol.

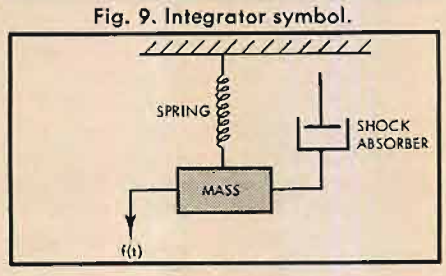

Fig. 10. Spring, mass, damper system.

Potentiometers can be used to obtain gain values. The input voltage, if fed into a potentiometer, will appear at the arm with a gain between 0 and 1 depending on the potentiometer setting. Thus, in *Fig.* 7 the input voltage appears at the amplifier output with the overall gain, $k_1 a$, where "k_1" is the ratio of R_a to $R_a + R_b$, and "a" is the ratio of R_f to R_i.

The integrator is shown in *Fig.* 8. In this case the feedback impedance is a capacitor. The relation from e_i to e_o becomes:

$$\frac{e_o}{e_i} = -\frac{Z_f}{Z_i} = -\frac{1}{Rj\omega C} = -\frac{1}{RC}\left(\frac{1}{S}\right) = -\frac{k}{S} \tag{12}$$

In LaPlace notation the $\frac{1}{S}$ signifies integration. A simple intuitive approach is given to show that this circuit does integrate. From equation 6 the currents into the grid point equal zero. Then if e_i is providing current, $\frac{e_i}{R}$, a current of equal magnitude must be flowing in the capacitor. This is possible only if the voltage across the capacitor is constantly changing. For a constant e_i the output e_o is then constantly increasing. This is integration. If e_i is removed, e_o will remain constant. For simplicity the integrator is given the symbol shown in *Fig.* 9.

The discussion of the integrator immediately leads to an analogy. If e_o is considered in a particular problem to be the position of a body, then e_i is the velocity of the body. The relation, again using LaPlace notation, is expressed by:

$$e_i = -k_1 S e_o \tag{13}$$

For this expression the S signifies differentiation. By the same reasoning the acceleration, which can be denoted by e_3 is:

$$e_3 = -k_2 S e_i = +k_1 k_2 S^2 e_o \tag{14}$$

The minus sign is associated with the minus gain of the amplifier. That is, a positive voltage at the input causes a negative voltage at the output. This reversal of sign is an important point to remember in setting up a system simulation.

In physical systems one relation appears more often than any other. This is the so-called "quadratic" response. The response of a spring, mass, shock absorber system as shown in *Fig.* 10 is of this type. The expression for this system response to an input F(t) is:

$$M\ddot{x} + K_d \dot{x} + K_s x = F(t) \tag{15}$$

This expression states that the input force is balanced by the acceleration, velocity, and displacement forces of the mass.

If LaPlace notation is used the expression becomes:

$$M S^2 x + K_d S x + K_s x = F(S) \tag{16}$$

which rearranges to:

$$\frac{x}{F(S)} = \frac{1/K_s}{\frac{M}{K_s} S^2 + \frac{K_d}{K_s} S + 1} \tag{17}$$

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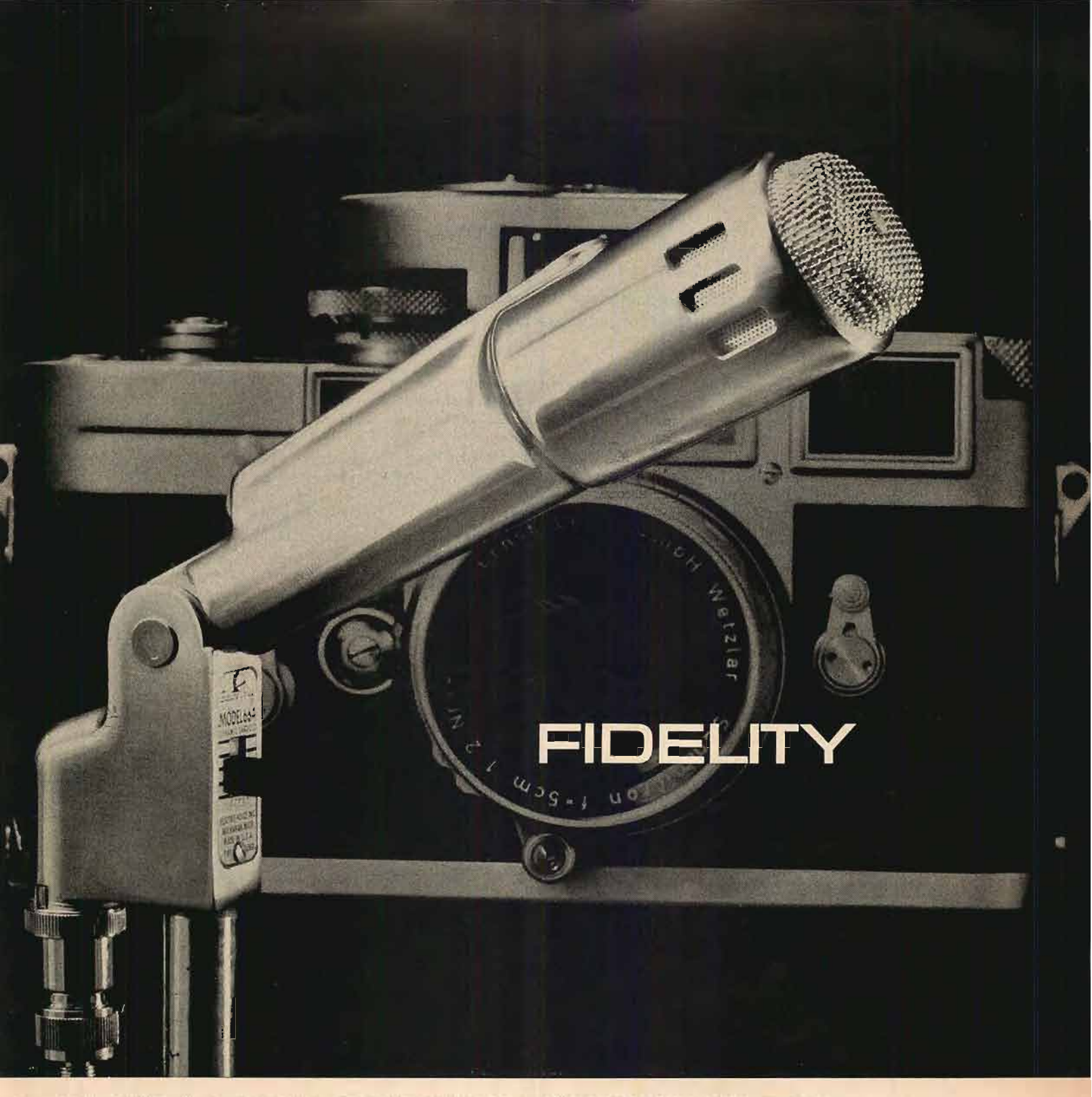

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Characteristics of Tape Noise

WILLIAM B. SNOW*

Tape noise is a fundamental limitation in all recording processes. Here are some criteria for judging a tape recorder with respect to noise.

NOISE IS A FUNDAMENTAL limitation in all recording processes. Unless a low noise level is achieved, true high-fidelity sound reproduction is impossible because low passages will be heard against a background of interfering and unwanted sounds. Low noise level with consequent wide dynamic range is a characteristic of modern magnetic tape recording

Signal-to-Noise Ratio

Signal-to-noise ratio in magnetic tape recorders is ordinarily expressed as the ratio of rms single-frequency signal at the level yielding 3 per cent harmonic distortion, to total noise measured over the complete reproducing frequency range. The 3 per cent point represents the maximum permissible recording level for signal peak amplitudes, and is usually measured at 250 cps.

When the signal-to-noise ratio is expressed as a single number in this manner for magnetic tape recorders, it essentially represents a signal-to-hum ratio. Hum reduction is particularly difficult with tape recorders because the magnetic reproducing head must be mounted near motors and power transformers which produce magnetic fields from which the head must be shielded. In addition, the playback equalization for magnetic recording necessitates maximum gain at low frequencies. It was felt that a somewhat detailed examination of the noise from a tape recorder would be of interest. A Movicorder tape recorder was employed operating at a speed of 7.5 inches per second.

* *Consulting Engineer, Santa Monica, California.*

Tape Noise Frequency Analysis

First, a portion of tape containing a 250-cps tone recorded at maximum level was reproduced to give a reference output reading. Then, erased tape was reproduced without alteration of the playback amplifier gain while noise output was measured through the electrical filters of two types of frequency analyzer.

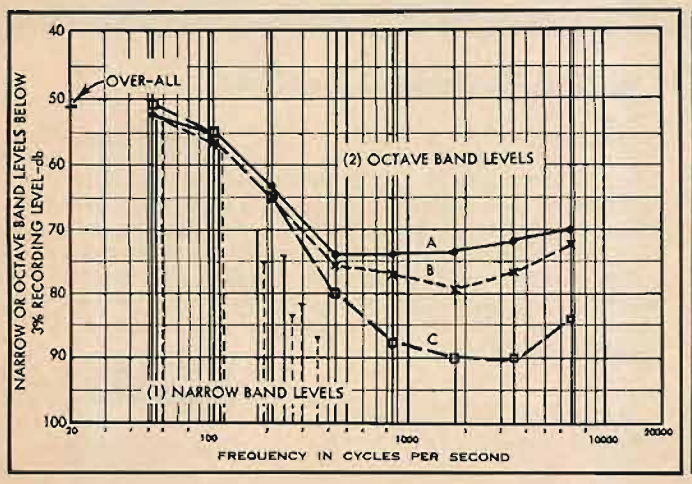
Figure 1 shows the results of the noise measurements made with a narrow band (25 cps) and an octave band analyzer. The usual signal-to-noise ratio described above is shown by the line at "Over-all" to be 52 db. With the octave filters, noise was checked for three conditions: tape erased in the machine (Curve A), bulk-erased tape (Curve B) and tape stopped showing only playback amplifier noise (Curve C).

It can be seen that the over-all level is mostly accounted for by the noise in the two lowest octave bands. Above 300 cps the levels are much lower. At low frequencies two sets of "spikes" are shown, measured with the 25-cps band analyzer which could separate the individual hum components. The noise in the two lowest octave bands is contributed almost entirely by the hum components, 60 and 120 cps, and is essentially unchanged when the tape is stopped. Above 200 cps, however, the noise comes principally from the tape, and residual electrical noise (Curve C) is negligible in comparison to it. The amplifier has the capability of playing much quieter tapes in the future as they are developed. Small difference between noise for bulk-erased and machine-erased tape indicates good balance in the erase oscillator.

Comparison With Room Noise

It is important to the success of magnetic recording that the signal-to-noise ratio at higher frequencies is much greater than the usual single number discussed above. The octave-band levels are roughly constant and are about 75 db below the standard 3 per cent distortion level. *Figure* 2 has been prepared to explain the significance of this. Rather than ratios, this figure shows actual sound levels as measured in a room with a sound level meter and analyzer. They have been plotted in the special form of "masking level"; that is, the level which noise from the reproducing system must attain if it is to be detected in the presence of the room noise. If it falls below

(*Continued on page 82*)



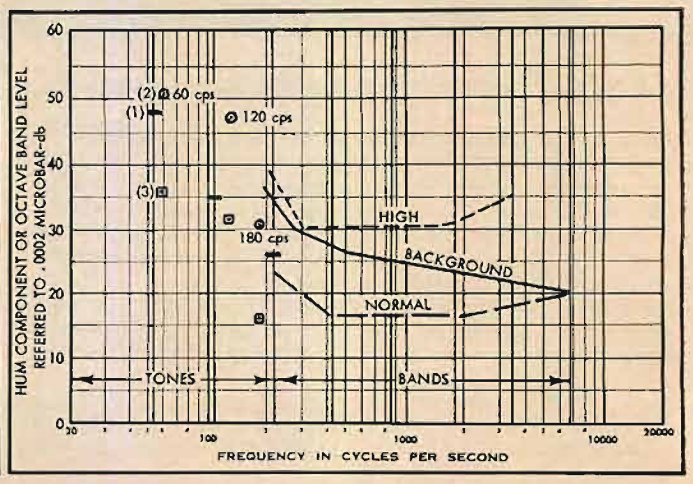
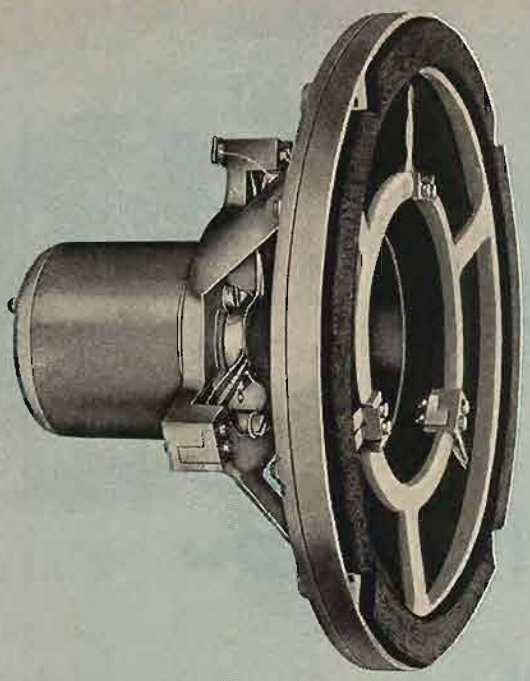
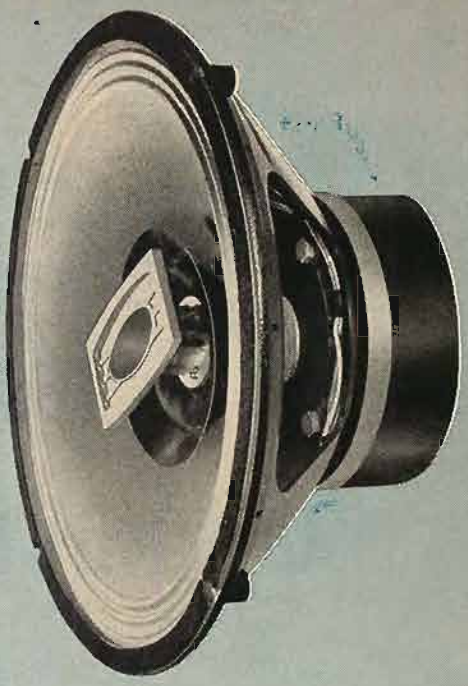


Fig. 1. (left) Results of noise measurements on a typical recorder. Fig. 2. (right) Recorder noise compared to room background noise for typical quiet room. Above 200 cps shown as octave bands; below 200 cps shown as single tones.

WITH GOODMANS LOUDSPEAKERS



...IT'S WHAT YOU DON'T SEE THAT COUNTS!



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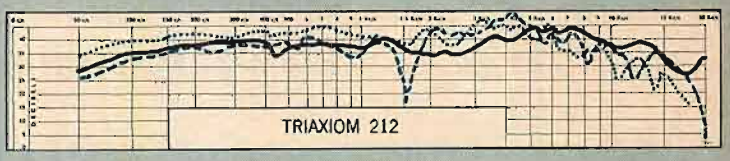

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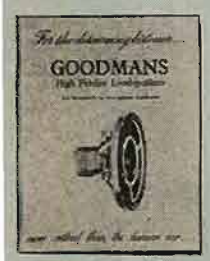

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Understanding the Tape Oscillator

Incorrect bias can increase distortion, reduce the amount of signal recorded, and also decrease high frequency response. Here is an explanation of biasing which will answer many questions as to how and why.

HERMAN BURSTEIN AND HENRY C. POLLAK*

ONLY IN ONE RESPECT—the oscillator—do tape amplifier circuits differ radically from the circuits normally found in control and power amplifiers. Otherwise, the tape amplifier employs similar means for the similar tasks of amplifying signals, controlling gain, shaping frequency response (equalization), minimizing noise and hum, and performing various switching functions.

Accordingly, the technician or audio-fan conversant with audio amplifier circuits should not find tape electronics presenting essentially different problems, except for the oscillator. Therefore it is the purpose of this article to provide a basic understanding of the oscillator circuits commonly found in tape recorders. Such an understanding will facilitate the work of the individual seeking to restore a tape oscillator to correct operation, to improve its performance, or to build a tape amplifier capable of recording satisfactorily.

Functions of the Oscillator

The oscillator operates only when the tape recorder is in the record mode and supplies high-frequency current, also known as bias current, to the record and erase heads. The frequency is usually between 40,000 and 100,000 cps. In a few recorders employing a permanent magnet for erase or in special machines such as tape duplicators, where erase is not required, current is supplied only to the record head.

Bias current in the record head serves two vital purposes. It increases the amount of signal recorded on the tape. It reduces distortion. Unfortunately, as bias current is increased above a certain point, high frequency response deteriorates. Hence one must guard not only against insufficient bias current, which results in excessive distortion and poor signal-to-noise ratio, but also against too much bias current, which produces severe treble losses. The slower the tape speed, the greater are these high-frequency losses.

Bias current requirements of record heads are usually quite modest, on the order of 1 ma for many heads. In contrast, erase heads require a good deal more current in order to perform effectively. A typical erase head may require from 15 ma upwards.

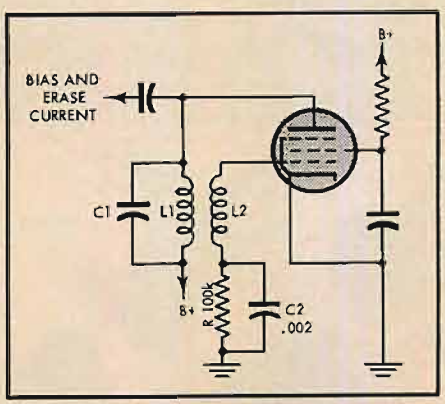

Fig. 1. Single-ended oscillator employing plate-to-grid feedback.

Oscillator Operation

Most oscillators employed in tape recorders operate by applying positive feedback between appropriate tube elements, usually between plate and grid, in an amount sufficient to sustain oscillations in a tuned circuit consisting of a coil and capacitor. The values of the coil and capacitor essentially determine the frequency of oscillation.

The operation of a tuned-circuit oscillator is a complex process, with many things happening at once. A complete description requires tracing over one cycle of oscillation the phase relationships between voltage and current in electromagnetic and electrostatic fields and in a tube circuit. Instead of going through such an analysis, this article will attempt to provide a simpler, basic insight into how an oscillator works.

A fundamental explanation can be based around *Fig. 1*, a simple oscillator similar to that actually found in many moderate-price tape recorders. To understand why oscillation takes place, it is helpful to consider first just the tuned circuit, comprising *C1* and *L1*. Assume that for some reason the upper plate of *C1* is charged, that is, contains more

(*Continued on page 32*)

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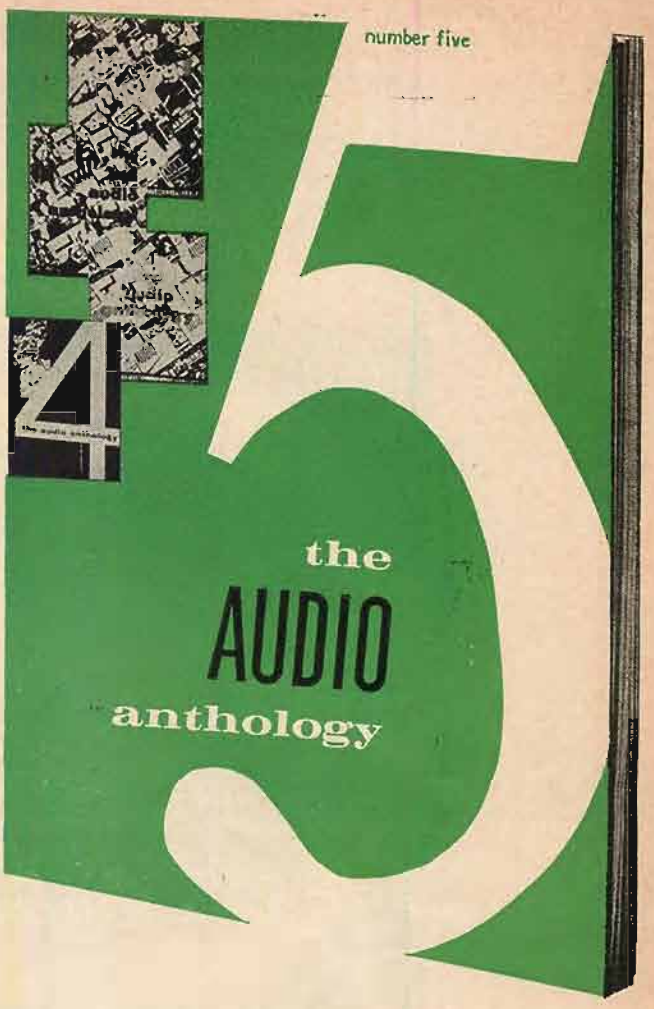

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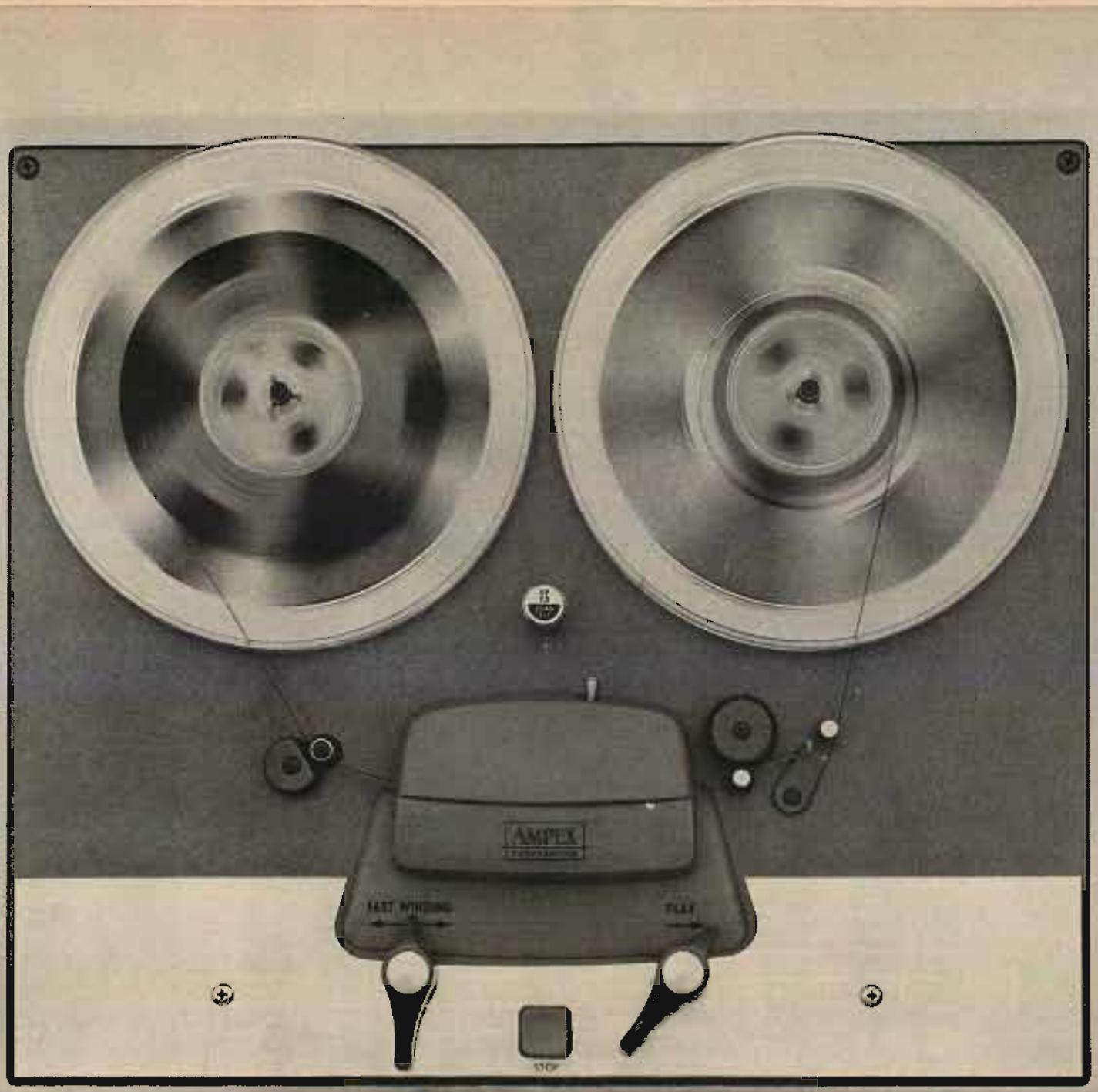

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TAPE GUIDE

(*from page 28*)

electrons than the lower plate. Seeking equilibrium, electrons tend to flow from the upper to the lower plate through the path afforded by *L1*. This flow creates an electromagnetic field about the coil and, by Lenz's Law, induces a voltage across the coil of a polarity such as to prevent electrons from flowing rapidly through the coil. Thus the electron flow *gradually* reaches a maximum and then starts to slow down as the charges on the upper and lower plates approach equilibrium. However, when the rate of discharge of electrons from the upper to the lower plate begins to slow down, the field of *L1* begins to collapse. By Lenz's Law, a voltage is again induced which opposes the change in electron flow through the coil. Thus the collapsing electromagnetic field promotes the continued flow of electrons from the upper to the lower plate. In this manner the lower plate collects not just enough electrons to restore equilibrium with respect to the upper plate (zero voltage across the capacitor); rather, it accumulates an excess of electrons compared with the upper plate.

Eventually the coil's field has fully collapsed so that no more electrons arrive at the lower plate. Now this plate has an excess of electrons; in other words, the capacitor has an electrostatic field, which is the counterpart of the coil's electromagnetic field. Therefore, electrons begin to flow from the lower to the upper plate through the coil. As before, an electromagnetic field is built up around *L1* and, when this field collapses, it results in the continued accumulation of electrons on the upper plate of *C1*, so that the original state of matters is restored: an excess of electrons exists on the upper plate. This completes one cycle of oscillation.

Assuming no resistance in the coil and no load, the tuned circuit produces a perfect sine wave, eminently desirable for tape recording purposes to achieve a minimum of noise. In practice, this is, of course, impossible; some distortion is always present. However, oscillator waveform distortion and resulting noise are kept to negligible quantities in high-quality tape recorders.

The frequency of oscillation—or the time required for one cycle—essentially depends upon the values of *L1* and *C1;* to some extent it is also governed by the slight amounts of inductance and capacitance found in the tube and other components associated with the tuned circuit. The coil and capacitor values, *in conjunction with each other*, determine how long it takes for the electromagnetic field of *L1* to build up and die

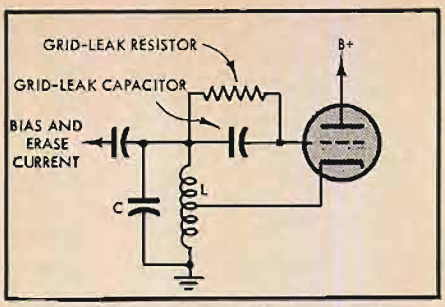

Fig. 2. Single-ended oscillator employing cathode-to-grid feedback.

away and for the electrostatic field of *C1* to do the same. The larger the inductance of *L1*, the longer its field takes to grow and fall. Similarly, the larger the capacitance, the longer it takes to discharge electrons from one plate to the other. At the oscillation frequency, the charge or discharge rates of the two components are equal, and they work in unison: the electromagnetic field stores energy for the same period that the capacitor is able to deliver it, and in turn the capacitor stores energy for the same period that the coil is able to deliver it.

Another way to appreciate why a circuit such as *Fig. 1* oscillates at one particular frequency is to consider the impedance between the plate side of the tuned circuit and ground. (It should be recognized that the bottom of the tuned circuit is effectively at ground so far as a.c. is concerned because of the filter capacitor associated with B-plus.) Maximum impedance of the tuned circuit occurs at the frequency where the reactances of *L1* and *C1* are equal. For any other frequency, the impedance is less, so that either the coil or capacitor tends to serve as a shunt to ground. Consequently, alternating current developed through oscillation tends to be shunted to ground except at the frequency where impedance is maximum.

Once started, oscillation in a tuned circuit would theoretically continue forever were it not for various losses, in-

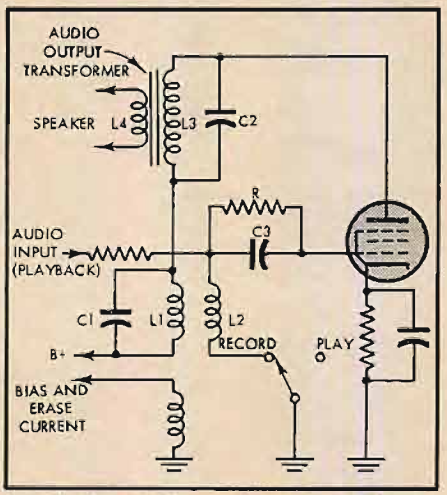

Fig. 3. Use of the audio output tube as an oscillator in the record mode.

cluding those due to coil resistance, capacitor leakage, and the load presented by the tape recorder heads and other circuit elements. For oscillation to be sustained, the tuned circuit needs outside aid. This is similar to the child on a swing, who keeps moving as the result of a moderate systematic push from someone on the ground.

The tuned circuit receives systematic aid from the tube circuit with which it is associated. When the upper plate of *C1* is to be charged, matters are arranged so that tube current increases, thereby sending more electrons to this plate. Conversely, when the lower plate of *C1* is being charged, tube current decreases, sending more electrons to this plate (from the viewpoint of a.c., a decrease in tube current is in effect a flow of electrons from B-plus toward the tube).

The purpose of *L2* in *Fig. 1* is to vary the grid voltage in a manner which causes tube current to assist the oscillation process. The changing electromagnetic field of *L1* cuts across *L2* and, by transformer action, induces a voltage across *L2*—that is, between grid and ground. The windings of *L2* are so connected to grid and ground that when tube current is increasing the grid end of *L2* goes positive, which causes a further increase in tube current. This of course is positive feedback. Similarly, when tube current is decreasing, the grid goes negative, resulting in a further reduction in tube current.

