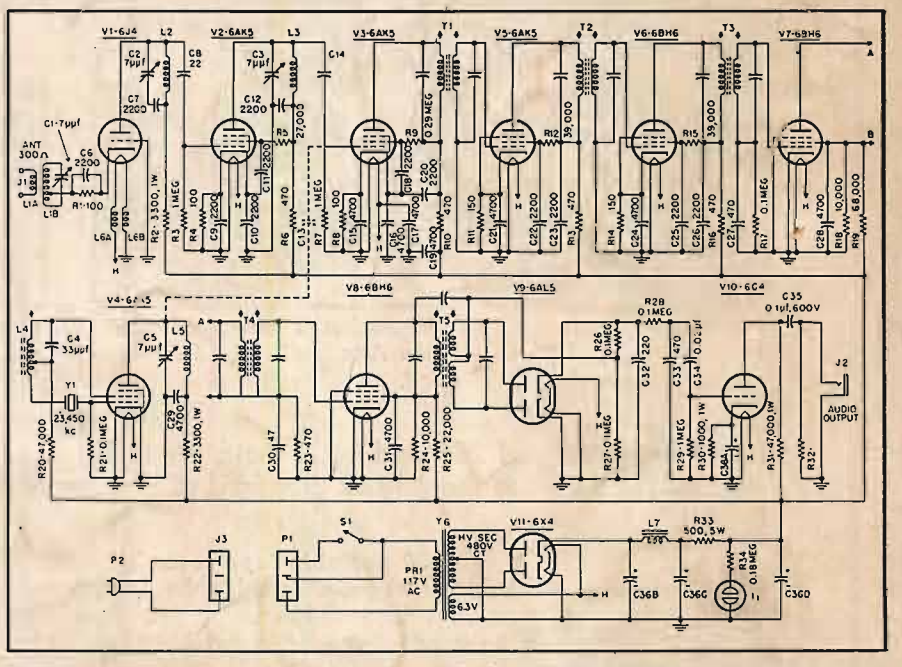
MARCH, 1955

50c

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

Recording fans often want facilities in their homes which compare favorably with those in studios, but few achieve them. One "At Home with AUDIO" reader did—see page 26.



FM reception is as much desired by those who live far from broadcasting centers as by those who live in the shadow of the antenna. One reader designed his own fringe-area tuner and regularly enjoys programs from 70 miles away. For a description, see page 22.

BACK TO CLASS B FOR HOME USE

AT HOME WITH AUDIO

EVALUATION OF HIGH-FIDELITY PHONOGRAPH PICKUPS

"GOOD MUSIC" TUNER FOR FRINGE AREAS

At **WLAU,** 250 watts, Laurel, Mississippi

"EVERYONE IS SOLD ON THE AMPEX 600"

Every week WLAU pays an "Ampex visit" to a different county school for a program called "Salute to Jones County Schools".

"If the Ampex 600 were paid a salary, the figure would run into the overtime column every week. It is used by the salesmen, announcers and the sports man. Everyone is sold on its performance and it's especially popular because it is so light and easy to handle. Since the success of a small station greatly depends on good local programs with the personal touch, we feel the Ampex 600 is the practical and economical answer to a real need."

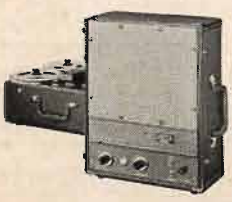
Norma H. Leggett

Mrs. Norma H. Leggett, Manager
Rodio Station WLAU, Laurel, Mississippi

For the grand opening of Sears Roebuck's newest and finest store in Mississippi (in Laurel), the Ampex 600 taped an interview with every department head.

Our program director interviewing the manager of Jones County Auto Sales at the showing of the new 1955 Mercury. We taped every new car showing in Laurel.

Broadcast stations of 250 and 1000 watts are today discovering that for them too the Ampex Standard of Excellence pays for itself.



Ampex 600 portable tape recorder
Weighs just 28 pounds and has the Ampex standard of quality, reliability and durability throughout. Prices are $498 unmounted or $545 in portable case.

Ampex 620 portable amplifier-speaker
The perfect monitoring and demonstration unit, matches the 600 in quality, size and appearance, costs $149.50 in portable case.

Ampex 350 studio tape recorder
"The big Ampex" — versatile, adaptable and durable, uses large or small reels, 7½ and 15 in/sec. tape speeds and connections for remote controls. Prices are $1205 rack mountable and $1315 console.

For full performance specifications on these machines, write Dept. B-1882

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DISTRIBUTORS IN PRINCIPAL U.S. CITIES
CANADIAN DISTRIBUTION BY CANADIAN GENERAL ELECTRIC COMPANY

AMPEX
CORPORATION

view with every department head.

Mercury. We taped every new car showing in Laurel.

MARCH, 1955 VOL. 39, No. 3
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

AUDIO (title registered U. S. Pat. Off.) is published monthly by Radio Magazines, Inc., Henry A. Schober, President; C. G. McProud, Secretary, Executive and Editorial Offices, 204 Front St., Mineola, N. Y. Subscription rates—U. S., Possessions, Canada and Mexico, $4.00 for one year, $7.00 for two years, all other countries, $5.00 per year. Single copies 50c. Printed in U. S. A. at Business Press, Inc., 10 McGovern Ave., Lancaster, Pa. All rights reserved. Entire contents copyright 1955 by Radio Magazines, Inc. Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

RADIO MAGAZINES, INC., P. O. Box 629, MINEOLA, N. Y.

easily changed to 50 ohms.

AUDIO PATENTS

RICHARD H. DORF*

THE WAY IN WHICH most inventions are made may not be familiar to most people who don't themselves do any inventing—at least in the legal sense. And as a result, perhaps the people who don't normally become inventors sometimes have an unduly magnified view of those who do, resulting in something of an inferiority complex on the score of inventing—which in turn prevents them from exercising inventive faculties latent in them. Besides not being a writer of short sentences and not being a patent attorney, I am not a psychologist, so I am not sure this is true. But it does lead into a double-barreled explosion of possible ideas; let us at least take it as a hypothesis.

The ideas in barrel one are yours, and those in barrel two the ideas of more habitual inventors. Nobody has a monopoly on ideas, except possibly those who were on the right side of the door when the brains were passed out. The "monopolists" do not by any means include only those who were around when the diplomas were passed out. As a matter of fact, probably most of the world's really momentous inventions were made by people who never got any nearer to a university than Adam. Tom Edison, for example, who was probably one of the world's greatest engineer inventors, had, if I recall, little if any formal technical education. The man who invented the wheel—and if you think about it for a moment, that invention was an almost incredible stroke of genius—probably didn't go to school because there were none. The man who invented and developed what I consider one of the most unlikely and successful approaches to an electronic tone generator has no degree. Samuel F. B. Morse was a Yale graduate but his degree was in the arts and he didn't turn to science until he was 42. These are just examples off the cuff without a trip to the library. But the moral is that you, too, can invent —if you take the trouble to gain an understanding of the field. This does not necessarily require either formal education or professional work in the field.

Most inventions are made simply because they have to be. A man is working on some kind of idea or gadget and he hits a snag. He wants to do something that hasn't been done before. So he thinks about it, lets his brain lead him up several possible paths, isn't afraid to wonder about possibilities that a more "sane" (translation: hidebound) man would pooh-pooh. If he thinks long enough and really wants the answer, he will go to bed one night discouraged and wake up the following morning with the solution staring him in the face, the result of the uncanny ability of the subconscious to work better on unorthodox problems than the inhibited conscious mind.

Sometimes, of course, people attain solutions to this sort of problem simply by direct work and perseverance along fairly standard lines. Such solutions are not, on the whole, really inventive. They do not tend to have the same character of unexpectedness, of an approach that you know instinctively almost no one else would have been likely to think of. Such things ought not to be patentable (and strictly speaking are not) but most patents are of this type and many of them stand up in court.

Now, it should be obvious that this kind of ability to be ingenious and to take an unexpected and bizarre approach is no function whatever of a technical education, too many of whose recipients know so much that they spend more time proving a new angle will *not* work than considering the possibilities of making it work. It is also no function of professional affiliations or avocational interests. If a man with an inventive mind happens to be in electronics he may invent a microwave matter transmitter. If he is a lawyer, he may gravitate in leisure hours toward a solution to the automatic bagle dunker. What make him inventive are his own characteristics, not those of the people who pay him a salary or handed him an education if any.

Now, the point of this harangue is very simple. If your interest is in electronics, and particularly in audio, and you have any kind of inventive mind, you may have considered tackling the solutions to a few problems that haven't yet been answered. You may even have found the solutions. If so, and if you really think these ideas are inventive and would be useful to others, you should discard all diffidence and do something with them. Write or see appropriate manufacturing concerns and see whether they are interested. If there is any interest, see a reliable patent attorney and make application for protection. Even if you are only a basement experimenter, you may contribute something to the art and make yourself some money besides. You may even hit something momentous, like the efficient, full-range loudspeaker requiring no room, bearing no resemblance in principle to present speakers; or a cheap, practical recording system with no mechanical moving parts. If you are potentially capable of any of these things, it would be too bad to give up before you start or hide your light under a bushel just because there is no "Dr." in front of your name or because you earn a living as a dentist.

What To Invent

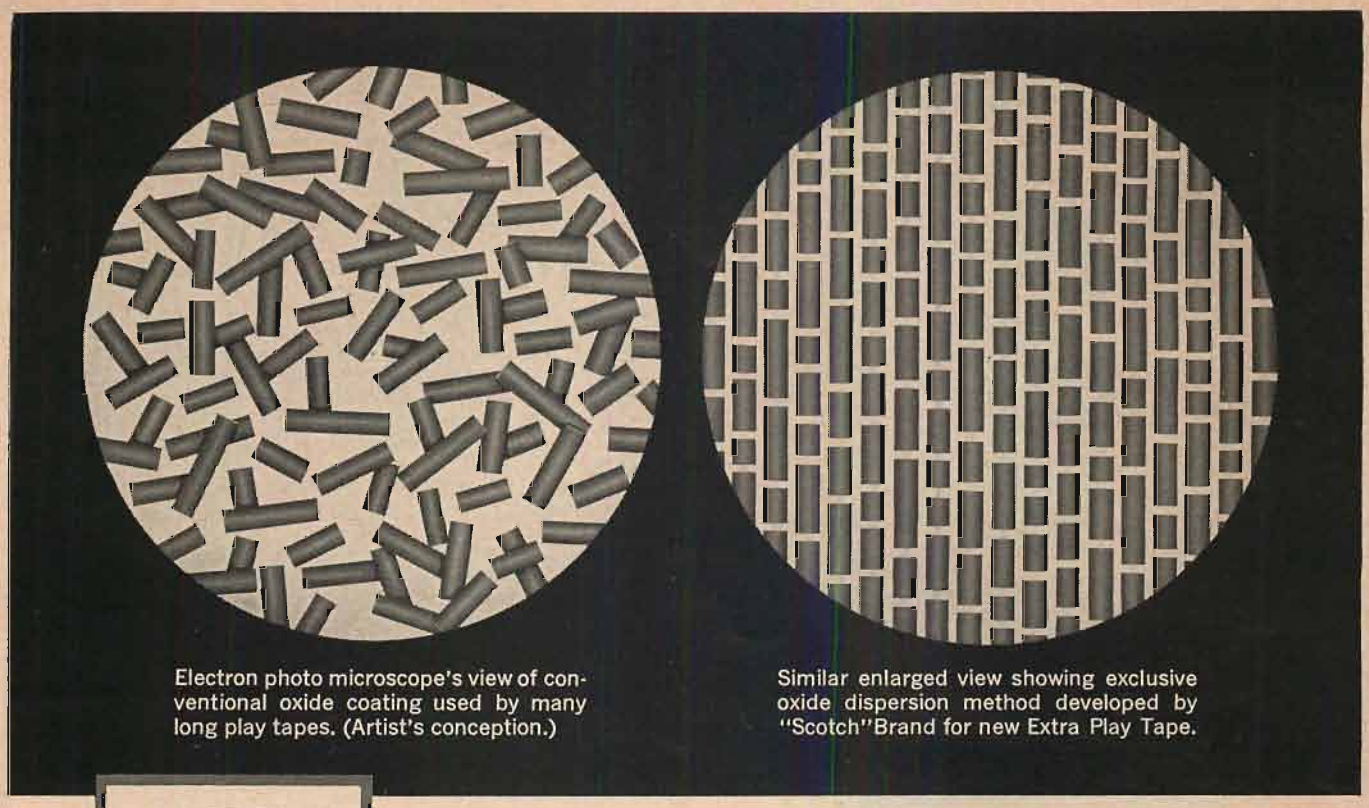
One of the biggest fences around potential inventors, professional and otherwise, is this very fact that most inventions are made because they are needed to carry through on some project in the works. The inventor of a new kind of limiting amplifier probably did it because he simply needed a limiting amplifier. Maybe his company was planning to put out a new line of broadcast equipment. Or perhaps he set up a recording system and found the peaks were getting away from him. A problem cropped up and he had to solve it.

But there are many thousands of people

(*Continued on page 57*)

* *Audio Consultant, 255 W. 84th St., New York 24, N. Y.*

MAGNETIC DRUM AND CORE MEMORY



Electron photo microscope's view of conventional oxide coating used by many long play tapes. (Artist's conception.)

Similar enlarged view showing exclusive oxide dispersion method developed by "Scotch" Brand for new Extra Play Tape.

SEE the difference...

then hear the difference...

You'll notice the difference at once—the way revolutionary "Scotch" Brand Extra Play Tape outperforms ordinary long play tapes with old-fashioned, *full-depth* oxide coatings. There's a crisper tone, higher fidelity on "Scotch" Brand . . . *and* a generous 3 db. boost in the high frequency range.

The secret of "Scotch" Brand's superiority? It's the completely new oxide dispersion process. By laying carefully filtered, fine-grain particles in a neat, orderly pattern, "Scotch" Brand is able to produce a super-sensitive magnetic recording surface that contains the same amount of oxide as conventional tapes, yet is 50% thinner. That's important to remember when buying tape. Because recording experts are aware that a thinner, more potent oxide coating is essential for improved results with long play magnetic tapes.

Ask for "Scotch" Brand Extra Play Tape *today!*

NEW! REG. U. S. PAT. OFF. SCOTCH BRAND

Extra Play Magnetic Tape 190

The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. Export Sales Office: 99 Park Avenue, New York 16, N.Y.

3M

LETTERS

The Other Side

SIR:

May I clear up some confusion created by Mr. Canby's comments on the Air-Coupler in your January issue? It is clear from his remarks that he was writing about the enclosure which the late E. T. Flewelling described in AUDIO ENGINEERING back in 1950. In *FM-TV Magazine*, his design was identified as the FAS, or Flewelling Audio System.

While it appeared that the FAS enclosure operated as a resonating column, the performance was good enough to encourage the belief that it had definite possibilities for bass reinforcement. Accordingly, I undertook to modify the FAS design. The result of this work was the addition of partitions arranged to break up the resonance effects in Flewelling's empty box. To this new design I gave the name Air-Coupler. It was first described in *FM-TV Magazine*.

I called it the Air-Coupler because it is so effective in loading the speaker. Just how effective it is can be judged from the following:

1. If an Air-Coupler is mounted under the floor, you will hear the remarkable bass which it delivers if you listen in the living room, but if you go down cellar, where the back of the speaker is exposed to the open air, you will hear practically nothing at the very low frequencies!

2. Here's a real surprise. Hold a small board over the port of the Air-Coupler, so that there is just a 1-in. opening. Then, while you hold a match in front of the port, run an oscillator connected to the amplifier at 16 or 32 cps. The match will be blown out so quickly you'll swear there must be a fan inside the enclosure!

I do not feel that the present Air-Coupler design is the last word; rather, it is a starting point from which something still better can be evolved, and I believe that its possibilities have been overlooked by acoustic engineers. Perhaps this is the reason:

Audio experts generally do their critical listening with the volume at a very high level. Under such conditions, conventional enclosures produce a substantial bass response. Bass reproduction falls off, however, as the volume is reduced. The Air-Coupler has an opposite characteristic. At very high volume, it breaks up. But from a comfortable level for home listening, right down to bare audibility, the bass is remarkably fine. That is the reason for the Air-Coupler's great popularity in so many homes.

It should be pointed out also that the Air-Coupler is not a substitute for conventional enclosures. Its usefulness is for bass reinforcement at frequencies from 175 cycles down. For that reason, and because of its peculiar bass response vs. volume characteristic, no direct comparison can be made between the Air-Coupler and horn-loaded or bass-reflex systems.

Mr. Canby referred to the fact that there are few tones to reproduce at 16 or 32 cps. That is also true at 15,000 cps, and many people can't hear anything up there anyway. But I'm sure we all agree that the better the response at those extremities, the more accurate the reproduction will be at frequencies approaching those limits.

One of the speaker manufacturers once said to me: "If a speaker design is right in theory but poor in performance, it's no good; but if it sounds right, the theory is unimportant." So I'm not going to argue with Mr. Canby about the theory involved in the Air-Coupler. But I'll be glad to arrange a demonstration for him any time he wants to gain some first-hand knowledge of its performance by listening to it. I think he'll be favorably impressed if he likes to hear music at a moderate volume level, or if he has neighbors in an apartment house who mustn't be disturbed when he is operating his audio system.

MILTON B. SLEEPER, Publisher,
Music at Home,
207 E. 37th St.,
New York 16, N. Y.

Transient Response

SIR:

The response of an amplifier at frequencies above the audible range might ordinarily be expected to make no difference to the quality of sound produced with the aid of the amplifier. Nevertheless, I have noticed an effect which has been confirmed by three other listeners, but I have not seen it mentioned in the literature and cannot think of an explanation for it.

The observation is that when an amplifier shows peaking and a train of oscillations at 40 to 100 kc or so in response to

(*Continued on page 21*)

of the 12AX7 and 5881 demonstrate that Tung-Sol quality control methods can achieve in regular production the performance levels required for highest

speaker design is right in theory but poor in performance, it's

SOME THINGS CAN'T BE RUSHED

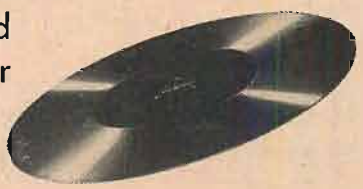
IT TAKES TIME TO SHIFT THE SANDS IN AN HOURGLASS...