The cumulative increase or decrease in tube current which takes place due to positive feedback approaches an end when the charge on either plate of *C1* approaches maximum. There is a slowing collapse of the magnetic field around *L1* and eventual reversal of this field as *C1* approaches maximum charge and then begins to discharge. This results, through transformer action, in a decrease in grid voltage (positive or negative as the case may be) and eventual reversal of grid polarity.

Though belated, an explanation of how oscillation gets started is now appropriate. Assuming that B-plus has been applied to the circuit and current supplied to the tube heater, initially there is zero voltage between grid and cathode. Due to the random motion of electrons emitted from the cathode, a minute voltage will appear at the grid. Assume that at a given instant this voltage is positive-going. Therefore the current through the tube increases. This increase in tube current results in a charge on *C1*, a change in the electromagnetic field of *L1*, positive feedback at the grid, a further increase in tube current—and the process of oscillation is on, as already described.

Grid-Leak Bias

The purpose of grid resistor *R* and

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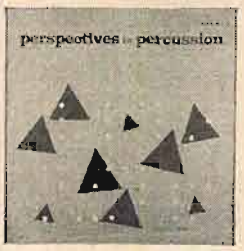

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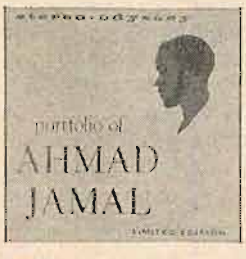

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grid capacitor C_2 in *Fig.* 1 is to provide the oscillator tube with the required negative grid bias. The amount of grid bias depends upon the magnitude of oscillation needed—within the tube's capabilities. When the grid goes positive and draws current, the resulting electron flow charges the top of the capacitor. The only path for the capacitor to discharge through is the grid resistor. As electrons leak slowly from top to bottom of the capacitor through the resistor, this flow causes a negative d.c. voltage to appear at the top of the resistor. This voltage also appears at the control grid.

The negative grid-leak bias reduces the transconductance (g_m) of the tube, and thereby the gain around the complete oscillation loop. If the loop gain is greater than 1, as it must be for oscillation to start, the amplitude of each successive oscillation will be greater than the previous one. This causes the grid to swing more into the grid current region on each positive half cycle, resulting in more grid-leak bias. But the bias affects the transconductance markedly; the greater the negative bias, the lower the g_m. So each positive grid swing results in added negative bias, reducing the g_m, and hence the gain, until the loop gain is exactly 1. The amplitude of the oscillations will remain at this value very closely.

The self-regulation of the grid-leak bias system is not perfect, but is sufficient to make the oscillator relatively insensitive to line voltage variations, changes due to normal heating of the components, and tube aging.

The grid capacitor loses some of its charge during every cycle, but unless the oscillations are getting smaller, each positive grid swing recharges the capacitor, thus maintaining the bias voltage. The time constant of the grid-leak capacitor and grid resistor (product of R times C_2) determines how long the capacitor can discharge through the resistor before the voltage has dropped appreciably. This time constant should be about 5 to 10 times the period of one cycle of oscillation to maintain grid bias adequately. For example, if the oscillator frequency is 50,000 cycles per second, one cycle is 1/50,000 second, or 20 microseconds (μsec); 10 times this amount is 200 μsec. The time constant of the 100,000 ohm resistor and .002 microfarad capacitor in *Fig.* 1 is 200 μsec.

Although grid-leak bias keeps the amplitude of oscillations from being extremely great, it is very desirable also that feedback be limited so that the tube operates within the linear portion of its characteristic in order to maintain an oscillation waveform with minimum harmonic distortion. In the case of *Fig.* 1, feedback is controlled by using a proper ratio of turns and the right amount of coupling between L_1 and L_2, thus limiting the voltage fed back to the grid.

Oscillator Variations

There are several variations of the single-ended oscillator of *Fig.* 1. In a popular variation, the oscillator coil is in the grid-cathode circuit, as in *Fig.* 2. For positive feedback to occur here, it is necessary that the grid go positive relative to the cathode when tube current increases, and negative when current decreases. Positive grid-cathode voltage, in turn increases tube current, and negative grid-cathode voltage decreases it. The cumulative buildup or decrease in tube current is controlled by the tuned circuit so as to sustain oscillation.

Assume that the current flowing from ground through the lower part of oscillator coil L and then through the tube is momentarily increasing. This increasing current induces a voltage across the grid-ground portion of the coil such as to oppose the increase. That is, the inductive reactance of the coil causes a voltage drop across it, causing the

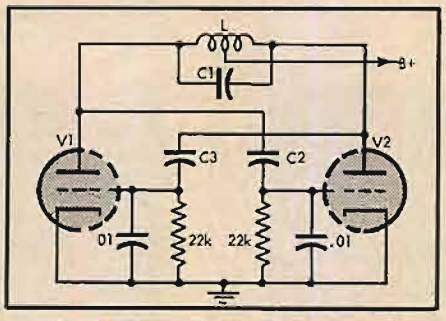

Fig. 4. Typical push-pull oscillator.

cathode end to go positive with respect to the ground end. By autotransformer action, the positive-going voltage at the cathode appears as a still more positive voltage at the grid, causing a further increase in tube current. Thus, as in *Fig.* 1, positive feedback is present. The voltage between grid and ground causes capacitor C to charge, making the grid-end positive and the ground-end negative. Since the tube current cannot increase without limit, the tube current eventually reaches a maximum, that is, a steady value. As a result, there is no longer an induced voltage due to tube current increasing. Consequently the grid-to-ground voltage decreases and capacitor C discharges upward through the coil.

As the grid-to-ground voltage decreases, the grid-to-cathode voltage decreases and so does the tube current. This induces a voltage in the lower portion of the coil, this time negative at the top and positive at the ground end. As before, autotransformer action causes the grid to go more negative with respect to the cathode, further reducing tube current, making the grid still more negative, and thus assisting the upper plate of the capacitor to go negative with respect to the lower plate. It should be kept in mind that the process of positive feedback and the turning points from increasing to decreasing tube current are under control of the tuned circuit, which determines the rate of increase and decrease in tube current and thus the frequency of oscillation.

Finally, it may be pointed out that while the locations of the grid-leak resistor and capacitor are different in *Fig.* 2 than in *Fig.* 1, the action is exactly the same.

Double-Purpose Oscillator

The majority of moderate-priced tape recorders contain a small speaker and a power amplifier, usually single-ended, for playback purposes. As a measure of economy, a number of these machines convert the audio output tube to an oscillator in the record mode. In a few instances, a similar double function is served by other tubes. For example, in one recorder the playback input stage becomes an oscillator when recording.

Figure 3 shows a circuit in which the audio output tube doubles as an oscillator. L_1 and L_2 constitute the oscillator coil, providing plate-to-grid feedback. The primary of the audio output transformer is in series with L_1. Capacitor C_2 across the output transformer primary offers a low-reactance path at the oscillator frequency between the plate of the tube and the primary of the oscillator coil. Similarly, L_1 of the oscillator coil offers a low-reactance path at audio frequencies between B-plus and L_3, the output transformer primary.

Push-Pull Oscillators

The great majority of professional and semi-professional tape recorders and a fair number of moderate-price ones employ a push-pull oscillator, customarily using the two halves of a dual triode such as a 12AU7 or 12BH7. While one triode is in the positive half of its oscillation cycle, the other is in the negative half. Thus, symmetrical forces are at work, reducing even-harmonic distortion. Distortion in the bias waveform is a source of noise. The greater the demands upon the oscillator to provide enough current for adequate erasure, the greater is the likelihood of distortion. Because of its lower distortion for the same output, the push-pull oscillator is favored.

Figure 4 shows a typical push-pull oscillator. Feedback is from the plate of V_1 to the grid of V_2 through capacitor C_2; and from the plate of V_2 to the grid of V_1 through capacitor C_3, C_1, as well as C_2 and C_3, together with coil L essentially determine the resonant frequency.

Assume the grid of V_1 is positive-going at a given instant. This produces a

(*Continued on page 82*)

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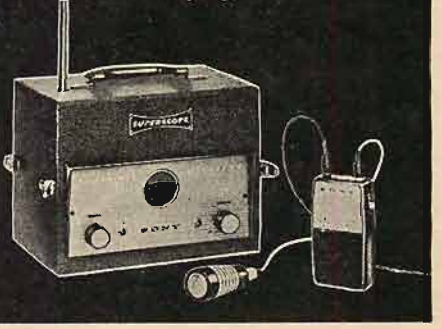

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Loudspeaker Design

Converting the electronic "message" from the amplifier into sound requires the loudspeaker to undergo physical contortions which may, or may not, distort the message. Understanding the fundamentals of achieving "distortionless contortions" may help in selecting the loudspeaker best suited to your requirements.

NORMAN H. CROWHURST*

THIS IS NOT an article on how to design a loudspeaker. For one thing, very few readers are likely to have the opportunity of designing their own loudspeaker. On the other hand, anyone pursuing audio as a hobby is interested in good reproduction and hence is concerned in getting a good loudspeaker. In this connection, many are wanting to know "what the score is" about the different ways of designing a loudspeaker system. This is because the fact still remains that the loudspeaker is the weakest link in the reproducing chain and because of the divergence of design approaches used in the products available in this field.

To clarify this matter we will explain some of the simple principles of loudspeaker design, so that those interested can better understand how different approaches to the problem attempt to achieve their objective. The aim of any system, of course, is to convert the electrical energy delivered by the amplifier into acoustical energy in the room, with the greatest degree of fidelity possible.

We would like to have sound waves whose pressure variations are directly proportional to the voltage variations at the output of the amplifier, regardless of the frequency and amplitude of the fluctuations. Unfortunately, however, to date there is no direct means that is commercially practical, of transferring electrical energy into acoustical energy without going through some mechanical medium. The nearest practical approach to this is an electrostatic loudspeaker. But this has to have a diaphragm to transform the electrical force between its plates into mechanical movement of the air.

* *216–18 40th Ave., Bayside, N. Y.*

Table 1

Mechanical system	Electrical system	Acoustical system
Force	Voltage	Pressure
Velocity	Current	Volume movement
Displacement	Charge	Volume displacement
Friction	Resistance	Viscous action
Mass	Inductance	Air mass
Compliance	Capacitance	Air compliance
Lever	Transformer	Change in area

The more conventional dynamic type loudspeaker uses a voice coil, the currents in which produce mechanical force, which in turn drives the diaphragm, and the diaphragm, by contact with the air, produces movement in the form of sound waves. So we have two transfers of energy to think about, electro-mechanical from the voice coil to the diaphragm, and mechanical-acoustical from the diaphragm to the atmosphere.

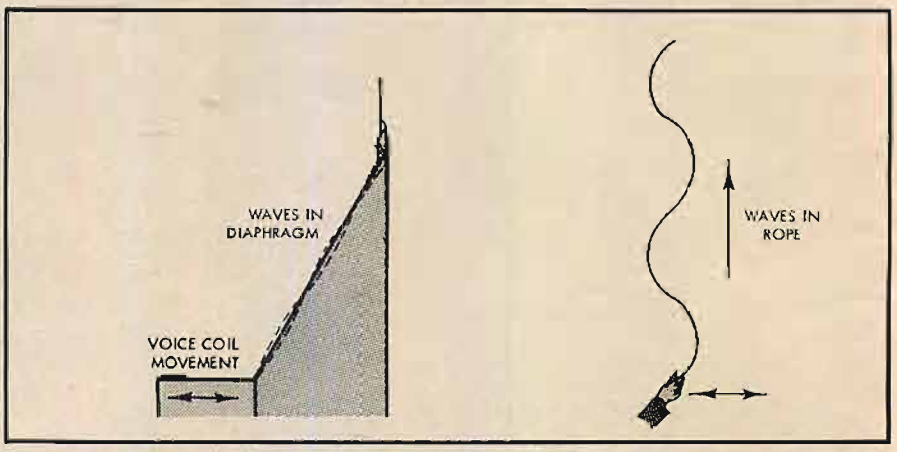

Fig. 1. Showing the manner in which transverse waves are set up in the cone or diaphragm of a loudspeaker: (a) a section through the voice coil and diaphragm; (b) an analogous form of wave propagation.

The Use of Analogies

A great help in understanding what happens is the use of analogies. When we start to learn about electricity, we often use analogies, from mechanical or other spheres, to help to explain the behavior of electricity. Now that electronic circuits have progressed so far, and the general understanding of them improved so well, it is often helpful to reverse the procedure and use electrical circuits as analogies for mechanical or acoustical behavior.

An important thing to realize is that an analogy is only a convenient parallel way of thinking. *It does not express identity,* nor does it relate quantities that can be transformed directly from one to another.

Table 1 lists the more conventional analogies used. The left hand column gives the mechanical quantity, the center column gives the equivalent electrical quantity in the analogy, while the right hand column gives the acoustical quantity that corresponds.

In this system of analogy we make force *equivalent* to voltage, but this does not say we can convert force into voltage in an electro-mechanical transducer. If we use an electrostatic device, it is true that the electrical voltage produces a deflection force on the diaphragm, but when we use a dynamic device, such as a moving coil loudspeaker, a different transfer takes place: it is current that is responsible for producing driving force in the coil former; movement of the coil former in turn produces voltage.

So if we were to use the direct transference that occurs in a moving coil transducer, we should reverse the order of the analogy and make current correspond with force and voltage with movement. On the other hand, in the electrostatic transducer, it is the voltage that produces force on the diaphragm; while movement of the diaphragm causes charge to flow in or out of the transducer in the form of current. To avoid confusing the issue, we will only use the one analogy.

Following the analogies down, they are fairly simple to follow: mechanical friction corresponds with resistance. This is evident because both are responsible for the dissipation of energy in their respective systems.

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The ultimate test of a high fidelity system, then, is a direct comparison with the sound of the original instruments.

The moment of transition from live to recorded sound: AR-3 speakers and Dynakit amplifiers take over from the Fine Arts Quartet.

Such a comparison was made during the recent hi-fi show in New York City, when AR speakers and Dynakit amplifiers vied with the Fine Arts Quartet in a "live *vs.* recorded" concert. At intervals the Quartet stopped playing and allowed the hi-fi system to take over, using pre-recorded sections of the music, without missing a beat.

McProud, editor of *Audio*, reported: "We must admit that we couldn't tell when it was live and when it wasn't." The *Herald Tribune* referred to "awesome fidelity". Record reviewer Canby wrote: "My eyes told me one thing, my ears another." Freas, audio editor of *High Fidelity*, wrote: "Few could separate the live from the recorded portions."

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Mass corresponds with inductance: the mass or weight of a moving object, which is called its inertia, tends to continue its course of movement until a force is applied to change it. Force is needed to start the movement, and again to stop it. In electrical circuits, using the analogy, this is the characteristic of inductance where the current tends to be steady and has to have a voltage applied in order to change it.

A compliance corresponds with a capacitance: application of a force produces a deflection or displacement in the compliance that will remain until the force is removed, the same as application of a voltage produces a charge on the capacitance. When the pressure on a compliance is changed, the mechanical device moves. When a voltage on the capacitance is changed, current flows in or out of it.

In an electrical circuit a transformer changes a combination of high voltage with low current to a lower voltage with higher current, or vice versa. It changes the relationship between voltage and current at which energy is transmitted. In mechanics a lever enables a small force with a large movement to produce a large force with a small movement or vice versa, thus performing a function in mechanical circuitry similar to a transformer in electrical circuitry.

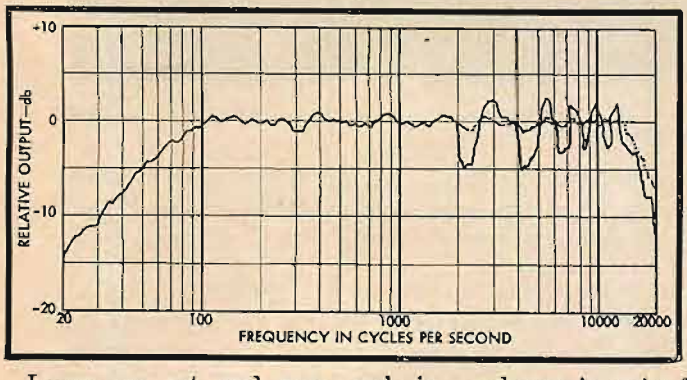

Fig. 2. The effect of the transverse waves in the diaphragm on the frequency response: the solid curve represents incorrect termination, while the dotted one shows what correct termination in the surround does.

Levers are not used very much in modern loudspeakers. The only types in which they have ever been used are the moving iron and the crystal types. This was because the driving force was produced by an extremely stiff device that was capable of large forces with small movement. The lever helped to get a larger movement more suitable for driving the diaphragm. In other words, it helped achieve mechanical matching.

The reason why levers are avoided in the mechanical design of loudspeakers is that they are not so easy to design with a wide frequency response as are electrical transformers. A lever to operate equally well at all frequencies from 20 to 20,000 cps is a very difficult requirement to meet.

Electromechanical Part

Now let's see how the electromechanical analogy helps us in understanding the behavior of a loudspeaker. We have a driving force from the voice coil, the object of which is to produce a movement of the diaphragm for the purpose of transmitting the energy to the air on a uniform voltage-pressure basis. To figure out an equivalent electrical circuit for the mechanical action, we have to think about what opposes the movement due to the force supplied by the voice coil.

This is equivalent to the impedance presented to an electrical source voltage. The current accepted by the impedance is analogous to movement: the lower the impedance, the greater the current; the lower the mechanical impedance, the greater the movement produced by a given force. So if forces due to two kinds of mechanical reaction are both combining to oppose movement of the voice coil, these two forces must be considered as equivalent to components of impedance *in series*. The movement, corresponding to current, is common to both and the force that they produce, due to their reaction, will be dependent upon the movement.

Assume for the moment that the voice coil with the diaphragm forms a rigid assembly and the only forces that will oppose its movement are due to the air in contact with the two sides of it. These two columns of air reflect as two impedances *in series* from the mechanical viewpoint. One due to the behavior of the column in contact with the back of the diaphragm, associated with the enclosure, and the other in contact with the front, which usually radiates out into the air. More of this anon; meantime this is somewhat of an oversimplification, based on the assumption that the voice coil is rigidly coupled to the diaphragm.

This is not quite true. It is coupled by material having certain mechanical properties and that is what we want to consider immediately. The diaphragm is not completely rigid, so the center part, attached to the voice coil, can move in a manner somewhat different from the outer periphery and the various other parts of the diaphragm.

The easiest way to think of the transmission of movement from the voice coil, applied at the inner periphery of a loudspeaker diaphragm, to the outer periphery is in terms of a mechanical transmission line. The force applied is approximately transverse. This is illustrated in *Fig.* 1. In our ideal conception the diaphragm should move back and forth as an entity with the voice coil, but due to its mechanical compliance or stiffness and its effective distributed mass, in conjunction with the effect of air in contact with its surfaces, it tends to behave like a length of string or rope when one end of it is waved to and fro sideways. The essential difference from this analogy is that the length of string is *relatively* flexible, while the diaphragm is *relatively* rigid. However, the same kind of effect occurs to a limited extent.

The transmission velocity or speed at which the wave travels outward from the voice coil is similar to—or not *very* different from—the speed of sound in air which, in *very* round figures, is 1000 feet per second. Using this figure, a wavelength at 1000 cps occupies one foot, which gives us a useful basis for considering when this transmission effect could set up interferenee patterns.

At high frequencies, where the wavelength is shorter, the distance from the voice coil to the periphery of the diaphragm becomes several wavelengths of transversely propagated wave, so the diaphragm can break up into patterns due to the reflected wave (if any reflection occurs). This is the cause of the irregularity in frequency response toward the top end of the frequency range of most single unit loudspeakers.

Much of this can be smoothed out by careful attention to the compliance of the diaphragm surround—the crinkled part that allows it to move back and forth freely at the periphery. Use of a suitable impregnating compound possessing an appropriate combination of compliance and viscosity, provides a terminating impedance in the mechanical material of the surround which prevents reflection and hence avoids the break-up effect. This method of treatment will do much toward flattening the upper end of the loudspeaker frequency response. *Figure* 2 shows this.

A difficulty arises in the fact that the properties of most of these impregnating compounds change with aging, and hence the upper frequency response deteriorates as the diaphragm gets older.

Attention to the compliance of the spider or centering device attached to the inner periphery of the diaphragm will also assist in controlling the movement, although this is strictly at the "sending end" of the transmission line and appears merely as a series element in the driving force.

If the loudspeaker is driven from an amplifier with a high damping factor,

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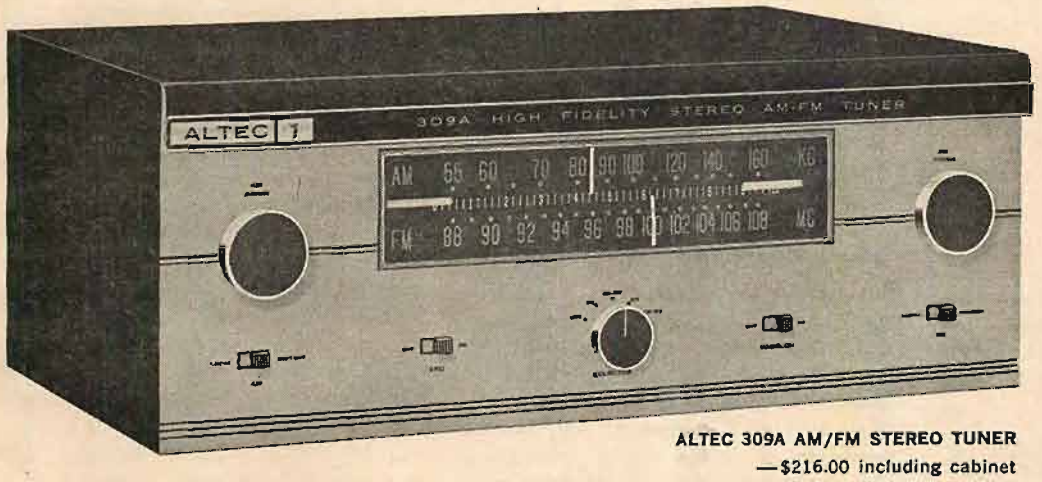

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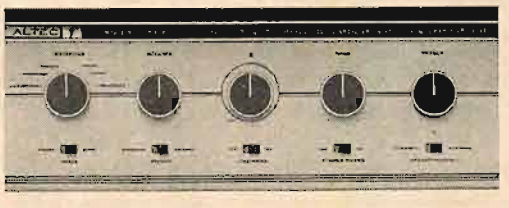

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Antenna: Standard 300 ohm—**Maximum Sensitivity:** 2 microvolts—**Quieting Sensitivity:** 2.9 microvolts for 20 db/7.0 microvolts for 30 db—**Frequency Range:** 86.5 to 108 mc—**Image Rejection:** 45 db—**IF Rejection:** 55 db—**Detector Peak Separation:** 450 kc—**Frequency Response:** ±1 db 20 to 20,000 cps—**Antenna Radiation:** Meets FCC requirements.

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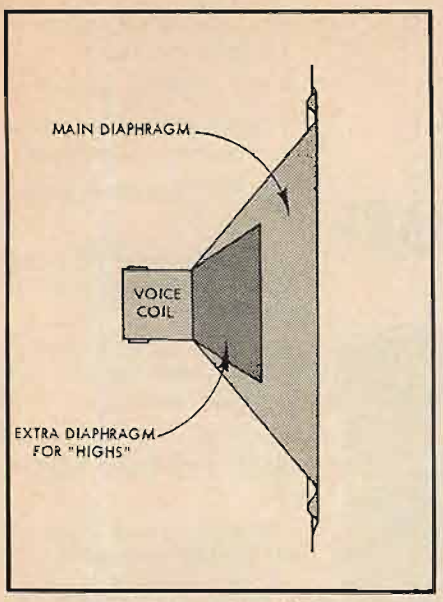

Fig. 3. One kind of modification to a loudspeaker diaphragm that is designed to augment the reproduction of higher frequencies.

the voice coil will offer fairly high mechanical resistance to being moved by the diaphragm, and hence the electrical effect can be considered as equivalent to a mechanical high impedance source. The effect of viscosity in the spider will merely add to the effective mechanical source resistance.

Nonlinear Distortion

A more important feature of the spider is that its compliance should have linear properties. The restoring force should always be proportional to the deflection, otherwise it will distort the movement of the diaphragm.

There are two possible causes of nonlinear distortion in a loudspeaker:

(1) due to nonlinearity of the driving force, because the magnetic flux in the air gap is nonuniform. This will mean that the same current in the voice coil will not produce the same force at all positions in the gap, and consequently the driving force from the voice coil will not be uniform with the electrical currents supplied to it.

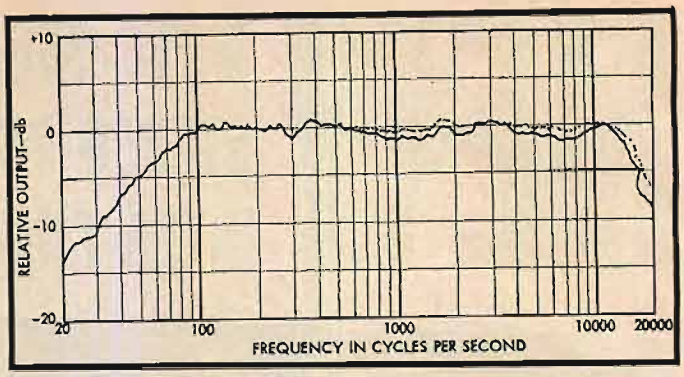

Fig. 5. The effect of the diaphragm arrangement of *Fig.* 4: the solid curve shows the fluctuation caused by the transition when successive rings become inactive; the dotted line shows what might be expected if the transition were continuous.

(2) due to nonlinearity of the opposition to movement, because the restoring force is not linearly proportional to the deflection of the diahragm. This means that the movement of the diaphragm will not be uniform with the force applied to it.

Special Diaphragms

What is the effect of a small diaphragm attached to the same voice coil inside the larger one, as at *Fig.* 3? From the mechanical standpoint this additional diaphragm is not likely to produce any irregularities. It will vibrate as an entity at the upper frequencies, and so will not behave as a transmission line, like the large one. For this reason it will prove more effective for the radiation of the higher frequencies in the band. As regards its effect on uniformity of movement at different frequencies, it should have quite a linear performance because it exerts a uniform additional opposition force at the voice coil. Its principal effect will be that of increased effective mass at the voice coil.

If it were attached at some point between the center and periphery of the large diaphragm there would be a time delay which would cause reflection defects and irregularities in the frequency response of the movement against driving force. But being attached directly to the voice coil former it should not produce this kind of effect. However, it may produce irregularities due to acoustic effects in the air adjacent to the two diaphragms. This must be considered separately.

There is another way of dealing with this problem which consists of introducing corrugations into the cone at one or more points other than the periphery. This is then analogous to a lump-loaded transmission line, in which the inductance and capacitance comes in lumps instead of being continuously distributed. This is illustrated at *Fig.* 4.

There is a difference between this arrangement and a transmission line: in this arrangement, energy can be radiated by movement, represented by current, in any part of the diaphragm; this is shown by resistance elements; in a

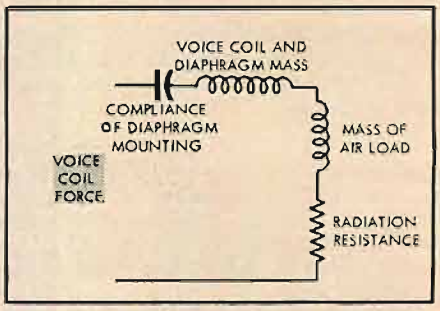

Fig. 6. Electrical equivalent circuit for the low frequency resonance of a dynamic type loudspeaker, not taking into account any effects due to an enclosure.

transmission line, we usually consider only the energy reaching the far end, which in this case is wasted in the surround.

At the lower frequencies, energy is radiated from the whole diaphragm; at higher frequencies, the low-pass action of the line elements prevents transmission to the outer rings and all the energy is radiated from the inner section(s).

The effect of this system is to produce a very gradual fluctuation in efficiency, represented in the response at *Fig.* 5. Compared with *Fig.* 2, this is an improvement, but the uniform diaphragm correctly damped *can* be better.

To summarize then, the mechanical part of the loudspeaker has two principal properties that contribute to its frequency response. These are:

(1) A major resonance, due to the mass of the whole of the diaphragm and voice coil, together with a quantity of air that can be considered as moving with it, in conjunction with the compliance of the surround and spider (neglecting for the moment the compliance of the air in contact with the diaphragm).

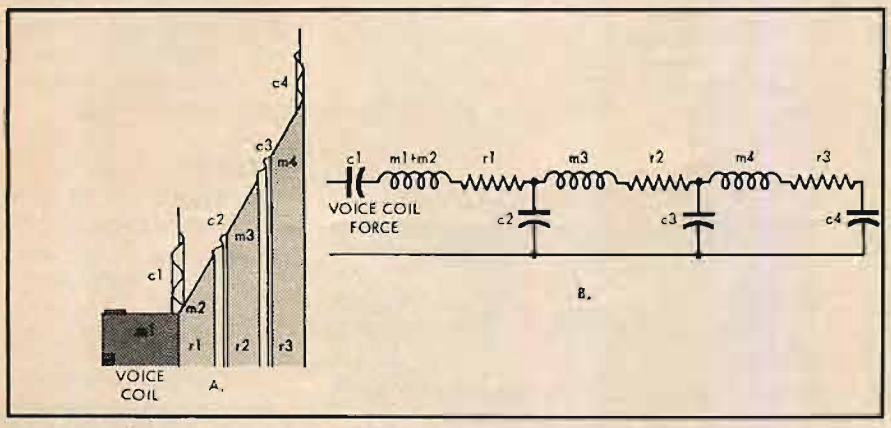

Fig. 4. Another method of improving the performance of a large diaphragm: (a) a physical cross-section through the voice coil and diaphragm assembly; (b) electrical equivalent circuit.