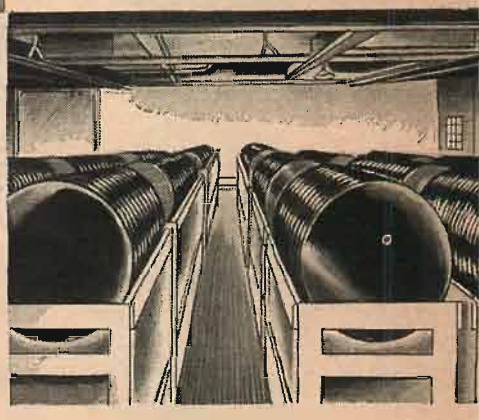
...and it takes *time* to make a good recording disc

Not the speed-up...but the slow-down...is the tempo of production in PRESTO's Recording Disc Division. PRESTO's engineers insist on time-consuming operations for the best reason in the world...it's the only way to make the best recording discs in the world!

Surprisingly, PRESTO superior quality discs are competitively priced... offer far more value for the money. See for yourself!

PRESTO Green • Orange • Brown and White label discs are used throughout the world wherever fine recording is done





TIME CONSUMING STEP #3 IN MAKING A PRESTO RECORDING DISC

The secret of clear, high fidelity reproduction is proper "aging" of recording discs. That's why PRESTO devotes so much time to the careful, unhurried "curing" of PRESTO discs. Each PRESTO disc is fully matured under temperature-controlled and dust-free conditions. No baking or other forcing methods are ever used! In time (plenty of time!) the perfect recording surface of PRESTO discs is produced.

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PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Instantaneous Recording Service, 42 Lombard St., Toronto

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

NEW LITERATURE

• **Cannon Electric Company,** Advertising Department, 420 W. Avenue 33, Los Angeles 31, Calif., has just completed a new 64-page engineering bulletin on all Model DP unit plug-in connectors. A superb example of industrial publishing, the format of Bulletin DP9 is strikingly modern and provides a complete and readable assembly of technical information. Among the features which make it of distinct value to design and purchasing engineers are: a descriptive index; exploded views; contact details; data summaries; extensive mounting area information, and wire and assembly data. **M-1**

• **General Industrial Co.,** 5725 N. Elston, Chicago 30, Ill., presents a wide selection of industrial equipment, ranging from office furniture to intercom systems in a new catalog which will be mailed on request. Hydraulic lift trucks and stackers, program timers, automatic-control furnaces, and steel cabinets with see-thru plastic drawers for storing small parts are among other items listed. **M-2**

• **Sanborn Company,** Industrial Division, 195 Massachusetts Ave., Cambridge 39, Mass., describes with excellent thoroughness the versatile Sanborn 150 Series oscillographic recording systems in a 6-page bulletin which has just been released. The booklet contains illustrations, technical data and specifications on two- and four-channel systems, a single-channel recorder, a four-channel system for use with analog computers, and individual portable cases for recorders and amplifier-power-supply units. Available on request. **M-3**

• **Leonard Radio, Inc.,** 69 Cortlandt St., New York 7, N. Y., is now distributing a new 160-page high-fidelity sound catalog which contains listings of latest models of virtually all leading equipment manufacturers. Included in the listings are all essential specifications, pictures, and dealers net prices. An 18-page introduction contains worthy information concerning the purchase and assembly of high-fidelity music systems. **M-4**

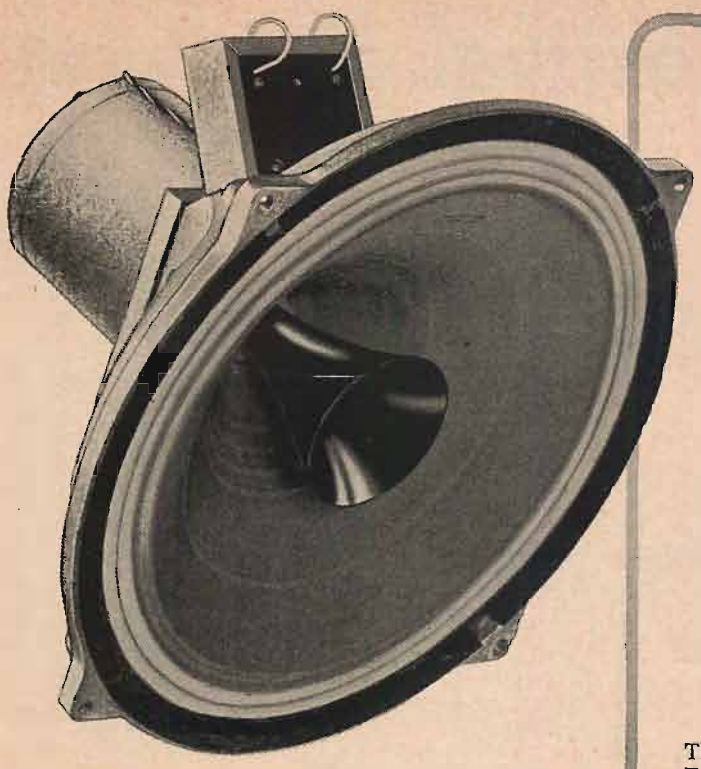
• **DuKane Corporation,** St. Charles, Ill., has performed a worthwhile industry service with the publication of new recommended standards for recording with automatic sound and projection equipment. Available at no charge, the information is contained in an 11-page booklet titled "The 30-50 Automatic Sound Slidefilm System." DuKane was host to an industry-wide conference of sound slidefilm engineers in 1954 at which an extensive range of standardization problems were examined. The recommended standards are the concensus of that meeting. Included in the recommendations are suggestions for standardizing tolerances on triggering tones, spaces between bands, length of tones, frequency response tones, silhouette of recording grooves, radius of needles, and minimum playing times for 10-, 12-, and 16-in. records. **M-5**

• **General Radio Company,** Cambridge 39, Mass., in one of the more attractive catalogs to cross this desk in many months, presents a revised listing of the firm's Variac continuously-variable-voltage transformers. So well organized is the written and illustrative material in Bulletin N that the publication may well be regarded as a standard reference work for users of transformers of this type. **M-6**

• **Allied Radio Corporation,** 100 N. Western Ave., Chicago 80, Ill., is now mailing without charge a new 68-page publication which combines an extensive, illustrated information section explaining high fidelity, with listings of hi-fi music systems and separate components. Titled "This Is High Fidelity," the book features an introductory discussion which analyzes the hi-fi dollar in terms of the percentage which should be spent on each component in a home music system. There are also many tips for the budget-conscious on how to save money in the selection and installation of hi-fi equipment. **M-7**

and physical shock;

tones, frequency response tones, silhou-



"Well worth careful consideration"
—HIGH FIDELITY TITH REPORT

Regardless of Price Class...

BEAM

STENTORIANS

Stand Alone

The superb, British made Stentorian line of High Fidelity Loudspeakers provides types and sizes to fit every audio purpose. Whether you select full range coaxial speakers or extended wide range direct radiators, tweeters or woofers you'll find a Stentorian to suit you perfectly. All models feature the revolutionary patented Stentorian cambric cones and suspension; Sizes 8 inches and up feature non-resonant die-cast chassis. Stentorians are unmatched in performance, craftsmanship and value. Hear Beam Stentorians – the Sound that "stands alone" – for yourself and be convinced.

12" Duplex (twin concentric) **$99.50**
Response, 20 to 20,000 cps; bass resonance, 35 cps; built-in crossover; 15 watts; gross weight, 16¼ lbs. Series Alcomax magnet system; net weight, 11½ lbs.; 31,000 Gauss; two 1½" voice coils.

12" Extended Range Direct Radiator $42.50
Response, 25-14,000 cps; bass resonance, 39 cps; 15 watts; gross weight, 10 lbs.; Alcomax magnet, 5½ lbs., 14,000 Gauss; 1½" V/C.

10" Duplex (twin concentric) **$44.50**
Response, 30 to 16,000 cps; 10 watts; gross weight, 6½ lbs.; 3 lb. 9 oz. Alcomax series magnet system; 25,000 Gauss; two 1" V/C.

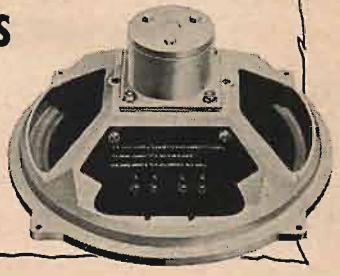
New 3 way variable impedance DIRECT RADIATORS

4 - 8 - 15 Ohms

You select the perfect impedance match for your system!

HF 1012 U-10" **$15.95**
HF 912 U-9" **12.55**
HF 812 U-8" **11.95**

Extended Range Response, 30 to 14,000 cps; bass resonance, 35 cps. 10 watts. These models also available with 15 ohms V/C only. All have 12,000 Gauss, 2 lb. 1 oz. Alcomax Magnets.



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QUAD

AMPLIFIERS

"Should Satisfy the Most Critical"
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- Response, 10-60,000 cps; 0.5 db
- 20-20,000 cps level at full 15 watts
- Total Distortion, at 700 cps, less than 0.1%
- Max. Intermod. Distortion less than 0.4%
- 3 position Filter Slope Control; Level to 50 db/ octave

Quad II Amplifier..... **$130.00**
Q.C. II Control Unit..... **$120.00**
System Complete..... **$237.50**

The Beam QUAD is a truly superior audio instrument, providing uncompromising quality *plus* unparalleled flexibility of control. Its scarcely traceable distortion is inaudible at any volume. Add high efficiency harmonic filtering, push-button equalization and channel selection, plug-in pickup matching, balanced feedback throughout, 13 section output transformer, superb British craftsmanship, and the most functional styling in high fidelity today – and you can see why QUAD is the recognized world leader in high quality audio reproduction. Hear it at your earliest opportunity.

Send for literature and detailed specifications on the Beam Products described above, and on Stentorian Speakers from 5" to 12" sizes, 5 and 15 watt pressure horn tweeters, matching crossovers, the Stentorian 18" woofer and Beam enclosures.

BEAM INSTRUMENTS CORPORATION
350 Fifth Avenue, New York, N. Y.

Festival of Sound

A Bold Experiment Succeeds

We wish to acknowledge with thanks the permission to reprint the following abstracts from the article entitled "Festival Of Sound" by F.L.D., which originally appeared in *Wireless World* published by Iliffe & Sons Ltd., London, England.

The Editor

When G. A. Briggs, Wharfedale Loudspeakers, announced his intention of taking the Royal Festival Hall in London for a lecture-demonstration on sound reproduction there was much shaking of heads. Could he hope to fill a hall with a seating capacity of 3000? Would the vast size and acoustic clarity of the Hall prove too searching a test for equipment designed primarily to give an illusion of reality in domestic surroundings?

The first question was unambiguously answered when it was announced that all tickets—including those for standing room—had been sold within four days. Any misgivings on the second were quickly dispelled that night when, after listening critically and perhaps a little anxiously to the opening items, we were able to sit back and enjoy ourselves—as Mr. Briggs intended that we should.

For many of the items a single Wharfedale "3-speaker" system was used; two of these units, in parallel, were used for organ and orchestral pieces demanding a greater power output.

Pilot lamps showed the audience which loudspeaker(s) were in operation, and a visual power level indicator enabled all to see what was going in at any given moment. Viewing this meter from a seat in the stalls, one gained the impression that levels in excess of 15 watts were extremely rare. The whole of one organ piece (Allegro-Voluntary in D, by John Stanley) was accomplished within the 3-watt level.

Records were played on a Garrard Model 301 transcription turntable in which the speed control enabled exact equality of pitch to be found with the "live" performances with which the comparisons were made.

All seats and standing room were filled long before 8 p.m.; thus, even before the proceedings were opened by the genial chairman, J. R. Tobin, B.Mus., we were already in debt to Mr. Briggs for showing us the strength of the public interest in good sound reproduction. With a disarming pretence of being non-technical, and with many bold sallies at the pundits Mr. Briggs quickly cut through the undergrowth of "hi-fi" to get at the roots of good sound reproduction where art is more important than science; in particular the importance of microphone and studio technique to create the exact degree of "atmosphere," "ambience"—call it what you will—when replayed in given surroundings. It followed that his choice of orchestral recordings for demonstration in the Festival Hall carried a higher ratio of direct to reverberant sound than would be chosen for playback in a small room.

The acoustic level of reproduction relative to that of the original has a profound influence on balance and quality and must obviously be exact when direct comparisons with the original are made. For some of the items this yardstick was not available, but in all cases one felt that judgment in the choice of level was well informed.

The most courageous of Mr. Briggs' experiments—the immediate comparison of live performances by Stanislav Heller (harpsichord), Ralph Downes (organ) and Denis Matthews (pianoforte) with disc and tape recordings—proved to be the highlights of the evening. The delicacy and precision of the harpsichord playing, with every gradation of tone crystal clear in the recording made by E. C. Watts, were exactly matched in the impeccable playing of Stanislav Heller. The background noises in the Hall, which fell to a level creditable for an audience of three in a country cottage rather than 3,000 in the heart of London, was an even more eloquent comment than the applause which followed.

In the Bach organ *Toccata in D* we were able to compare a tape recording, made in the Festival Hall by Ralph Downes, with a live repetition of the same piece by the same player. In volume and quality the original and the reproduction were again exactly matched. By listening carefully the slightly longer reverberation time of the recording was perceptible—proof that the Festival Hall really has got a hangover of sorts, if you go looking for it by successive recordings. This effect was absent in the harpsichord recording, which was made in accordance with the principle advocated by Watts of "no ambience" for solo instruments other than that of the space in which they are reproduced.

Unfortunately the piano available for Denis Matthews' playing of the Beethoven D minor sonata was not the one he used for the recording, so comparative analysis was given a holiday while we sat back and enjoyed two similarly realistic and virile examples of the pianist's art.

No live orchestra was available for comparison with the (London) Decca recording of the Beethoven 6th Symphony by the

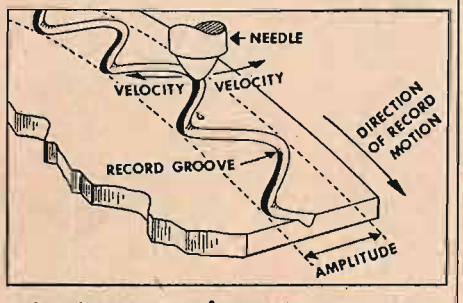
G. A. Briggs, who staged the comparative demonstration in London's Festival Hall

SONOTONE QUICK FACTS ON CERAMICS

By ROBERT L. LEWIS

If you haven't heard too much about ceramic cartridges, it's because this type is relatively new. Sonotone discovered the principle in 1946. Inherently, it had major advantages over other cartridge types—no deterioration from humidity or temperature... no magnetic hum pickup, no need for equalization, plus far higher voltage output. Since then, we've constantly improved the response curve, to its present superlative "flat" range.

The 1P described here is brand new. It's a single-needle type. We also make a turnover, two-needle type that operates on the same principles. Incidentally, both types eliminate one nuisance—you can remove or replace the needle in a second, just with your fingers. Simply snap it in.



This diagram helps explain why, using Sonotone ceramics, you get a flat response *without* an equalizer. With a velocity type pickup, the voltage output will be 30 times as great at 10,000 cycles as at 50 cycles. It responds to side-to-side *speed* of needle movement. But our ceramics work on the "amplitude" principle—they respond to the *amount* of side-to-side movement.

So a Sonotone ceramic cartridge will play back RIAA, Orthophonic, AES, LP and other common curves so close to "flat" that your ordinary tone controls amply cover any needed delicate adjustment for individual records...and individual ears.

About hum – you'll be glad to know that Sonotone ceramics give a high voltage output that overrides hum, and require no boost at hum frequencies. And the nonmagnetic structure means no worry about nearby fields or turntable causes.

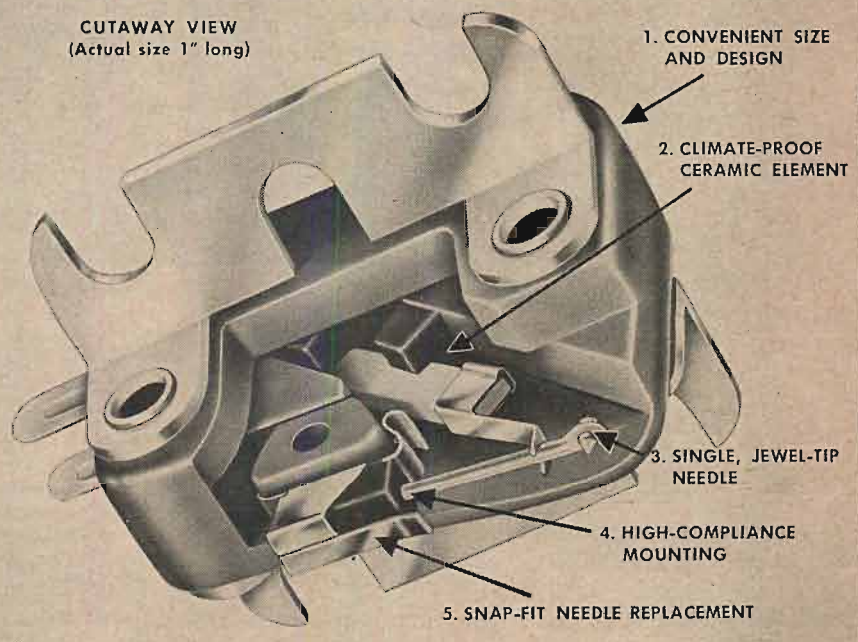
Sincerely,

Robert L. Lewis

Head of Electronic Applications Division

It gives you all the music – and none of the problems!