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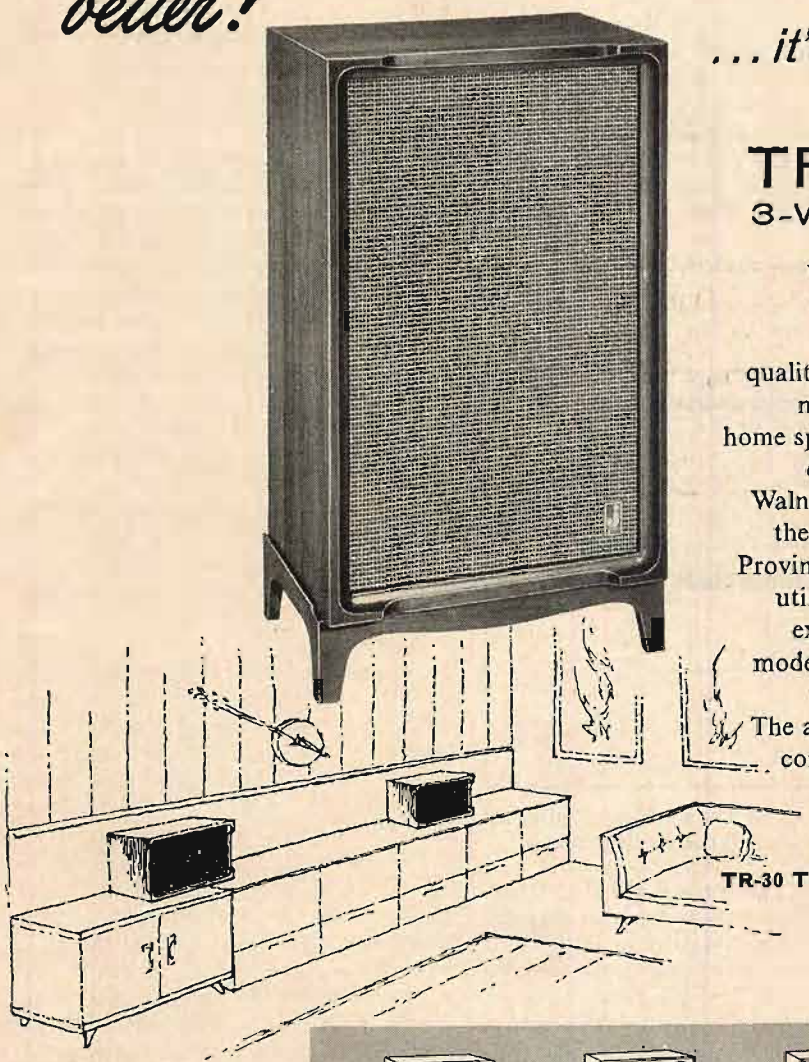

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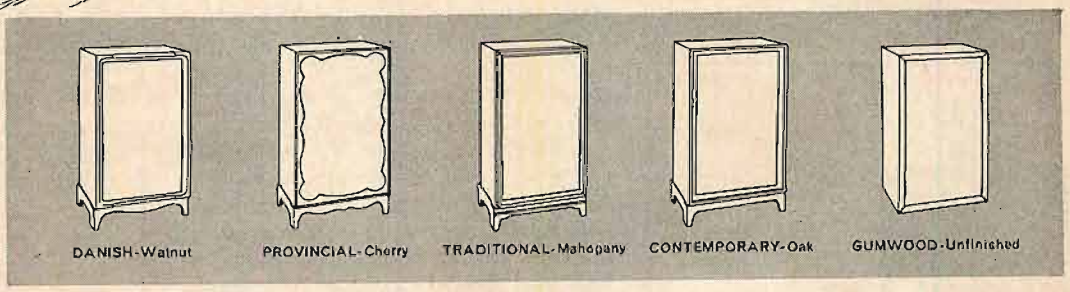

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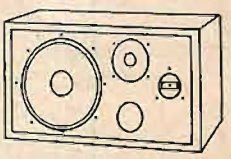

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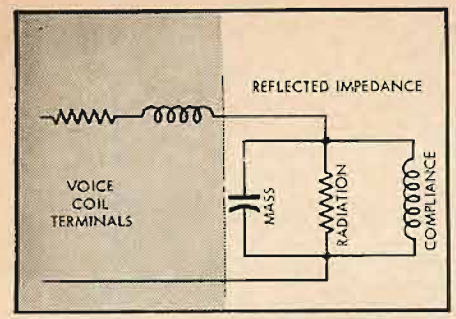

Fig. 7. The electrical impedance diagram, showing the components reflected into the electrical circuit due to the mechanical resonance represented in *Fig.* 6.

These two major lumped components produce a low frequency resonance, the equivalent circuit of which is shown at *Fig.* 6.

(2) At the high frequency end of the response the diaphragm tends to behave as a transmission line, causing some degree of breakup. The continuous type of transmission line cannot readily be shown as an equivalent circuit, because it consists of an infinitely distributed mass and compliance, the configuration of which is similar to that of a low-pass filter as at *Fig.* 4 but when the number of inductances and capacitances is infinitely large, and each is infinitely small, the arrangement does not produce a low-pass characteristic, but a progressive phase delay which can become several cycles by the time the terminating point, which is the periphery of the diaphragm, is reached.

Irregularities at this end of the response can be minimized either by ensuring that the equivalent continuous transmission line is correctly terminated, by attention to the properties of the surround material or by the alternative lumped arrangement of *Fig.* 4.

Electromechanical Coupling

The analogy circuit of *Fig.* 6 shows the resonant circuit as a series one because this is the way the mechanical behavior of the circuit works out, but the electrical characteristics as measured at the voice-coil terminals will also be influenced by the resonance. Because the diaphragm movement is greater at this resonant frequency there will be an increased back e.m.f. in the voice coil which will represent an increased dynamic impedance. From this it will be found that the electrical equivalent must take the form shown in *Fig.* 7.

This shows that the mechanical analogy series circuit transfers through the electromechanical action to become an effective parallel resonant circuit. The magnitude of the reactance values in this electrical resonant circuit will depend on the efficiency of the electromechanical transfer.

Similarly, looking at the mechanical arrangement the effectiveness of the electrical damping, provided by the voice coil with a high damping factor amplifier, will also depend upon the electromechanical efficiency. This means the effectiveness of any attempt at damping by adjusting the amplifier damping factor is definitely limited.

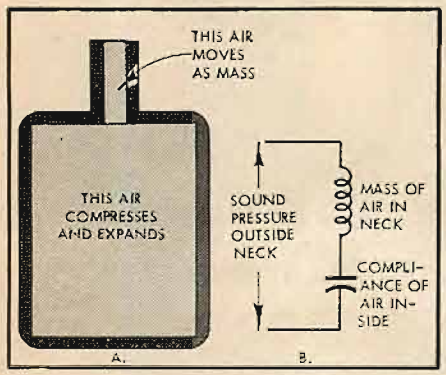

Fig. 8. A narrow necked bottle, or Helmholtz resonator, illustrates the basic acoustical analogy: (a) a cross-section through the bottle; (b) electrical equivalent circuit for same.

Mechanical-Acoustical Coupling

We have discussed the factors controlling the relationship between the electrical driving force and the diaphragm vibration. The next thing is to transfer the diaphragm vibration to the air.

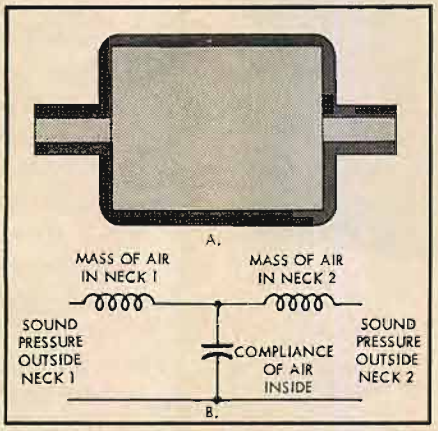

Fig. 9. Bottle with two necks: (a) physical cross-section; (b) equivalent circuit.

To see how these things work we need to understand the acoustical analogy. Here we make the sound pressure in a wave correspond to voltage. The volume movement velocity of air corresponds to current. The volume displacement will correspond to charge.

Acoustical resistance due to the viscosity of the air when particles have to move over some surface or one another, is equivalent to resistance. The mass, or inertia, of the air in movement is equivalent to inductance; while the compliance, or compressibility of the air, is equivalent to capacitance.

These last two are the most important ones to understand and particularly is it important to grasp how they fit together in an equivalent circuit. Consider a Helmholtz resonator—or just a bottle with a narrow neck—as at *Fig.* 8.

The air inside the bottle contributes to the resonant frequency excited at the mouth merely because of its compressibility. This air does not move appreciably—it just compresses and expands alternately. In the neck of the bottle, on the other hand, the air oscillates to and fro, and hence the important feature about this "piece" of air is its mass. So the resonant frequency is determined by considering the effective compliance of the volume of air inside the bottle, in conjunction with the effective mass of the air that goes to and fro in the neck.

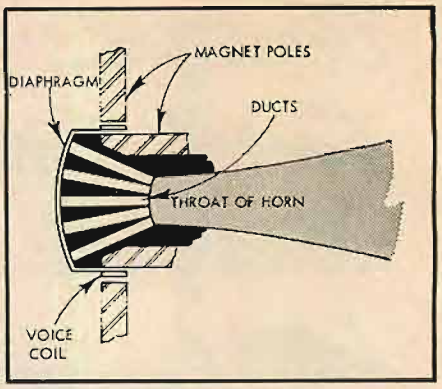

Fig. 10. Cross-section of simple acoustical transformer, applied to a horn type loudspeaker unit.

As a very small sound pressure at resonant frequency will cause a big volume movement of air in the neck of the bottle, the equivalent circuit is that shown at *Fig.* 8b, it is a series resonant circuit.

Now suppose we have a container with an opening at both ends and a volume of air enclosed as at *Fig.* 9. A sound pressure at one opening will have immediately next to it the opposing force of the mass of air in the neck which looks like an inductance. At the other end of this neck is the volume of air the compliance of which looks like a capacitance. As the pressure of all the air in the bottle is approximately uniform throughout, the mass of air at the other end of the space has the same pressure at its input side as has the mass of air at the first neck on the inside of the bottle. This whole volume is at constant pressure at any instant in time.

So the inside of both necks must be

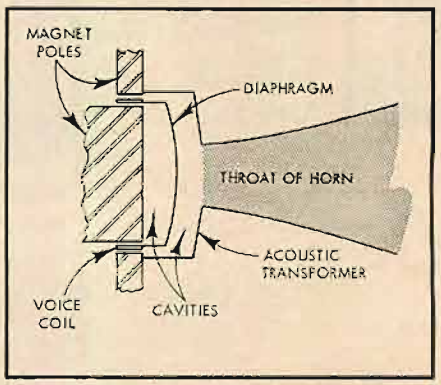

Fig. 11. An improved type of acoustical transformer.

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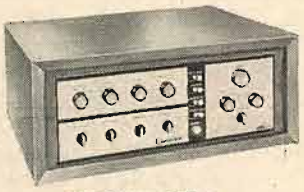

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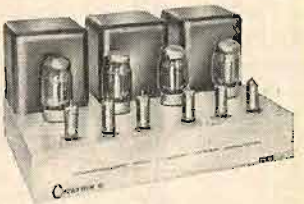

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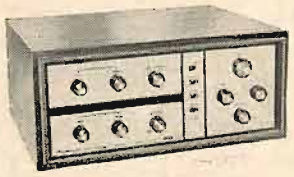

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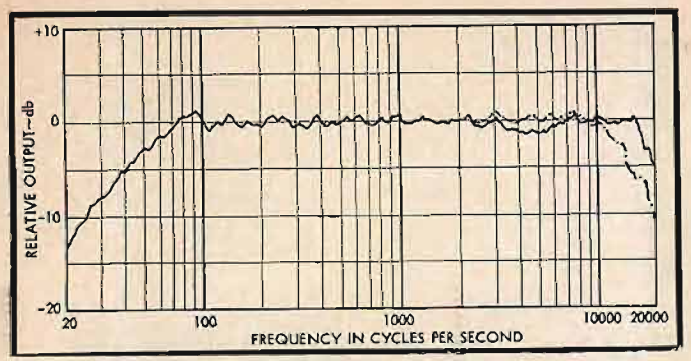

Fig. 12. The acoustical effect of the diaphragm shown in *Fig.* 3: the solid curve shows the response produced, the dotted one the theoretical effect of eliminating the acoustic absorption. The dot-dash section represents removing the small diaphragm.

represented, in an equivalent or analogy circuit, by the same electrical point in the network. This means that the analogy circuit of the whole arrangement looks like a low-pass "T" filter configuration as at B in *Fig.* 9.

From the acoustic response viewpoint it would not matter appreciably whether the two necks were located at opposite ends of the space, or next to one another, or in any other position, because the pressure inside will vary without appreciable volume movement of the air. In practice there will be some slight difference due to the fact that air does move to a small extent inside the space. There is not a sudden transition from air that moves to air that compresses. There is a small region where the air does both.

Propagation

A sound wave propagated through air in the form of a plane wave—that is, where the frontal area of the wave is not expanding—presents a transmission impedance that is characteristic, because the pressure and velocity get passed on unchanged, except for a slight attenuation due to the viscosity of the air.

A continuous exponential horn above its cut-off frequency looks like a resistance too. This is because the wave propagates down the expansion and produces a gradual transition, from high-pressure high-volume movement at the throat or neck, to a low-pressure low-volume movement at the flare end. If the rate of transition from one end to the other is correct, the ratio between the pressure and particle velocity at all points down the development will be uniform, which means that the horn development looks like a constant resistance.

A transition in area, from small to large, or large to small, through a relatively short distance, behaves as an acoustical transformer. In a narrow neck, for instance, a high pressure with a given volume displacement, on reaching a sudden expansion encounters a sudden freedom of movement which causes the pressure to drop. At the same time the volume movement is allowed to increase at this point. So the step in area exchanges one ratio of pressure to volume movement for another ratio, like a transformer changes the ratio of voltage and current from one impedance to another.

When sound is radiated outward freely, the air near the source moves more, for the pressure fluctuation involved, than the air further out. This means it has an inductive component to its impedance. In fact a large proportion of the inductance in *Fig.* 6 is due to radiation. This is why the resonance of this kind of speaker has to be at the low-frequency end. That way, a constant voltage, representing constant sound pressure, is delivered to the inductance-resistance combination. This principle is termed mass-controlling diaphragm movement, because the principal reactance opposing movement is mass, throughout the audio spectrum.

Application

All of these simple acoustic devices occur in loudspeaker design somewhere or other. The acoustic transformer is utilized in horn-type loudspeakers to match the diaphragm movement to the throat of the horn. Usually the diaphragm is larger than the throat of the horn as shown at *Fig.* 10. The air movement picked up from the diaphragm has to be compressed down to the size of the throat.

If any cavity is enclosed *between* the diaphragm and the throat, this will behave as a capacitance and cause a high-frequency roll-off by absorption. So, to minimize the volume of such cavity a good method adopted is the use of a number of channels to pick off the pressure uniformly from different parts of the diaphragm and conduct the column of air into a single throat, as shown in *Fig.* 11. This makes an efficient transformer up to quite high frequencies, whereas the abrupt change in size loses efficiency at the high frequencies due to the capacitance effect of the cavity which it produces.

Another example of cavity effect can occur with the diaphragm arrangement shown in *Fig.* 3. As it is not a deep cavity—nor does it have a narrow mouth—its effect will not be very pronounced, but it will result in a slight absorption over a fairly wide range of frequencies, as suggested in *Fig.* 12.

Enclosures

But the thing which is of greater interest in loudspeaker design is the construction used for the lower frequencies—enclosures of various types. The bass-reflex enclosure operates in a manner similar to the container with a neck at both ends, the diaphragm being placed in one neck as the driving point, while the other neck is the vent of the enclosure.

Figure 13 shows the simplified analogy diagram for a bass-reflex enclosure, assuming that the volume is pure capacitance and the port pure inductance. In practice these assumptions are not quite true, but they do not seriously invalidate the representation. This circuit shows how the enclosure can damp the basic resonance of the speaker by having the combined dynamic impedance consisting of the port, the volume of the enclosure, and the radiation resistance, as a shunt tuned circuit, damp the series tuned circuit, consisting of front radiation resistance with the effective mass and compliance of the diaphragm and its associated components. It is possible for these two to be exactly complementary so as to damp out the mechanical resonance of the diaphragm system.

If this was all that a bass-reflex enclosure did it would merely pull down

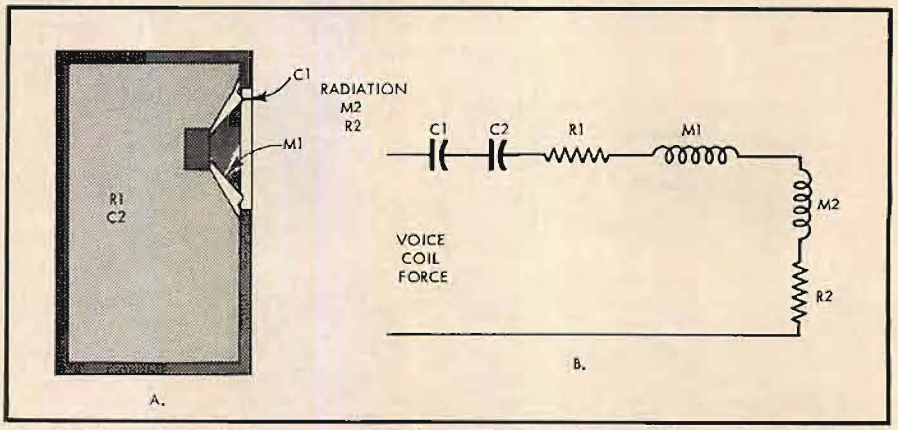

Fig. 13. The action of a bass reflex enclosure is somewhat similar to the bottle with two necks of *Fig.* 9: at (a) a cross-section through a bass reflex enclosure; (b) the equivalent circuit.

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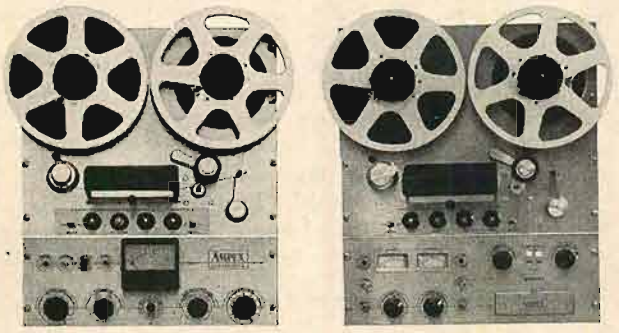

THE AMPEX 354, STEREO/MONO
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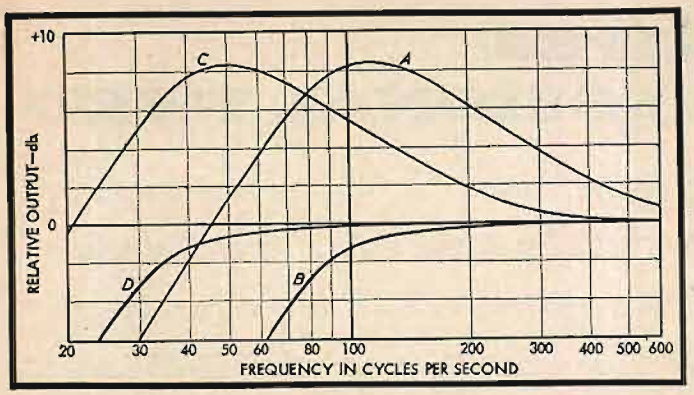


Fig. 14. Action of a bass-reflex enclosure. *A* is the curve of the unit without an enclosure; *B* represents the effect of the enclosure in pulling down the peak.

the peak at the low-frequency end of the loudspeaker's response curve without extending the frequency range any lower down, as in *Fig.* 14. But the additional mass (inductance) of the port, lowers the resonant frequency, without having to make the diaphragm mass too great for good operation at higher frequencies.

At the mutual resonance of the system the radiation from both the diaphragm and the port is in phase. This can be appreciated best by thinking of the resonance of the bottle with two necks. Although the energy is excited in one neck, due to the fact that the air inside the bottle compresses and expands as an entity, the air flow in the two necks will be almost exactly in phase, there being just a slight lead in the one providing the drive. This is in fact what happens with a vented enclosure.

In the case of the latest type of low-frequency reproducer the *mechanical* construction is made with a very large compliance, so that the natural resonance is extremely low (this is when no enclosure is used). Then the size of the enclosure, which is sealed and not vented, is adjusted so that the over-all compliance of the diaphragm and that of the enclosure produces a resonant frequency at the extreme bottom end of the audio spectrum—where it should be. The interior of the cabinet is treated to provide an acoustic resistance effect that damps the resonance. An analogy circuit is shown in *Fig.* 15. In this way an extremely smooth low-frequency response can be obtained.

This is just one approach to the problem and it involves the use of one of the newer special type loudspeaker units, with extremely high compliance, so that the diaphragm appears to be very floppy. These units can only be used in such enclosures, otherwise they would rapidly damage themselves.

Other approaches to the low-frequency problem use all kinds of enclosures with labyrinths and folded horns. In the case of a folded horn, the objective is to maintain a correct exponential rate of expansion during the folding of the expanding channel in different directions. This way effective transmission is achieved without the need for the excessive length necessary in a straight horn development.

Some units use a folded horn development from one side of the diaphragm, usually the rear, with a built-in acoustic low-pass filter, using a large cavity for the capacitance and a slot for the beginning part of the horn as an inductance. This makes the horn useful for only a comparatively narrow range of frequencies between its own natural cutoff, which is very low, and the acoustic low-pass filter cutoff. The entire arrangement provides loading for the rear of the diaphragm in this frequency range. Above the low-pass cutoff frequency the diaphragm loses its rear loading, allowing it to radiate from the front side. So the result is, that frequencies above the chosen crossover, which may be, say, 200 cps, are radiated directly from the front of the diaphragm, while frequencies from 20 to 200 cps are radiated via the acoustic horn. This is illustrated at *Fig.* 16. In this case, the length of the horn and the position of its mouth must be adjusted so that the radiation is in phase from back and front of the diaphragm at the chosen crossover frequency. This is just an example.

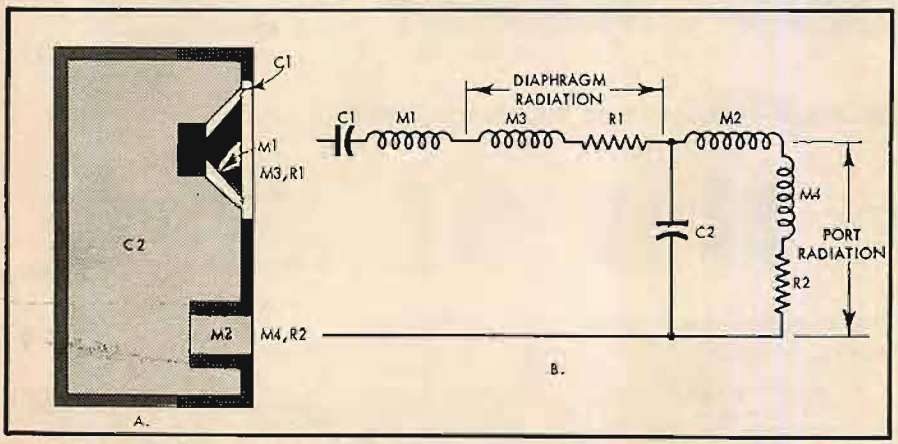


Fig. 15. A comparatively new method of handling low-frequency response: at (A) a cross-section; at (B) an analogy diagram. C_1 is several times as great as C_2, so that the latter becomes the controlling compliance.

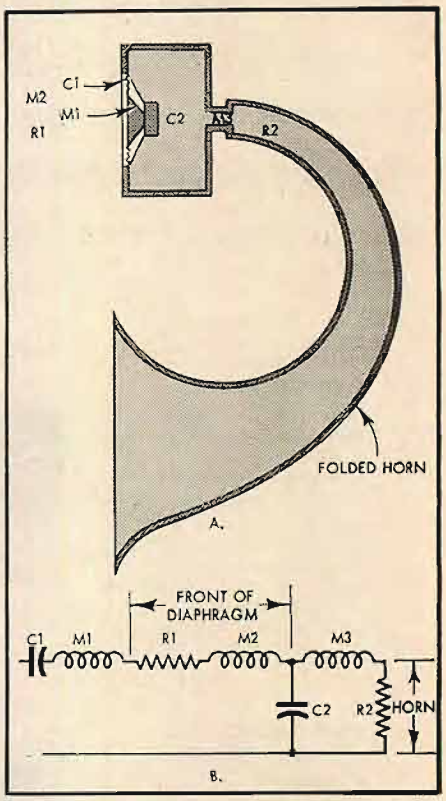
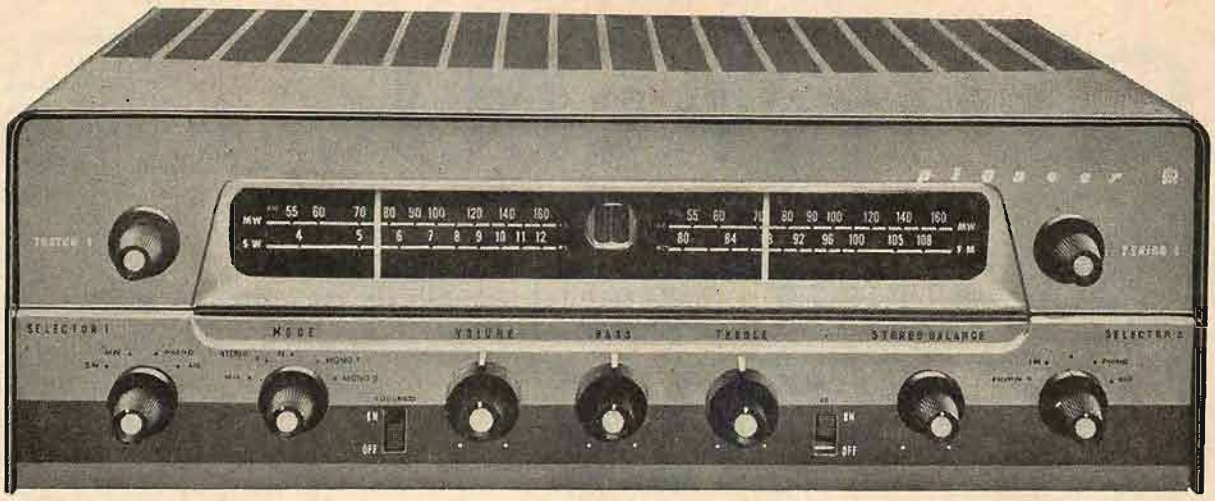


Fig. 16. Another kind of low-frequency system, using a folded horn and acoustic low-pass filter: (A) a simplified physical diagram (in practice the horn is folded, to save space); (B) analogy diagram. The value of r_2 is much greater than r_1, so that for frequencies below the acoustic low-pass filter (c_2, m_3) rolloff the major radiation is from the horn. Above this frequency r_2 ceases to be coupled, so the major radiation is from r_1, m_2. The physical disposition of the horn mouth and diaphragm must be such that, at the chosen crossover, the energy from both emerges in phase.

To give details of every enclosure system on the market would take a separate article to describe each and show how its design was developed. The foregoing provides a basis so that anyone interested can figure out how any particular loudspeaker system has been engineered to get the desired results. This knowledge will then prove helpful in judging to what extent the design is successful in achieving its objective. Æ



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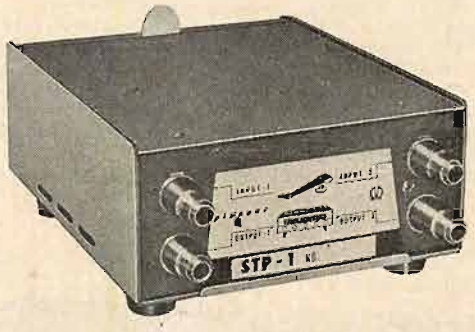

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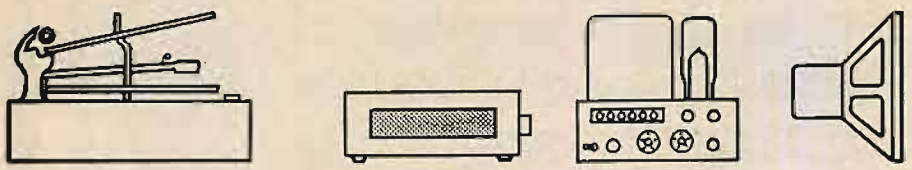


SARGENT-RAYMENT SR-8000 STEREO TUNER-PREAMP AND SR-202 REVERBERATION UNIT

The basic difference between high-quality preamplifiers resides in the fundamental system philosophy underlying the design, for any engineer worthy of the name *should* be able to design an amplifier which is equivalent to any other amplifier, as far as performance is concerned. Almost the same statement applies to tuners, either AM or FM, and the basic difference between the performance of two different tuners can be determined almost by the price tag alone. It is very unlikely that some one manufacturer has found the secret of making a piece of high-quality equipment at a cost differential of much more than 10 per cent below another.

Sargent-Rayment equipment has never been low priced. Neither have Cadillacs—at least within the memory of most of you. (There was a time when Fords cost $900 and Cadillacs cost $800, but that was around 1909.) But if it has not been low priced, it has at least been of high quality. We have reported in these pages the SR-68, an AM/FM tuner; the SR-58, AM only; and the more recent SR-1000, an AM-FM-stereo tuner of superb listening quality. Barring the now defunct t.r.f. tuners generally following the design of the old Western Electric 10-A Radio Receiver, it is probable that the SR-1000 had better AM quality than most anything else on the market. The SR-58 was better, but with the great increase in FM listening, AM receivers have become almost as obsolete as 24A tubes.

The SR-8000 combines an FM tuner, an AM tuner, and a complete stereo preamplifier in one chassis. The AM tuner section is practically the same as the AM section in the SR-1000, and consists of a 6BE6 mixer-oscillator and a 6BA6 i.f. amplifier stage feeding the patented Sargent-Rayment AM detector, which has a very low distortion. The 8000 employs two germanium diodes as the second detector, resulting in a saving of space as compared with the SR-1000. Both models used i.f. transformers with tapped secondaries connected to switches to provide narrow or broad-band reception, with a resultant improvement in the high-frequency response when in BROAD.

The FM sections differ considerably in detail, though not in philosophy. The SR-8000 employs the inductance-tuned dual triode circuit originally developed in Europe and furnished as a separate and completely self-contained cartridge. A.f.c. is provided by the use of a voltage-sensitive diode in series with a small capacitor and controlled from the ratio detector circuit. Two i.f. stages and a single limiter serve to feed the detector stage which employs two diodes in a wide-range ratio detector circuit.

The outputs of the two tuners are fed to the selector switch of the control unit, as are the ouputs of the two equalized preamp stages which accommodate magnetic pickups and tape heads. These stages use 12AX7's with low-noise resistors in the plate circuits of the first stages. Following the selector switch are the SEPARATION control, the REVERSE switch, and the BALANCE control. These are followed, in turn, by the tone controls which feed the pentode sections of 7199's, and these are followed by the RECORD outputs, the SCRATCH and RUMBLE filters, the VOLUME control with its associated LOUDNESS switch, and the triode sections of the 7199's. A cathodyne phase splitter follows to provide connection to either plate or cathode in the "A" channel for phase reversal, and a cathode follower only for the "B" channel.

Referring to *Fig.* 1, the controls are as follows, from left to right: SEPARATION and BALANCE, the REVERSE switch, the SELECTOR switch, with the indicator lights showing which circuit is in operation. The next five switches are PHASE, FM A.F.C., AM BROAD, RUMBLE, and SCRATCH. These are followed by the VOLUME control, the LOUDNESS switch, and the BASS and TREBLE tone controls. All of the switches are of the push type, with one push actuating the related circuit and the next releasing it. The AM tuning control is at the upper left and the FM control is at the upper right.

Using the built-in ferrite loopstick on AM, the sensitivity is rated at 20 μv; for 20 db quieting, the sensitivity on FM is 1.8 μv. Harmonic distortion measured at less than 0.1 per cent on either AM or FM at 1 volt output, with IM distortion 0.18 per cent on FM and 0.22 per cent on AM at the same output.

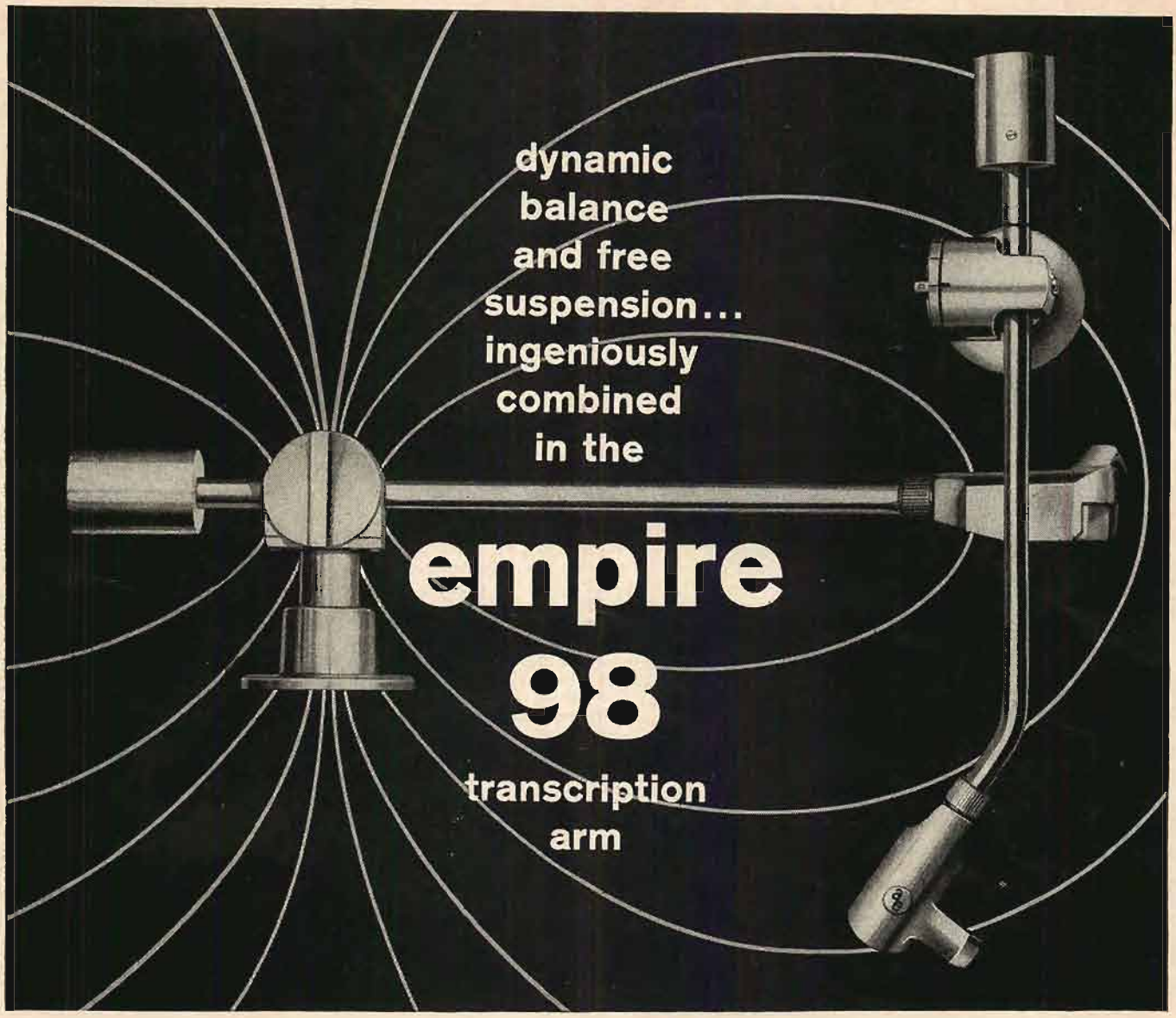
Bass controls provide a boost of 14 db at 50 cps and a cut of 16 db at the same frequency. The turnover point of the controls is at 350 cps. The treble controls gave a boost and cut of 10 and 14 db respectively at 10,000 cps, with a turnover at 1800 cps. Phono equalization measured within 1 db of the RIAA standard, and the tape head input measured within 1 db of the NAB characteristic from 30 to 7000 cps—above which frequency it increased appreciably over the standard, presumably to give the needed boost for recorders with insufficiently narrow head gaps. For a 1-volt output, a signal of 0.87 mv was required at 1000 cps on the phono inputs, and 1.6 mv at the tape head input. For auxiliary inputs the equivalent input signal was measured at .057 volts. When powered by SR amplifiers, the signal-to-noise ratio measured 72 db on phono and tape-head inputs and 61 db on the high-level inputs. Tracking of the volume control was measured at ±3 db over the range from maximum to 40 db down; of tone controls ±5 db over the same range. As noted, the SR-8000 is not self powered, but must have plate and heater supply from some other source. All SR basic amplifiers are equipped with power output sockets which will supply the required power; for installations where a separate power supply must be provided, the SR-900 furnishes the required voltages. For the hypercritical, the SR-9000 furnishes d.c. for both plates and filaments.

The SR-8000 measures 14⅞ in. wide by 5¼ in. high by 13⅛ deep, and it weighs 21 pounds.

By today's standards, the sensitivity of the FM tuner is not high, nor is that of the AM section. But for high-quality AM reception, it is necessary that the listener be within 20 miles of the transmitting station, and it is rare that good FM reception is reliable with signal intensities of less than about 5 μv. In other words, this is an excellent and very luxurious tuner within the primary service ranges of either AM or FM stations—as a matter of fact, there is little difference in sound quality from AM and FM provided the noise limitations of the AM channel allow satisfactory broad-band reception.

One of the great advantages of the SR-8000—as well as many other SR units—is that they are powered from the main amplifier and therefore do not have any heat

Fig. 1. Sargent-Rayment Model SR-8000 AM/FM stereo tuner and preamplifier.



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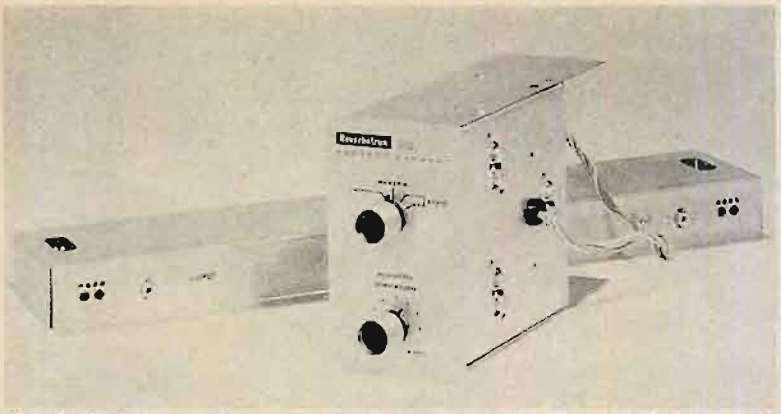

Fig. 2. SR-202 reverberation unit incorporates the Hammond delay unit and the Sargent-Rayment electronism.

or hum problems from the built-in power supply. There is something to be said for either system, but it seems that there might easily be adequate power available from almost any main amplifier to feed the relatively low power requirements of a tuner-preamp, and the elimination of the a.c. circuitry from the preamp chassis is definitely an advantage.

SR 202 Reverberation Unit

The reverberation units which have appeared on the market during the last year are all alike in the basic principle of operation, although there is considerable difference in the electronic circuitry which actuates the Hammond unit which is the heart of all the systems. The SR-202, shown in *Fig.* 2, employs the Hammond unit with the small electronic package which is pewered from either the main amplifier or a separate power supply such as the SR-900 or SR-9000.

The Hammond unit, which consists of two coil spring assemblies, each driven at one end by a common transducer, with the delayed sound being picked up at the other end of the springs by a similar transducer. The individual spring assemblies consist of two sections, wound in opposite directions so as to preclude "unwinding" over a period of time, and the delay times of the sections differ—one being in the vicinity of 28 milliseconds and the other around 37 ms. In the SR system, the two outputs from the preamp are combined to provide A+B signal which is fed to the driver transducer. The output from the driven transducer feeds the two channels simultaneously. The actual circuitry consists of two 12AX7's and a 6DJ8—all being dual triodes. The inputs are fed to the two grids of the first 12AX7; their outputs are combined and fed to one section of the 6DJ8, which feeds the driving transducer. The delayed output from the springs is then fed to the second section of the 6DJ8, thence to a "volume" control with the arm circuitry being split to the two grids of the second 12AX7. The unreverberated signal is fed from the first to the second stages by a resistor coupling the two cathodes. Thus a certain fixed value of "direct" signals from the two channels goes straight through, while a controllable delayed output of the sum signal is fed simultaneously to the two channels.

In the SR model, there are four positions of the control switch—OFF, in which the output of the preamp is fed directly to the power amplifiers and the heater current is switched off; REVERB, in which the signals are mixed and fed back with a controlled delay into both channels, as described, in addition to the straight through feed of undelayed signal; ECHO A and ECHO B, in which reverberation is applied to either channel A or channel B, the other being normal.

Some reverberation units using the Hammond device have been demonstrated with too little "straight-through" signal, so that the unreverberated signal is relatively low in level, and as the reverberation is added the over-all level increases by as much as 10 db. These are, in our opinion, nothing less than abominable. However, when the straight-through signal is sufficiently great that addition of the reverberation does not appreciably affect the over-all volume, the effect is pleasing and the Hammond unit may be said to be performing excellently —better, in fact, than many devices costing several times as much.

The design of the electronic package of the SR-202 is such that it is not probable that the listener will get too much reverberation. We find the over-all effect pleasing with the addition of small amounts of reverberation—so much so that we have installed the basic idea into our reference system, with some modifications, of course.

For the technically inclined, the driving signal fed to the Hammond unit should be in the vicinity of 5 volts, approximately —in any case, it should be enough so that the signal-to-noise ratio does not suffer in the reverberation circuit. But under proper conditions of operation, the device works wonderfully, and with judicious control makes an interesting addition to any hi-fi system. B-26

SHURE STUDIO DYNETIC STEREO PICKUP AND ARM

There is much to be said for the integrated arm and cartridge, for the manufacturer is then able to adjust the characteristics of the two elements to each other —much in the same manner as when a loudspeaker and enclosure are engineered by the manufacturer to complement each other. In 1957, the first Studio Dynetic cartridge-and-arm made its appearance, and we reported on the combination at that time (AUDIO, May, 1957). Since then we have continued to find the performance of the original pickup/arm combination practically faultless.

The stereo version of the Studio Dynetic was bound to appear, of course, and on outward appearance there is little difference. The arms are counterbalanced in the same manner, with the counterbalancing weight being supported on a spring steel strip which is damped to eliminate the low-frequency resonance which is usually encountered in the vicinity of 5–10 cps. The arm itself does not raise up or down—the cartridge is mounted on a pivoted arm which is also counterbalanced to provide an adjustable stylus force between 1.5 and 2.5 grams. The cartridge is raised or lowered by pressing a plastic button on the top of the arm, but it is almost as easy to slide the stylus across the record to the desired point without raising it (though this is not recommended) since no scratch is observable on the record surface, nor can it be heard on subsequent playings.

The stereo arm is fitted with two contacts for the "hot" leads from the stereo pickup, on which the outputs appear as two contact pins. When the equivalent mono cartridge is to be used, the two contacts touch both sides of its single output pin, thus paralleling the two amplifiers with no change in switching being required. The sleeve of the mounting carries the common ground terminal on the stereo pickup, as

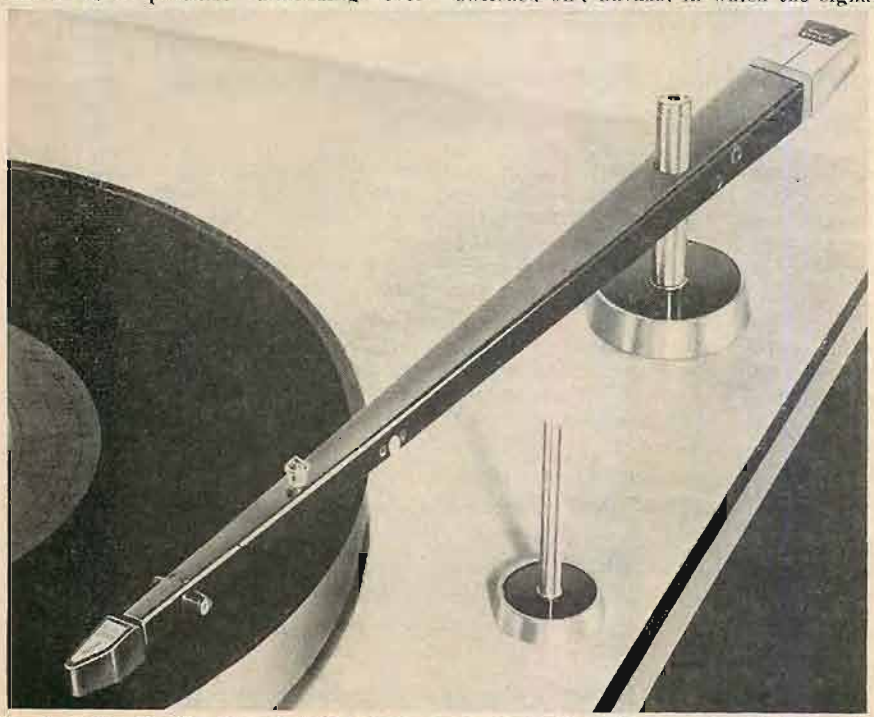

Fig. 3. Shure Studio Dynetic integrated stereo cartridge and arm. Arm takes either stereo or mono cartridges.

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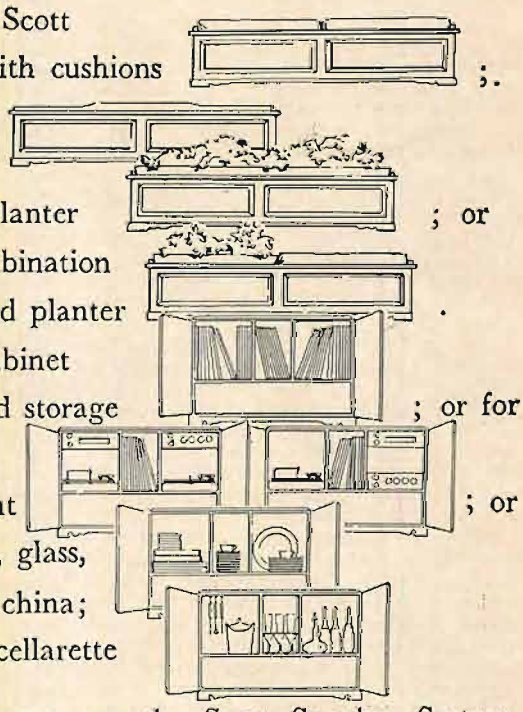

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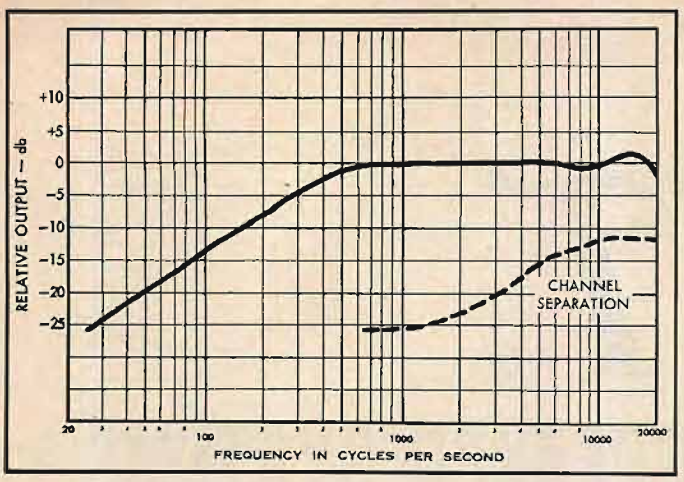

Fig. 4. Measured output of Shure Studio Dynetic cartridge (solid line) and separation (dotted line).

well as one of the output circuits on the mono unit.

Figure 3 shows the M216 model, which has an over-all length of 14¾ in.; M212 is a shorter model with an over-all length of 11-5/16 in., and is perfectly suitable for the usual home turntable. The bearing on the vertical axis of the arm is a ruby, providing a minimum of friction; the cartridge is carried on two additional ruby bearings (actually four separate bearings, since there are two sleeves and two caps). Compliance is claimed to be 9×10^{-6} cm/dyne, which is relatively high. The output per channel, feeding into a recommended load impedance of 47,000 ohms, is approximately 4.5 mv for a stylus velocity of 5 cm/sec at 1000 cps. *Figure* 4 shows the measured response from a test record cut with constant amplitude up to the turnover frequency (500 cps) and at a constant velocity above turnover. The two channels measured within 0.8 db of each other throughout the range indicated. Separation is greater than 25 db at 1000 cps, and at no place is it poorer than 10 db.

One of the features of this arm-cartridge combination that attracts us most is its ability to track the record groove when used in a typical pull-out drawer turntable mounting. Several types that we have tried would jump out of the groove as the drawer was opened or closed; these were especially susceptible to vibration of the floor as one walked (or jumped up and down) in front of the cabinet. (We can see no reason for jumping up and down in front of the cabinet, but it seemed like a good test.) In no case, however, was the Studio Dynetic affected. It was still not posssible to slam the drawer after putting the stylus down on the first groove, but it could be closed without any jumping whatsoever, and without a great amount of care being required.

While most modern cartridges measure reasonably well, there is often some difference is sound quality that the measurements do not show up—which only indicates that there are some things which we are probably not measuring. But for quality of reproduction from a subjective standpoint, we feel that the Studio Dynetic is exceptionally good. When this is coupled with excellent tracking ability under severe vibration, it becomes the logical choice for many installations. B-27

FAIRCHILD 440-2 TURNTABLE

The Fairchild model 440 is a 2-speed belt-driven turntable designed to provide performance suitable for the rigorous demands of stereo records. We are all too familiar with the excessive sensitivity to rumble of stereo pickups. This is inherent in the necessity to track both vertically and laterally. Thus, for truly fine stereo performance, a turntable must have very low rumble. Of course wow and flutter must also be exceedingly low, but these problems were solved satisfactorily in monophonic days. An interesting note here is the strip chart that is supplied with the model 440. It is a recording of the final test for wow and flutter on the specific unit. The interesting aspect of this, aside from the superb performance recorded, is that Fairchild is so confident of its manufacturing skill as to provide the actual test performance for each turntable it makes.

The 440 makes a rather handsome package mounted on the special mounting board and base available as optional extras. In addition, the mounting board is isolated from the base by means of four special rubber feet; the board just rests on these feet, held down only by the weight of the components mounted on it. The visual effect of this arraugement is a little disconcerting at first because, until one examines it more closely, the mounting board seems to be floating above the base.

Speaking of mounting, the entire mechanism—motor, turntable, controls, etc.—are mounted on a rigid U-channel which, in turn, is attached to the board. The motor mounting is isolated from the turntable to avoid rumble. The use of the U-channel makes installation of the 440 a rather simple procedure. It took us about 3 minutes with Fairchild's mounting board.

A feature of this turntable is that it is belt-driven—and two-speed. The speed change is accomplished in a simple manner; the belt is straddled by two wire "fingers" which push it to one or the other of the steps in the two-stepped motor shaft. Each of the stepped surfaces is slightly crowned so that when the finger pushes the moving belt, the crown helps it work its way to the other step. This system works well unless the belt stretches.

The 440 uses a 4-pound turntable similar to that on the Fairchild model 412. This turntable is balanced and rides on a micro-finished ball-thrust bearing in a nylon seat. The main shaft is micro-honed and rotates in a polished babbitt bearing. In order to satisfy our own curiosity about the balance and freedom from friction, we leveled the turntable, removed the belt, and rotated the platter by hand. The turntable continued to rotate for nearly 3 minutes. Although this is not an accurate test, we have been doing this on similar rotating equipment for years, and find it a good rule-of-thumb indicator for rotational performance. On this score the Fairchild rates excellent.

All controls of the 440 are located on the top of the mounting board and include a speed control as well as an on-off switch and the speed-change lever. The speed control can vary turntable speed by as much as 1½ per cent. It does this by applying d.c. to the motor windings.

The test chart provided with the turntable is ample proof of the practically unmeasureable amount of wow and flutter in this turntable. Nevertheless we tried a listening test using several records reserved especially for this purpose—piano records for wow and violin performances for flutter—and confirmed the results of the test chart; neither wow nor flutter is detectable to the ear. Rumble, both lateral and vertical, is 56 db below 7 cm/sec at 500 cps.

The 440 achieved operating speed within one revolution as verified by the stroboscopic disc supplied with the turntable. One minor annoyance with this type of disc is that a fluorescent or neon light source should be used, and such sources are not always easily available where the turntable is located; it wasn't in our particular situation.

In operation in our listening area, using the Fairchild mounting board and base, there was no acoustic feedback discernible. In addition, it is extremely handsome. We are often willing to forego appearance for the sake of performance, but it is all the more enjoyable when we can have both. It will soon be available in kit form. B-28

Fig. 5. Fairchild 440-2 two-speed belt driven turntable.

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60-21

H. H. SCOTT LT-10 FM TUNER KIT

During the New York High Fidelity Show, way back in September of last year, we had the opportunity to observe two pretty young ladies constructing FM tuners in the H. H. Scott booth. At that time we were impressed by the relative ease with which these young ladies were manufacturing FM tuners. Of course, being old cynics, and having built many an FM tuner kit in the past, our first reaction was to disbelieve what we were seeing. We couldn't prove it but we were convinced, within ourselves, that these two builders were really technicians in shapely clothing. Perhaps this is just our own personal reaction to all the superlatives we encounter nowadays.

Anyhow, since that time we have constructed the LT-10 ourselves—and most humbly apologize for our base thoughts. This kit is the simplest to build we have seen to date. It took us *less than 7 hours* to put it together, and that includes alignment. In addition, since completing this unit, we have operated it almost continuously for nearly three months without even a hint of difficulty. Without hesitation, we would recommend the H. H. Scott LT-10 FM tuner kit to the beginner as well as the more experienced audiofan.

Before continuing, we should mention that in the realm of kits the H. H. Scott LT-10 exemplifies engineering of the highest calibre. Surely only the most sophisticated engineering thinking could design a kit as simple and foolproof as this one is. Although virtue is said to be its own reward we do hope that such excellence receives appropriate recognition.

Up to this point we have confined our discussion to the LT-10 as a kit. In reality there is a more fundamental question to be answered, "How good a tuner is the LT-10?" To put the answer in some frame of reference we will point out that the LT-10 is essentially a model 314 in kit form. That makes it a good FM tuner. It utilizes the well-known silver plated front end and the wide-band circuitry which is a feature of all H. H. Scott tuners. During the several months we have had it in operation no less than nine different people—guests—have had to be shown that an FM tuner was the music source, and not a record. We should mention that it is not common practice to count guests in our home—but we were impressed by the relatively large numbers involved.

Fig. 6. Completed H. H. Scott model LT-10 FM tuner kit.

Figure 6 shows the LT-10 completely assembled in its case (not supplied with kit). The tuning meter shown on the left front is quite sensitive and is illuminated so that it is easy to read at night. The tuning dial is also illuminated and unusually easy to read. At night the edge-lit plastic tuning dial is handsome as well as functional. It should be noted that the action of the tuning dial is extremely smooth and sensitive, although just a shade too sensitive for our taste. We like a little more positive feel. In comparison, it is like the power steering employed on Chrysler cars as contrasted to that used by General Motors. We prefer the more positive feel of the GM type.

Circuit Description

In most respects the circuit of the LT-10 is completely straightforward: cascode r.f. amplifier utilizing a 6BS8/6BQ7A; 6U8 oscillator-mixer; a pair of 6AU6 i.f. stages; and a limiter consisting of the pentode section of a 6U8; the detector, which is the unusual feature of this circuit, uses a pair of 1N294 diodes; and the audio output is the triode section of the 6U8 limiter used in an anode-follower configuration. The anode follower here provides some additional gain and permits cables up to 70 feet in length.

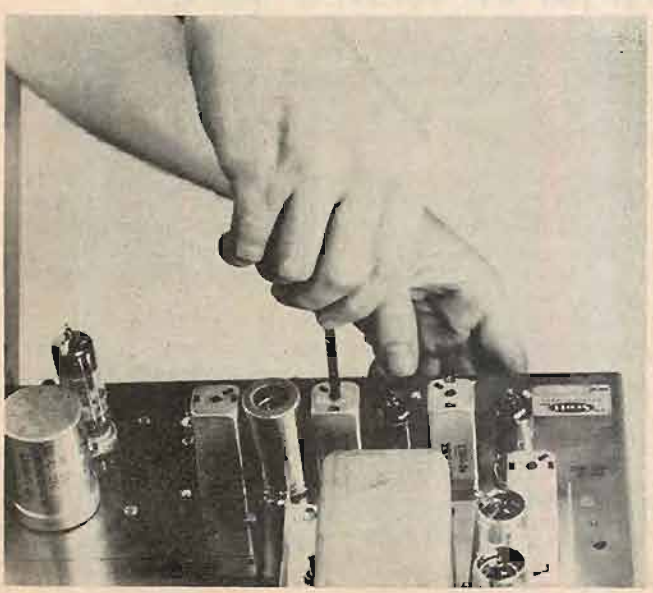
The really different feature of this circuit, as we mentioned previously, is in the detector stage. In common with all of the H. H. Scott FM tuners, the LT-10 uses a ratio detector. One of the advantages of the ratio detector is the additional limiting it provides. Another, and probably the greatest, advantage is the wide bandwidth obtainable. The 2-megacycle bandwidth of this detector is, to a large extent, responsible for the freedom from drift of this tuner. For this reason the LT-10 does not provide a.f.c.—nor do any of the H. H. Scott tuners. From our experience, it is not needed.

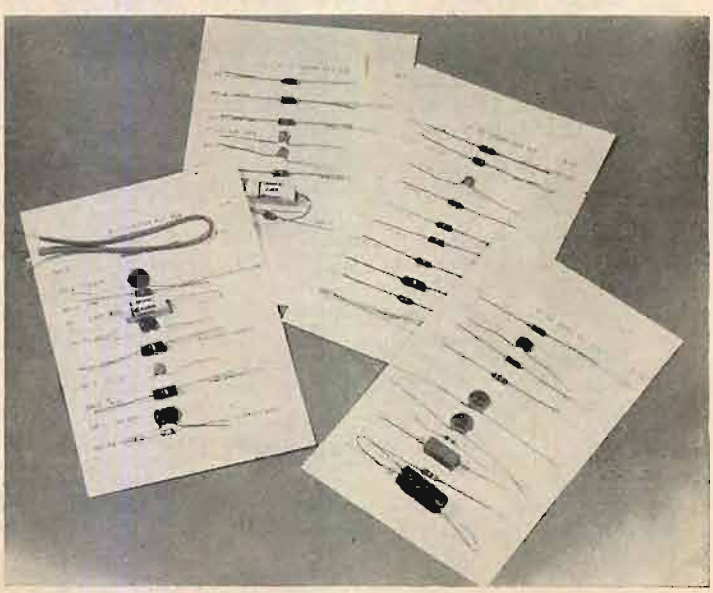
Although it doesn't actually pertain to circuitry as such, a great deal of attention has been paid to reducing circuit losses. This is evidenced by the silver-plated front end and the copper-bonded-to-aluminum chassis. Details such as these permit the circuit to operate at its full capability—precautions which are especially important in r.f. circuits.

Alignment

Alignment is the most difficult stumbling block facing the audiofan who builds an FM tuner kit. Precise alignment requires the use of various types of test equipment which are not usual audiofan gear—an FM signal generator and an oscilloscope to name some. There have been many schemes devised to help solve this problem—pre-

Fig. 7 (left). Tuner is aligned with H. H. Scott system requiring neither special tools nor test equipment. Here the top slug of the limiter can is being adjusted. Fig. 8 (right). All parts are mounted on Part-Charts in order of assembly.





the giggles

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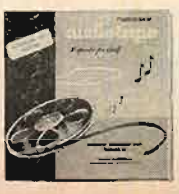

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Fig. 9. This is the way it looks when it is first opened. Tag at lower right is supplied with kit to be pasted on after completion.

assembling and pre-aligning the i.f. stages, printed circuit boards, using the tuning meter, and so on. By and large these methods have been increasingly successful, although still not as precise as the factory procedure. The method devised by H. H. Scott engineers, although not necessarily more accurate, is decidedly less critical. This is one of the bonus extras accruing from the wide-band detector.