NEW SONOTONE 1P CERAMIC CARTRIDGE

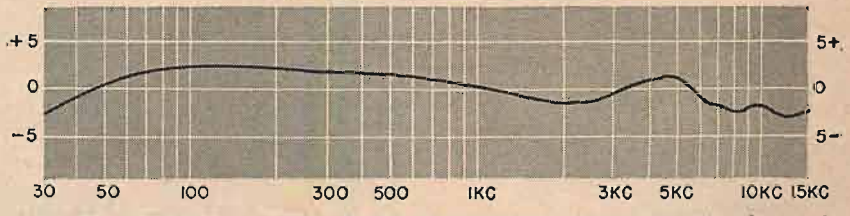


1. Easy to install. Fits most arms now in use.
2. Ceramic element gives superlative response (see curve)—requires no preamplification or equalization! No deterioration problem as with other types... virtually immune to hum pickup!
3. Replaceable needle, diamond or sapphire. Models for 33-45 rpm, or 78 rpm.
4. Extreme lateral compliance and low-mass design give superior tracking, low wear.
5. Needles snap in, snap out easily without tools.

New, Simpler Way to Finest, Noise-Free Reproduction

A Sonotone 1P Ceramic Cartridge gives you superb response—compare it with *any* type of cartridge at *any* price! In addition, this Sonotone Ceramic Cartridge eliminates expensive, cumbersome equipment...*along with all the noise inherent in such circuitry*. You get full-range, *quieter* reproduction—more simply, and at lower cost. Model 1P with sapphire, $8.50; with diamond, $30 list.

RESPONSE 30-15,000 ± 3 DB!



Response to new industrywide RIAA characteristic shows how 1P *self-equalizes*, because it works on "amplitude" rather than "velocity" principle.

SONOTONE CORPORATION
ELMSFORD, N.Y.

Write Dept. CA-35 for free Specification Sheet

Part of the gallery audience at Festival Hall.

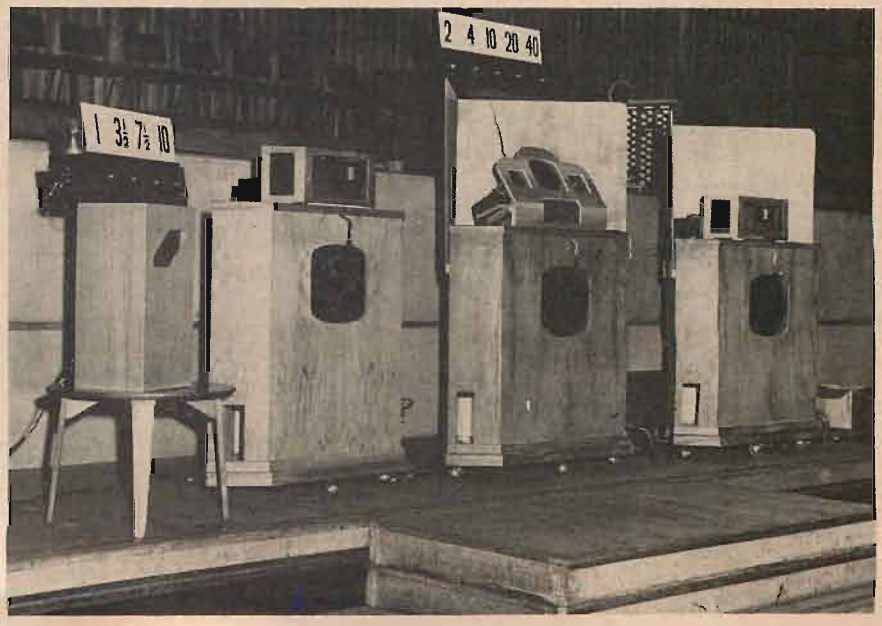
Concertgebouw orchestra under Erich Kleiber; but none was needed, for the inherent clarity and definition of all the parts was self-evident. The sight of an empty stage was the only incongruity. The string tone was as near the real thing as the tone of one violin is to another.

Those whose appetite for the classics is insatiable would have liked longer excerpts from many of the works, but that would have deprived others in the audience of a hearing of some remarkable sound effects, the records of which are themselves classics in their sphere. There was R. Bradford's recording of breaking glass, the B.B.C. recording of awe-inspiring reverberation effects in the Hamilton Mausoleum, the incisive tugboat engineroom noises captured by Mercury Sound Recordings, Ltd. and the W. S. Barrell collection of percussion instruments, with and without high frequencies.

Mr. Briggs made some pithy comments on exaggerated claims for frequency response, particularly in the bass, and proved his point by having 32-cps and 16-cps notes played on the organ. The 32-cps pure tone sounded useful, but most people would have needed a barometer to detect the 16-cps tone. A 32-cps reed pipe gave a plausible imitation of the loudspeaker with the coil off-centre.

The last item on the programme was the Vaughan Williams Sea Symphony. A suggestion from Mr. Briggs that Ralph Downes should double the organ part was received in shocked silence by the musical purists, until Mr. Briggs fired a characteristic parting shot: "Well, if he plays as loudly as all the rest put together, we shall be only 3 db up—and what's 3 db among friends?"

On this note ended a most successful evening. The sound reproduction community owe a great debt to Wharfedale Speakers and to Mr. Briggs for his courage, vision and drive in staging this event.



The battery of loudspeakers, which were heard singly and together during the demonstration.

Even a one-record collection deserves G-E Cartridge quality!

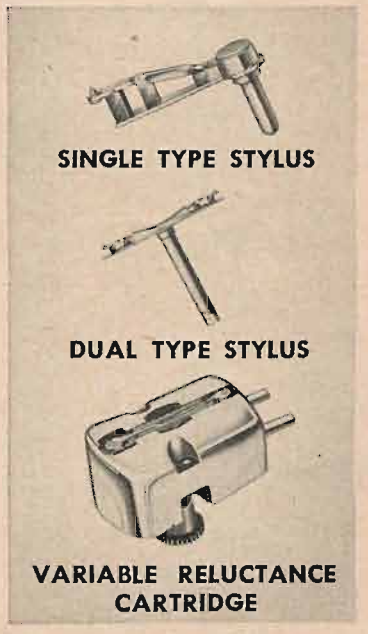
PROVE it to yourself with your favorite record. Just one demonstration at a local music store will convince you! Listen while General Electric faithfully reports a range of sound you never knew existed—even on favorite recordings. This is the cartridge leading broadcast stations depend on . . . and leading manufacturers of true high-fidelity systems include in their finest designs.

There's a complete line of diamond and sapphire* styli to choose from. *Compare* them with any other *for performance or economy*. Only G-E wins the popular vote on both counts!

**Some sapphires are synthetic.*

Prices of G-E cartridges with stylus start at $5.97†

CARTRIDGES AND STYLI



†Slightly higher West and South. Subject to change without notice.

Progress Is Our Most Important Product

GENERAL ELECTRIC

leading manufacturers of true high-fidelity systems include

NOW! 5 the famous HORIZON high

NEW SPEAKER SYSTEM

Furnishings by Paine's of Boston

the National CATENOID

Now! National introduces five brilliant new additions to its famous high-fidelity line — four superb new speaker systems and a magnificent new high fidelity changer!

Now, National gives you the widest choice in complete, integrated high fidelity systems — from the new Horizon 100 Record Changer, the Criterion Tuner, Horizon 5 Preamplifier and Horizon 10 and 20 Amplifiers to a complete new line of Loudspeakers . . . every component is engineered to match the others perfectly for flawless reproduction. You can select any one of 16 different systems! There's a National system for every taste, every budget! Visit your National dealer today and listen to the highest achievement in the art of audio!

a whole new approach to speaker system design!

The National Catenoid Speaker System is the first basic improvement in loud speaker design in more than ten years. A true corner horn, (not a back loaded or semi-horn) the Catenoid is the only *practical* means of reproducing the power and dynamic quality of rich bass tones.

Catenoid design maintains the catenary taper in the horn throat within a few per cent, important because air pressures are quite high in this region of the horn. Also, the Catenoid's single path, as opposed to an exponential system's multiple path requirement, results in much simpler construction, smaller size and lower cost.

The Catenoid System consists of a full catenoidal horn from the 30 cycle region to 300 cycles; a direct radiator from 300 to 6500 cycles, and a high frequency tweeter unit from 6500 to beyond 17000 cycles per second.

Driver unit specifications were established as a result of free field measurements of more than 40 different drivers. Excellent high frequency tweeter response has been made possible by covering only a bit more than one octave and equalizing the tweeter input.

All high frequency fundamentals of the musical spectrum are fed through the mid-range speaker, adding the feeling of "presence." The 300 cycle cross-over point, as the upper cut-off for the low frequency horn, is used in order to avoid bouncing of higher frequencies in the fold of the horn. Tone bursts and square waves reproduce in a far superior manner as compared with reflex boxes and pipes.

IMPEDANCE: 8 OHMS CAPACITY: 30 WATTS
SIZE: 36" HIGH, 40⅛" WIDE, 27½" DEEP
Available in hand-rubbed walnut or mahogany or with Formica impregnated blonde mahogany, walnut or natural mahogany to resist scratches, scuffs, burns or liquids.

tuned to tomorrow

Distributed in Canada by Canadian Marconi Company, 830 Bayview Avenue, Toronto, Ontario. For foreign sales, contact American Steel Export Company, 347 Madison Avenue, New York, N. Y.

National NC

NATIONAL COMPANY, INC. 61 SHERMAN ST., MALDEN 48, MASS.

Now, National gives you the widest choice in
All high frequency fundamentals of the musical

brilliant new additions to fidelity line!

NEW SPEAKER SYSTEM

choose from high fidelity's largest and finest integrated line!

the National FANTASIA

Exclusive cabinet design featuring laboratory-developed dual clusters of distributed ports and internal vents with dual heavy-duty drivers for exceptional peak-free bass response in minimum size. Unusually smooth middle and high frequency ranges. 16 ohm impedance. Available in hand-rubbed mahogany and walnut or scuff and burn resistant impregnated Formica, blonde or natural mahogany and walnut.

NEW RECORD CHANGER

the HORIZON 100

Jam-proof! Stall-proof! Quiet! Intermixes all size records without adjustment or pre-setting! Six-second changing cycle regardless of speed! 4-pole motor, 2-knob control, weighted turntable, automatic idler disengagement, shut-off and muting switch, universal spindle, rubber turntable mat, stylus pressure adjustment, 2 plug-in heads. Complete with base, G. E. cartridge, all cables and connectors.

NEW SPEAKER SYSTEM

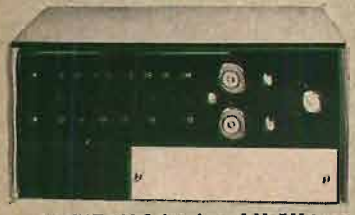
the National WELLESLEY

Distributed ports control the Helmholtz resonance of dual 8-inch drivers to give big, clean, well-defined bass and mid range. Corner design utilizes room walls as horn extensions for even lower fundamentals. Equalized super tweeter extends range to hearing limits without harsh peaks. Impedance 16 ohms. Available in Formica impregnated or hand-rubbed blonde, walnut or mahogany.

NEW SPEAKER SYSTEM

the National COPLEY

A two-way system of moderate cost featuring heavy duty 8" driver and superb high flux density tweeter for silky highs. New porting system increases distribution and peak-free acoustic damping of lows by unique slots. Sealing of tweeter section eliminates inter-action with other elements to achieve new low in intermodulation distortion. Impedance 8 ohms. In Formica impregnated or hand-rubbed blonde, walnut or mahogany.



HORIZON Criterion, AM-FM tuner
Based on circuits developed by leading National audio consultants. Receives full-band AM, drift-free FM, both simultaneously, or binaural broadcasts. Sensational Mutamatic FM Tuning eliminates hiss and noise between stations. .5 microvolt sensitivity.

HORIZON 20, 20-watt amplifier
Utilizes revolutionary new "unity-coupled" output stage, eliminating impulse distortion caused by transformers in conventional circuits. Frequency response is ±1 db 10 cps to 100 kcs at full rated output.

HORIZON 10, 10-watt amplifier
New "unity-coupled" output circuit offers performance never before achieved at such a low price! Built-in preamp-control unit 3 inputs, 3 record equalization curves, loudness control, separate bass and treble controls.

HORIZON 5, preamp-control
Achieves a new high in frequency response and output, a new low in distortion. Offers 4 inputs, 7 record equalization curves, loudness volume control, separate boss and treble controls. Plugs into tuner or 20-watt amplifier.

WRITE FOR COMPLETE DETAILS ON 16 SUGGESTED COMPLETE HIGH FIDELITY SYSTEMS TO DEPT. F-355

EDITOR'S REPORT

AUDIO FAIR—LOS ANGELES

THE THIRD SHOWING of the Audio Fair—Los Angeles came off just about as expected, as most of the Audio Fairs do, with enthusiastic reception by those who attended—and in this instance the figure is given as 28,000, which would seem to be just about right to one who has attended all of the Audio Fairs ever held so far. Starting the complete event on Wednesday evening, February 9, was the First Annual AES Banquet in Los Angeles. On Thursday evening, the Fair opened to dealers and those who had learned of the show through the trade press and from their equipment distributors—with a surprising attendance of over 1000 registered. This was the night for the more serious hobbyist—the sort of interested individual who stands in line at the beginning of every Audio Fair because he can't hardly wait to get in to see the new equipment—the loudspeakers and housings, amplifiers and preamplifiers, turntables and record changers, tuners, and everything else that makes the Fair so interesting to the music lover and audio hobbyist.

Friday, Saturday, and Sunday were the days for the general public, the days that had been advertised widely for everyone, the day when everyone came. All in all, it was a fine exhibit, and those who participated were more than satisfied.

The real value of an Audio Fair, in our opinion, is in the opportunity it gives for manufacturers—of both equipment and magazines—to become better acquainted with their customers. From our own experience, we believe that this direct, person to person contact with AUDIO's readers gives us a far better picture of the likes and dislikes than we could possibly get from the occasional letter from these readers. Not only because it gives a wider coverage of the reading public, but because a person is far more likely to say exactly what he *thinks* than he is to write it, and it is so much easier to *tell* us what he likes and doesn't like than it is to put it on paper. And while we do gain hundreds of subscriptions at each show we attend, and while we distribute hundreds of copies to potential new readers, we feel that the most important benefit is in getting to know those readers who stop by to say a few words of either appreciation or deprecation. All opinions are valuable for it tells us what you want in the magazine, and what you think is unnecessary and undesirable.

So we shall continue to show up at all of the shows—and to always have an open ear to our readers to the end that we may try to build a better magazine, one which is exactly what every single reader wants. We are always glad of the chance to see and talk to our readers, and we take this opportunity to thank each one who came in to talk to us during this most recent Audio Fair—Los Angeles.

THE MONTREAL SHOW

Almost obscured, in point of time, by the long established show in Los Angeles, the first Canadian Audio Show was held in Montreal at the Windsor Hotel on February 3, 4, and 5. Obscured it was in that it was announced too late for publicity in the January issue, and there was no point in mentioning it in the February issue which would not have been in readers' hands in time for them to make plans for attendance anyhow. But as it turned out, the show's *entrepreneur*—Emery Justus—stirred up enough interest by himself to draw an attendance of over 5000, which is not, in the vernacular, to be sneezed at. Thus we have had it proved that the U.S.A. is not the only country in which there is a strong leaning toward good audio. At the Canadian show, some 43 rooms were occupied with exhibits—which compares favorably with the first Audio Fair in New York back in 1949 when 44 rooms were occupied —so we have something to look forward to in our neighbors to the north.

Immediately, however, we have the Toronto Audio Show to look forward to, for this event is scheduled for April 27–30 at the Prince George Hotel in that city. And if we may be permitted an apology for not being able to announce the Montreal show in time, let us hope that this may be the first public announcement of the one in Toronto.

In any event, we extend our best wishes to Mr. Justus for his enterprise in starting the Canadian Audio Shows, and we trust his second will be as successful as the first.

GREMLINS

Into any well organized life, some troubles are bound to occur. Undoubtedly sparked by the acoustic phonograph industry, some gremlins—or whatever are the audio equivalents of these legendary creatures which were first named, if our memory serves us right, by the fly-boys during World War II—seem to have done wrong by us in the February issue.

1. Author Norman Crowhurst was moved by us back to London, a city which he forsook many months ago for a go at the new world. It wouldn't be so bad if we hadn't published one of his stories back in October, 1954, wherein his correct address—150-46 18th Ave., Flushing 57, N. Y.—was listed. May this set anyone straight who was about to write Mr. C for further information about his article.

2. On both the cover and page 20 we published a schematic showing two tubes—both pentodes—and labeled them 6AV6. Now everybody knows that a 6AV6 is a double-diode-triode, so the drawing could not have been right, but there it was and here we are with the second red face for the month.

3. On page 36 was a headline that didn't make any sense at all. It read "'Realist' Components Corporation's Radio Shack." When the page proof for this one came along, two of the lines were transposed. We believed them to have been marked properly to put them right, but this is what we got when it was all through. Anyway, it should have read "Radio Shack Corporation's 'Realist' Components," as has probably been guessed by now. That explain's our third red face for the month of February.

Does this prove that there is an advantage in being three-faced in this business? Better than, two, anyway.

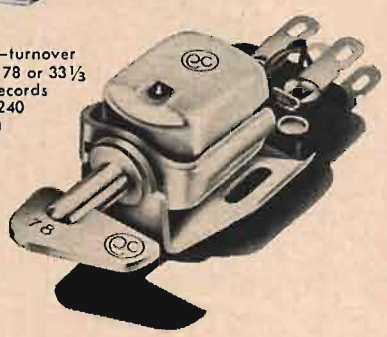
PICKERING *models* 220 / 240 *cartridges*

The Most Nearly Perfect Phono Pickups Ever Produced

. . . they are sold separately for all standard arms or mounted back-to-back to make up the famous PICKERING 260 TURNOVER PICKUP.

MODEL 220—for 78 rpm records diamond or sapphire stylus

MODEL 240—for 33⅓ and 45 rpm records diamond stylus only



MODEL 260—turnover cartridge for 78 or 33⅓ and 45 rpm records (the 220 and 240 back-to-back)

The 220 and 240 are engineered to maximize performance. By comparison they are without equal . . .

The **220** *and* **240** *are*

Lighter— 5½ grams

Smaller—⅝ by ¾ by ⅜ inches

The **220** *and* **240** *have*

Highest Output—30 millivolts/10cm/sec.

More Compliance with Less Tracking Force

Lower Overall Distortion

Less Moving Mass

Wider Frequency Response

Mu-Metal Shielding for Less Hum

These characteristics have real meaning to those who understand that maximum performance depends upon components which meet professional standards. If you want the best that high fidelity can offer, ask your dealer to demonstrate the 220, 240 and 260 Pickering cartridges . . .

to demonstrate the 220, 240 and 260 Pickering cartridges . . .

The Most Nearly Perfect Phono Pickups Ever Produced

PICKERING ***and company incorporated • Oceanside, L. I., New York***

PICKERING COMPONENTS ARE PROFESSIONAL QUALITY

"For those who can hear the difference"

. . . Demonstrated and sold by Leading Radio Parts Distributors everywhere. For the one nearest you and for detailed literature; write Dept. A-7.

ABOUT MUSIC

HAROLD LAWRENCE*

There'll Always be a Grove's

EVER HEARD OF Louis Schindelmeisser, Wolfgang Schmeltzel, or Alfonso Ferrabosco? How about the flügelhorn, tárogató, or tromba marina? No, these are not the final tough questions in a puzzle contest calculated to eliminate ninety-nine percent of the contestants. The six unfamiliar names of composers and musical instruments represent merely ten of the more than eight million words that go into the fifth edition of *Grove's Dictionary of Music and Musicians* (St. Martin's Press—$127.50)—the indispensable companion of every A & R director, musicologist, editor, librarian, critic and music lover. For, in the 8,516 pages of this nine-volume set, practically everything on and in the world of music, from India to Bulgaria, organum to *musique concrète*, or medieval caricatures to postage stamps, is at your disposal.

Curiously, the man originally responsible for *the* standard reference work on music in the English language was not primarily a musician. London-born Sir George Grove (1820–1900) was a civil engineer who constructed such things as cast-iron lighthouses and a tubular bridge. Engineering activities, however, did not prevent Grove from taking over the post of Secretary of the Society of Arts in 1850, and of the Crystal Palace two years later. His first excursion into the field of research occurred in the mid-fifties when he collaborated on a *Dictionary of the Bible.* This project, for which he wrote a fourth of the articles and paid two visits to Palestine, took up all his spare time for almost seven years. (Grove, incidentally, did a lot of traveling in his lifetime. As engineer, he went to Glasgow, Jamaica, Bermuda, Chester, and Bangor. As official, he lived in Sydenham and London. He journeyed as musical writer and researcher to Vienna, Oberammergau, Naples, the United States, Canada, Berlin, Leipzig, etc. On one histroic trip to Vienna with Sir Arthur Sullivan, he unearthed the score of Schubert's *Rosamunde.*) In 1873 Grove resigned his secretaryship of the Crystal Palace to devote himself to the editing of the *Dictionary of Music and Musicians.*

Ever since he heard his mother play excerpts from *Messiah* "out of an old vocal score with voices and figured bass only," Grove's heart belonged to music. He was an amateur in the true sense, buying scores, attending concerts, devouring books on music, and writing warm, unpedantic articles and program notes. His musical activities

Eric Blom

reached a high point in 1883 when, after five years of speech-making, circular-writing and fund-raising, he succeeded in organizing the Royal College of Music. Grove was knighted for this achievement—and "for the preparation and publication of a 'Dictionary of Music'."

Grove I has been described as a "solitary edifice of musical scholarship in the Victorian desert." It came into being in an age that liked to refer to musical works in the most flowery prose sprinkled with literary allusions and glowing superlatives. Take the following 'evaluation' of the *Magic Flute:* "This last opera of Mozart's, written only a few months before his death, approaches so near to perfection that one amost feels in it the motion of the spirit-wings which were so soon, alas! to bear away Mozart's genius from earth . . ." (Not that echoes of Victorian style don't exist today!) The words, "Nature," "Love" and "Humanity" played important roles in the style of critics and musicologists. Grove had little use for this approach and managed to convey his ideas within a more objective framework.

As *Grove V*'s editor Eric Blom pointed out, the editors of *Grove II* (1900), *Grove III* (1927), and *Grove IV* (1940) had, "for the sake of piety, as well as for practical reasons," left much of the original edition intact. They made corrections wherever

(*Continued on page 65*)

* *26 W. Ninth St., New York 11, N. Y.*

Refreshing!

THE **Collaro** RC-54

The Automatic Record Changer That First Introduced . . . JPF

Just **P**lain **F**idelity

Refreshing is the word—because for once, we have penetrated the maze of superlatives that has confused the whole idea of music reproduction. We have developed a clear understanding that what the listener wants is faithful sound . . . and this means fidelity . . . not 'high'—not 'super'—and not 'ultra'. . . *just plain fidelity.*

We decided that fidelity cannot be improved upon—not even by qualifying the word with an adjective. So, we turned our attention to improving the product. And by so doing, achieved what others belabored . . . fidelity . . . *just plain fidelity.*

This is immediately apparent in the new Collaro RC-54, the most modern of all record changers. Used with a high quality amplifier and speaker system, the performance of the RC-54 is a rewarding experience. It is smooth and foolproof. It won't stall or jam . . . and handles your records with utmost gentleness.

The Collaro RC-54 operates at all three speeds: 33⅓, 45 and 78 rpm. The change cycle takes only 7 seconds regardless of the record speed. And for your added convenience, the new RC-54 intermixes all size records in any sequence, and without pre-setting.

Sold by Leading Sound Dealers

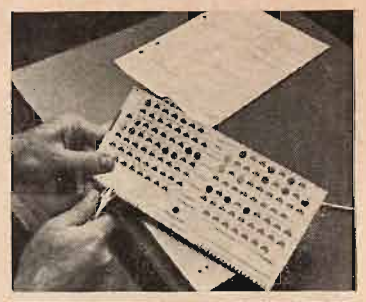
Complete specifications are available by writing to Dept. UC-1.

ROCKBAR CORPORATION • 215 East 37th Street • New York 16, N. Y.

Net $48.75
Slightly Higher West of Rockies

How your telephone call asks directions... and gets quick answers

1



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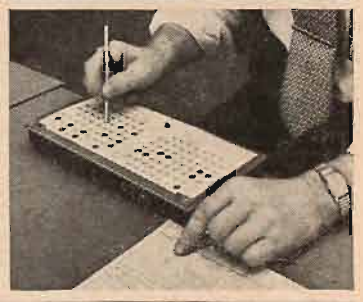
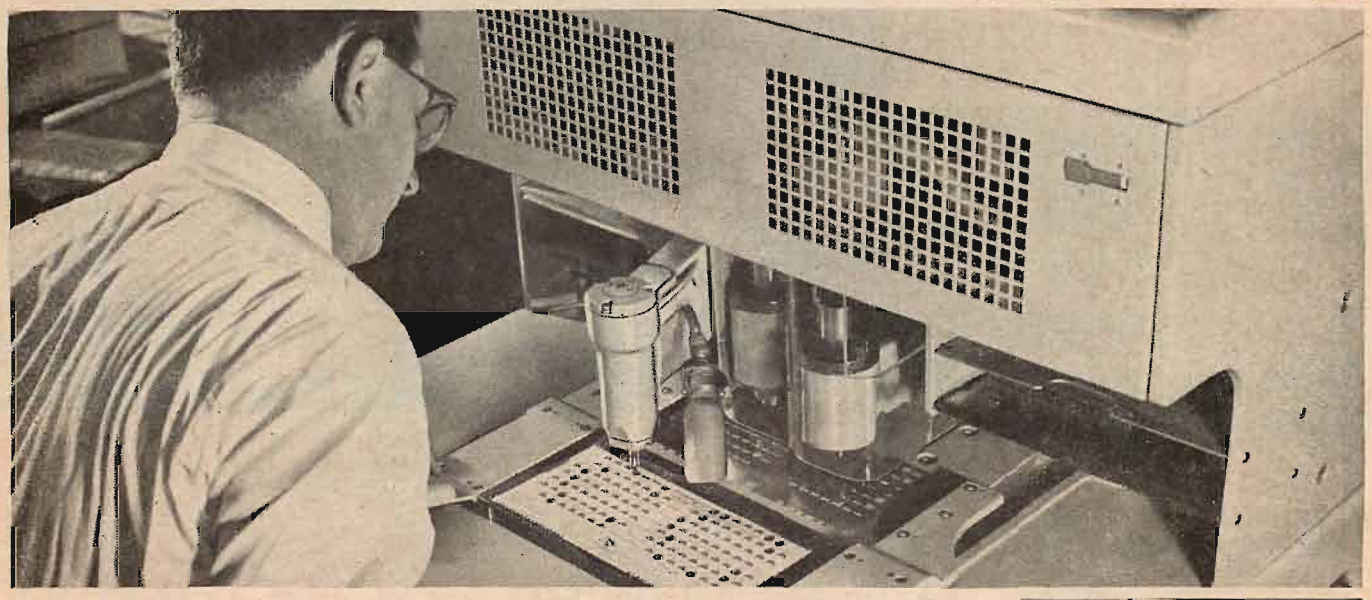


Perforated steel cards, which give directions to the Long Distance dial telephone system, are easy to keep up to date. New information is clipped (1) and punched (2) by hand on a cardboard template. This guides the punch-press that perforates a steel card (3), and the two are checked (4). The new card is put into service in the card translator (5).

↓3



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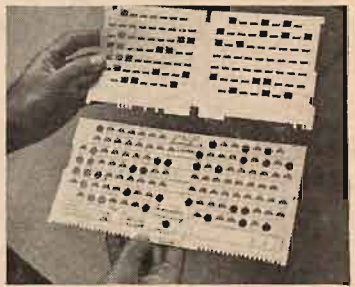

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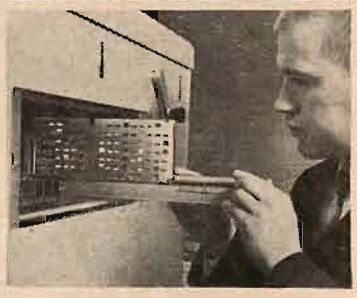


When the Bell System's latest dial equipment receives orders to connect your telephone with another in a distant city, it must find—quickly and automatically—the best route.

Route information is supplied in code—as holes punched on steel cards. When a call comes in, the dial system selects the appropriate card, then reads it by means of light beams and photo-transistors. Should the preferred route be in use the system looks up an alternate route.

It is a simple matter to keep thousands of cards up to date when new switching points are added or routing patterns are changed to improve service. New cards are quickly and easily punched with the latest information to replace out-of-date cards.

This efficient, flexible way of keeping your dial system up to the minute was devised by switching engineers of Bell Telephone Laboratories, who are continually searching for ways to improve service and to lower costs. Right now most of the Long Distance dialing is done by operators, but research is hastening the day when you will be able to dial directly to other telephones all over the nation.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

steel cards. When a call comes in, the dial system selects the appropriate card, then reads it by means of light beams and photo-

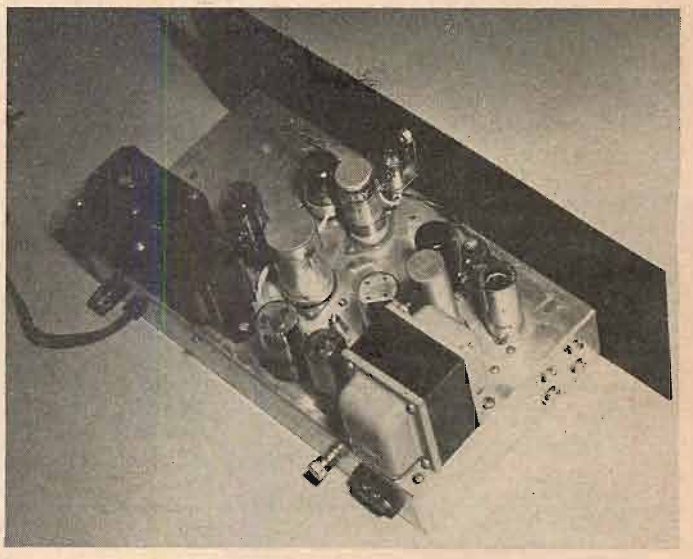
Back to Class "B" for Home Use

JOEL JULIE*

A re-study of the requirements of Class B has yielded an amplifier design which can be compact and efficient, and yet be capable of good quality.

IN RECENT YEARS the interest in high-fidelity sound reproduction has gathered momentum, and the sale of equipment designed for this purpose has assumed all aspects of a major industry. The designers and so-called "hi-fi experts" have constantly come up with "bigger" and "better" amplifiers to supply the ultimate in sound reproduction. Many amplifiers designed for home use are overdesigned, both from the standpoint of power handling capacity and the amount of steel and copper that goes into these amplifiers. Needless to say that the cost, installation and proper ventilation of these monstrous amplifiers has burdened the hi-fi enthusiast unnecessarily. As far as power output requirement is concerned, 10 watts is about as much as the average listener will ever use in a living room.[1] Even if we were to completely disregard the requirement of the listener and design the amplifier for the maximum power that the loudspeaker can handle without too much distortion, we find that even the best 15-in. direct radiator loudspeakers produce about 3 percent distortion with 10 watts input power.[2] To feed these loudspeakers with more than 10 watts would, therefore, be absurd when high-fidelity reproduction is desired.

The amplifier described here is an example of a high-quality amplifier for home use, incorporating all necessary controls for proper sound reproduction and tone control, yet weighing only nine pounds and consuming less than half the power of comparable 10-watt amplifiers.



Compact yet neatly laid out, and with a 10-watt output.

With an amplifier as light and compact as this, there was no need to separate the controls and preamplifier from the main chassis. In order to make the amplifier as light as possible, it was decided to use a class B amplifier in the output stage. Since this was intended to be a high-quality amplifier, a large amount of negative feedback is necessary. This requirement as well as that of light weight excluded the possibility of using transformer couplings. Cathode-follower drivers were used occasionally where economy of the circuit was a prime consideration. Here the cathode follower driver is used in a manner consistent with the requirement for high-quality sound reproduction.

The output stage consists of a single 6N7 operated in class B. In order to obtain the necessary low impedance for the grid circuit of the class B stage, a cathode-follower driver was used. The use of a cathode-follower driver is superior in many respects to the conventional transformer driver. For one thing, it would be virtually impossible to apply an appreciable amount of negative feedback with transformer coupling due to the phase shift in the transformer. Furthermore, a high quality class B coupling transformer costs about 7 to 10 times as much as a tube.

* *Research & Development Engineer, Daystrom Instrument Division, Daystrom, Incorporated.*

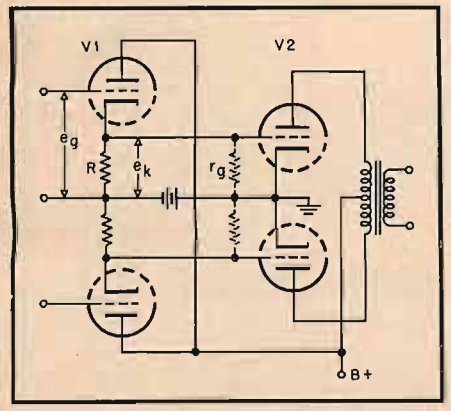


Fig. 1. Simplified schematic of cathode follower driving a Class-B stage.

Cathode Follower Driver

Figure 1 shows a simplified schematic diagram of a cathode follower V_1 driving a class B stage V_2. As long as there is no grid current flowing in V_2, the cathode follower presents no problem. The gain of the cathode follower is then:

$$A = \frac{e_k}{e_g} = \frac{\mu}{1 + \mu + \frac{r_p}{R}} = const. \qquad (1)$$

Under zero grid current conditions the only load on the cathode follower is the cathode resistor R. Since μ and r_p remain constant under these conditions, the gain also remains constant.

As soon as V_2 begins to draw grid current, the cathode follower load changes. This new variable load r consists of the cathode resistor R in parallel with r_g : $r = \frac{R \times r_g}{R + r_g}$, where r_g is the variable grid resistance whose magnitude is a function of the magnitude of the driving voltage under grid current conditions. The gain is no longer constant and is a function of the magnitude of the driving signal. For any particular driving signal amplitude this gain is:

$$a = \frac{\mu}{1 + \mu + \frac{r_p}{r}} \qquad (2)$$

Since r decreases as the driving signal increases, we should expect the gain a to decrease also and introduce nonlinear distortion. This would indeed be so if r_p remained constant under grid current conditions. Fortunately, r_p changes also under these operating conditions in a manner that tends to make the ratio r_p/r nearly constant. Indeed, we can

* *Research & Development Engineer, Daystrom Instrument Division, Daystrom,*
consistent with the requirement for high-
with r_g : $r = \frac{R \times r_g}{R + r_g}$, where r_g is the vari-

create an operating mode of the cathode follower under which the ratio r_p/r remains within reasonable limits.

Figure 2 shows a plot of plate resistance *vs.* grid bias for a triode. It can be seen that the plate resistance decreases as the grid bias becomes less negative. Since the bias resistance under grid current conditions consists of $r = \frac{R \times r_g}{R + r_g}$ and the value of r decreases with driving signal, the plate resistance also decreases which tends to make the ratio r_p/r constant. If we were, therefore, to set the bias of the cathode follower by adjusting R to such a value that the rate of decrease in r_p corresponds to the rate of decrease in r under grid current conditions, we would in effect keep the gain constant. By suitable choice of driver tube and value of R the ratio of r_p/r can be kept within tolerable limits.

Upon examining Eq.(*2*), we see that if we choose a high μ tube, in addition to the above mentioned design procedure, we can effectively nullify whatever discrepancy there remains in the ratio r_p/r. The fact that μ rises with increasing grid current also helps matters considerably (see *Fig. 2*).

It would seem from the foregoing that any of the high μ high-transconductance double triodes, such as the 12AT7 or 6BQ7-A, should be a suitable choice for this type of cathode follower. Investigation showed, however, that it was hard to select such a tube in which both elements of the double triode were properly matched for balanced operation.

It is also desirable that the cathode follower have a gain as near unity as possible so that the stage feeding the cathode follower is not taxed too heavily. From Eq. (*2*) it would seem that a tube with a high μ and low plate resistance would be desirable.