The procedure itself is really simple. The sequence is as follows: the second i.f. can is tuned for maximum indication on the tuning meter, the bottom slug being tuned before the top slug; the limiter can is tuned the same way (see *Fig.* 7); the first i.f. can is also tuned the same way; then the r.f. circuit is tuned for maximum deflection of the tuning meter; finally the detector can is aligned, again adjusting the bottom slug first. Adjusting the top slug is the most difficult procedure of all, and it is at this point that the "piece de resistance" is unveiled; an ingenious method utilizing a light bulb. The bulb, which will later illuminate the tuning indicator, is connected to the speaker terminals of an audio amplifier to which the tuner has been connected.

Next, the bulb in its holder is then placed between an i.f. can and the shield over the tuning capacitor. Now the slug is rotated and the resulting brightening and dimming of the bulb noted and compared with the patterns illustrated in the manual. Then, all that is necessary is to locate the slug at a particular "bright" point which is identified in the instructions. This is a simple procedure which actually produces good results. We checked the setting with an FM signal generator and an oscilloscope and found it to be near perfect—within a cat's whisker. Actually we didn't "touch up" the alignment until some weeks later, purposely, so that we could listen to it with the original alignment. We could not hear any difference after the tuner was aligned using test equipment.

Performance

The performance specifications of the LT-10, as stated by the manufacturer, are quite good: especially in light of the explicit guarantee by the manufacturer that these are *minimum* specifications. It should be noted that H. H. Scott adheres to IHFM ratings. For example, a usable sensitivity of 2.5 microvolts is claimed. Some other manufacturers use a different rating system which makes it seem that their tuners are more sensitive. In reality, if the same conditions were used to rate the LT-10, it would appear to be much more sensitive; or conversely, if the other tuners used the IHFM ratings, they would appear to be less sensitive. Apparently, out of conviction that the IHFM ratings should become "standard," H. H. Scott is adhering to a rating system which seems to place his product at some disadvantage. We cannot help but admire such integrity.

One of the things we have been amazed at with this tuner is its ability to pull in stations with a short piece of coaxial cable for an antenna. This occurred when we connected the test cable from our FM signal generator to the antenna terminals. With no more than this 18-inch piece of coaxial cable we were able to receive any station in the New York City area. With the dipole antenna supplied with the kit we received a station in Connecticut which is about 50 miles away.

Construction

Figure 8 shows some of the Part-Charts on which all the loose parts are mounted. Each chart has a key number which matches a particular page in the instruction manual, and in addition each component on the chart has a key number which indicates the exact assembly step where it is used. To make the assembly procedure even more foolproof, the illustrations related to each assembly group are in colors so that the parts are placed visually as well as by description. Unlike many instruction manuals, this one is extremely easy to read.

Figure 9 illustrates the appearance of the LT-10 when the box is first opened. One of the innovations in this kit is that it can be constructed in the box. This is a great convenience for those whose construction facilities are limited. Note the small label in the lower right corner of *Fig.* 9. This self-adhesive label is to be filled out with the constructor's name upon completion of the kit and attached to the chassis in an appropriate position. We presume that this is meant to confer status and recognition upon the kit-builder. It may at that.

The under-chassis view of this kit is slightly unusual; it is just too simple for an FM tuner. We are used to the "rat's nest" maze of wires common to most FM tuners. In contrast the wiring of the LT-10 seems barely appropriate for a baby rat.

In summation, the H. H. Scott model LT-10 is an excellent FM tuner kit which is unusually easy to build. It is well within the capabilities of even a beginning kit builder—providing he follows the simple instructions. **B-29**

ERCONA NORDIC I SPEAKER SYSTEM

If we weren't already convinced, this diminutive speaker system would certainly prove that size isn't everything. When we first removed the Nordic I from its packing we were certain, without even hearing it, that we couldn't expect too much from such an unusually small enclosure—a mere $7\frac{1}{4} \times 10\frac{5}{8} \times 22\frac{3}{4}$ inches.

Before going into further discussion of its sound qualities, we would like to say a few words about the appearance of this speaker system. Without knowing why, we knew that the cabinet had been manufactured in some Scandinavian country the first moment we laid eyes on it. (It was manufactured in Sweden.) We still don't know why, but we can guess that it is due to the way the wood is finished. The unit we have is mahogany (it is also available in teak), but it is not a variety we see very often; it is reddish in color like Philippine mahogany. Anyhow, it is hand rubbed and the resultant cabinet seems to have a warm glow about it. Very tastefully done.

We have just demonstrated the difficulty in using words to describe the quality of an object where there are no rules to go by—indeed there can be no rules in such a subjective area. This is the same problem we are faced with when we try to describe a speaker system. For example we described the sound quality of the system as exceptionally clean. By this we mean that there is a high degree of naturalness about the sound it produces; highly listenable and non-fatiguing. It reminds us of the Saab automobile (another Swedish product)—not an ounce of fat on it, and with performance way beyond its size.

The bass sound of the Nordic I can best be characterized as tight and non-boomy; it does not have the depth and richness a large system such as the Patrician which was discussed last month. Nevertheless, as far as it goes, it is smooth and solid. The source of bass is an 8-inch speaker with patented, multi-layer, cone construction. Apparently the cone consists of several layers of different fibres, alternately hard and soft, in a sort of Dagwood sandwich configuration. Sounds tempting.

The crossover frequency is 7500 cps although the 5-inch tweeter actually starts operating at 5000 cps. The tweeter is mounted on a rigid, solid, die-cast frame which makes it an unusually rugged unit.

The music power rating of the Nordic I is 20 watts. We used a 10-watt amplifier to drive it and obtained all the sound we could stand—in level, that is. We might add that the sound did not seem "forced" at high levels.

In sum, then, the Nordic I is ideal for the audiofan with limited space and a modest budget. Its sound quality is excellent and should provide many hours of enjoyable, non-fatiguing, listening. **B-30**

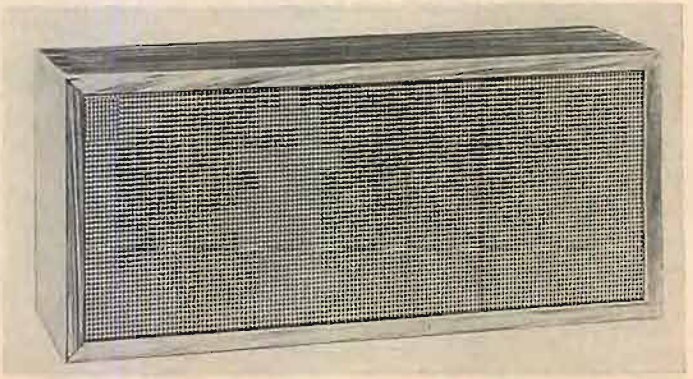
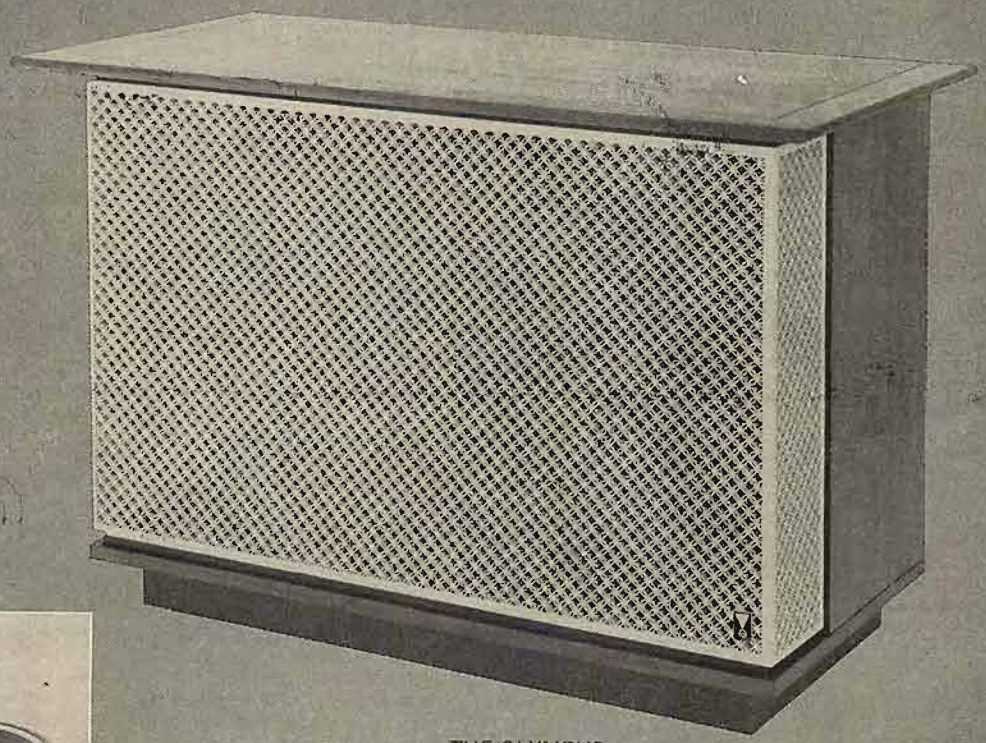


Fig. 10. Ercona Nordic I speaker system.

A NEW LINEAR EFFICIENCY SYSTEM

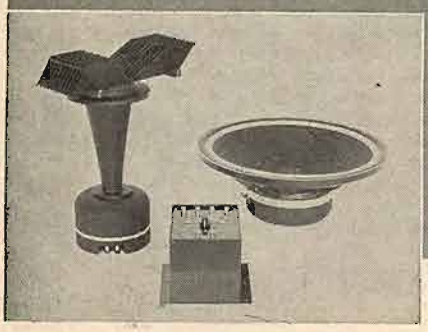
with 15" low frequency unit



THE OLYMPUS

JBL

MODEL D50S6



This is the new JBL S6 Linear Efficiency System with a new 15" low frequency unit, new dividing network, new high frequency driver, and new horn and acoustical lens. The new LE15 is made with a 4" edge-wound copper ribbon voice coil, long-throw Lans-a-Loy suspension, rigid, cast frame designed for mounting from either the front or the rear of the baffle. This is the only 15" unit on the market capable of linear cone excursion of ¾ inch. Free air cone resonance is approximately 20 c.p.s. The new LX5 Dividing Network matches the LE15 perfectly to either the new LE75 (in S6 Kit) or the new LE85 (in S7 Kit). Crossover is 500 cycles. The LE75 and LE85 are laboratory standard high frequency drivers with silver impedance compensating rings; voice coil and pole piece assemblies are held to previously unattainable tolerances. The new HL91 Horn-Lens Assembly, specifically designed for the new drivers achieves completely uniform dispersion over a 120° horizontal × 45° vertical pattern through its full range from 500 c.p.s. to beyond the limits of human hearing.

A sensational sight with sensational sound, the new JBL Olympus has been enthusiastically acclaimed at every preview for its unprecedented flat, accurate reproduction of the entire audio spectrum. The Olympus has remarkable bass response... goes all the way down smoothly clean. It reproduces the lowest fundamental in all its rich, original power. And does it in the JBL manner—with precision articulation, accurate delineation. The new slant-plate acoustical lens refracts equally all frequencies which pass through it. Not only does this heighten realism from any listening point, but permits a new latitude in speaker placement in stereophonic installations.

The C50 enclosure is styled with timeless elegance. Top edges are tapered to slim the cabinet's proportions. The wrap-around grille disguises the sturdy, heavily braced sides. Though the C50 is a six cubic foot enclosure, its bulk is comparatively small when the magnitude of the system's performance is taken into consideration, and the D50S6 might be accurately described as "a compact system." The new wood grille is shown above. Also, you have your choice of a fabric grille.

Production of the new systems is underway. To reserve a proximate place on the backlog, it might be advisable to get your name on the list without delay.

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AUDIO ETC

(*from page 15*)

do, in fact, share very little common sound, whether room liveness or the sounds going to the opposite mike. They stand on their own, without recorded liveness, and they may indeed be played back in the absolute manner, i.e., at the literal volume of the original sound, for a very literal sort of reproduction, each voice or instrument located in its own speaker.

But you will find, I think, that for general entertainment and/or reproduced impact the good old exaggerations of ordinary recorded sound serve better. The principle of "realistic distortion" easily wins out and you'll play your recordings generally much louder than the originals. We always do, in room-size recordings.

In fact, here you have a rather special and unexpected dramatic tool of great flexibility for your playback sound. You may vary the relative loudness of your two channels for each performance, with astonishingly different results! You have two volume controls, not just one. You can adjust the playback balance between channels over a relatively huge range, and you never need hear your recordings twice in the same way. New and quite surprisingly different, you'll admit.

For instance, I made one very pleasant recording, via this principle, of a boy with a low bass voice singing a quiet blues song, to an accompanying guitar. Following the Two-Point system, I put one mike right next to the fellow's mouth, since he sang at a very low volume. The other mike went close to the guitarist's fingers, a couple of yards distant. You could scarcely hear the "live" singer across the room; but I had playback effects in mind. One channel picked up 95 per cent voice, the other the same on guitar; the overlap of sound was just barely audible.

On playback, the light bass voice was amplified hugely, and turned out as a tremendous, big, solid sound—this is an old mike trick. The guitar recording was literal, absolute, but could be played at any volume, from a whisper up to an ominously huge, heavyweight beating, almost orchestral in impact. I was thus able to vary the combined channels for a whole gamut of different musical effects.

Use your Two-Point close-up technique, then, ad lib for a choice of literal realism or free fantasy. Vary your playback—realism in one speaker, fantasy in the other. A tiny voice on the right, a mammoth monster on the left. Experiment with various musical combinations. . . . You can go on and on.

Three Points and Up

When you begin, inevitably, to experiment with more than two sound sources you will edge into a less extreme but even more flexible category—it was here that I discovered dual-channel surrealism.

If you record two guitars and a singer you'll have to divide your material two to one; but your Two-Point technique is only moderately modified. Keep the maximum separation. On the mike that picks up two sounds, two performers, you'll move back a bit, to take in both. Less literal in the pickup, with somewhat more room-sound (liveness), but even so, you can follow the Two-Point Principle and you'll get a new range of dramatic effects.

Record a three-way dramatic sequence, for instance, with two characters (close-up) in one channel one in the other. The isolation in space of the single character heightens his alone-ness, the bunching-up of two people into the other speaker dramatizes their togetherness. Given the right material, this arrangement adds enormously to recorded dramatic impact. Similarly, you may record two musicians on one mike a third on the other.

You may, of course, try the next category, two performers on each mike, but a much more interesting variant of the Two-Point approach is that which treats of groups. When you have a larger number of people to cope with you will be tempted to try real stereo—i.e., to move your mikes back for an over-all "sound-curtain" pickup, with everybody located in his rightful position across the stage.

Don't do it! Don't even try. For you'll very likely fail. As I say, real stereo is tricky and needs precisely right mike placement and right acoustics, seldom of the sort found in living rooms.

Instead, divide your people into groups. Cluster one group around one mike, another around the other, all as close as conveniently possible. (Note that as long as a few voices—or instruments—are highlighted close to the mike, the listening ear will not object to an "off-mike" sound, at a distance, for numerous others. The contrast affords audible perspective, near and far. It is when *all* your sounds are too far off that the recording is a failure.)

Inevitably, in spite of the closest possible mike positions, you will begin to include an appreciable amount of general room liveness, sound common to both channels, in this sort of group recording. That will be enough. Don't force the stereo issue. If you consistently avoid stereo via maximum group close-ups, you'll likely end with an appreciable true stereo effect in spite of yourself. Works that way.

And now for surrealism. What do you do if there are three or four groups? Can't put two in one mike. The answer, I found, is simple. Just jump your mikes around, from group to group, freely in the hand.

What? Move the mikes in the middle of a recording? Professionals will swoon with horror. But that is exactly what I did.

For example, one evening I took down a lot of party singing. The gang started on a musical round—four parts. Four groups. What was I to do? I pointed mike No. 1 at group No. 1 when they began the tune, mike No. 2 at the second group as it took up the round in turn. Then when group No. 3 came in, I simply switched the first mike through the air, at arm's length, right over to that group, and the same with the second mike for group No. 4. Needless to say, both mikes pulled in large amounts of background singing and the groups were merely closer to a given mike by, say fifteen or twenty per cent. But the mere effort on my part to get each mike as close as I could to the center of each group ensured (as the British say) that the over-all sound was alive and not overly off-mike.

And what happened with the flying mikes? I looked like a windmill, and each mike traveled dozens of yards through space during the recording. But on the playback, not a singer moved an inch. The whole gang seemed to be neatly lined up on a wide stage, to left and right. In fact, to my amazement, this was a real stereo recording—surrealistically achieved.

The principle is simple and interesting, well worth taking to heart.

Though the recording mikes may move erratically and even wildly, pointing any old direction, front, rear, up, down, side to side, the playback sound reflects almost none of this. Instead, the images move slightly if at all, and most of the motion seems to be quite formal, from side to side, as on a stage.

Amusingly, everybody "looks at you" in the playback, regardless of positions in the recording. A helter-skelter crowd of people lounging all over a room, standing, sitting, facing this way and that, emerge in a dual-channel recording neatly lined up and all facing straight forward! Thus you don't have to arrange your amateur recording performers in lines and ranks. Just take them where they stand or sit, making sure only that they bunch to some extent into groups (as they usually do anyhow) for the exploring mike, close-up.

The strangest aspect of this surrealistic realism (and it's an eye-opener as to the relation between recorded sound and live originals) is that the dual-channel medium will make proper, staid, rational recording out of the zaniest mike antics you can imagine. Anything goes. Anything goes, that is, so long as you make no attempt whatsoever to be *literal*. That you cannot do! No matter how hard you try, the two speakers will take your spatial material and rearrange it according to their own principles. You can make only one mistake: too-distant miking. As long as you will insist upon some part of your total roomful of sound being *close to one mike or the other, or both*, you cannot go wrong at all.

You may move your mikes quickly anywhere you wish, to fulfill this closeness, and the motion will be undetectible. It cannot be perceived, in the playback, as motion; it comes out instead as a kind of professional fade-up, or fade-out. Move your mike quickly away from one voice or instrument and the sound merely fades down unobtrusively in the playback. A polished and very professional sound it is, though to look at your mikes zooming hither and yon, you would not believe it possible.

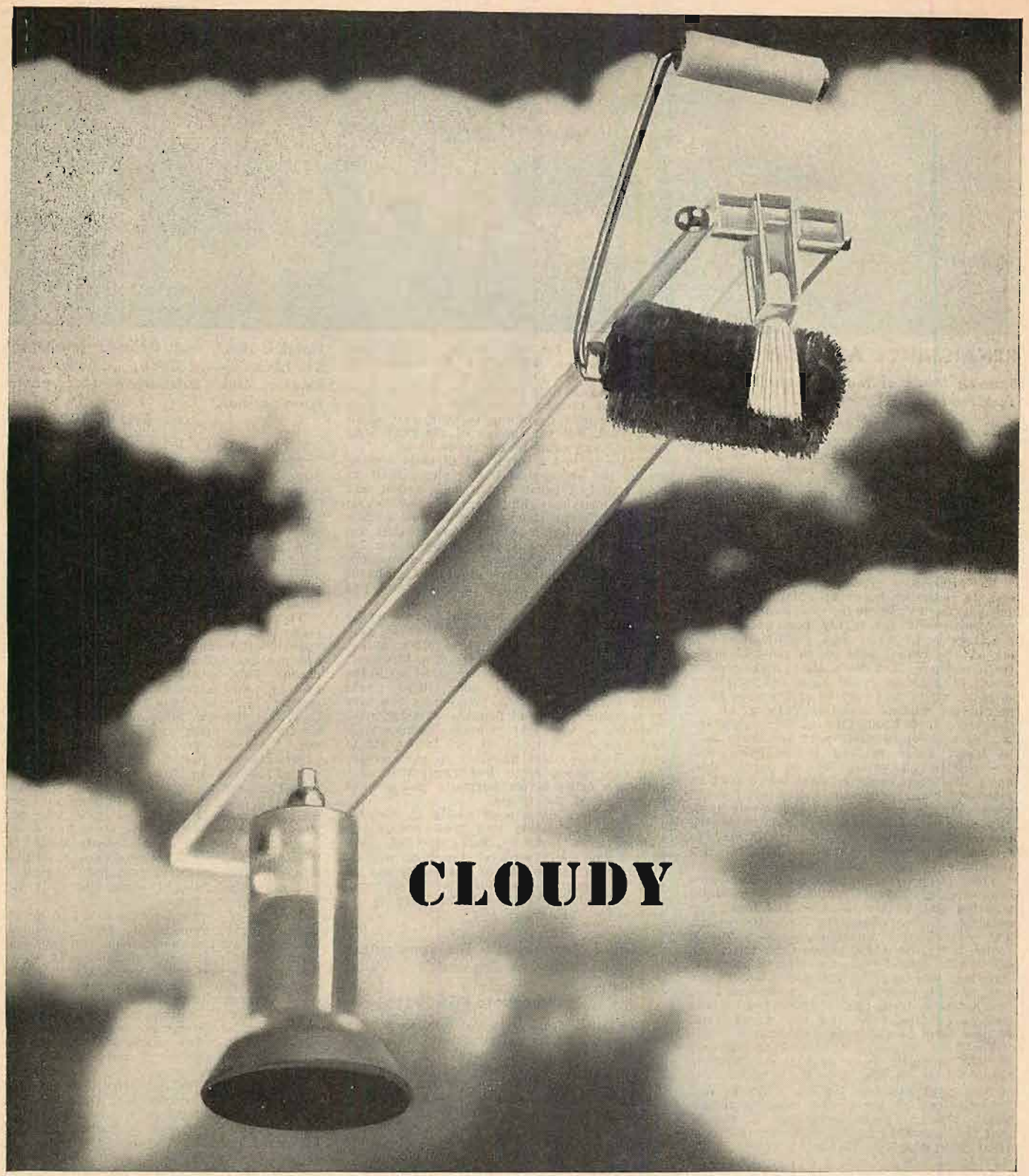
Knowing that anything surrealistic you can do will merely add to the "realism" and impact of your recording, you will soon learn to follow up and exaggerate your surrealism. During that musical songfest, for instance, I noticed one little five-year-old ecstatically singing away to himself as the others sang, making up his own words and tune. I quickly whooshed one of my two outstretched mikes over to him, holding it a few inches above his head (and looking fixedly in another direction to distract him). The result was delightful and a great success in playback though the voice was enormously blown up in size. A good close-up.

* * *

Yes, there are other, more reasonable (and more difficult) types of dual-channel mike technique for home use, including careful, calculated semi-pro stereo. I'll relegate them to a later moment, including an old favorite recording device of mine, now enthusiastically revived—true binaural recording for earphones. I'll never tire of that, and I'm now making new converts among those who have been subjected to it for recording purposes.

My most spectacular recording to date, I'll let on, was a tape of an entire Thanksgiving day dinner for 35 people, straight through from cocktails to dishwashing, done binaurally via two mikes draped over the back of a corner chaise lounge. I just let 'er run. Afterwards, I sat myself in the same chaise lounge at the same spot and heard the entire party all over again in my phones, conversation by conversation. Fascinating.

But before your Mr. Average Home Tape User tries that (and he'll need a pair of phones for every listener), by all means urge him to try just plain, ordinary, simple Two-Point Close-up home recording. It's marvelous fun, and the "surrealisticer" the better. *Æ*



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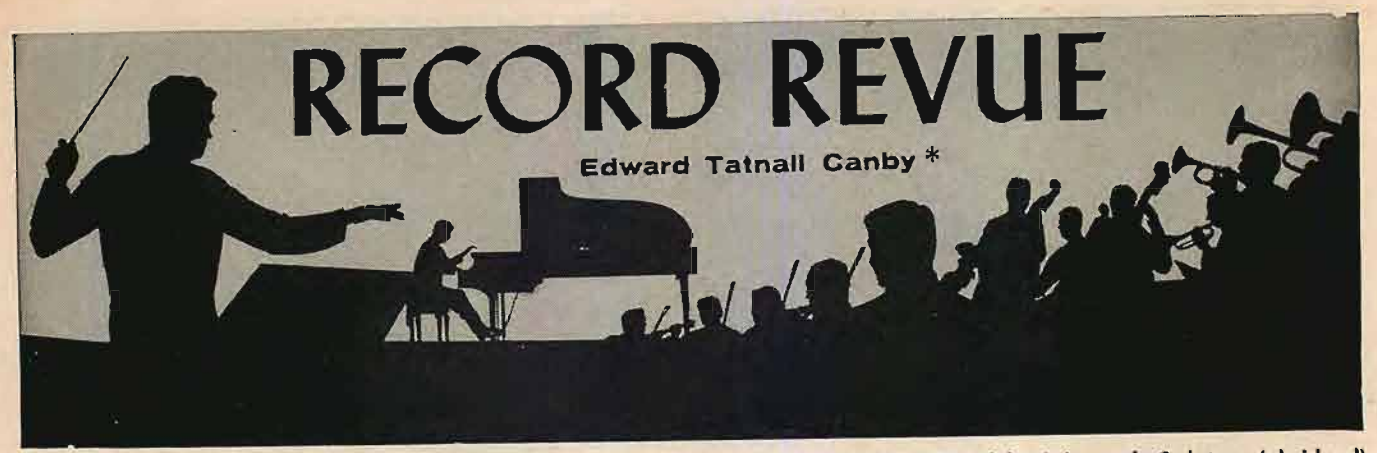

RECORD REVUE

Edward Tatnall Canby *

RENAISSANCE AND BAROQUE

Spanish Music of the Renaissance. New York Pro Musica, Greenberg.

Decca DL 9409

The Pro Musica, under Noah Greenberg, has developed into a remarkably efficient unit of production for the reconstruction of "old" music into practical modern performance. It has built up its own music library, bought a fascinating brace of old instruments—bells, virginals, harpsichords, viols, portative organs—has an office and a mailing list, a musicologist to dig up the music and prepare it for mass-production. . . .

The group now gives hundreds of concerts and its repertory burns up old music almost as fast as TV burns up its material. The performance is thoroughly professional, impeccable as to notes and technique but a bit on the casual side as to musical penetration—there just isn't time. Not even a group of geniuses could turn out music of so many styles and periods at the rate these people do without running into a bit of this trouble. And yet, I'd say, they are growing, as a group, finding more and more how to blend their modern personalities and modern trained voices into a hypothetical unity that must evoke musical sound that is, remember, an unknown quantity. Nobody knows exactly how much of this music actually sounded; the best of scholarship still leaves enormous leeway for variation, in tempo, in dynamics, phrasing, balance, and especially in vocal tone quality.

The group varies in detail. The new countertenor, Robert White, is a splendid addition and, at the moment, the most persuasively musical singer in the entire group. The instrumental music, closer to a known sound, is on the whole better than the vocal, which still suffers from the modern operatic-style loud voice quality. The choral motets, unaccompanied, have not freed themselves from that tell-tale march-time rhythm that plagues modern renditions of the old works (and reduces them to rhythmic dullness).

You'll be surprised at the expressiveness of "old" Spanish music as here so vibrantly brought back to life, if you are a follower of the more familiar Italian, Flemish, and French music of the period. Wonderful material. My copy was mono but I assume that this recording is also available in stereo (that would be DL 79409).

Tavern Songs, Vol. 2. Deller Consort.

Vanguard BGS 5030 stereo

The Catch Club. Randolph Singers.

Elektra 204-X stereo

If you catch glee fever, catch fever, round fever, you are a plague to your neighbors and a pest to your friends, until you dragoon them into joining your catch singing. I know the species from its present-day practitioners, no less ardent than the original gentlemen who were nuts on catches back in the 17th and 18th centuries; no two of them can be together for a few minutes without starting in on one of these musical jollities; they haunt the libraries and ransack their acquaintances for new music to try, and occasionally—an unheard-of faux-pas—they allow a girl to sing with them.

But that is only because in the old days they used countertenors, and countertenors today are only beginning to be grown again from seed. Not yet enough of the gentlemen sopranos and altos to go 'round.

A glee is just a sweet bit of male harmonizing, the ancestor of barber shop. A round is a round, a canon which goes 'round and 'round, everybody singing the same music but at different times. A catch has *double-entendres*, blanks here and there so that unmentionable meanings are produced via interaction between voices. Good clean fun, and in those days you could say almost anything between friends in music, and you did.

The two collections here suffer to varying extents from a major difficulty with all professional performance of this older music, the clearly different concept of a "trained" voice that exists now as compared with the voices that must have sung these ribald little works. The human instrument can take an amazing variety of forms and styles, with training, as we ought to know. Today's rich, heavy, wobbly voice, loud and inaccurate in pitch, is just plain ill-suited to such music. Amateur voices, much less impressive, nevertheless make better harmony and clearer sense out of the music.

The Dellers do a more easily appreciated job with the music and their singing is lighter, more sprightly, beter blended. Both groups are well aware of the high comedy and low suggestiveness of the songs and do well in projecting the same via the cold, impersonal mike! Texts—all that are fit to print—are included.

Madrigal Masterpieces. The Renaissance in France, Italy and England. The Deller Consort.

Vanguard BGS 5031 stereo

The Deller Consort is the ranking British production unit for old music and its volume is probably as great as that of the New York Pro Musica (and the Belgian Pro Musica under Safford Cape, to my mind the finest of all these groups). The Dellers keep to a somewhat more limited range and feature largely singing, minus the profuse instrumental variety offered by both the other groups.

This collection, a cross-section of the 16th century and early 17th centuries, includes some of the most wonderful music of the sort ever written, ranging from the sweet and gracious French love music of Lassus (*Mon Coeur se recommande a vous*) through some exquisite Monteverdi and a brace of solid British fare. The Dellers, too, suffer from assorted wobbles and over-brilliant tone production, but Deller himself has no vibrato at all, when he wants to dispense with it, and in many places his direction produces a perfect blend. The ensemble is more pliable, softer, less metallic, than that of the New York group. Also, perhaps, both more musical and a bit more eccentric.

I think there is much meaning in these works that has not yet been extracted; but their best sense is surely available in this well-styled production.

Handel: Acis and Galatea (abridged). Soloists, Oberlin Choir, Camerata Academica Des Salzburger Mozarteums, Paumgartner.

Epic BC 1095 stereo (mono: LC 3724)

This is a curious mixture in the performance, and most revealing, too. The singers are students of Oberlin College in Ohio, spending their entire junior year in Salzburg; the orchestra is the local academic outfit attached to the Salzburg Mozarteum. The conductor, Herr Paumgartner, is the Salzburg factotum, a first-rate conductor of Mozart opera though a rather academic leader of purely instrumental Mozart—as evidenced on numerous earlier Epic recordings.

There is much sweetness and light described in the record notes concerning this "providential conjunction" of unlikely forces, but my ear tells me a different story. The chorus kids sound all too much like a healthy American chorus, complete with midwest accents and a brash, unsubtle loudness, as though this were the "Messiah" or the Star Spangled Banner, which it is not. The solo voices, earnest, often very expressive but just as often making rather pitiful boners in tone quality and pitch, would appear to be Oberlin students though Robert Bruce, the giant Polyphemus, produces a more professional job. The girl, singing Galatea (Maria Harvey), has a nice sort of advanced musical comedy voice; the boy, (Richard van Vrooman), the Acis, sings manfully for the most part but in some of the rapid portions he clings for dear life, on the edge of disaster.

I might of course be wrong, but to me the whole vocal element in this production smacks of student operations, and too much so. There is practically no feeling at all for the delicate pastoral style which this flowery early Handel seeks to promote. It is done without delicacy in a conventionally loud "oratorio" manner; the whole simply smacks of narrow, over-technical musical education, of voice production not yet perfected, at the expense of musical knowledge dismally absent.

And what of the Salzburgers and the expert Mozart orchestra man, Dr. Paumgartner? He runs this show in steamroller fashion, ploughing forward as though to get it all over with. I can only guess, but my strong feeling is that Herr Paumgartner was driven to desperation by this impossible mixing of studentry and professionalism and reflects his musical impatience in a headstrong, unmusical accompaniment. What else?

Maybe—just maybe—this is the course of too many of our vaunted international cultural exchange programs. The intent is noble, always. But are the results?

Handel: Organ Concertos, vols. I, II (complete). Walter Kraft, Eva Hoelderlin; Stuttgart Pro Musica Orch., Reinhardt.

Vox Boxes 23, 24 (3 each)

This compound reissue set is worth mention for the nice sound quality achieved from tapes that, I figure, must have reached

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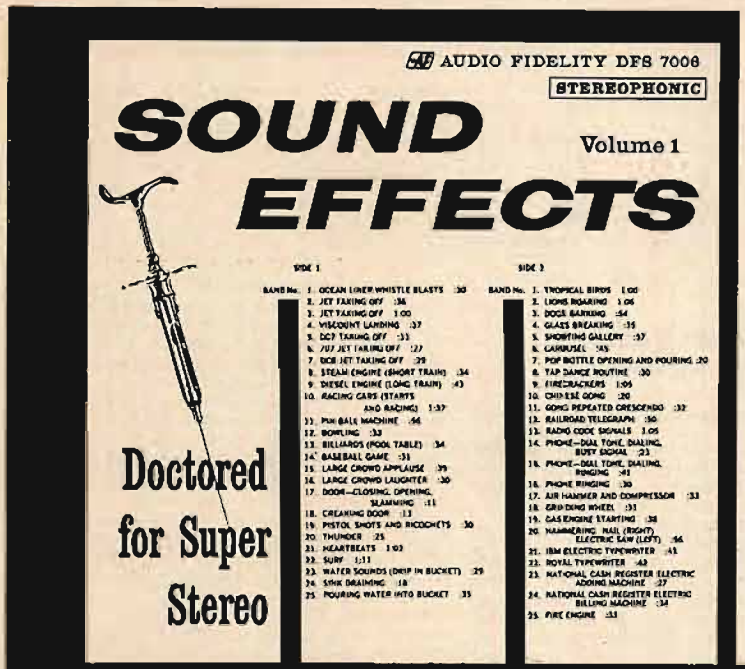

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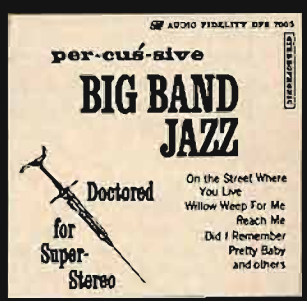

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me in LP form back around 1954. A number of Vox sets have been combined here to cover the whole set of concerti, and hence the pair of organists.

These are lively, straightforward playings, with an intelligent recorded balance between the organ and orchestra, the organ big enough but not, as in some recordings, so close as to destroy the sense of ensemble. The orchestra, though in a big space, is leaner and livelier than that in the Columbia Biggs series under Boult and, on the whole, is a bit more modern in its playing style.

I compared some of the old recording with the reissue and was gratified to find, in addition to the adjustment to RIAA (easily noticeable), a smoother sound and, most notably, much improved surfaces. Our present semi-noiseless plastic is perhaps the greatest improvement in recorded effectiveness over the last five or six years, stereo or no stereo.

QUARTETS AND BALLETS

Gould: String Quartet, Opus 1. The Symphonia Quartet.

Columbia MS 6178 stereo

If the young composer of this quartet were not such a valuable piece of pianistic property, Columbia might not be promoting this particular recording. But the music is interesting as an example of the work of an unusual musical mind in this day and age.

It is both diffuse and naive, yet complex and advanced; its inconclusive style stems most prominently from early Schoenberg, but shows the influence of a dozen others, from Bach and late-Beethoven to Strauss, Franck, and almost anybody else of a serious nature you can mention!

In other words, this is a half-baked work, but of great earnestness and intensity, striving for the highest sort of expression in a great tradition and hitting it off momentarily in many quite startlingly powerful passages. Like many an early work from a strong musical mind, it throws the book, yet manages to be verbose and diffuse too. Fugues, contrapuntal structuring, large-scale sonata form, pregnant motives à la Beethoven (last quartets), a motto of four notes out of which everything in sight and sound is derived—chromaticisms, long passages of ominous tremulandos, and, of course, the obviously pregnant fact that this is a *quartet*, not a symphony: in ten seconds you will know that the quartet form is here chosen as the highest form of musical expression. It's that kind of music.

There are passages that sound merely inept to me and there is a vast sense of dramatic anticlimax, thanks to too-hard working of lofty material. But as I say, there are suddenly striking passages too—often those which are furthest out in stylistic incongruity, such as the Brahms-like second theme. The whole work is a sincere and heartening change from too much sure but empty technique as displayed in a thousand-and-one noisy, skillful, contemporary pieces.

This, I'd say, is how an honest performer *should* inevitably begin to write, in our time of diffuse influence out of many a century. How else, in all honesty? If Mozart's early compositions were impeccable, so was his early training in the then exclusively "contemporary" music that was all he ever heard. Composing and performing were one. As a pianist, today, Gould's performing reflects our times, from Bach to Webern. Can his own music do otherwise?

Beethoven: The Middle Quartets (Opus 59, Nos. 1–3; Op. 74; Op. 95). Budapest Quartet.

Columbia M4S 616 stereo (mono: M4L 254)

The Budapest Quartet is recording the Beethoven Quartets for the third time since joining Columbia in the 78-rpm days (and before that they did splendid work for RCA Victor). The group is now the "Biggest Name" in the chamber music business and, by dint of sheer passing time, is now clearly a middle-aged quartet, if not an elderly one. (Specifically the oldest is 62, the youngest 51). All of this shows up in this new album, which is dolled up in a pleasing manner with a long essay on the Budapest excerpted from the New Yorker, by Joseph Wechsberg.

The Budapest Beethoven shows both the advantages and disadvantages of long experience on the highest plane. The interpretations, *per se*, can scarcely be beat by any other living, quartet for sheer economy of presentation, for the depth of understanding on emotional and architectonic planes. The playing itself, however, begins to show the rigors of time—not in any fading of intent, but simply in a softening of the sharp outline of tone, in weak notes here and there (utterly unimportant, but there nevertheless), in a slightly thin, metallic tone of ensemble as compared to the unctuous richness of some of the more self-conscious younger quartets.

Columbia has nicely solved the problem of quartet stereo—whether to bunch the players in the middle for a semi-mono effect or to spread them out, with a risk of the inadmissable "straight line" effect, all the players lined up in a row. Here, a mild but definite big liveness helps to place the group between the two speakers and a bit back; yet there is enough separation so that the first fiddle is clearly more to the left than the viola and the same with second fiddle and cello.

You'll find that a very delicate adjustment of the balance control is required to get the quartet squarely in between your two speakers, assuming as always that you have them far enough apart to provide a respectable stereo effect. (More than six feet in most living rooms.) If you have one-piece-cabinet stereo you might as well forget about all this; your music is mostly mono, and that is that.

Ballet Music from the Opera. Paris Conservatory Orch., Fistoulari.

RCA Victor LSC 2400 stereo

Maestro Fistoulari appears to be an impressive conductor for ballet-type music of this pleasantly old fashioned sort, judging from this and the London-Richmond mono releases I've been listening to. This is a grand stereo recording, a clean, peppy but well-mannered performance—rather surprisingly neat and in tune for a French playing—which does the best that can be done for the music without pushing it too hard into something it isn't. Impeccable tempo, phrasing, lovely balances everywhere, ingratiating sound of smoothly played violins. Nice hi fi, too, with the familiar bass-drum-and-cymbal thumps most effectively recorded.

There's French and Italian dance music from "William Tell," "Khovantchina," "Samson and Delilah," and "Aida."

Tchaikowsky: Swan Lake (complete). London Symphony, Fistoulari.

Richmond BA 42003 mono

Tchaikowsky: Sleeping Beauty (complete). Paris Conservatory Orch., Fistoulari.

Richmond BA 42001 mono

Here is more Fistoulari ballet music, and two lovelier low-priced specials I can't conceive of. The recordings, in mono, are really splendid and perhaps only the lack of a stereo version puts them into the inexpensive category. Favorable economics for the consumer!

The complete Tchaikowsky ballets can be heavy going in the long pull—they aren't short and, though key themes do return often, the sheer piling up of so many short-ish dance pieces, plus those eternal fancy musical peroration (for the dancers, of course—to be played against storms of clapping and bravos) can run you quickly into satiety. But worst of all, with Tchaikowsky, is any performance that tries to push the well-known Tchaikowsky weeping and wailing too hard. It *never* should outwardly

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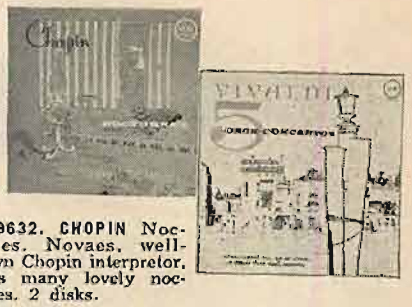

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5-V-15. BACH, Suites for Unaccompanied Cello (complete). Cellist Gaspar Cassado. 3 disks.

5-V-14. MOZART, String Quartets, Vol. III (complete). Performed by the Barchet Quartet. 3 disks.

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be pushed in any of his scores, symphonic or no. He tells his own story best in terms of careful, accurate playing as per the written score. But in ballet music, the over-ripe approach, the semi-hysterical, can be utterly deadly.

Fistoulari is marvelous here. Everything wonderfully neat and accurate, the music sparklingly alive and expressive yet never out of the careful scale.

I don't know how a ballet dancer would feel about these performances—I am not one. But for top listening, this man, with both the British and the French orchestras, has the right, the musical way and no doubt about it for my taste. I'd put these at the very top of all recordings of this music.

Tchaikowsky: Allegro Brillante (Piano Concerto No. 3). Glasounov: Pas de Dix. Glinka: Pas de Trois. New York City Ballet Orch., Irving.

Kapp KC 9046-S stereo

I played this disc a few days after I'd made a pleasing visit to the City Center itself (different music) and I was astonished to find how familiar was the sound of these ballet scores. The City Center productions have a very positive, though perhaps indefinable, aura and quality all of their own, compounded of excellences and bumblings, of sheer verve and occasional over-brashness. Oddly, these over-all qualities come through in the music itself, minus ballet.

The only notable difference I noticed here was the sort you'll always mysteriously find in recordings, with their very special methods of getting put together: in the flesh I found this orchestra excellent in the strings, but (that evening anyhow) very wobbly in the brass and woodwinds. Here, the roles are changed and the brass is excellent but the strings aren't very reliable in detail. Could be merely the large difference in audible distance. I was well back in a balcony, whereas here I am placed, via the mikes, only a few yards away.

Irving is a splendidly practical, workmanlike and musical ballet conductor even if he is not always able to make his somewhat frenetic players sound like the Philadelphia Orchestra. A good disc, this.

The cover titles are those of the ballets; the music is the seldom-heard fragmentary Tchaikowsky *Third Piano Concerto*, selections from "Raymonda" of Glazounov, and "Russian and Ludmilla" of Glinka, the whole disc Russian.

ODDITIES

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This collection makes a nice addition to those I've had previously from the Bornand company and others. The variety is quite large, and a few of these machines produce remarkably involved and interesting musical arrangements of overtures and the like. No wheezing and out-of-tune sound here—Miss Ford keeps 'em in apple pie order. Featured are the orchestrion, a beer garden (yep), an ariosa, a manopan, assorted Swiss clock boxes and an 18th century organ from England.

A Program of Russian Song. Jaroff Women's Chorus, Serge Jaroff.

Decca DL 710019 stereo

The diminutive conductor of the Don Cossacks (he's always called that) is now almost too plump for his cossack uniform after some forty-odd years of plumping for Russian music outside of Russia, but he still has the same way with his voices—even these ladies, a new angle to his characteristic work. They're good, very good.

What I keep wondering, now more than ever, is how do the Cossacks (and these new ladies) keep perpetuating themselves from non-Soviet sources? Are they really Russian? They sound it. Do they never get any older? They don't seem to. How recent is their

latest contact with the Mother-land? Is the tradition (including the singing style) kept alive strictly in exile, without refertilization from the home country?

By the sound, I'd guess that the various Jaroff groups still do not reflect the changes brought about by the Soviet system in all its cultural complexity—those of us who have heard numerous recent Russian folk recordings (have the Cossacks?) will note the new harder, more dynamic styles, the higher tension. These exiles (or are they just Americans and assorted Europeans, trained to sing à la Russe?) produce a lovely, more leisurely brand of Russianism. Up to date or no, the Jaroff singers of both sexes are unfailingly musical and boast tremendously interesting and varied vocal prowess. Good stuff.

AE

AUDIOCLINIC

(*from page 4*)

3-speaker systems. I have set the level controls according to the method described by the speaker manufacturer—by ear. The results are satisfactory to me. However, after awhile, it seems that maybe a little stronger treble would sound better. Therefore, I increase the gain on the treble horn. Then later, I may find that by raising the level of the midrange speaker I improve the "presence," and so on.

Although I understand that the actual sound quality from the speakers depends very much on the room or the environment in which the speakers are placed, is there not some way to determine at what setting my speakers are balanced other than by using my ear? I would not stick to this setting if it did not please my ear, however. James J. Allain, Jr., Por Allen, Louisiana.

A. Since the actual balance among the three speakers in a 3-way system depends upon the room in which the equipment is housed (as you suggested), it is impossible for the manufacturer to give you any additional instructions other than those he provides with his speakers. If you have an audio oscillator and a calibrated microphone, more accurate control settings can be found.

Of course, the calibrated microphone must be placed in the position which the listener would use or the resulting readings will be faulty. The use of a calibrated microphone may not be feasible for you, but your ear can be used as a good substitute.

By using the audio oscillator to sweep the audio range you may well hear whether the midrange is louder than the woofer, etc. The best way to accomplish this result is to sweep from a point somewhat below the crossover point to one which is somewhat above this point. An octave on each side of the crossover point should be sufficient. This technique can be used for both the midrange and tweeter crossover points.

This procedure should be followed with the observer in the position most usually occupied by the listener or listeners to the equipment. AE

ABOUT MUSIC

HAROLD LAWRENCE*

Portrait of a Rehearsal

THE CONDUCTOR, David Randolph, would have been justified in experiencing a degree of apprehension on the morning December 10, 1960. The Masterwork Chorus (Morristown, New Jersey), which he had co-founded in 1955, was scheduled to make its Carnegie Hall debut that evening under his direction in Bach's *"Christmas Oratorio."* A three-hour session had been called for 9:30 a.m. at Carnegie Hall for the first and only full-scale rehearsal with all the musical forces involved in the performance. It was imperative that Mr. Randolph operate with unusual speed and efficiency. The allotted rehearsal time did not permit a run-through of the complete oratorio which, counting pauses, is itself more than three hours long. To cover the ground, the conductor planned to omit certain repeats and to move ahead to the next movement whenever things appeared under control.

In previous rehearsals, Mr. Randolph had worked with the chorus for several months, imprinting on the minds of its members detailed instructions regarding tempo, diction, phrasing, accents, and tone quality; and, during the week before the concert, he had held sectional rehearsals with the orchestra, soloists, and chorus. Now the component parts were meticulously prepared, but the fact remained that they had not yet been assembled. This was not due to an oversight. The budget of this non-profit choral organization was already strained by the expenses of a New York concert—rental of the hall; printing of tickets, programs, and miscellaneous literature; payment of ushers and stagehands; and costs of transporting and accommodating in New York the out-of-state choral singers. Finances simply ruled out more than one "dress" rehearsal.

Some two hundred and seventy performers, therefore, were gathering together for the first time. Critical adjustments would have to be made to each other and to the acoustical properties of the hall. The conductor could only guess at the potential sources of trouble: ensemble problems would be the easiest to spot and correct; more tricky were the factors of balance and dynamics upon which the hall's sonic character would have so great an effect. As the stage began to fill up before him, Mr. Randolph must have felt like a space scientist watching a missile on its launching pad at firing time.

Busy counting the noses of arriving performers, the conductor found that his own nose had become the object of an early-bird photographer, who had focused an exposure meter on it to obtain a light reading. Other amateur photographers had also

* *26 W. 9th St., New York 11, N. Y.*

(Photo by Harold Lawrence)

Fig. 1. David Randolph conducting the "Christmas Oratorio."

infiltrated into the rehearsal, their tripod cases passing for bassoons. One had set up a large camera in a first-tier box, another had squeezed into the woodwind section of the orchestra to aim his Hasselblad up towards the podium, and a member of the chorus (honor) carried a 35-mm camera along with his music. By mid-morning, there were some half dozen cameramen perched on different vantage points in the hall. The clicks of shutter releases and the squeeks of film transport mechanisms at times provided a steel-cricket obbligato to the musical performance—an appropriate effect for the movement which opens Part II of the "Christmas Oratorio," the *Pastoral Symphony*.

The battery of lenses aimed at the podium might have rattled other conductors, but Mr. Randolph was beyond distraction. There were more urgent matters at hand. For example: "Where was the harpsichord?" "Why hadn't risers been laid down for the chorus?" "How are we going to fit the instrumentalists on the crowded stage?" The harpsichord finally arrived, but not the risers; and the orchestral players were accommodated snugly on the apron of the stage. The clock in the wings read 9:30. Mr. Randolph inspected his musical forces. Noticing an unevenness in the ranks of sopranos and altos, he called out, "Will the pregnant women please sit near the door?" Concert hall esthetics disposed of, he dispatched Shirley May, the president of the chorus, and three other musicians into the hall to function as aural monitors. This was a necessary precaution. Conductors know that the podium can be a deceptive listening point from which to evaluate balance, dynamics, and even ensemble in an unfamiliar auditorium. And this was Mr. Randolph's first conducting experience in Carnegie Hall.

The opening of the "Christmas Oratorio," *Jauchzet, frohlocket!* with its joyful punctuation of trumpets and timpani, got the rehearsal off to a vigorous start. At the conclusion of the movement, the conductor asked the opinion of the monitors. "Diction, David. We can't hear a word back here, it's all a wash of sound." Mr. Randolph replied, "You realize, of course, Shirley, that the chorus is not on risers. Nevertheless, we'll try it again. (To the chorus) You all heard that. While we're on the subject, I should like to add that there's not a rolled 'R' in the bunch. And smile, darn you, this is a happy work!" Articulation and spirit improved noticeably in the second attempt, but the ensemble broke down in the sixteenth-note passages. The conductor offered a practical solution: "Stay with me, don't go by what your neighbors are doing."

As the last notes of the choral "Wie soll ich dich empfangen" melted into the quiet hall, Mrs. May, unmoved by the performance, uttered the startling suggestion, "Shoot the bass!" The bass line, it seems, had upset the musical balance by emerging above the other voices. In another choral, Mr. Randolph checked a bad case of sagging pitch with the admonishment, "Think high."

The first and only purely orchestral movement in the work, the *Pastoral Sym-*

(*Continued on page 78*)

CHARLES A. ROBERTSON*

STEREO

The Modern Jazz Quartet: Third Stream Music — **Atlantic SD1345**

Jackie Gleason: Lazy Lively Love — **Capitol SW1439**

New jazz categories are constantly being thought up to soothe persons who like to claim they never listen to jazz, and two of the most recent succeed in avoiding any use of the word. Efforts to combine jazz and classical forms once were described adequately as chamber jazz or symphonic jazz, depending upon the number of players and decibels involved, but both terms now are in disfavor. Third-stream music, a substitute phrase which Gunther Schuller coined and then introduced to the public in billing a concert of his works last May, is the latest vogue. Jazz journalists immediately saw magic in the words and are reporting each development with all the avidity of fashion writers at a Dior opening. As the tag also is affixed to the Modern Jazz Quartet's new album of works by Schuller, Jimmy Giuffre and John Lewis, with the promise of more to come, it should remain in style until next season at least.

Once the album title lures listeners with concealed leanings toward jazz, all three composers are careful not to displease anyone. Of course, a name like the Third Stream Quartet might mollify some purchasers further, but very little in the way of jazz is asked of the group and it sounds even more subdued than usual. Mood music devotees in particular will find it restful when the Jimmy Giuffre Three joins in on two pastoral settings, both devoid of disturbing animal life. Should the record fall into hands of the more violent detractors of the Quartet's previous work, they will be unable to apply their favorite epithet "pallbearers of jazz," as the corpse never arrives this time.

The longest and most interesting work is *Conversation*, Schuller's lone contribution, which engages the Quartet in a clever dialogue with the visiting Beaux Arts Quartet. The classical contingent is given the dominant role for once, and supplies the excitement usually asked of jazz players in a series of dramatic interludes that resemble the climaxes of Bartok's string quartets. The two opposing forces never get together for a joint statement, however, and the jazz group has the limited task of resolving tensions already introduced. The Modern Jazz Quartet, which has resisted efforts of jazz copyists to ascend to the same pinnacle, is reduced in this context to the emotional level of Martin Denny's group of South Sea Islanders. The exotic bird cries are absent, but the presence of Ornette Coleman on another of Schuller's compositions should correct that omission in the near future.

The packaging is just fashionable enough for people too pretentious to keep jazz about the house under its proper name, with a cover abstraction in Grand Rapids modern and imported liner notes purchased from an English critic. The stereo engineering by Earle Brown and Frank Abbey is faultless and comes from Capitol studios.

*732 The Parkway, Mamaroneck, N. Y.

Jackie Gleason's mood albums rack up enviable sales figures, yet introduce such jazz worthies as Bobby Hackett and Lawrence Brown to people who might not hear them otherwise. The meetings are usually carefully arranged, with the soloists surrounded only by circumspect strings. If the truth were known, the rotund comedian long ago launched a scheme to gradually increase the jazz content of his offerings. One of his choice customs is to engage a good group headed by Max Kaminsky, an unreconstructed Chicago-style trumpeter, for a little travelling music to enliven his arrivals and departures on road trips. A jovial host, he hates to think anyone is missing the fun.

Just such a group goes to work on his latest LP, and it stretches the mood category to the breaking point. Instead of a lone soloist in the foreground, the massed strings compete with the full stereo spread of an uninhibited nonet. Something has to give with a front line of Ruby Braff, Buck Clayton, and Yank Lawson on trumpet, Buster Bailey and Andy Fitzgerald on clarinet, and Lawrence Brown on trombone. Gleason shows that he also can turn the tension and relaxation trick, first programming such lazy melodies as *Speak Low, Lover Man,* and *It Had To Be You.* Then to leave the customers happy are such lively alternates as *Exactly Like You, Too Close For Comfort,* and *Breezin' Along With The Breeze.* The rhythm team includes Claude Hopkins, Al Caiola, and Milt Hinton, while the arrangements are credited to George Williams.

As Gleason proceeded with the plan to bring jazz to the stage where it equalled or overbalanced the mood portions on his LP's, he realized the end product would need a new label. After much scholarly research, he decided the right mixture would be called fourth-stream music. To arrive at this title, he was forced to look outside musical fields and investigate thoroughly the secret art of blending. It refers to the four main varieties of Scotch pot-still whiskies which Highlanders combine to produce the final harmonious article.

Gleason's present concoction seems about right, and the next one may suit his standards of perfection well enough to wear the new title in public for the first time. When that happens, other entrepreneurs who hide jazz in mood settings are expected to reveal their part in the plot. Among his fellow conspirators are Steve Allen, Arthur Godfrey, Michel Legrand, Paul Weston and Henri Rene. Just so long as the strings hold up, a label which carries so many pleasant connotations should endure.

Bill Holman's Great Big Band — **Capitol ST1464**

Between playing tenor sax on other leader's dates and arranging chores for various bands, Bill Holman found time to assemble a big studio band and work out some of his writing ideas in his own way. Perhaps the best vindication of all the effort is found on *Spinuet,* a superb blues waltz that descends directly from Duke Ellington's scoring of the film "Anatomy of a Murder." Holman arranged the theme first as a background for Peggy Lee's lyrics to *I'm Gonna Go Fishin',* then as a buoyant instrumental for the Gerry Mulligan concert band. The next logical step could only be an extension of the theme, and he takes his men right up to the edge of the mythical creekbank and sits them down. Like so many other jazz artists, arrangers often do best when not creating to order.

Holman's scoring is generally lighter and more swinging than on a previous band date for the Andex label a season or so ago, and the change in sentiment is expressed on his lively *Quickstep.* His other original is a peace offering for Capitol engineers, and the pipe is passed back and forth Indian fashion by brass and reed sections on *Stercoso.* The control room returns the compliment and favors his first band offering for the company with outstanding sound. Holman's treatment of standards assures a return visit, and he solos longingly on *In A Sentimental Mood.* Conte Candoli, Bill Perkins, Joe Maini, Jimmy Rowles, and Mel Lewis are among the California jazz specialists who help out on such tunes as *Shadrack, The Moon Is Blue,* and *June Is Busting Out All Over.*

Tex Beneke: The Alamo — **RCA Camden CAS655**

Dutch Swing College Band: Twelve Jazz Classics — **Perfect PS14038**

Besides presenting a good stereo spread, these low-priced albums are durable and handy to have about the house for the next dancing party. In fact, Tex Beneke's selections from the Dimitri Tiomkin score probably will be played long after the film sound-track LP is forgotten. Arranger Ray Martin gives the more fetching themes considerable space and a rhythmic beat, with only a slight nod in the direction of purely descriptive interludes. The lad from Texas feels right at home on the vocals, still has the old Glenn Miller touch as leader, and plays free-and-easy tenor sax.

The Hollanders take up a stand midway between srtaight New Orleans style and the happy traditionalist sounds of their English cousins. They play the regular dixieland book, take a flyer at Ellington on *Black And Tan Fantasy,* and offer one or two originals, notably *March Of The Indians.* The clarinetist, possibly the best to be heard the other side of Britisher Monty Sunshine, solos long and eloquently. Tuba and banjo are arrayed in stereo to steady any faltering steps.

Stan Kenton: Live At The Las Vegas Tropicana — **Capitol ST1460**

Only the rarefied armosphere of Las Vegas could cause Stan Kenton to unbend enough to indulge in a little dixieland tomfoolery on a tune called *You And I And George,* which allows the trombone section to run riot. And the paying customers are entertained further as Billy Root wheels a rakish baritone sax through Gene Roland's whimsical *Puck's Blues.* Some degree of order is restored before long, but the band continues to swing unrestrainedly and does full justice to *Tuxedo Junction, Sentimental Riff,* and *Bernie's Tune.* Soloists Lennie Niehaus, Jack Sheldon, and Richie Kamuca find their luck running high and ride it to the limit. Capitol engineers turn in another fine on-location job, and the leader, in stereo, seems to hold the Tropicana audience right in the palm of his hand.