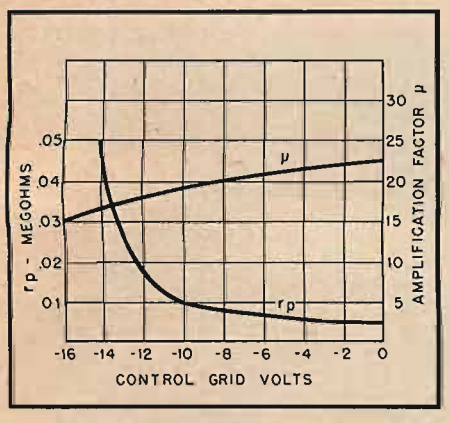
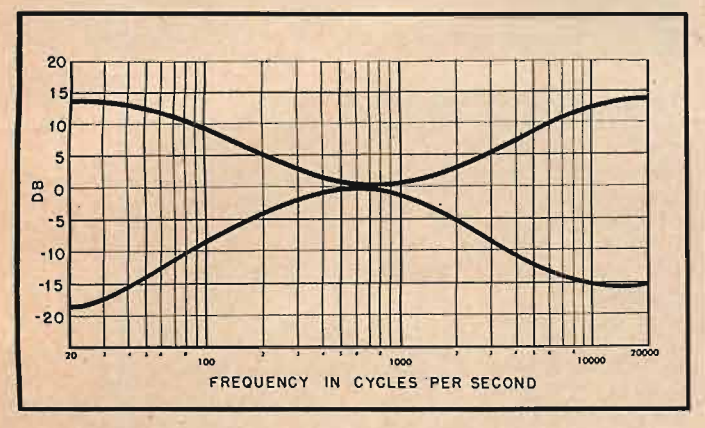


Fig. 2. Graphs of plate resistance vs. grid bias for a triode and of μ with respect to the ratio r_p/r.



Curves showing tone-control range for the author's amplifier.

In the actual design the 6SN7 was chosen as a reasonable all around compromise.

The output stage bias voltage is applied by way of the driver cathodes. The bias voltage is adjusted to a value which yields a quiescent current for both sections of the 6N7 tube of 12 to 15 ma. With the output stage so adjusted, a power output of 10 watts was obtained with only 1.3 percent distortion and 15 db negative feedback. The plate circuit efficiency was measured to be over 65 percent. As a result the power transformer in this amplifier can be kept very small. A power transformer with a rating of 40 to 50 ma for the plate winding is ample. The output load impedance was chosen at 20,000 ohms. This value yielded maximum plate circuit efficiency and required less grid driving power than the normal recommended plate load.

In order to obtain a low impedance bias supply for the output stage, the positive terminal of the d.c. filament supply for the preamplifiers was grounded, leaving the negative terminal available for bias purposes.

Other features of the amplifier include a two-stage preamplifier for magnetic cartridges with a choice of equalization having turnover points at 250, 500, and 800 cps; a five position program selector for tape, phono, AM, FM and TV; continuous bass and treble controls (see *Fig. 3*) and a high-frequency cutoff filter to limit the response of the amplifier when playing noisy or distorted records. The power amplifier is shown in *Fig. 4*.

The Cutoff Filter

In order to provide a high rate of attenuation, the cutoff filter was designed as a three-section filter using a constant-*k* middle section and two *m*-derived terminating sections; and to prevent ringing, the corner at the cutoff

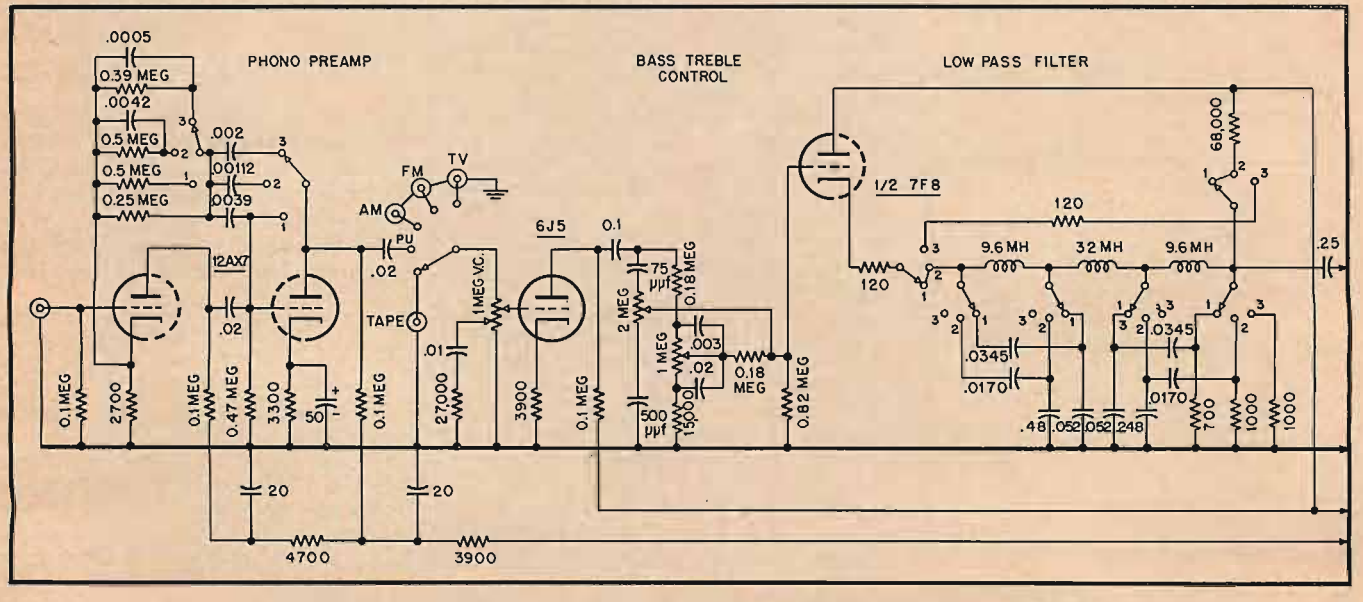
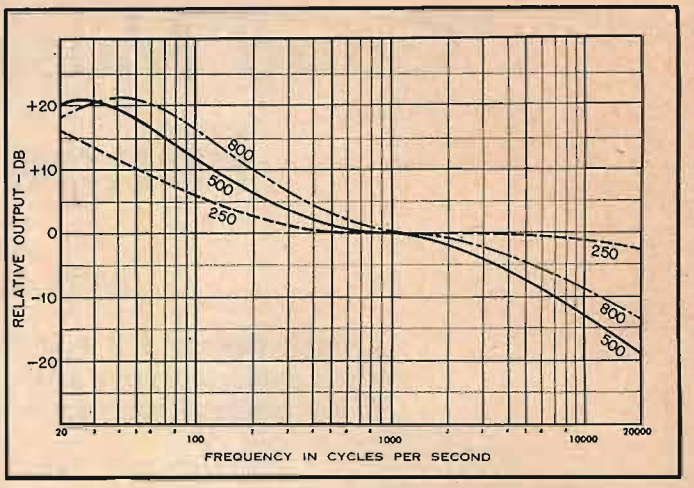


Fig. 3. Input section of the amplifier. This is built together with the output section, Fig. 4.

point was well rounded by controlling the Q of the coils. The inductances are fixed and the variable cutoff is obtained by changing the capacitors as well as the termination impedances. The characteristic impedance of the filter was chosen to be quite low to minimize hum problems. The required low input impedance is determined by the impedance of the cathode follower, which, in turn, is controlled by the bias of that tube. In the 7,000-cps cutoff position the output impedance of the cathode follower is 570 ohms. This value of cathode follower impedance was obtained by adjusting the bleeder current through the terminating resistor. A 130-ohm series resistor with the cathode raises the source impedance to the desired 700 ohms. In the 10-kc cutoff position the characteristic impedance is 1,000 ohms. The operating mode of the 7F8 cathode follower was so chosen that a fixed bleeder current of 2.85 ma through the termination resistors will yield the image of that impedance at the input of the filter. Thus, if 5,000 or 13,000 cps cutoffs were desired, it would only be necessary to change the terminating resistor to 500 and 1,300 ohms respectively. Of course, additional switch positions and tuning capacitors would be required in that case. This bleeder current also helps to decrease the cathode follower plate voltage variations when the power supply impedance is large. A switch position is also included in which the filter circuit is bypassed to provide a flat response position.

A balancing control is incorporated in the driver stage to balance the bias for the 6N7 tube.

It should be pointed out that although this amplifier was designed to deliver only 10 watts, there is no limitation on cathode follower drive for class B operation. The circuit used here can very well be adopted to amplifiers of multikilowatt size, such as would be required for transmitter modulators. The saving in cost and improvement in performance become more pronounced as more power handling capacity is required.



Response curves from the preamplifier section—tone controls flat.

Appendix

The class-B stage driven by a cathode follower can be made practically immune to "notch" response caused by plate current cut-off in the presence of output transformer leakage inductance. This is accomplished by operating the output tubes at a slightly higher current than would be dictated by maximum efficiency requirement and deliberately choosing a slightly higher output impedance than called for by other considerations. When these precautions are taken and the cathode-follower load resistors are so adjusted as to cause the cathode follower to cut off before the output tubes cut off, "notch-free" operation will result. In this respect, the cathode follower is superior to the conventional input transformer.

It should be apparent that a cathode-follower driver used in conjunction with the precautions mentioned above should also make an ideal driver for class AB stages for "notch-free" operation. Under these conditions, a cathode-follower driver is vastly superior to a distortion free class A, R-C driver.

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[1] Harry F. Olson, "Matched line of hi-fi equipment." Audio Engineering, August, 1953.

[2] H. F. Oson and A. R. Morgan, "A high-quality sound system for the home." Radio & Television News, November, 1953.

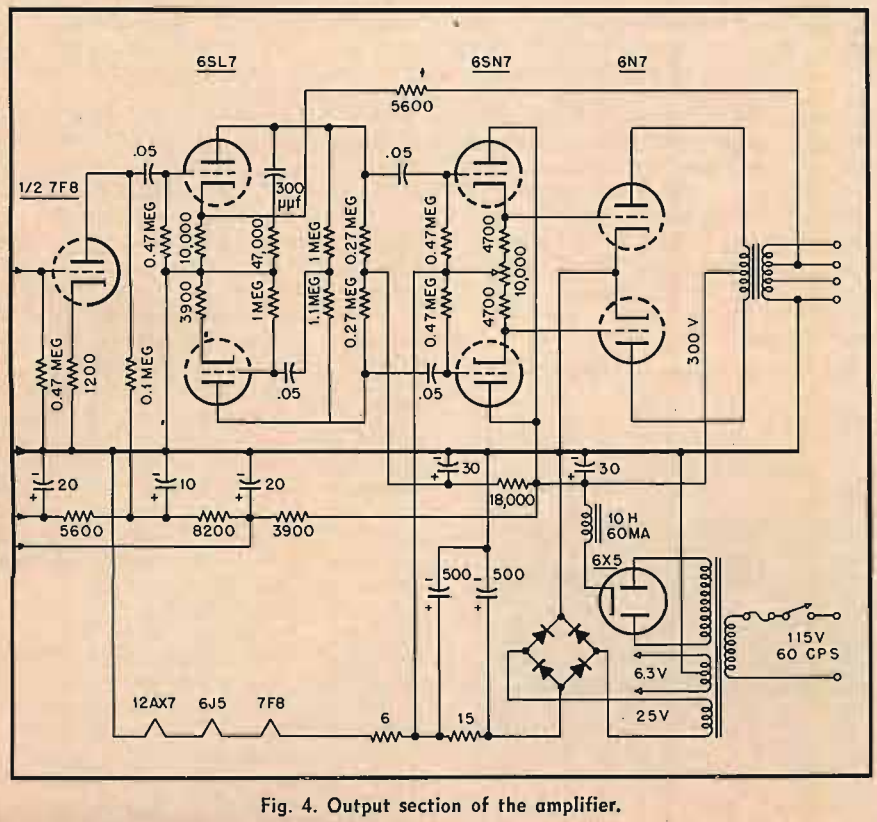


Fig. 4. Output section of the amplifier.

LETTERS

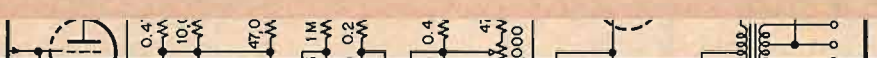
[from page 4]

40 to 100 kc or so in response to a square-wave input, then the high notes sound harsh and rough. If this ultrasonic resonance is removed, the high notes become smoother and cleaner. This effect has been noticed with both expensive and inexpensive speakers.

Since I have been able to improve the performance of two commercial amplifiers by adjusting the size of the capacitor in parallel with the feedback resistor, I wonder if this point is generally appreciated. Or have I made a mistake somewhere?

Robert L. Post, M.D.,
6310 Vanderbilt Medical School,
Nashville 5, Tenn.

(*You have made no mistake in* this, *at any rate. Transient response is important, and absence of ultrasonic peaks is essential for good quality, as has been indicated in some earlier articles, notably by Hafler and by Sarser and Sprinkle. An amplifier should be adjusted—by the expedient of varying the capacitor across the feedback resistor or some other method which will correct phase shift—to eliminate the peak in the ultrasonic range if quality is to be optimum. This adjustment should be made under varying load conditions—with zero resistance load, with capacitive loads from .01 to 10 μf, and with no load, as well as with the normal speaker loading.* Ed.)



by adjusting the size of the capacitor in

"Good Music" Tuner For Fringe Areas

BASIL C. BARBEE*

A single-channel FM tuner brings in the signal in an area where good reception is not normally consistent with ordinary tuners. A construction project for the experienced.

THOSE FORTUNATE ENOUGH to live in or near one of the metropolitan areas which boast of "good-music" stations will hardly be interested in constructing a tuner such as is to be described. In the fringe areas, however, we "electronic musicians" need something better than the average manufactured tuner in order to pull in a distant "good-music" station satisfactorily. Here at Nacogdoches, Texas, noted for its poor radio reception, the FM stations in the nearest large population centers (Houston, 137 miles airline; Dallas, 153 miles) are beyond the normal range of good reception and even AM reception is poor at night, being hopelessly congested. A survey was made, using several FM tuners of various highly advertised makes with a *rotatable all*-channel TV antenna, to determine whether it would be possible to receive consistently some "good-music" station, thus eliminating the bad music, offensive commercials, and other undesirable program material heard on many stations.

The station offering the most and best music was KIXL-FM at Dallas (104.5 mc), which during two weeks of monitoring was received with sufficient consistency to indicate that with certain improvements in the receiving system, 23½-hour-a-day reception should be possible. (The station shuts down for half an hour each morning for maintenance.) While all of the store-bought tuners tried would produce good reception some of the time, none of them, to paraphrase the famous remark, would produce all of the time.

The difficulties in the way of consistent reception were chiefly (1) airplane flutter, (2) ignition noise, and (3) front-end noise when the signal would fade. It was decided that it would be possible to overcome these obstacles by (1) more over-all gain, (2) better limiting action, and (3) more directionality and gain in the antenna, combined with more gain ahead of the mixer. Perusal of the catalogs revealed that no high-gain, highly directional antennas were offered for the desired frequency. Two choices remained—scaling down a stock channel-6 yagi TV antenna, or designing and constructing an antenna particularly for the purpose. Since most TV yagis are designed as a compromise among cost, directivity, wide bandwidth, and ease of erection, the former choice was foregone in favor of the latter. But that is another story. Suffice to say that a 6-element narrow-band yagi was the outcome. Design data may be found in various literature, such as: "The Radio Amateur's Handbook" and "The ARRL Antenna Book" (American Radio Relay League, West Hartford, Conn.), "Antenna Manual" (Editors and Engineers, Santa Barbara, Calif.), "Television Antennas" (Howard W. Sams & Co., Inc., Indianapolis, Ind.), and "The Johnson-Bassett Antenna Handbook" (E. F. Johnson Co., Waseca, Minn.).

* *1608 S. Fredonia, Nacogdoches, Tex.*

Circuit Design

This article concerns primarily a description of the tuner arrived at after breadboarding various combinations of stages to arrive at a suitable design. The programs heard on KIXL-FM were good enough to warrant putting all our eggs in one basket and building a single-channel tuner for maximum performance on this one frequency. Since the designing of electronic apparatus usually proceeds in reverse order, i.e., from output to input, the circuit will be described in that fashion. The tuner is shown in *Figs.* 1 and 2 and diagrammed in *Fig.* 3.

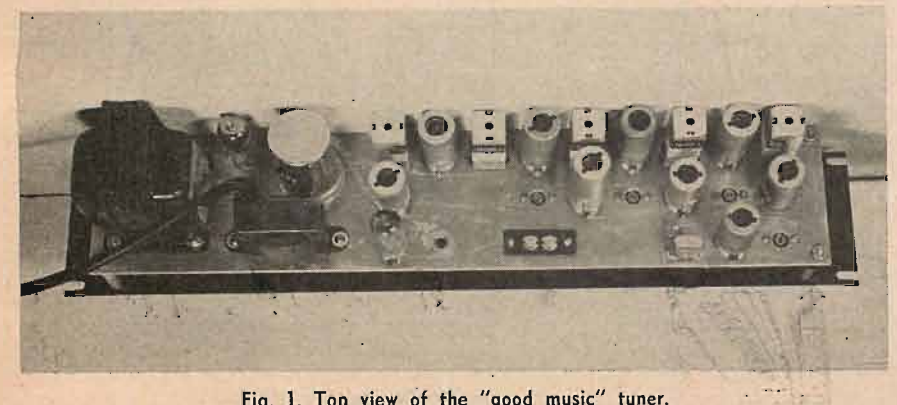


Fig. 1. Top view of the "good music" tuner.

A 6C4 triode resistance-coupled audio amplifier stage was included to raise the output level of the discriminator to 1 volt, r.m.s., the standard inter-unit level for home music reproduction systems, and to provide a reasonably low-impedance source to avoid excessive high-frequency attenuation in the output cable. A cathode-follower stage after this voltage amplifier would have been desirable for a cable more than a few feet long. In this case, however, the tuner was intended to be mounted near the control unit, with only about two feet of shielded cable between, so that loss of highs is negligible.

A Foster-Seeley discriminator was chosen because of its superior linearity. A 6AL5 double-diode is employed, in conjunction with a Miller 1464 10.7-mc transformer. A tube was chosen from among several 6AL5's for lowest hum level in the completed tuner. A slight heater-cathode leakage not detectable on a tube-tester may produce audible hum when followed by an amplifier and speaker with response below 60 cps.

The second limiter stage, using a 6BH6 tube, was designed with a grid-circuit time constant of only 2.5 microseconds to combat ignition and other impulse noise. Its plate and screen voltages were adjusted to a value just sufficient to produce 1 volt r.m.s. at the output jack of the tuner with maximum deviation of the signal and both limiters saturated. This adjustment was made after the rest of the tuner was completed. The first limiter stage, another 6BH6 tube, was made identical to the second except for R_{17} and R_{19}. These different resistance values provide a different time constant and a lower plate and screen voltage, the former to further reduce the effects of impulse noise (see

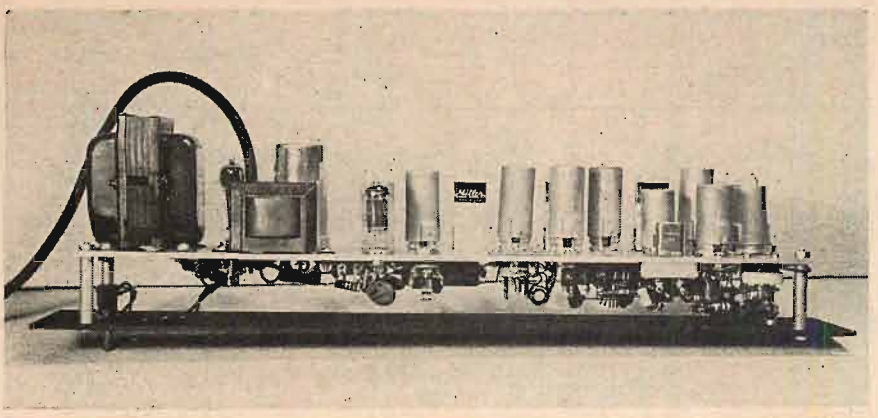


Fig. 2. Side view shows how the ⅛-inch aluminum chassis is mounted to the rack panel with spacers.

Hund, "Frequency Modulation," on this subject) and the latter to lower the plate supply to only 20 volts to assist in smoothing out airplane flutter. A higher voltage is necessary in the second limiter in order to provide enough drive to the discriminator.

The first and second i. f. amplifier stages, employing type 6BH6 tubes also, are identical and use the circuit values recommended in the tube manuals for maximum gain. The interstage coupling devices between all i. f., limiter, and mixer stages are Miller 1463 10.7-mc i. f. transformers. The Meissner 16-3487 units should serve as well and in some respects have a slight advantage mechanically.

For the mixer stage, a 6AK5 tube was chosen for its superior high-frequency performance. The operating conditions were arrived at experimentally by making variable the cathode and screen resistors R_8 and R_9 and adjusting them after completion of the tuner for optimum signal-to-noise ratio. Oscillator injection is achieved by dressing the mixer grid coupling capacitor C_{14} close to the stator of the multiplier tuning capacitor C_5 forming C_{15} from stray capacitance.

The oscillator-multiplier tube, another 6AK5, operates as a third-overtone crystal oscillator with the screen acting as the anode, and quadruples in the plate circuit. The crystal frequency is 23.450 mc, and the multiplied output frequency is 93.800 mc, just 10.7 mc below the signal frequency of 104.5 mc. Naturally, for any other signal frequency the crystal frequency must be chosen so that some harmonic of its oscillating frequency will differ from the desired signal frequency by 10.7 mc or very nearly so. An error of a few kc is tolerable here, but too much variation will result in having to shift the intermediate frequency to something other than the 10.7 mc for which the i. f. transformers were designed, which will in turn affect the balance of the discriminator and the bandwidth of the system. Crystals ground to within .01 per cent of the specified frequency are available at a very reasonable price.

Other Frequencies

The exact crystal frequency required for stations operating on other frequencies may be calculated from the formula:

$$f_x = \frac{f_c \pm 10.7}{n}$$

where f_x = crystal frequency of oscillation in mc

f_c = carrier frequency of station in mc

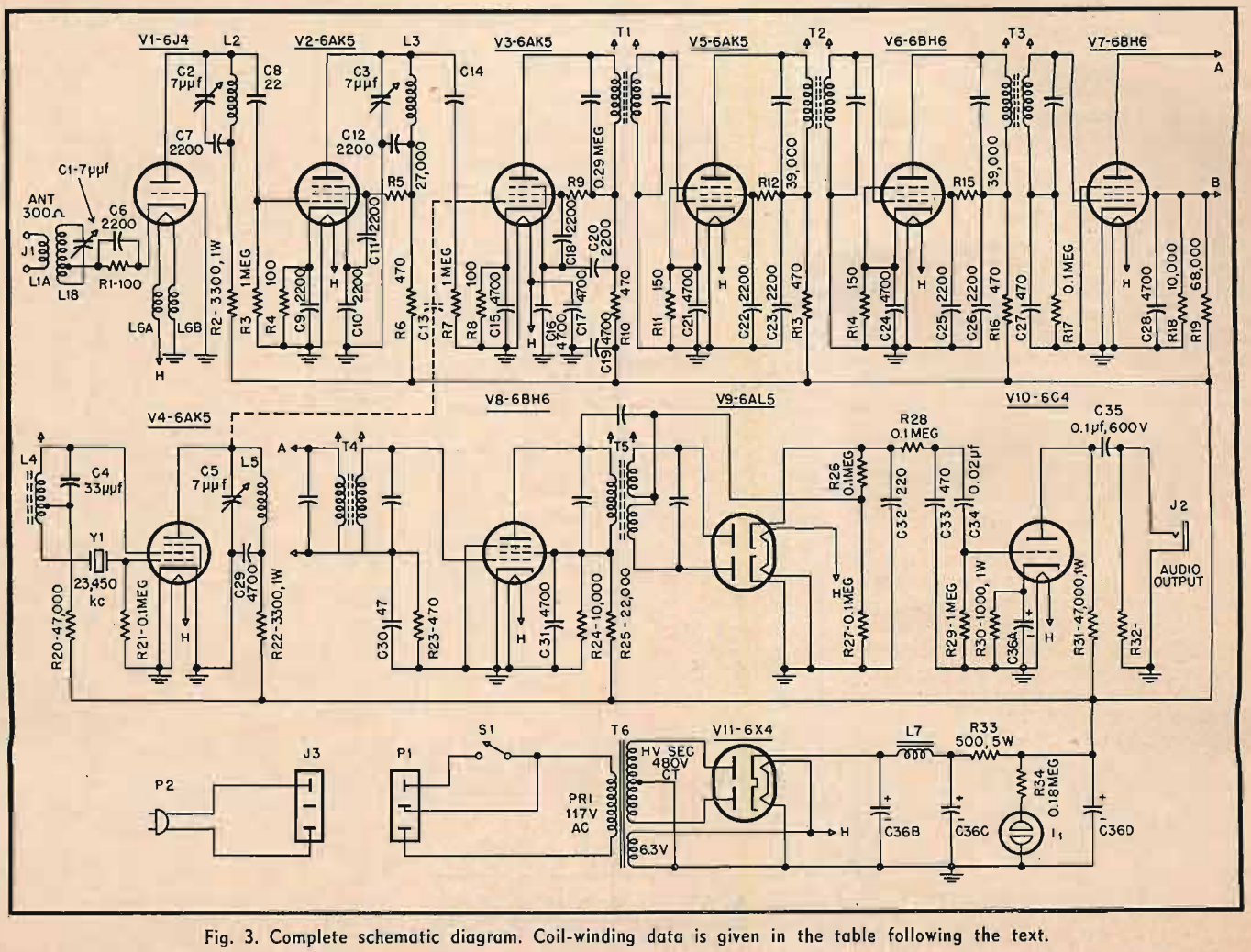


Fig. 3. Complete schematic diagram. Coil-winding data is given in the table following the text.

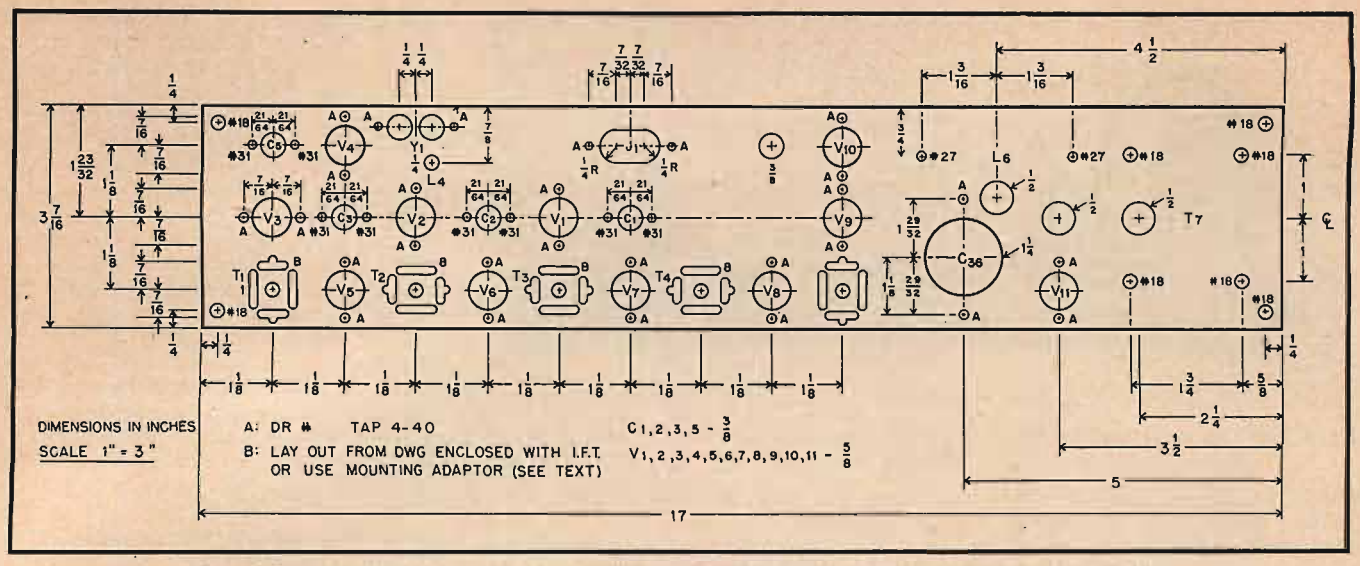


Fig. 4. The author recommends that constructors follow this detailed layout drawing for best results.

n = any small integer; in this case, $n = 4$.

Intermediate frequency = 10.7 mc.

Should it be desired to use a crystal of such frequency that n is some integer other than 4, is necessary to alter the values in the tuned circuit C_4L_4 so that it is resonant near the new crystal frequency. Both the capacitance of C_4 and the inductance of L_4 should be varied in inverse proportion to the crystal oscillating frequency in accordance with the formula for resonance

$$f_r = \frac{1}{2\pi\sqrt{LC}}.$$

Since the inductance of a coil is roughly proportional to the square of the number of turns, i. e.,

$$\frac{La}{Lb} = \left(\frac{Na}{Nb}\right)^2$$

where La is the inductance of the coil for the new crystal frequency, Lb is the inductance of the coil wound according to the data given near the end of this article, Na is the number of turns on the coil for the new frequency, and Nb is the number of turns given in the data, the number of turns on L_4 vary roughly inversely as the square root of the crystal frequency. It should not be attempted to make n greater than about 6; otherwise the harmonic output of the multiplier stage will be too low for efficient mixing action.

Many available war-surplus crystals may be made to oscillate on their overtones in the regenerative circuit shown. If such crystals are used, their *oscillating* frequencies should be accurately measured, since the overtone frequency will not be an exact multiple of the labeled frequency of the crystal.

The second r. f. stage, employing still another 6AK5, is conventional in every respect, except that the value of cathode resistor is about half that recommended in the tube manuals. With the recommended value, the plate current was only about half the listed value, and the gain of the stage was unexpectedly low. With the values shown, a stage gain of 6 was obtained. To prevent self-oscillation due to plate-grid feedback, a tinned-copper shield (detailed at (a) in *Fig.* 5 —not clearly visible in the photograph) was closely fitted to the tube socket and soldered to the center rivet, pin 4 (the grounded heater pin), and solder-lugs under each socket mounting screw. All B-plus and heater bus leads passing by this shield were bypassed to the shield with 4700-μμf disc ceramic capacitors (C_{16} and C_{19} in *Fig.* 3.)

The first r. f. stage uses a 6J4 triode tube in a grounded-grid circuit for low input noise. While the gain of this stage is only 4, it is adequate to burrow down into the noise level received from the antenna and deliver the signal if it is there. (In any urban location, the man-made noise level is the determining factor of the signal-to-noise ratio, rather than the thermal noise of the antenna itself.) The over-all sensitivity of the tuner for 20 db quieting, measured with a 300-ohm dummy antenna, was 1.6 microvolts.

The power supply consists of a 480-volt center-tapped power transformer, rated at 50 ma, with a 6.3-volt, 2.5-amp. heater winding, a 6X4 fullwave rectifier, and two sections of filter. The first is a "pi" section consisting of a 10-henry choke and two 20-μf capacitors; the second is an "L" section with a 500-ohm resistor and another 20-μf capacitor. The hum is undetectable with this arrangement, either by ear or with an oscilloscope, in the output of the tuner. The 2.5-amp. heater winding is used to full capacity, plus ⅛ amp, with the tube lineup shown. A neon pilot light is used to avoid a greater drain on this winding (about as much as an additional tube) and to provide a less glaring light which would interfere with musical enjoyment in a dimly lit room. It would have been possible to use a size larger transformer, but unfortunately those available have considerably higher plate-voltage windings, necessitating getting rid of the excess voltage by means of resistors, which would have generated considerable heat. The light overload of the heater winding appears to be of no consequence, since the transformer does not run hot, even after hours of operation. Many larger tuners employ an additional 6.3-volt filament transformer to carry the extra load occasioned by the available transformers having been designed for broadcast-receiver replacement with a low ratio of heater to plate power.

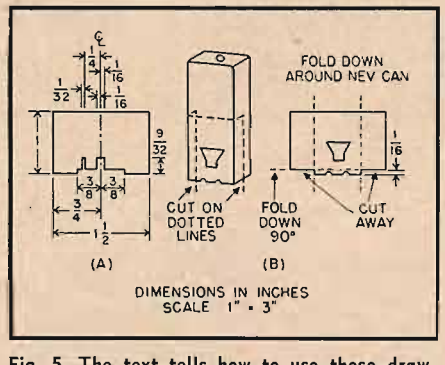


Fig. 5. The text tells how to use these drawings to make templates for modifying coil cans for the ⅛-in. chassis.

It will be noted in *Fig.* 3 that the power cable has 3 conductors, terminating in a 3-contact plug. The third conductor, from the "hot" or switched side of the power tranformer primary, runs to a control unit for control of the power amplifier. The adapter P_2-J_3 is convenient for plugging the tuner into a standard a.c. receptacle on the workbench for initial alignment and subsequent maintenance.

Mechanical Layout

The mechanical construction of the tuner is unusual, the chassis being a single flat sheet of ⅛-in. aluminum, 3-7/16 x 17 in. If this material is not available in your "fringe area," it may be cut from an aluminum relay rack panel at slightly higher cost than from a sheet metal shop. All components except the switch and pilot light are mounted on the chassis, which in turn is supported by ⅜-in. spacers 1½ in. long from the front panel, a standard 3½-in. aluminum rack panel. The layout is as shown in *Fig.* 4. Variations in

(*Continued on page 56*)

tal frequency. It should not be attempted

henry choke and two 20-μf capacitors;

to a control unit for control of the power

Evaluation Of High-Fidelity Phono Pickups

JOHN M. SALANI*

What to look for in evaluating a phonograph pickup in the home, where elaborate instruments are not available for making measurements which would be considered a necessity in the laboratory.

THE PAST FIVE YEARS have witnessed the transition of high-fidelity sound reproduction from a laboratory curiosity to a household reality. Probably the biggest single factor underlying this transition was the development of fine-groove disc recordings. This new medium offered a degree of operating convenience and inherent quality never before attainable, and marked the beginning of the "Golden Era" of audio in the home.

The faithful reproduction of fine-groove recordings imposes several design requirements upon a pickup which are considerably more stringent than were encountered in the design of reproducers for 78-r.p.m. recordings. As a result, several new pickup designs have appeared on the market so that today, the prospective buyer of a hi-fi pickup has over a dozen different types from which to choose. He is also confronted with a myriad of technical performance claims put forth by the various manufacturers in support of their products. This article does not purport to evaluate or recommend any specific phonograph pickup, but rather to present some of the considerations which enter into the design and performance of any pickup. An attempt will also be made to show how a pickup may be evaluated in an environment such as the home where extensive laboratory equipment is not available for making measurements.

Terminology

A brief discussion of some of the terminology peculiar to phonograph pickups may be of interest here, and may also serve to render the magazine ads more meaningful.

Frequency Response: This is the output voltage of a pickup in response to a recorded signal of constant level and variable frequency. (The level referred to is that of the input signal to the recording system and presupposes an ideal recording system resulting in a record of perfect constant-velocity characteristic.) High-frequency pickup response depends on pickup characteristics and record material, while bass response is also influenced by the tone arm.

Distortion: The term "distortion" as applied to phonograph pickups is generally a reference to the tracking distortion which occurs when the reproducing stylus is unable to exactly track or follow the groove modulation inscribed by the cutting stylus. This is a form of mechanical distortion as opposed to the distortion which may arise in the process of converting the motion of the stylus into an equivalent electrical signal. (For example, the distortion which would be generated by magnetic saturation or by a nonlinear flux field in a magnetic pickup.)

Tracking distortion should not be confused with tracing distortion; the latter results from the difference in shape between the cutting and playback styli. The predominant form of distortion generated by a pickup is usually that brought about by mechanical tracking difficulties.

Vertical Tracking Force: The vertical force which acts to hold the pickup stylus in the groove is known as the vertical tracking force. (This is sometimes erroneously referred to as the tracking presure.) Typical values of the vertical tracking force required for hi-fi pickups run from 2 to 8 grams.