J. J. Johnson: Trombone And Voices — **Columbia CS8347**

George Shearing: The Shearing Touch — **Capitol ST1472**

If Jack Teagarden and George Shearing can cash in on mood albums, who will deny J. J. Johnson the right to reap the profits from one of his own? Frankly, the change of pace and style on this LP gives the top-ranking jazz trombonist a chance to disclose aspects of his playing that are usually hidden. Cast as the leading voice in a wordless choir which arranger Frank DeVol pipes in from various points on the stereo stage, he adopts a bigger, warmer tone and drifts effortlessly through Bernard Hermann's *Jennie's Song, Motherless Child,* and *In A Senitmental Mood.* One or two technical displays are set off to keep in trim, but for once Johnson's work is characterized by Hoagy Carmichael's *Lazy Bones.*

George Shearing's supporting choir on this occasion is composed of just strings, arranged

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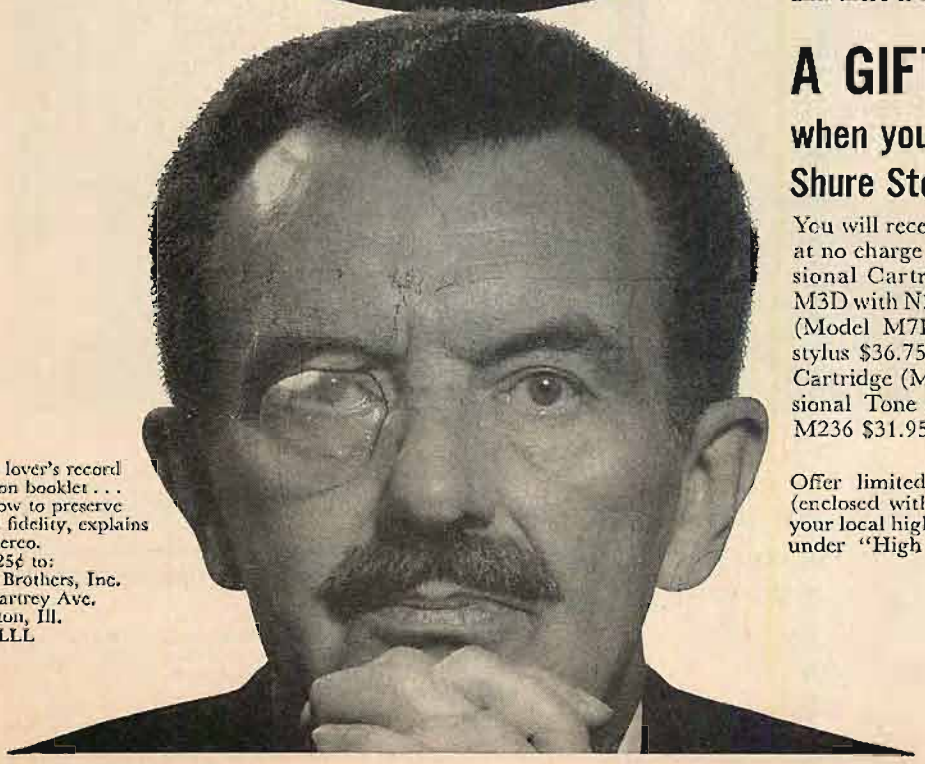

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in numbers ample enough to assure a plump stereo sound by an equally large-proportioned Billy May. A dozen themes associated with other keyboard notables receive the Shearing touch, including Claude Thornhill's *Snowfall*, Eddie Heywood's *Canadian Sunset*, Erroll Garner's *Misty*, and Andre Previn's *Like Young*. Playful salutes to the original versions in passing again prove the pianist to be a master stylist. Perhaps out of respect for his fellows, Shearing is pictured at the piano on the cover, replacing the calendar art on his recent mood albums.

Lambert, Hendricks And Ross Sing Ellington — Columbia CS8310
The Double Six of Paris — Capitol ST10259

After setting a mark on Count Basie standards for other jazz vocal groups to shoot at, Lambert, Hendricks and Ross pick out a notable sheaf of Duke Ellington compositions as targets and rack up another high score. Appearing in stereo just as they do at concert and club performances, they apply a special brand of vocal legerdemain to such favorites as *Caravan*, *Things Ain't What They Used To Be*, and *Midnight Indigo*. They never resort to the electronic crutches of overdubbing or channel switching to simulate full orchestral textures or original solos. On the theory that most audiences know the arrangements well enough to compensate for any missing parts, they depend for support solely upon the Ike Isaacs trio, their regular accompanying group. As before, they are most comfortable on the blues or at dazzling fast tempos. Hendricks seems ill at ease on the balladic *All Too Soon*, but Miss Ross restores the balance with a lovely solo on *In A Mellow Tone*.

The Double Six is almost as much a product of electronic trickery as it is the brain child of Mimi Perrin, who formed the group on hearing its American counterpart sing Basie in 1959. The six voices dub in the brass and reed section work, after actual instruments are used to record the rhythm parts, and return again to imitate various solo flights. Stereo ties the whole package together in realistic band dimensions. Besides providing novel French lyrics, Miss Perrin sings in deep tones that complement the sensational high notes of Christianne Legrand, the only other feminine member of the team. The sister of Michel Legrand, she often assists on the vocal backgrounds of his mood albums and also ghosted Brigitte Bardot's scat-singing in the film "La Parisienne." According to the liner notes, no recording tricks are involved in her ability to match the upper reaches of Yma Sumac's ascents. Recreations of Quincy Jones arrangements, introduced during his recent European band tour, comprise the bill of fare which lists *Meet Benny Bailey*, *For Lena And Lennie*, and Horace Silver's *Doodlin'*. College students should find something in the lyrics to confound French professors, and Hendricks may feel impelled to start work on a Quincy Jones set.

Sound Effects, Volume 1 — Audio Fidelity DFS7006

Fifty different sound effects are compiled on this first volume, and where the total will stand at the conclusion of the projected series is anybody's guess. Among the interesting comparisons afforded is one between a Royal typewriter and an IBM electric typewriter, so perhaps the intention is to work up to the thought processes of an IBM electronic computor. To get the show on the road, return visits are paid to many favorite subjects heard on previous albums of a similar nature, whether produced by Audio Fidelity or other labels. The diesel and steam engines, jet airplanes, racing cars, thunder and surf are all here, along with a number of unexpected surprises. Just two examples are water draining from a sink as though the plumber was on hand to help it along, and an unknown expert ringing all the changes on a pin ball machine.

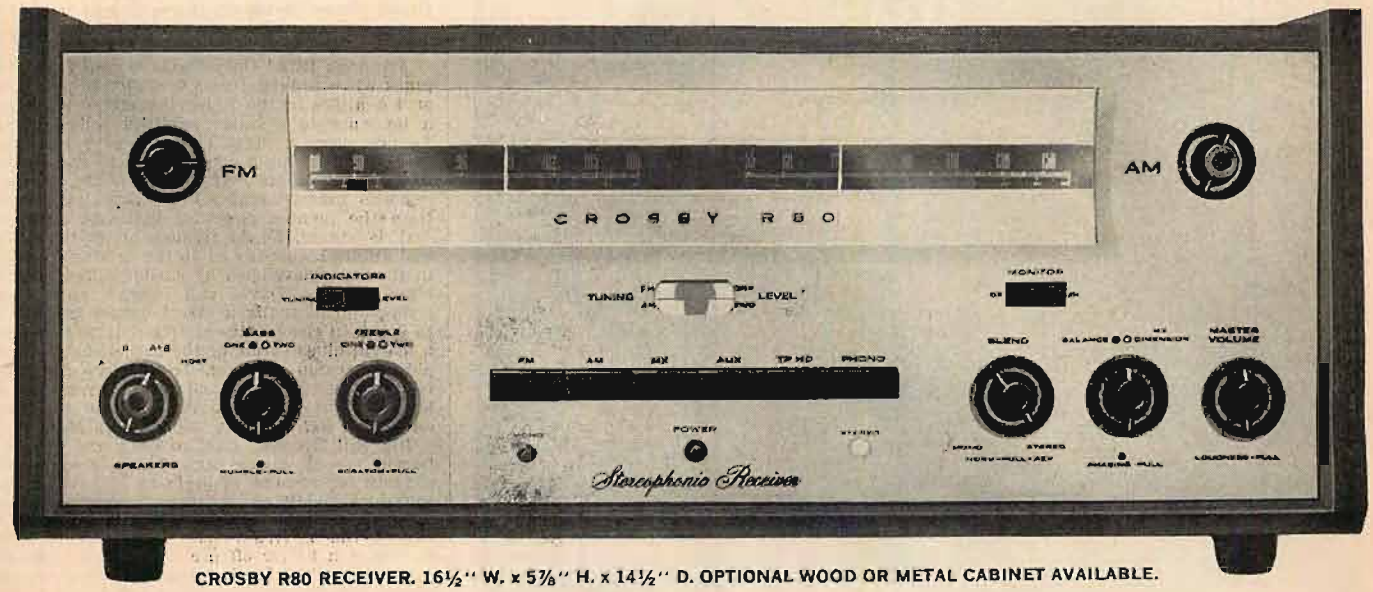
Although the volume is listed in the com-

the remarkable touch of Crosby

The touch of Murray G. Crosby has created a truly remarkable stereo receiver . . . the R80. Like all other receivers, it combines AM and FM tuners on the same chassis with stereo preamp and dual power amps, but here the departure begins.

Examine first, power. The R80 boasts 80 distortion-free watts, 40 per channel, enough to drive any speaker system made. To control this magnificent component is sheer simplicity. Wherever possible ganged, push-pull knobs are utilized. Source selection is achieved through push-buttons. Visually, the R80 is exceptionally pleasing and compact for custom installations. The handsome face is brightened by a concurved, illuminated tuner dial, variable mono/stereo blend lights and an exclusive two-channel indicator for tuning and program level. Exhibiting versatility, the unit features front panel controlled speaker/headset selector, tape monitor facility, and special volume control for 3rd speaker stereo installations. With an eye to the future, Crosby has eliminated the chance of obsolescence by including a Multiplex Dimension control and powering facilities for a non-powered accessory Multiplex Adapter.

Unique features, excitingly used, make the R80 the remarkable receiver that it is. And though the performance stands above all others, the price doesn't . . . just a value-setting $375.



CROSBY R80 RECEIVER. 16½" W. x 5⅞" H. x 14½" D. OPTIONAL WOOD OR METAL CABINET AVAILABLE.

stereo BY Crosby

Crosby Electronics, Inc. • 135 Eileen Way • Syosset, L. I., N. Y.
Manufacturers and designers of stereophonic components, speakers and the Crosby Compatible Stereo FM Multiplex System.

pany's Super Stereo series, the only doctoring administered is a microscopic examination of some sounds that are ordinarily heard in noisy surroundings. A door creaks at a ghostly touch, while an air hammer and compressor blot out passing street traffic. Only the operators, live or ethereal, would stand as close as the microphones are placed. If anyone wants to know how it feels to go through a pane of glass, the experience is right here waiting and nothing softens the blow. In these cases, the avowed purpose is to present effects in the purest state possible, before they become diluted or diffuse. Crowd noises, zoo animals, and the blast of an ocean liner are recorded at a more normal distance. Considerable patience and know-how is devoted to making each come alive with stunning realism.

The listener who wants a succession of spectacular effects in rapid order will find the grooves between bands locked, and the pickup must be moved each time. A boon for home tape enthusiasts, this safeguard frees both hands for use in manipulating a tape machine and introduces no unwanted noises as the locking grooves are silent. The more experienced should have a fine time adding reverberation to some episodes, or altering the perspective on others, depending upon the context in which the material is to be employed. Science fiction fans are hereby alerted that the next chapter deals with Outer Space, but the end is not yet in sight.

Jo Stafford: Jo Plus Jazz
Columbia CS8361
Kay Starr: Jazz Singer **Capitol ST1438**

At a time when few female jazz singers are worthy of the name, the arrival of two vocalists from the popular field is a welcome event. It becomes doubly so when the visitors call on the respective arranging and conducting talents of Johnny Mandel or Van Alexander, who supply rugged tests of a singer's ability. Jo Stafford is able enough and knows as much about the art as anyone else. If the accompanying group slightly overshadows her, neither she nor the listener has reason for complaint. She aims at nothing less than the top, drawing responses of similar loftiness from the likes of Ray Nance, Johnny Hodges, Ben Webster, and Mel Lewis. The Ellingtonians do well by *Day Dream*, with John Latouche lyrics, and other tunes associated with their employer, while the singer recalls her Dorsey days on *For You, What Can I Say After I Say I'm Sorry*, and *Dream Of You*. Another Dorsey alumnus, Frank Sinatra, might try Mandel's brand of swing for a change.

Kay Starr nearly qualifies as a jazz singer whatever the context, but her break with the popular idiom sounds a little tentative, almost as though Capitol wanted to look at the sales sheets before allowing her to go further. Alexander gives her a chance to try her luck on a variety of settings, spotting an electric organ or singing ensemble on some, and using a big swinging band on others. A good indication of what she could accomplish with an Ellington contingent, or at a reunion with Charlie Barnet for that matter, occurs on *Hummin' To Myself*. Her brash style and full, rich tones are eminently suited to *My Honey's Lovin' Arms*, and *Hard Hearted Hannah*. Always a pleasure to hear, her big voice is one that remains undiminished in stereo.

Belafonte Returns To Carnegie Hall
RCA Victor LS06007

Now that Carnegie Hall is safe from would-be demolishers, Harry Belafonte's concerts there can be looked forward to as an annual event. The one-the-spot recording of his second appearance is as fully rewarding as its predecessor, especially since the singer welcomes two of his proteges. Odetta performs *Water Boy*, and *I've Been Driving On Bald Mountain*, as well as being a foil for Belafonte's quips on the delightful *Hole In The Bucket*. He in turn acts as a partner for Miriam Makeba, the South African girl he encouraged to come to this country, on *The Click Song*. Belafonte also sings in her native Xosa dialect, but only Miss Makeba can say how well he has mastered the tongue-twisting language. The Chad Mitchell Trio does its specialty, *The Ballad Of Sigmund Freud*.

All of the Belafonte numbers are new to stereo, although two were recorded before. As was the case with the first concert album, interest centers on his fine sense of timing and ability to react to an audience. When the Belafonte Folk Singers join in at Bob De Cormier's direction, the stage fills with sound and movement. Bob Simpson, who also engineered last year's concert, sees that none of it is lost on the stereo version.

MONO

Blind Gary Davis: Harlem Street Singer
Prestige/Bluesville 1015

Although Blind Gary Davis turned from the blues when ordained as a minister in 1933, he still qualifies in the Bluesville category due to a tendency to practice youthful follies while he preaches. A blues timbre creeps into his voice even during a song as joyous and cheerful as *Lord, I Feel Just Like Goin' On*, and his sermons follow country blues phrasing rather than the printed pages of hymnals. After a text is stated, Davis frequently omits words and allows his guitar to do the talking for him in the style developed by earlier religious and blues singers. Davis can depend upon this companion of many a street corner gathering to speak in clear tones of spiritual affirmation, a tearful blues throb, or the happy shout of an old-time camp meeting. It requires no electronic amplification, and the revival flame burns bright when the two declaim together on *Let Us Get Together Right Down Here*.

Big Bill Broonzy used to draw the line between gospel music and blues singing as sharply for reasons of style as Mahalia Jackson does today on religious grounds. Every respectable gospel singer should know a little about "the Devil's music," however, if only to mount a better offense against the ancient enemy. So when Davis sounds like Broonzy at times, it just means the Devil is going to be fought that much harder. Davis tells of his own struggles and conversion on *Great Changes Since I Been Born*. If Broonzy were still alive to witness some recent mock weddings between gospel and blues, he might

adopt a pseudonym and preside at a few legitimate ones himself.

After first recording more than twenty-five years ago on the old Perfect label, Davis next appeared on two early LP's, but always missed one of the recurring waves of interest in country blues. Only a few collectors had the foresight to acquire copies before they vanished from the lists. Never one to worry about worldly success. Davis continues to ply his trade, happy in the knowledge that police seldom bother a street minstrel who sticks to religion. Years spent in the open have made his voice rough and leathery, yet it overflows with compassion and seems to bear a personnal message for each member of his small circle of listeners. He takes his song-sermons into Harlem storefront churches on occasion, but lofty pulpits and large congregations would be unsuited to his homely parables.

Davis marches along in the tradition of Blind Willie Johnson, who recorded in Dallas for Columbia in 1927, and revives the legendary Texas singer's interpretation of the Samson and Delilah story, along with his *Twelve Gates To The City*. Johnson's versions filled a need during the depression and were among the few recordings to sell widely, so perhaps their return to circulation in these days of "The Bomb" is appropriate. Producer Ken Goldstein and engineer Rudy Van Gelder also contribute to an admirable LP.

Bunny Berigan And His Boys
Epic LA16006
Glenn Miller and His Orchestra
Epic LA16002

Jazz researchers often find the most revealing period in a player's career occurs shortly before the heavy hand of public approval rests on his shoulders, and these collections of historical reissues cover just that interval in the lives of two renowned swing-era leaders. Bunny Berigan, in the opinion of many, did his best work before the burden of maintaining a big band wore him down. Certainly few trumpets have sounded more vital and pure than Berigan's horn does on the lyric first version of *I Can't Get Started*, and other numbers recorded with small pick-up groups. His ballad style is beautifully relaxed, making it a joy to revisit such old tunes as *A Melody In The Sky*, and *I Nearly Let Love Go Slipping Through My Fingers*. And the list of Boys who were glad to be asked to the sessions includes Jack Teagarden, Artie Shaw, Bud Freeman, Dave Tough, and Cozy Cole.

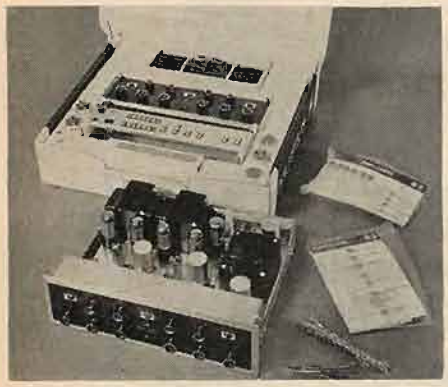
Glenn Miller teamed Berigan with Charlie Spivak when shaping his own orchestra, and they went into the studio on April 25, 1935 to appear together on its first date. In fact, one of Miller's earliest compositions, *Solo Hop*, turns up on both LP's. Two sessions held two years later show Miller on the threshold of the formula that carried the band to the top, while Berigan struggled elsewhere with the problems of keeping an organization together on the road. Smith Ballew's vocals are ancient enough to hold a certain charm, and Miller always played for dancers.

Jim Copp and Ed Brown: Thimble Corner
Playhouse 303

A clanging trolley bell signals the start of the glorious sound effects which set the two previous LP's in this series apart from the ordinary children's release. Two Los Angeles bachelors, Jim Copp and Ed Brown, spend the better part of a year on each, creating a special little world "for small fry and sophisticated adults" to share together. Copp is responsible for the songs and stories, while Brown designs the distinctive covers and joins his partner in playing numerous roles. The wonderful people and animals that inhabit Thimble Corner make it a funny place, and fortunate listeners will meet a talking duck, a turkey dressed in satin, Anderson cat, and the dog that went to Yale. Each personality is developed by characteristic sounds as well as words, and just a few of those described are Harrison Garrison, Luck Gluck, Thaddeus Hop, Hooligan Flea, and the dog with the longest name in the world. A return visit is paid to Miss Goggins, whose teaching methods are the despair of all modern educators. The annual release is timed to catch the Christmas trade, but better shops should keep copies on hand for birthday gifts. AE

NEW PRODUCTS

• **72-Watt Amplifier Kit.** Taking its place beside the unusually well-designed H. H. Scott FM tuner kit is this 72-watt amplifier kit, the Scott LK-72. On the surface this kit seems to have all the virtues of the tuner kit—that is extreme simplicity for the kit builder combined with factory performance standards. From the way these kits go together it seems that the designer was ordered to remove the drudgery and leave only the cost-saving fun. In appearance this amplifier is a perfect match for the tuner kit so that the builder



may have a system which is matched in appearance as well as performance by the time he is finished. Specifications for the LK-72 read like those for any factory-assembled unit: full power 72 watts (36 watts per channel); IHFM power band extends down to 20 cps; total harmonic distortion is less than 0.4 per cent at full power; hum level is better than 70 db below full power output. Among the many additional features of the LK-72 are a "center channel" level control, scratch filter, tape recorder monitor, and separate bass and treble control for each channel. The H. H. Scott Model LK-72 retails for $149.95. H. H. Scott, Inc., Dept. P, 111 Powdermill Road, Maynard, Mass. **B-1**

• **Unique New Mixer.** UltrAudio Products, a division of Oberline Inc., has introduced a mixer amplifier offering features heretofore unavailable in either professional or home units. Designated Model M-5 Custo-Mixer it is available for rack, console or carrying case use. The amplifier offers five mixing positions for microphones, phonos, tuner, tape output, etc., and a master gain

control, with high and low impedance inputs and output, illuminated VU meter, turntable cueing, and equalizing. The mixer utilizes a standard 5¼ x 19 in. panel, weighs but 20 pounds, complete with self-contained power supply. Special features are the plug-in input transformers and preamps which one buys only if needed, and the patented "Straight-Line" volume controls. Replaceable designation strips permit indication of which source is connected to each mix position. UltrAudio Products, Dept. P-1, 7471 Melrose Ave., Los Angeles 46. **B-2**

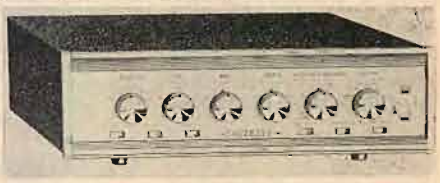
• **4-Speed Transcription Turntable and Tone Arm.** Each unit engineered to complement the other, Lafayette's new 4-speed turntable and tone arm are supplied on a single mounting plate. Designated as Model PK-449 they are priced at only $49.50. The turntable features a heavy duty 4-pole induction motor, free floating and shock mounted to eliminate vibration. The 3-pound, rim-weighted, 12-inch alumi-

num table is constructed with a permanently lubricated oilite bronze bearing while the spindle turns on a single ball bearing. Speeds are selected by means of a click-in shift lever and the idler is disengaged in the off position. A fine-speed control permits adjusting the speed up to plus or minus 7 per cent. Noise and rumble are 50 db below average recorded level with wow and flutter less than 0.2 per cent. The 12-inch tone arm is easily adjusted for different stylus forces by means of a knob at the rear of the arm. Additional features include a plug-in head and an ON/OFF switch located in the arm rest; simply lift the tone arm to start the motor and replace in the arm rest to stop it. Supplied with a strobe disc, 45-rpm adapter, shielded hook-up cables. Lafayette Radio Corp., 165-08 Liberty Ave., Jamaica 33, N.Y. **B-3**

• **Speaker System Kit.** Solving the perplexing problems of enclosing electrostatics or of finding a woofer whose efficiency and sound "character" match the electrostatic units, the new JanKit manufactured by Neshaminy Electronic Corp. contains an electrostatic mid- and high-range speaker, its power supply, and a matching woofer—all pre-mounted on a rigid 19½

by 16 inch panel designed for custom installation in a location of your own choosing. Mid- and high-frequency reproduction in the JanKit 41 comes from a JanZen electrostatic speaker whose two push-pull radiators are stated to produce uniform frequency response from 700 to beyond 30,000 cps. Bass is provided by a Neshaminy Model 350 11-inch woofer. This highly compliant speaker is specifically designed to match the JanZen electrostatic and to retain full efficiency down to 30 cps in enclosures as small as 2 cubic feet. Priced at $99.95 the JanKit 41 comes with complete instructions for building an inexpensive, shelf-type enclosure or for mounting in existing cabinets. Neshaminy Electronic Corp., Neshaminy, Penna. **B-4**

• **80-Watt Stereo Amplifier.** Sherwood's Model S-5000 II is an 80-watt (music power) stereo amplifier and preamplifier and is an improved model of the Sherwood S-5000. The S-5000 II provides either stereophonic or monophonic system operation with only one set of basic controls, yet offers every important control feature essential to stereo or mono operation. These include 10 two-channel controls, stereo normal/reverse switch, phase inversion switch, and dual amplifier monophonic operation with either set of input sources. The five modes of operation



(stereo, stereo-reversed, mono 1, mono 2, mono 1+2) are selected by a function switch which also operates a corresponding group of indicator lights to identify the selected mode. Other features include presence-rise switch, phono channel hum and noise 60 db below rated output, and phono sensitivity of 1.8 mv. There is also a "third channel" output. Price is $199.50. Sherwood Electronic Laboratories, Inc., 4300 N. California Ave., Chicago 18, Illinois. **B-5**

• **Electrostat-2 Full-Range Speaker System.** Featuring a 4-element electrostatic tweeter, the new Electrostat-2 introduced by Radio Shack of Boston is intended to provide good sound quality at a reasonable price. The highs in this full-range system, as previously indicated, are handled by a 4-element electrostatic

tweeter which is placed so that a 120-degree dispersion is achieved. The lows are handled by an 8-inch woofer. Crossover frequency is 7500 cps and level attenuator is included to permit sensitive balance of the highs. An ON/OFF switch is provided to control the electrostatic element. Frequency range is stated as 30 to 25,000 cps for the system. Power handling capacity is 20 watts, impedance is 8 ohms. In addition the Electrostat-2 is available in a choice of two decorator cabinets: genuine mahogany or imported teak. Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass. **B-6**

• **Economy Tape-Head Demagnetizer.** A new economy priced tape head demagnetizer which will remove permanent magnetization—a significant cause of high noise level and harmonic distortion—has been announced by Robins Industries. Known as Model HD-3, it features a special plastic sleeve on the tip of the probe

BREAKTHROUGH IN KIT DESIGN!

New LK-72 72-Watt stereo complete amplifier kit (left), $149.95. LT-10 Wide-Band FM Tuner kit (2.2μv sensitivity), $89.95.*

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2. Every wire and cable is already cut to exact length and pre-stripped. This saves you time and assures professional performance because exact lead length is automatic.
3. To take the guesswork out of assembly, electronic parts are mounted on special cards in the order in which they are used. No loose bags of parts to confuse you.
4. Full color diagrams in easy-to-follow instruction book simplify assembly and reduce errors because you match the part to the color diagram.

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". . . designed to professional standards; sound absolutely clean, very sensitive; instruction book of outstanding clarity." — Major B. W. Cotton, Jacksonville, Ark.

"Looked long for the best kit — and found it . . . best instructions I ever saw, unbelievably simple to build." — M. Greenfield, White Plains, N. Y.

". . . I would run out of superlatives if I tried to adequately state how I feel about this tuner . . ." — Samuel R. Harover, Jacksonville, Ark.

". . . without a doubt the easiest kit I have ever built (out of 11) . . ." — B. P. Loman, Jr., Rochester, N. Y.

". . . finest kit I have ever built. And one of the finest tuners I have heard, kit or otherwise." — A. J. Zilker, Houston, Texas.

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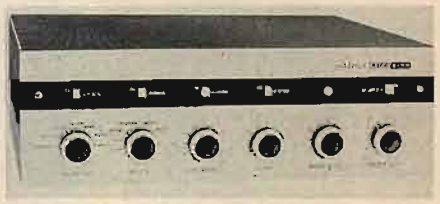
that prevents accidental scratches to the tape. The specially shaped probe makes any head accessible and the HD-3 can be used equally well for both monophonic or stereophonic tape heads. Claimed to be the first quality, low cost, American-made

demagnetizer, the HD-3 is priced at $5.95 which should make it very attractive to amateur tape fans. Robins Industries Corp., Flushing 54, N. Y. **B-7**

• **New Erase Heads.** The Nortronics Company has announced a new line of stereo and monophonic erase heads for use with two- and four-track magnetic tape machines. Three basic mounting styles facilitate the installation of the HQ series heads in all types of tape recorders.

Double-gap construction is used for clean erasure with minimum power requirements. The tape comes into contact with only the polished metal face, giving long life, low tape friction, and freedom from oxide loading. The heads are available in two impedances: the No. 1 high impedance head requires approximately 115 volts at 60,000 cps; the No. 4 low impedance model operates with 35 volts at 60,000 cps. Further information and specifications from The Nortronics Company, Inc., 1015 South 6 Street, Minneapolis 4, Minn. **B-8**

• **Integrated Stereo Amplifiers.** Two new integrated stereo amplifiers, the 70-watt ST70 and the 40-watt ST40 (shown), have been introduced by Eico. Both amplifiers are able to handle any stereo program source: FM-AM radio, FM-Multiplex, magnetic cartridge, ceramic or crystal cartridge, tape head, or preamplified tape. Controls include selector switch, tape monitor switch, separate level and balance controls, balance check switch, scratch and rumble filters, loudness-level switch, and individual feedback-type bass and treble tone controls for each channel. The ST70 has, in addition, a tape speed equalizer



and a speaker phase reversal switch. Frequency response of the ST70 is stated as plus or minus ½ db from 10 to 50,000 cps and harmonic distortion is less than 1 per cent from 25 to 20,000 cps. The dual power amplifiers of the ST40 are Williamson-type circuits employing voltage amplifiers and split-load phase inverters driving the output stage. Frequency response of the ST40 is stated to be plus or minus ½ db from 12 to 25,000 cps; harmonic distortion is less than 1 per cent from 40 to 20,000 cps. The ST70 sells for $94.95 in kit form, $144.95 wired. The ST40 sells for $79.95 in kit form, $124.95 wired. All prices include metal cover. Eico Electronic Instrument Co., Inc., 33-00 Northern Blvd., L.I.C. 1, N.Y. **B-9**

• **Stereo Receiver.** Following the same design principles as the Fisher Models 600 and 800, the new 500-S, priced at $349.50, is Fisher's answer to the need for a quality FM-AM stereo receiver at a relatively moderate cost. The 500-S is a completely integrated system of matched Fisher components on one chassis. All that is required for a complete system is a pair of speakers and a record player. Sensitivity of the FM tuner is 0.9 microvolts for 20 db of quieting with a 72-ohm antenna; 1.6 microvolts with 300-ohm antenna. A.g.c. on FM and a.f.c. on AM maintain

the desired volume level at all times. The audio control center has a total of twenty controls and switches, the controls being grouped functionally to make operation simple for even the "uninitiated." The dual-channel power amplifier supplies 45 watts—music power rating. There are 13 inputs and 5 outputs on the rear panel, including a "center channel" output. The Fisher 500-S is 17 inches wide, 4 13/16 inches high, and 13⅞ inches deep. Fisher Radio Corp., 21-21 44th Drive, Long Island City 1, N.Y. **B-10**

NEW LITERATURE

• **Pocket-Size Aid for Planning Stereo System.** Pickering & Company has just published a brochure entitled "Tech-Specs" which was written and designed to assist the audiofan in planning a stereo high-fidelity system. Pocket-size, "Tech-Specs" is a guide which helps plan for needed space and coordinates the components to the enclosure or cabinet. Contents include a planning chart and complete technical specifications of the line of Stanton Stereo Fluxvalves. Available at no cost by writing to Dept. PR6, Pickering & Company, Sunnyside Boulevard, Plainview, New York. **B-11**

• **Allied's 1961 High-Fidelity Catalog Ready.** Allied Radio announces the availability of its 1961 catalog. Consisting of 444 pages it lists more than 40,000 items. In addition to Allied's own Knight line of components a complete line of other famous brand names are included. Featuring extensive listings of components, the allied catalog also includes a wide selection of complete systems. "Do-it-yourself" enthusiasts will find a greatly enlarged selection of Knight-Kits. Included are basic amplifiers, stereo and monophonic amplifiers, preamps, tuners, a universal stereo tape recorder-playback preamp, and speaker enclosure kits. A complete selection of furniture to house all high-fidelity components is featured in this year's catalog. Also included are listings of specially selected stereo records and recorded tapes. This catalog is available without charge upon request. Write to Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. **B-12**

• **Loudspeakers and Equipment Cabinets.** Listing their complete line of high-quality speakers, speaker systems, equipment cabinets, and crossover networks, this new brochure from R. T. Bozak Sales Company provides a comprehensive description and technical specifications of all the products listed. Free copies may be obtained from any Bozak dealer, or by writing to R. T. Bozak Sales Company, Darrien, Connecticut. **B-13**

• **New Jensen Loudspeaker Catalog.** A 24-page loudspeaker catalog is now available without cost from Jensen Manufacturing Company, 6601 S. Laramie Ave., Chicago 38, Illinois. Catalog 165-F contains: a guide for planning stereophonic and monophonic systems as well as converting monophonic systems to stereo; complete descriptions, specifications, and illustrations of complete loudspeaker systems and cabinets; loudspeaker kits; and the complete Jensen component line. Also described are the principles of operation of the Jensen high compliance Flexair woofers and tube-vented Bass Superflex enclosures. **B-14**

• **Audio Dynamics Corporation,** 1677 Cody Ave., Ridgewood 27, N. Y., manufacturers of the ADC line of stereo cartridges, makes available a free, multi-colored brochure describing the ADC-1 cartridge. Included in the brochure are complete technical specifications of the cartridge plus a description of how the unusually high-quality performance is achieved. **B-15**

• **Guide to Hi Fi.** A new 36-page booklet explaining in clear language the fundamentals of monophonic and stereophonic sound reproduction has been published by Eico. Written by Mannie Horowitz of Eico's engineering department, the booklet covers such subjects as the factors comprising high fidelity (including sections on the nature of sound and the problems that a sound reproducing system is faced with); the component parts of high-fidelity systems; the meaning of stereo, and how to convert a mono system to stereo; and how to save money when buying high-fidelity equipment. The booklet is available from Eico, 33-00 Northern Blvd., Long Island City, New York for 25 cents.