Effective Stylus Mass: The mass of the pickup stylus itself plus a part of the mass of the moving system go together to make up the effective stylus mass, also known as the effective mass referred to the stylus tip. This mass should be reduced to a minimum value consistent with other considerations so that the mechanical mass reactance presented to the record groove does not become excessive. In general, the higher the effective stylus mass, the more difficult it becomes for the groove to drive the stylus. Typical values for the effective stylus mass in the lateral plane of groove modulation are from 2 to 10 milligrams.

Stylus Compliance: The stylus compliance is the reciprocal of the mechanical stiffness at the stylus tip, and is a measure of how much force is required to produce an incremental stylus deflection. A pickup stylus must be compliant in both the lateral and vertical planes in order to track a lateral disc recording properly. The lateral stylus compliance of hi-fi pickups generally is of the order of $1-6\times10^{-6}$ cm/dyne. The vertical stylus compliance can be, and usually is, considerably lower.

Equalization: The electrical output from many phonograph pickups is not usable until it has been corrected for the characteristics of the pickup itself and for the intentional alterations of the audio signal which occur during the recording process. This correction, or equalization, may be accomplished by a network of resistors, capacitors, and inductors inserted at some point in the reproducing channel.

Pickup Types: Operationally, phonograph pickups may be classified under two general categories, depending on whether the output voltage from the device is proportional to the lateral velocity or the lateral amplitude imparted to the stylus tip as it tracks the undulations of a modulated groove. Magnetic, dynamic, and ribbon pickups are of the velocity type; crystal, ceramic, capacitive, and strain-sensitive pickups are amplitude type devices.

Neither the velocity nor the amplitude type pickup has any inherent advantages over the other with respect to the quality of reproduction; both types have the same potentialities for hi-fi applications. Expressed another way, it is not the principle of operation which is important, but the manner in which the principle is applied in practice.

Objective Pickup Measurements

The most easily determined but not necessarily the most important characteristic of a pickup is its frequency response. A hi-fi pickup should exhibit a response characteristic which is reasonably linear and can be made "flat" or uniform throughout the audio frequency range with ordinary equalizers. Any appreciable departures from this condition will upset the tonal balance of the music as originally recorded, and the quality of reproduction will suffer accordingly.

The frequency response of a pickup is intimately associated with its mechanical resonances and the means employed to control these resonances. *All* pickups, in combination with any given tone arm, exhibit at least two basic mechanical

(*Continued on page 50*)

* *Radio Corp. of America, Engineering Products Div., Camden 2, N. J.*

ment is not available for making meas- mass of the moving system go together principle is applied in practice.

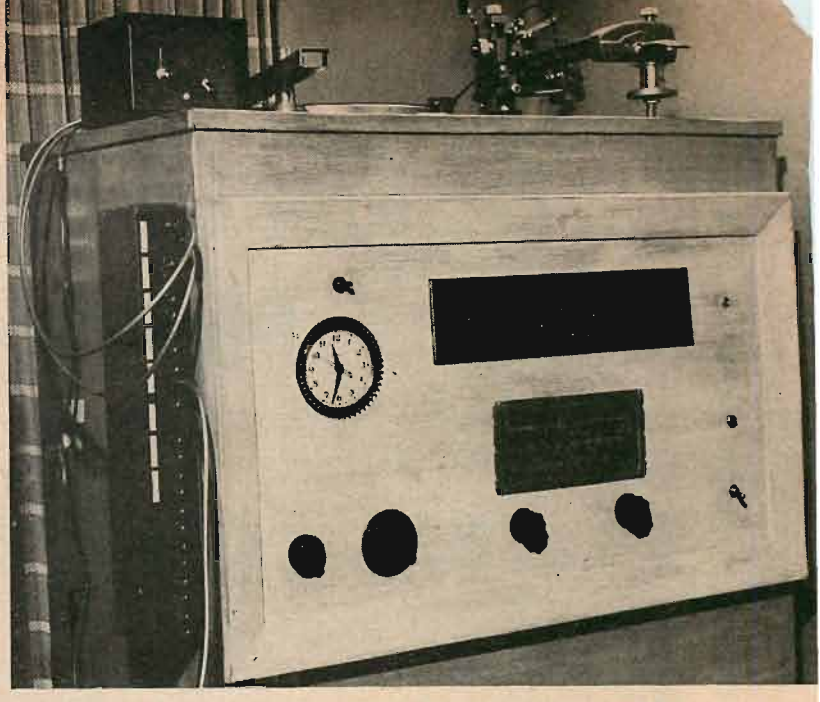


Fig. 1 (left). Setup of versatile hi-fi audio system along window-wall of 14 by 19 living room shows center cabinet housing recording amplifier and tape recorder; second cabinet houses record turntable and recording head, preamplifier, tuner, automatic clock, jack panel for patch system. Small cabinet lower left contains auxiliary speaker system, used also for monitoring recording amplifier in addition to headphones. Fig. 3 (right). Closeup of patch system strip showing insertion of hi-lo filter between pickup arm cartridge and preamplifier input. Clock is peg-controlled for presetting listening, recording or playback functions. Each peg represents 15-minute interval, providing precise programming and scheduling. Toggle switch over clock kills entire system.

at home with AUDIO

LEWIS C. STONE*

Onward and Upward with Hi-Fi

WHEN WE enumerated in this department (December) the array of hi-fi equipment apparent these days in its natural habitat—the well-fitted home entertainment center—we neglected to include such other captive audio items as disc recording tables, cutters, recording heads, and recording amplifiers. Not to mention earphones with foam-rubber padded earpieces (for fine monitoring and to keep calluses off your ears). All of them, if you know how to use them, play a major role in the arts of record and playback. But our omission (it happens we didn't want to spend your hi-fi money too fast) is not without its compensations. For this month such a listing is no mere cataloging of the available range of audio devices for the dedicated amateur but rather, in this reportage, the content of a system that actually boasts their frequent use as a vital part of living AT HOME WITH AUDIO.

Upward . . .

In the fullness of their functioning hi-fi fitments of quality are extenders of our sensory perceptions, and might well titillate a psychic taste-bud or two. Among our superior fleshly weaknesses is the desire for self-extension managed, by most of us, with having children, period. Some of us make it with a sport or hobby, family or no. Some play hobby the hard way, with liquids and lights and with stains to show on their pants for their pains. And among these and other "at home" hobby-absorbed men we find you, and you, and you—taking yet another self-extension course by way of acquiring a "family" of hi-fi components. Not all at once perhaps, but surely with the basic four of (the best affordable) tuner, amplifier–preamplifier, player-changer, loudspeaker. For all of its high-level dividends this hi-fi hobby is a young one. The wildest and wooliest of amateur audio-ists can count back to barely five–six years. (*MISTER Stone. Where were you in 1931?* ED.) And if so he has without doubt been the beneficiary of a growth industry whose areas of development have in that bitsy time come up with astonishing improvements in units and unified audio results. This has meant, too, that the original and usual quintet of units if not altogether "traded up and out" is by now grown to a family of ten, maybe as many as twenty, units of hi-fi equipment—and not just by adding more speakers, that is.

In fact the hi-fi system under review this month is possessed of but one main speaker system plus an auxiliary speaker, with some eighteen or more other hard working components, as we shall soon describe. Ears there may be that have heard as good as the brisk baying of the main speaker, or the lusty crowing of the bantam alternate speaker in this audio system—provided, that is, that the signal is generated by equipment of equal breeding. But our guess is that relatively few have heard sound so variously and flexibly generated, through as many signal sources, in the privacy of the home. (See photograph, *Fig.* 1, and block diagram, *Fig.* 2).

Onward . . .

Ear-hardy hi-fi enthusiast Schwartz (New York) has in the past three–four years had sonie items of equipment which promised well but were in one way or another, in practice disappointing. So that in this man's hi-fi family there have been a variety of amplifiers, one or two tuners, turntables, microphones. And during the elapsed period of "investiture" his remembrance of things past includes another make tape recorder, various speakers. Out of each component purchased and adopted, our reader has contrived to draw direct, and also developmental, knowledge, often adding some-

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fine monitoring and to keep calluses off another self-extension course by way of breeding. But our guess is that relatively

thing of his own devising as he trended toward finalizing his requirements in hi-fi. Haunting hi-fi demo salons and back rooms, and while in the homes of friendly practitioners of at home with audio, he noted and became aware of instrument likenesses by the slight differences one from another, and he gained slowly a more complete knowledge of one class of equipment by living with and studying the other, as it were.

In common with most other audio-ists our reader has been (and is) of a mind to accept available-best against promise of future-best. We have seen, as has the builder and owner of this month's audio system, tomerow's specifications of home audio instrumentation written from the hi-fi highlights of today's practice and use leading perhaps to a purer, surer design. Such as, for instance, would cancel mere size (the quantitative) from being also the measure, inseparably, of quality. Consequently audio sound of a fidelity a few years ago impossible, for space reasons, to generate adequately inside the average home, today does come flowing in—round, or pear-shaped; elongated, or lightning-riven—from equipment more easily and plausibly fitted into living rooms of no great area or cubic content, and rather simply cabineted.

Flexible and fluid is our system-of-the-month, capable of diversified and diverting antics. Do you place your bet on this thoroughbred equipment to "show," then may you, for instance, come up with a winning combination, a divertissement, by so opposing the parts as to create an echo (effect) without benefit of echo chamber. The parts, according to avid audio-ist Schwartz, are no more special than you can obtain commercially anywhere that good amateur hi-fi equipment is sold. Does this bring you sharp on the brink of curiosity you will find a detail or two about this manipulation involving a recording amplifier, a three-head tape recorder, etc., further on, with a sequence sketch to boot. What all this comes to is a proving-up of audio system flexibility without going pro, a sort of conditioned-reflexing of hi-fi sound.

The system is notable in many respects, not the least being a well set up disc recording unit, which our reader finds indispensable in his social life. Himself a bachelor, he is blessed with many married friends and with respect to them he occupies and enjoys an avuncular niche. He uses the equipment frequently in this capacity as "uncle" to record and send his voice with personal greetings and special blessings and messages to newlyweds, their (in due time) new-born babes, graduations, anniversaries, etc.

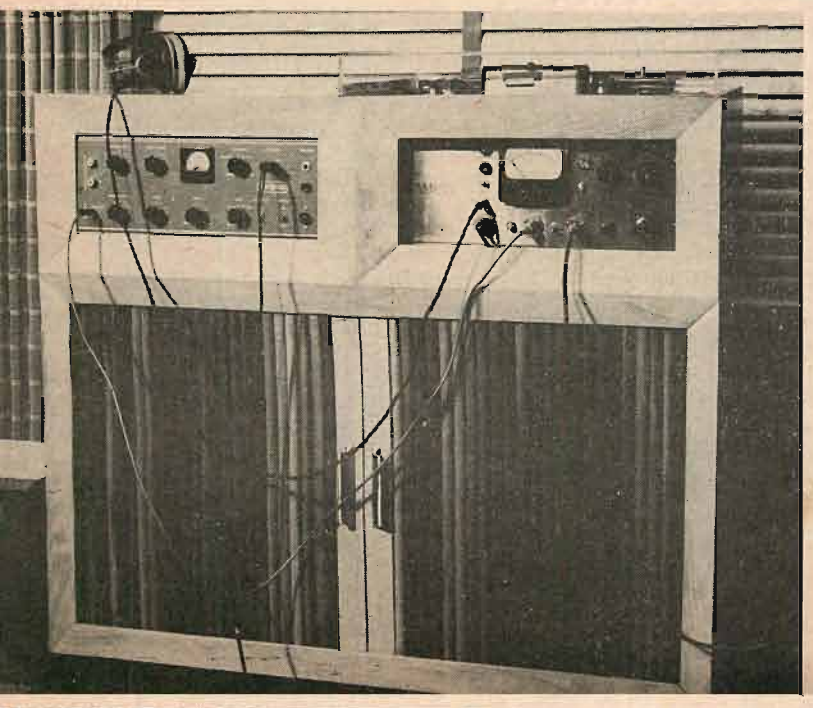
5-Finger Exercises Among the Decibels

The system is additive-loaded with ear-beguiling cousins and other respectable members of the modern hi-fi audio genealogy. A full-blooded use of these components and their varieties of unisons is pointed up with the introduction of a patch system which is simply an internally wired-up strip or jack panel supplying extra inputs and outputs and acting as a semi-automatic distributor-head for a variety of signal channels. (See photograph, *Fig.* 3, and diagram, *Fig.* 4). Where the average audio system is on the static side, the patch additive enables you, for example, to watch TV and at the same time have a tape recording of a radio program under way, and vice versa. Or you can transcribe a disc recording onto tape by feeding the signal into the recording amplifier (which now becomes a mixer) then plug the microphone in the other channel on the "mixer," connecting its output to the input of the tape recorder. Or, you can hold forth from a live mike with a background of music signalled in from air or disc. Such goings on are flavor and savor for our reader (as they can be for you)—who feels justifiably that he can extract about as much variety from his thoroughbred amateur radio equipment as can normally be obtained from the far costlier kind of equipment used in professional studio systems.

This montage of equipment has been made orderly by a rather urgent seeking for method and orientation, which is no more than a natural carryover tendency from the exacting nature of our reader's business as contract division manager with a supplier of hospital equipment, involving always problems of fitting apparatus into difficult spaces. The trim cabinets are all self-made. One cabinet houses the tape recorder and its amplifier and alongside it the recording amplifier which serves the disc-cutting mechanism mounted on cabinet number two over the preamplifier, power amplifier, tuner, and automatic timer clock. A third cabinet (not shown) houses the main speaker system. Over it sets the TV set, contained in a "slip case" housing which, though it fits snugly (as only good cabinetry can) is removable for servicing the chassis by dropping a facia plate below the screen and simply pulling straight off, like skin off a banana. The TV is operated by remote control, from the panel containing the tuner and preamplifier. The other components are also accessible for servicing through the backs of their cabinets. In adition, the Ampex 400A tape recorder can be removed bodily and handled as a fully portable unit when necessary.

The main speaker system is similar to the Altec-Lansing 820A offering, with 803A 15-inch woofer and cross-over at 800 cps, 802B tweeter and H-808 multicellular horn. The cabinet, however, is patterned on the Helmholtz resonator principle, as used in RJ enclosures. The living voice comes through an Electro-Voice 650 low-impedance microphone, channelled at will direct into the tape recorder. Or, with his line transformer converting it to high impedance, he uses it with the recording amplifier when that item is used as a mixer. Such electronic veins and arteries impart an undeniable sentiency to the entire system. For example, the Fisher 50C master audio con-

Fig. 5 (left). Shows cordsets used in hook up of output of tape recorder to input of recording amplifier, with Permoflux headphones positioned for cuing through monitor jack of tape recorder. Fig. 6 (right). Close up of Rek-O-Kut cutting lathe mounted with Presto recording head. Discs are micro-made, in addition to usual playback of complete records.



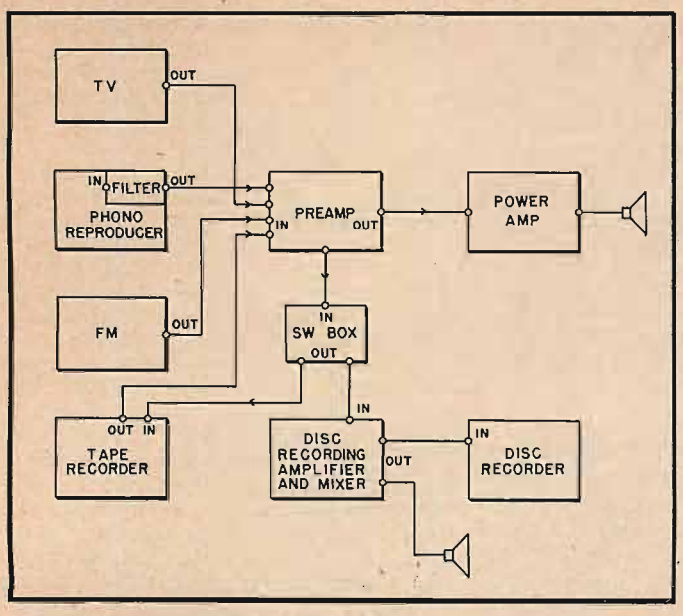


Fig. 2. Block diagram shows flexibility of system in recording, generating and reporting signals from and through a variety of components as, tuner, TV, tape recorder, disc recorder and record playback, all culminating in main speaker system.

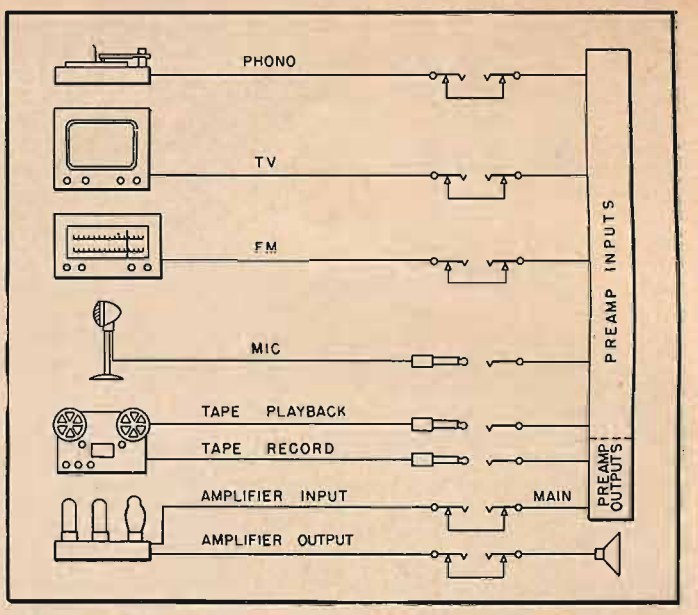


Fig. 4. Patch system functions as distributor-head for entire system, gives it complete flexibility and permits semi-automatic operation from owner's couch.

trol is a part of it because our reader needed a front end in which the TR output is "live" at all times. And at the time of purchase and component collation a few years back, this particular unit was "it," the only one on the market. Such outputs have become the rule on latter-day front ends of equal quality.