ABOUT MUSIC

(*from page 67*)

phony, is perhaps the most familiar excerpt from the "Christmas Oratorio." Mr. Randolph departed from the 'traditional' tempo, ranging from *adagio* to *andante*, and chose instead *andante quasi allegretto* (halfway between *andante* and *allegretto*) to emphasize the airy texture of the score. Because of the faster tempo, the strings tended to slur the dotted eighth-note figures and rush the beat. The players were reminded to attack the phrases precisely and not allow the gently tripping 12/8 rhythm to develop into a slow jig. The accompanying photograph (*Fig.* 1) was taken during a rehearsal of this movement (in a different location). Note the left hand, cupped to indicate a rising phrase, and the right hand, drawing a figurative bow.

The leitmotiv of the rehearsal was 'balance'—"A little less instruments here, just a touch more solo." "Softer, tenors!" "Altos, more body to the tone." "Up orchestra, *down* chorus!" This last instruction crystallizes Mr. Randolph's approach to performances of Baroque choral music. "Historically speaking," he said, "our chorus is eight times too large. Bach rarely worked with more than thirty voices. Despite this, it has been my intention to avoid the massive nineteenth-century sound that still ruins many Bach performances nowadays. I wanted each sixteenth note to be heard and every word distinctly projected. Clarity and lightness, not blurred lines and thick texture, are my goals." Mr. Randolph held the reins of dynamics firmly. There were moments when the chorus took on the sound of an intimate ensemble, although, looking over the singers, one had the impression that, if they felt like doing it, they could have easily huffed and puffed and blown the orchestra and soloists right off the stage.

The numerical disparity between chorus and instrumentalists was considerable. The orchestra approximated in size that employed by Bach when he produced the oratorio for St. Thomas's Church in Leipzig (1733–4): in the Carnegie Hall performance, there were 8 first violins, 7 second violins, 6 violas, 4 celli, 3 doublebasses; 2 flutes, 2 oboes, oboe d'amore, bassoon, 3 trumpets, 2 French horns, timpani, harpsichord and organ. The chorus numbered 225. Mr. Randolph nevertheless struck a happy balance between the two forces.

It was a distinct pleasure to hear this well-rehearsed, carefully disciplined chorus reach the point in the rehearsal at which the music took over and all sang as one. This fusion of voices is possible more often when a choir sings for its own leader than when it is imported by an orchestral conductor for an occasional concert. "Members (of a chorus)," wrote Virgil Thomson (in *The New York Herald Tribune*, May 9, 1943), "will sing in pitch and in tune (for the latter, and) will obey him with vigor and all promptitude. But their work will not have the poetry, the personality, the expressive variety that it has under the man they are used to, the man with whom they have an accustomed spiritual intimacy." Æ

CUSTOM CONSOLE

(*from page 19*)

of fast changing developments in the audio component field, and their effects on obsolescence, we designed the control panel and the attached supports, such that the unit is entirely removable. Two screws are used to fasten the panel assembly. For instance, should it become necessary due to a future acquisition of a multiplex unit, the sum of less than $5 (coupled with a morning's effort) will find a new panel and support assembly framing the revised "front ends".

In the same vein, future purchase of the almost inevitable tape machine, will find a generously spaced home in the right hand lower compartment now occupied by a patented, slide-out, record storage rack (*Fig.* 6). The space available for the tape instrument is designed to accept rack mounting type recorders as well as the more diminutive portable instruments. As the reader may well reason, audio custom design is not all black and white! This addition of a possible tape instrument is obviously confined deep in stage one!

Lastly, several features were incorporated which are well nigh invisible, but do much towards adding convenience and mobility to the entire system. Previously mentioned, there is the inclusion of the sliding record rack. In connection with the turntable compartment, looking at *Fig.* 7, one notes the use of a lamp. This lamp is automatically switched by a push-pull pressure switch operated by the door closure. This feature was added at very reasonable cost when I discovered a General Electric Co. automatic closet lamp fixture for under $2.00! In conclusion, the entire console (in operating condition weighing some 200 pounds) is mounted on four 2-inch rubber tired casters so that the efficient housewife is not hampered in her tidying up. The console rolls quite easily at such times!

Many excellent treatises are available on the manner and methods of wood finishing. The only comment necessary here is that the basic ingredient needed to acquire that professional hand-rubbed look so desired by all, is simply hand sanding and polishing! No small contribution to the sheen of the final finish, were the long hours spent sanding and polishing (with 4-0 steel wool) the unstained raw wood. This was an extra smoothing operation in addition to the polishing done after staining and between each of the three successive coats of lacquer. The whole ensemble is stained a platinum walnut. The color of this stain is beautifully enhanced by this lengthy but rewarding process.

Fig. 6. Record storage now—tape recorder later.

It is rather evident that there has been a deliberate attempt on the part of the author to minimize the description and attendant elaboration on detail. This elaboration was purposely avoided. Any audiofan proceeding seriously from stage one to stage two and including in the planning stage the requirement for custom cabinetry, must of necessity tailor his design to his individual specications, both in choice of instrumentation and decor. Very briefly: The author's console scales 50 inches long, 30 inches high, and 23 inches in depth, while the speaker enclosures were modified (in decor only) from factory plans included with each speaker component kit.

The solutions presented herein, particularly that of laminated case construction, are sufficiently adaptable to permit their inclusion in the majority of instances where the audiofan is desirous of having the type and quality of furniture housing that will be commensurate with the quality of his carefully chosen components. It is hoped that the methods of achieving this custom look as presented herein may satisfy his needs and desires, while consuming less of his exchequer than were he to purchase the equivalent in the trade marts. Æ

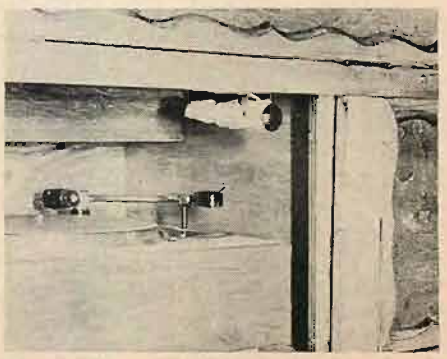


Fig. 7. The turntable—with an automatic lamp to light the way to the spindle.

"ERSATZ STEREO" UNLIMITED

(*from page 21*)

an independent power amplifier—a Fisher 200—and from that through an Altec network with a crossover frequency of 1000 cps between the woofer and the tweeter. To feed the 515 woofer on the same baffle, another Fisher 200 power amplifier was fed direct from the Grommes preamplifier, with the output of this amplifier directed to an Altec network with a crossover frequency of 500 cps, the Low output of this unit feeding the 515 woofer. To assure even better bass response, this old 515 was modified to reduce its cone resonance to 23 cps. This was effected by running a Casco tool around the outside edge of the cone, sawing the spiders half-way through.

To feed the Jensen bullet tweeter, an independent Grommes LJ7 power amplifier is used, its input fed from the High end of the Heathkit electronic crossover and its output feeding the 302-A through a Jensen network with a crossover frequency of 4000 cps.

With the lowest and the highest ranges thus provided for, attention was next directed to the midrange. On hand was an Altec 285 multicellular midrange horn. Properly placed, this would assure not only good response but also adequate dispersion of sound. With an ear to the elimination of gaps, several locations were considered. The final choice: ceiling level of the corner to the far right of the AR-1W floor woofer. With this horn angled at about 30 deg. and pointing corner to corner, dispersion is well-nigh perfect, and virtually free of the influences of parallel reflecting surfaces.

Feed for the midrange horn was taken from the High output of the Altec crossover network the Low end of which was used to feed the 515 woofer, all frequencies above 500 cps therefore being directed to the midrange horn.

System response? Here it is, per speaker channel: the AR-1W, flat up to almost 100 cps; the 515, flat up to almost 500 cps; the woofer of the 604-B, flat from about 400 cps to almost 1000; the 285 horn, flat from about 500 cps to about 10,000; the tweeter of the 604-B, flat from about 1000 cps to almost 14,000; the 302-A tweeter, flat from about 4000 to almost 20,000 cps.

With all the speakers in operation, the quality of sound is impressive. And little wonder, for, as a glance at the block diagram will show, here we have, in fact, a monophonic system of four channels, with three of these channels utilizing frequency separation before power amplification. Why this expensive departure from the conventional? Well, for one thing, as was said earlier, stereo was not only unavailable but generally unheard-of when the Dyers wanted concert hall realism. For another, Mr. Dyer reasoned: why not utilize the available speakers and equipment in such a manner as to amplify in each channel only the desired range, and thereby at the same time obtain the best possible control and flexibility!

Needless to say, a system of this kind can be even more expensive than stereo. But it shows what can be done to and with a mono system when one demands continuous improvement. It also shows how earlier units can be effectively combined with the latest. Possibly the system will in time give way to stereo. Meanwhile, there is nothing static about this system or the results it produces. Listening to it, however, one quickly forgets the experimental aspects, the techniques that are, and in all art should be, not the end but the means to it.

In that respect this installation has brought about another phenomenal growth—that of a music library which in size and quality can well be the envy and inspiration of many a professional endeavor. And here, heard on this unique

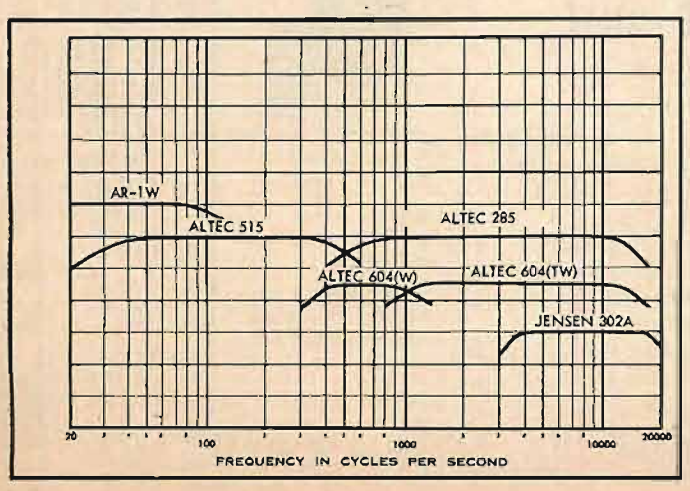


Fig. 7. Frequency response of the 6 speakers.

system in the cozy livingroom overlooking the mountains, the cottonwoods and the river, the masters of music come truly into their own, with presence, fidelity, definition and perspective about which nothing of the ersatz is discernible. Æ

TAPE GUIDE

(*from page 34*)

negative-going voltage at the plate of V_1, which is transferred to the grid of V_2, causing the plate of V_2 to go positive. The voltage fed from the plate of V_2 to the grid of V_1 is therefore of the same polarity as the original signal on this grid; feedback is positive. The same is true for the voltage fed from the plate of V_1 to the grid of V_2. However, the voltages on the grids of V_1 and V_2 are of opposite polarity, so that one triode is in the positive half-cycle while the other is in the negative half. B-plus is supplied to the plates of V_1 and V_2 through the center-tapped coil, L. The grid resistors and grid capacitors of each triode produce a negative d.c. bias in the same manner as in *Fig.* 1.

The feedback capacitor of each triode forms a voltage divider in conjunction with the grid capacitor. Voltage divider action limits the amount of feedback to the grid, preventing the tubes from being driven excessively. In *Fig.* 4, the .01-μ grid capacitor has a reactance much smaller than 22,000 ohms at the bias frequency, roughly 50,000 cps, so that the voltage divider consists principally of the feedback and grid capacitors.

Sometimes, to supplement the d.c. bias obtained by grid-leak action, cathode bias is also used. That is, instead of connecting the cathodes of the triodes directly to ground, they are both connected to ground through a common resistor with a value of several hundred or a few thousand ohms. Æ

TAPE NOISE

(*from page 26*)

this value, it will be "masked" by the room noise and will not be heard .

A typical quiet, listening room background noise condition (1) is shown by the solid lines. This is given in terms of *tones* in the hum region, and *octave band noise* above 200 cps. Of course, the noise level in rooms varies, but the shape remains much as shown.

Figure 2 also shows two reproduced noise conditions during playback taken from Curve A and the "spikes" of *Fig.* 1. The one labelled High (2) is for a volume control setting giving maximum

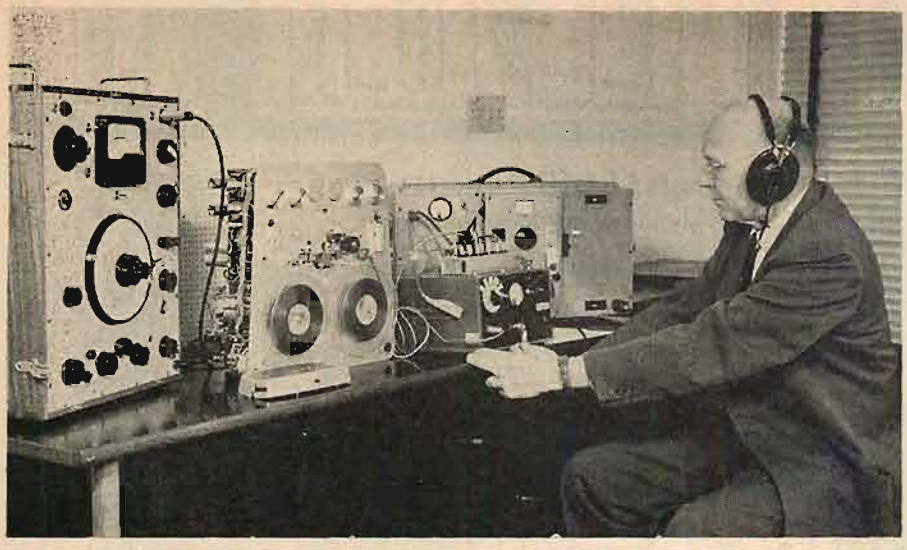


Fig. 3. The author shown measuring signal-to-noise ratio of a Movicorder.

octave band program readings of 95 db in an ordinary living room—a level used mainly to impress friends with the height of the Fi. The one called Normal (3) represents a reproducing level 15 db lower, which is more representative of a usual domestic listening intensity. What stands out is the fact that the shape of the noise curve from the reproduction matches the shape of the background noise with which it competes. At the High setting noise is audible at both high and low frequencies to about the same degree during completely quiet intervals of program. At the Normal setting the reproduced noise would not be audible in this "typical" room, although it might be in very quiet rooms. But, even in a completely quiet room, the *shape* of the reproduced noise curve would remain satisfactory, because the actual minimum sensitivity of hearing nearly parallels the room noise curve.

Weighted Signal-to-Noise Ratio

The effects described above are recognized in communication and noise measurement, where frequency "weighting" of the response of the measuring instrument is used to reduce the contribution by low frequencies. Usually an unweighted and a weighted value are given, and this might be a useful concept for tape reproducers. In the case of the results just presented, for example, and using the A weighting scale of a standard sound level meter, the signal-to-noise ratios measured were

Unweighted, C-Scale	52 db (as given above)
Weighted, A-Scale	74 db

These two numbers show that the most intense noise components are at low frequencies where more can be tolerated, while the high-frequency contribution is a great deal lower. If only the unweighted number is given, a recorder with poor tape or poor construction could measure nearly as well, yet give prohibitively annoying high-frequency noise. Thus by adding one additional number, obtained with a relatively simple addition to standard measuring equipment, a great deal of meaning could be added to signal-to-noise ratio specifications. In the critical listening region good tape recorders give, not the 50 db ordinarily thought of, but 70 db and more. Æ

COMPUTERS IN AUDIO DESIGN

(*from page 24*)

From mechanics the general expression for the quadratic response to an input, y, is:

$$\frac{x}{y} = \frac{K}{\frac{S^2}{\omega^2} + \frac{2\delta}{\omega} S + 1} \qquad (18)$$

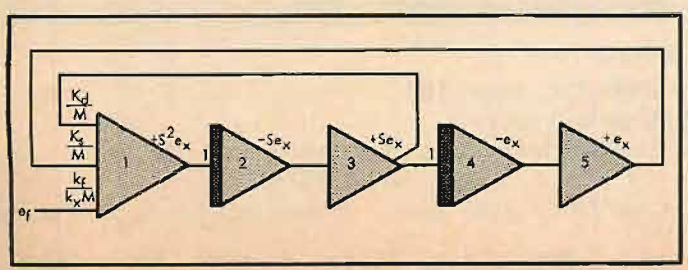


Fig. 11. Complete analog of a quadratic response.

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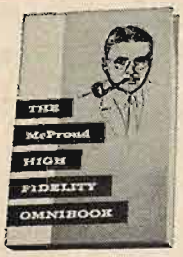

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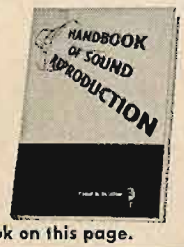

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where

K = gain
ω = natural frequency
δ = damping ratio

By comparing (17) and (18) it is seen that:

$$\omega = \sqrt{\frac{K_s}{M}} \tag{19}$$

$$\delta = \frac{K_d}{2}\sqrt{\frac{1}{K_s M}} \tag{20}$$

$$K = \frac{1}{K_s} \tag{21}$$

In order to show how an analog circuit is constructed, equation (16) is employed.

Solving for the S^2x term equation 16 becomes:

$$-S^2x = \frac{K_d}{M}Sx + \frac{K_s}{M}x - \frac{F(S)}{M} \tag{22}$$

Putting equation 22 into computer form is done by using scale factors as previously shown in equation 5. When this technique is used, equation 23 is obtained.

$$-k_x S^2 e_x = \frac{K_d}{M}k_x Se_x + \frac{K_s}{M}k_x e_x - \frac{k_f}{M}e_f \tag{23}$$

Constants such as K_d, M, and K_s are not scaled as they will appear as fixed gains. It is also seen that the scale factor k_x is independent except relative to k_f since it cancels in all the e_x terms.

Assume that the voltages on the right hand side (Se_x, e_x, e_f) of equation 23 are available in the simulation. These are then added in an adder amplifier through gains proportional to the coefficients $\left(\frac{K_d}{M}, \frac{K_s}{M}, \frac{k_f}{k_x M}\right)$. This is shown at amplifier 1 of the basic analog circuit shown in *Fig.* 11. The output of amplifier 1 is $+S^2e_x$. Amplifiers 2, 3, 4, and 5 are straightforward integrations and sign inversions to find Se_x and finally e_x itself. By using these signals as "feedbacks" to amplifier 1 with the proper gain ratios as indicated, a complete analog of equation 22 is found. Since equation 22 is equivalent to equation 18, this is also an analog of equation 18, the quadratic response.

The main characteristics of the quadratic are the frequency and damping. These quantities are seen to be determined in the analog by the gains into amplifier 1.

Variations in these gains are analogs of variations of frequency and damping of the system described by equation 22. Optimum values can be quickly determined and translated back to the actual system parameters.

The general use of the quadratic response has been described because it is

the most common expression in audio work.

In the tone arm-cartridge combination, for example, this expression appears three times. The spring of the stylus, the mass of the arm and cartridge, and the damping of the pivots form one resonant quadratic system. The spring of the stylus, the mass of the stylus, and the damping of the signal pick-off form the second. The spring of the record vinyl material, the mass of the stylus assembly, and the pick-off damping provide the third.

The speaker system contains a quadratic response with the mass of the cone, the spring of the cone mounting, and the damping of the magnet being the parameters that contribute.

Other examples can be found in microphones, amplifiers, tape transports, and tuners.

TO BE CONTINUED

LIGHT LISTENING

(*from page 10*)

itself is available in both English and French on the Columbia label. Unfortunately, not all listeners searching for the authenticity of the mother tongue will invest in the French version just for the sake of a few hit songs. This release lets one eat the best part of the cake. Then too, Patachou's frnut on records is 100 per cent vocalism. These lyrics are not handled by someone who was also hired to act the part on stage. In addition to the four songs from "Irma La Douce," two other French ditties round out side one of the records. The rest of the program offers samples of six American shows in the ever-surprising wrinkles that Patachou gives to even the most familiar English lyrics. Her intimate approach in *Mack the Knife* from the "Threepenny Opera" and the rakish tilt she gives the words make this one of the best things she's done on records. Incidentally, the mono sound of this disc has the close-to brightness that registers effectively even when played with a stereo pickup that drops off in response above 12,000 cps.

Stereo adds somewhat to the dimension of the voice in Patachou's Columbia disc. As part of an ambitious project recorded in Paris, Volume 1 of "Les Grande Chansons" wastes no time in getting down to cases. In close-up stereo as biting as anything produced in America, the cream of the Parisian favorites roll out in rapid succession. A particularly welcome feature of the set is the inclusion of the printed French lyrics of each song along with its English translation.

The World of Suzie Wong (Original Soundtrack Recording)
RCA Victor LSO 1059

Now it is Hollywood's turn to take a commercial interest in the problems of Hong Kong's Suzie Wong. George Duning, the composer of the score, uses a simple device to point up the international flavor of the locale. The mood music has just enough suggestion of the Chinese pentatonic scale to set apart this album from the dozens of movie jobs issued every few months. The American influence enters in the form of original jazz compositions as well as straight readings of such standards as *Out of Nowhere, I'm in the Mood for Love,* and *Hit the Road to Dreamland* played by a large jazz aggregation. These probably sound a bit more enticing in Technicolor surroundings. The "mood" orchestra is led by the English conductor, Muir Mathieson, whose name is seldom absent from the opening credits of major British films. The sound is a far cry from the narrow-throated fare we had from Hollywood when the stereo disc first attempted to take in the sound stages.

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Industry Notes . . .

SHURE, WESTMINSTER PRODUCE STEREO RECORD. An unusually interesting approach to merchandising cartridges and tone arms is the stereo record commissioned by Shure Brothers, Inc. The recording, "The Orchestra . . . The Instruments," No. LS661, by Westminster Recording Co. is not for sale but is available at no charge to buyers of Shure cartridges or tone arms. According to Shure, this record offers an excellent test of a stereo system's capabilities.

ROBERTS BUILDING NEW PLANT. With tape recorder sales 98 per cent ahead of projections for the year, Roberts Electronics has been forced to expand facilities. The new 50,000-square-foot plant, which will be located at 5918 Bowcroft Ave., Los Angeles, is scheduled for completion on the 1st of March.

ACRO CHANGES NAME. Acro Products Company has finally confirmed a fact we have strongly suspected these many years —they are in the electronics business. From now on they'll be known as the **Acro Electronic Products Company.** In keeping with this change Leonard Klingsberg has been appointed Executive Vice President and member of the Board of Directors. Also William F. Carter has been appointed assistant to Chief Engineer (and President) Herbert I. Keroes.

STROMBERG-CARLSON APPOINTS V. P. George J. Dickey, of Princeton, N. J., has been appointed vice president and assistant general manager of the Stromberg-Carlson Division of General Dynamics Corp. Mr. Dickey comes from the corporation's headquarters office in New York, where he was assistant to Executive Vice President C. Rhoades MacBride. A native of New York City, Mr. Dickey was educated in the Ridgewood, N. J. public schools and at Northeastern University. Before joining General Dynamics in March 1960, Mr. Dickey worked for John W. Stokes Co. of Boston, and Johnson & Johnson in New Bruswick, N. J.

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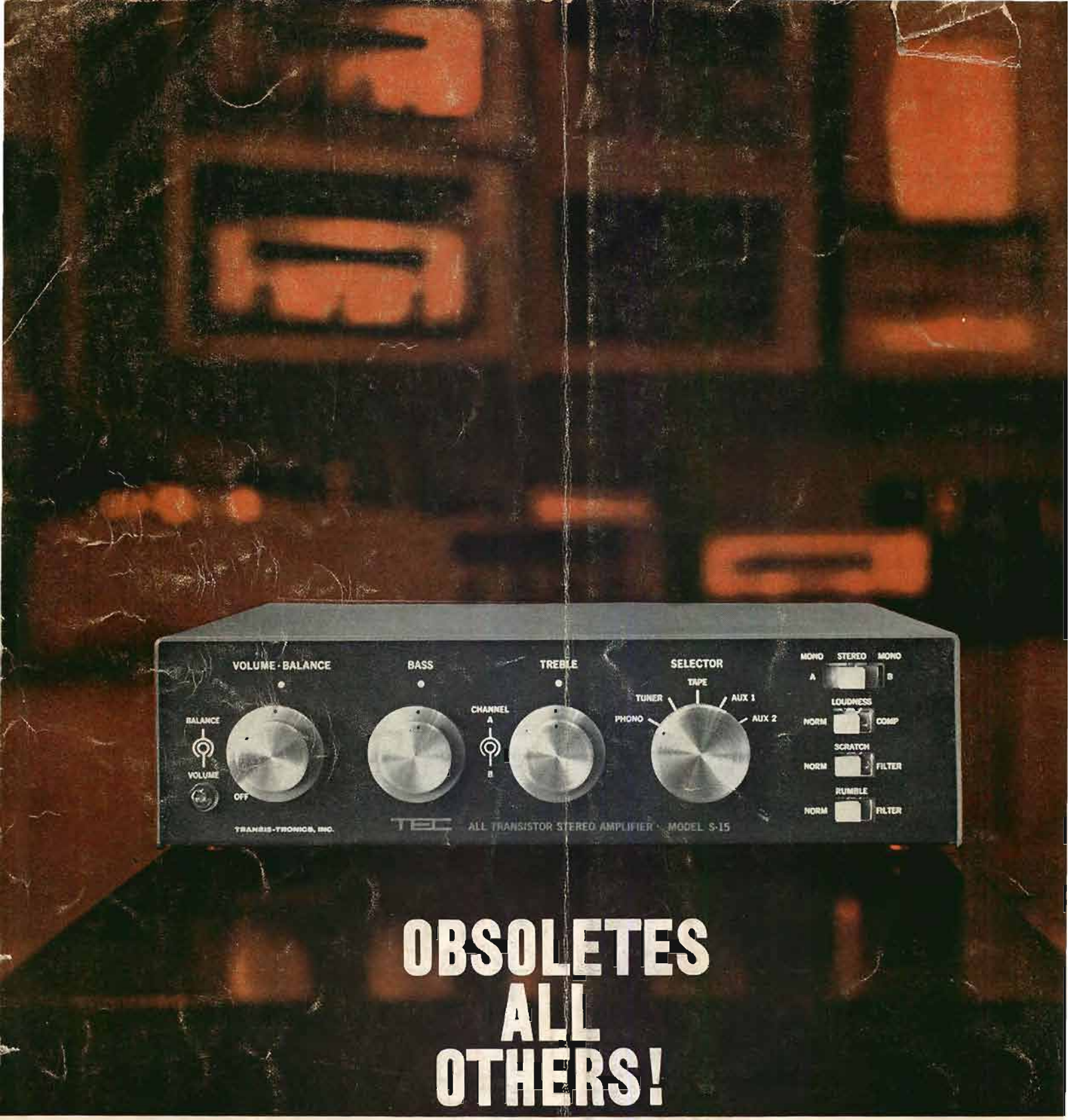

OBSOLETES ALL OTHERS!

The TEC S-15 all transistor 40 watt stereo amplifier brings a space age concept to high fidelity. Never before has the audiophile been able to get so much high quality sound for so little. A neat package 10" long and seven pounds light puts out 40 watts of pure undistorted sound. And the price is as exciting as the package—only $129.50. Because of its all-transistor circuitry, the unique S-15 has no heat, no hum, no microphonics. Quite naturally, from Transis-Tronics. Write for your copy of complete specifications. Power Output 40 watts (20 watts per channel). Frequency Response ±0.5 db 20-20,000 cps. Response is 3 db down at 6 cps and 45,000 cps. Intermodulation Distortion less than 0.9% at rated output, 60 and 6000 cps. Harmonic Distortion less than 0.5% at rated levels. Inputs 5 pair: magnetic phono, tuner, tape, auxiliary 1, auxiliary 2. Front Panel Controls: volume, power; balance; bass channel A; bass channel B; treble channel A; treble channel B; function (phono, tuner, tape, auxiliary 1, auxiliary 2); mode (mono A, stereo, mono B); loudness; scratch filter, rumble filter. Balance Control for equalizing speaker outputs. At full rotation will completely cut off sound from either speaker. Circuitry, 2 germanium diodes, 3 silicon diodes. Power Requirements 105-120 volts AC, 50-60 cps; 12-28 volts DC for battery operation.

TEC S-15

TEC Transistor Engineered Components TEC

TEC IS THE TRADEMARK OF TRANSIS-TRONICS, INC.

Transis-Tronics, Inc., 1601 Olympic Boulevard, Santa Monica, California