The Fisher 50F hi-lo filter in the system is inserted between the preamplifier input and power amplifier input only when 78's are being played or when they are being dubbed to tape. He can keep down to 3000 cps if needed to filter excess surface noise and scratch from the usually well-worn 78's. Himself owner of LP's only, the hi-lo unit is an in-and-out device, mostly to accommodate friends who (as is typical of early nibbles at hi-fi) bring their favorite 78's for a spin on sturdy, modern turntable to hear a comparator playback (for a change) via finely engineered pickups and through a better speaker system. Which would be impossible, of course, without the intervention of the noise-disbarring cut-off filters. This friendly accomodation (and incidental proselytizing) is an outgoing gesture then, and demonstrates again that the hi-fi room can be a most sharable and sociable home entertainment center.

It is an alerted system, mainly by means of the jack panel and patch cords. There are two cord sets in position at all times (as *Fig.* 5). One travels a signal through the patch system from tape recorder output on the preamplifier to input on the TR, ready for recording from any signal source. And just as live is the playback hookup, from output of the TR to input of the preamplifier. And of course the system would be a flop in our reader's eyes, did not the Permoflux headphones hold hands with the monitor jack of the tape recorder for cuing, the process requiring also the hookup of the output of TR to input of the recording amplifier. By the same token, the system of checks and balances (a sort of "constitutional" form of audio performance control, so to speak) is the presence of a number two (pickup) arm at the recording table, mounted backwards, to monitor the playback simultaneously with the cutting of the record, practically. (See *Fig.* 6). What better way to check the quality of the disc recording, to make any adjustments in treble boost or bass attenuation during the process, as well as to detect symptoms of stylus wear, or excessive surface noise, turntable hum, and last but not least, turning out therefore as near an impeccable recording as the fine equipment is capable of offering?

Audio Prone

The payoff is in the operative behavior of this hi-fi family. Lying prone on a couch, relaxed and resting, does reader Schwartz yet guide and control every single member of his audio flock. See (in *Fig.* 7) how an ordinary foam-rubber cushioned couch is also audio-control loaded. Centered below the seat cushion are three toggle switches within easy finger-tip reach, the remote control for start, stop, and record modes of the tape recorder. And within easy lying-down reach just overhead are the control knobs of the tuner (rarely touched except for station selection), a full battery of controls on the preamplifier, and the master on-off toggle switch alongside the peg-rimmed automatic clock. The latter, too, he can handle from the prone, for presetting or scheduling the playing of FM radio or TV. Each peg represents 15 minutes of automatic play or record time: two pegs give you 30 minute intervals, and so on. You do not ever have to set the hands on the face of the clock to work the system—it is all a "pegged" operation. At the end of a hard day, our reader finds this a most pleasant formula for relaxing at home with audio and having it, too.

The cabinetry is as unassuming looking as the parts it houses are (in their way) sterling as to pedigree and brilliant in their impact upon the ear. The lower part of the TR and recording-amplifier cabinet (back of the tambour doors) is used to store miscellaneous gear, among them an audio oscillator to record different frequencies for experimental purposes; a vacuum tube voltmeter; a Magneraser 200C for total tape erase; a Shure 768 lapel microphone; a 950 Electro-Voice microphone stand.

Play and Play-About

Did you want to try putting this kind of audio equipment through a pace or two, why then you could work out a reverberant or echo effect sans chamber. Confessedly, this is among the minor triumphs in the area of cord-plug-and-jack bouncing, but one which nevertheless may give you the feel of the versatility and somewhat infinite possibilities of a full-blooded family of hi-fi equipment, as mentioned earlier. (See *Fig.* 8).

Step by step, here's the way reader Schwartz proceeds. You need, of course, a tape recorder with three separate heads, because these give you the time delay between signals that produce the desired effect. The time delay is a function of the actual distance between recording head and playback head. In this case, the actual distance measures approximately 2 inches. At 7½ ips tape speed, the interval comes to about ¼ second; at 15 ips tape speed it comes to about ⅛ second—sufficient lag between signals to create the illusion of a quite

Fig. 7. Relaxing executive lies down to job of enjoying multi-source hi-fi system arranged for "automation." From the prone, preamplifier controls are within reach overhead; three switches in frame of couch are at finger's end of other hand for activating or muting tape recorder. Also shown are two cord sets in position at all times, from tape recorder output on preamplifier to input of tape recorder, through patch system, for recording. The other cord set goes from output of tape recorder to input of preamplifier for playback.

noticeable echo. Get this end result by (a) Feeding the program source (FM, TV, disc) through the patch system into tuner input of disc-recording amplifier. (b) Microphone is connected to mike input of recording amplifier. (c) Input of tape recorder is plugged into monitor output of recording amplifier. (d) Selector switch on recording amplifier set to "record" position. (e) Fisher master audio control set to tape-recorder playback position.

The above hookups function for you as follows: (a) With tape recorder in record mode and output switch on tape recorder set to playback position, a balance is then looked for by turning up the microphone gain-control and positioning the microphone facing the wall opposite the speaker, to a point just below where the feedback occurs, determined by ear. A balance will be reached by adjusting microphone gain-control and playback level control on the preamplifier until the desired echo effect is heard

Well, this physico-spatial "circuit" is one way to get the echo effect. (It is a sort of "belch" for the signal is re-circulated and pursues itself through the audio circuitry to come out again at an interval massive enough to be re-heard separately, but fainter—the echo.) Whereas, on the other hand, reader Schwartz can (and no doubt intends to) bring this about through purely electronic circuitry to recreate the signal as an "inside job," needing no physical confrontation of speaker and microphone for the purpose. Of this gambit you may find fullsome discussion and instructive schematics in 2nd audio anthology, pages 115 through 124, the subject being Editor McProud's universal amplifier for magnetic tape recorder, which he has designed so that among some dozen or so capabilities, it also can readily function as a reverberation generator. Also, there appears to be a freshly fabricated (by Pilot) multi-out-and-inputed front end that makes this kind of hi-fi *gambado* absolutely easily and simply accomplished. Fun!

Homespun Ultra-Linear

To lave hearts awash under the acid of burning curiosity with the soothing balm of revelation (even if it happens to be just another version of the Ultra-Linear) we here unveil (as in *Fig.* 9) schematic of the 30-watt modified Williamson amplifier, all of it mounted on an aluminum chassis 12 by 7 by a compact 4 inches deep; all of it cable wired, with Vector sockets; all of its components having one common ground —all of it, moreover, slowly and painstakingly built for reader Schwartz with parts as listed elsewhere.

Modifications that may be of interest to do-it-yourselfers lie in the use of a low-impedance driver tube 5687 and a low noise input tube 12AY7. (Amount of feedback is approximately 24 db.) The voltage regulator in the power supply is a standard degenerative regulator. The 6AS7 is used as a variable impedance; the 6SJ7 is used as a d.c. amplifier; the pair of 0B2 are used as reference voltages.

Our list of components excludes the tubes, but these are identified in the schematic, and your close inspection of it is recommended, especially in view of the following briefing on the functioning of some of its key components. Part insignia R_{31} is the B-plus voltage control; R_{18} in the amplifier is a balance control which balances the currents through the output tubes. The amplifier is wired to accommodate three different speaker impedances, but the speakers actually used at the moment are of 16 ohms impedance. There is a level control on the input of the amplifier so that you can adjust its output level for a moderate setting of volume to prevent overload of amplifier and speakers. The finer points of volume control are achieved by using the audio control unit which is the preamplifier-equalizer (tone control).

Cabinetry Data

In addition to the usual battery of hand tools (listed in AT HOME WITH AUDIO for April, 1954) possession of the following basic woodworking machine equipment is ten-tenths of the law of production of the finer cabinetry: a 12-inch radial overhead saw, with 2 h.p. motor; a ½ h.p. operated router; an oscillating sander; and add a paint sprayer (handy for a professional job of lacquering, also). Supplied with, or having access to these, you can then concern yourself with some details of the shell construction. The innards you can dope out for yourself, as the proportions and dimensions of the audio equipment itself should guide you well there, which reader Schwartz (no master cabinet maker himself) discovered, as he ventured along step by step.

The cabinet housing the recording amplifier and tape recorder is 46 by 21 by 39 in. high plus 2-inch ball-bearing casters, to a total of 41 in. The removable tape recorder is placed on a shelf 12½ in. below the top of the cabinet and is protected by a domed plastic lid. The cabinet housing the disc recorder, tuner and preamplifier has been sized to accommodate the equipment compactly and is a good fit at 33 by 18 by 31 in. high, with 10-in. sturdy splay legs to bring it up to the matching height of 41 in. The small speaker system housing (also on the Helmholtz principle) is 14 in. high by 11½ in. wide and 11½ in. deep; its contents, an 8-in. Wharfedale woofer, an Atlas tweeter and hi-pass filter.

All the cabinets are built of ¾-in. lumber-core oak-faced plywood. Even the tambour doors are do-it-yourself made, of ½-in. half-round solid mahogany stock molding glued to heavy canvas backing. Shadow-box panel details on the fronts of the cabinets are solid oak, of lock miter construction made with special cutter heads interchangeably mounted on the overhead radial saw unit. The smaller cabinets are built with splined mitered joints. However, let's not overlook the condition that this is a free country, where every man may joint as he pleases. Take you then to the ordinary, or Sears-Roebuck miter-box to get your 45-degree framing joints, such as you find in the door casings at home or in the better kind of commercial unpainted furniture. Or, to simplify, simplify, simplify, eschew the face trim and go in for flush, flatface cabinets—giving them a sort of Dior look which

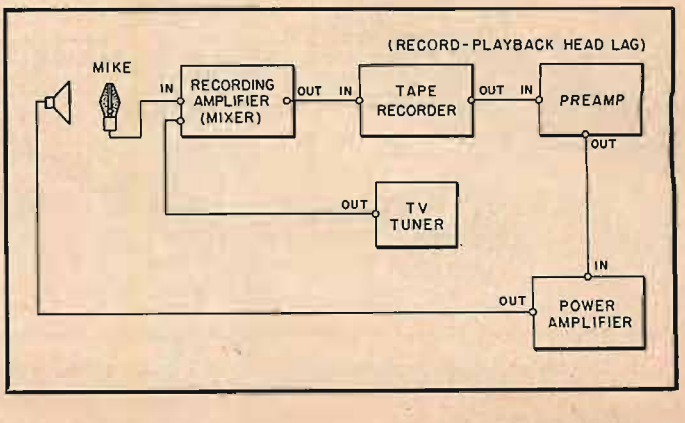


Fig. 8. Demonstration of responsiveness of system by creating echo effect with components hooked up as shown, with microphone rerouting original signal for repeat path through circuitry, resulting in noticeably close-following second signal, or echo.

Well, this physico-spatial circuit is one way to get the echo effect. (It is a

Cabinetry Data

such as you find in the door casings at

your missus may appreciate on account of it is easier dusted and is "more" less obtrusive in the average living room decor. Thus may you keep the home-audio peace and at a lower price, too.

System Specifications and Product Guide

In abc order for ready indentification, the components contained and used actively in our hi-fi system of the month follow:

1. Altec-Lansing 803A woofer with crossover at 800 cps; 802B tweeter, 808 multicellular horn.
2. Ampex 400A dual track tape recorder, 15 ips and 7½ ips.
3. Atlas HR2 multicellular tweeter and FN1 high-pass filter.
4. Bace Television remote control.
5. Browning RJ42 AM-FM tuner, with but two controls—band and tuning.
6. Electro-Voice 650 microphone with line transformer for high-impedance use.
7. Fisher 50C master audio control.
8. Fisher 50F hi-lo filter.
9. Permoflux dynamic earphones, DHJ-17B.
10. Pickering 190 pickup arm, with double diamond turnover cartridge 260.
11. Presto 1-C record cutting head.
12. Radio Craftsman RC100A TV chassis.
13. Rek-O-Kut R8A recording amplifier.
14. Rek-O-Kut TR-12H dual speed turntable.
15. Rek-O-Kut M-5S master-pro 16 in. overhead recording mechanism with MS-210 microgroove leadscrew 210 lines/inch.
16. Telechron automatic peg-operated clock.
17. Wharfdale Super-8CSAL speaker (in cabinet with Atlas unit above).
18. Williamson ultra-linear custom-built amplifier, 30-watts rated, with regulated voltage supply.
19. Switchcraft mixer for patch system.
20. Magneraser 200C bulk tape eraser.
21. Shure 76-B lapel microphone, high impedance.
22. Electro-Voice 950 microphone stand.

And of woodworking machine tools used in building the cabinets, the following: Delta 2-horsepower, 12-inch radial saw, plus interchangeable cutter heads. Delta oscillating sander. Stanley RTA ½-horsepower router. Also a DeVilbis P-MCD paint sprayer to apply lacquer for the natural wood finish.

Amplifier Parts List

C_1, C_2	40 µf, 450 v, electrolytic
C_3, C_4, C_5, C_6	0.25 µf, 600 v, paper
C_7	500 µf, 50 v, electrolytic
C_8	100 µµf, 400 v, mica
C_9, C_{10}	16 µf, 700 v, oil filled
C_{11}, C_{12} C_{13}	0.1 µf, 600 v, paper
C_{15}	750 µµf, 1000 v, mica
C_{16}	25 µf, 50 v, electrolytic
L_1	20 H, 225 ma. (UTC S-31)
R_1	0.1 meg, potentiometer, audio taper
R_2	10,000 ohms, ½ watt
R_3	0.27 meg, 1 watt, wire wound
R_4	47,000 ohms, 1 watt, low noise
R_5	0.1 meg, 2 watt
R_6	22,000 ohms, 2 watt
R_7, R_8	24,000 ohms, 1 watt, low noise, matched
R_9, R_{10}	0.5 meg, ½ watt
R_{11}	1200 ohms, 1 watt, low noise
R_{12}, R_{13}	50,000 ohms, 5 watt, wire wound, matched
R_{14}, R_{16}	0.1 meg, ½ watt
R_{15}, R_{17}	1000 ohms, ½ watt
R_{18}	100 ohms, wirewound, potentiometer
R_{19}, R_{20}	100 ohms, 2 watt
R_{21}	10 ohms, wirewound
R_{22}, R_{23}	47 ohms, 1 watt
R_{24}	9000 ohms, low noise
R_{25}	22,000 ohms, 1 watt
R_{26}, R_{27}	0.1 meg, 1 watt
R_{28}	50,000 ohms, 25 watt, wirewound
R_{29}	0.5 meg, 2 watt
R_{30}	0.2 meg, 2 watt
R_{31}	0.1 meg, 2 watt potentiometer, linear
R_{32}	50,000 ohms, 2 watt
T_1	Acro TO-300
T_2	425-0-425 v at 250 ma, 5 v at 3 a, 6.3 v at 3 a, 6.3 v at 3 a (UTC S-40)
T_3	6.3 v filament transformer, 10 a (UTC S-61)
V_1	12AY7
V_2	5687
V_3, V_4	KT-66's
V_5	83
V_6	6AS7
V_7	6SJ7
V_8, V_9	OB2

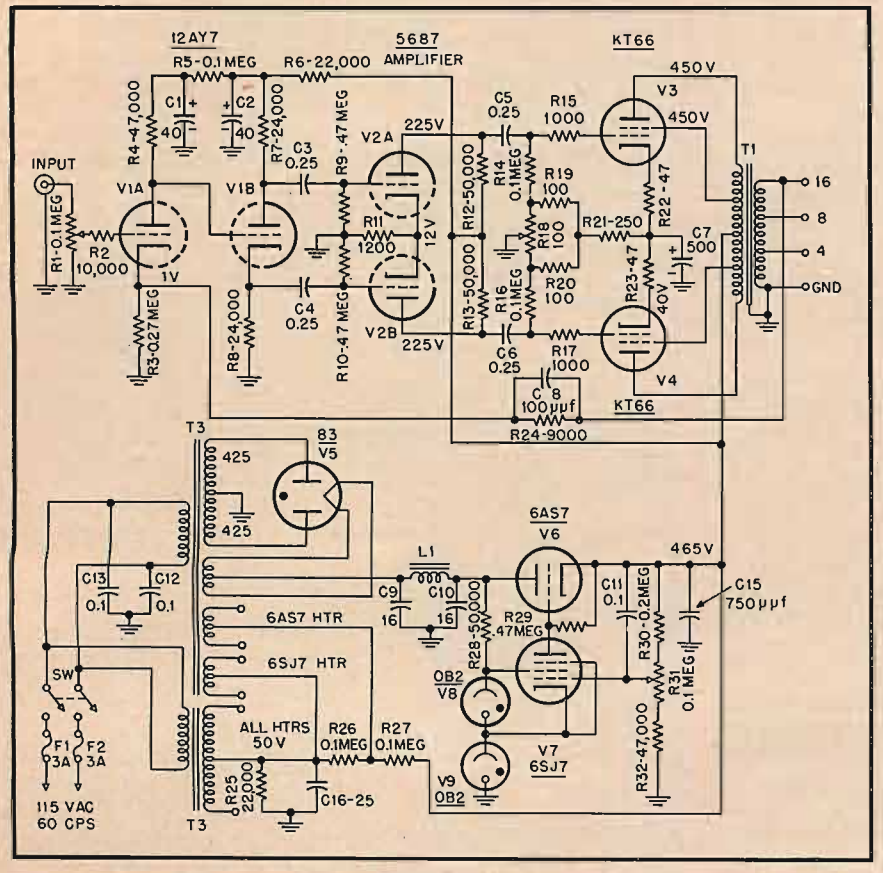


Fig. 9. Schematic of home-made adaptation of Williamson ultra-linear power amplifier, with voltage control.

Employment Register

• Positions Wanted

• **E.E.—Audio equipment and transformer design engineer.** Six years experience includes diversified background in audio amplifier, broadcast audio, and recording system design, and a.f. transformer design. Presently engaged as consultant on audio transformer and amplifier application. Desires permanent, responsible position in NYC or vicinity with a progressive company that seeks the services of a dependable, versatile engineer, with experience in any or all of the above fields. Box 301 AUDIO.

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It Has Everything . . .

Beauty – Operating Convenience – Quiet Performance

Quiet, constant-speed operation is obtained with a precision helical gear drive. This was developed for H. H. SCOTT by international authority Professor Earle Buckingham of M. I. T., designer of the drive mechanism for the Mt. Palomar 200 inch telescope.

FREE TECHNICAL BULLETIN A-553

THE NEW **H. H. Scott**

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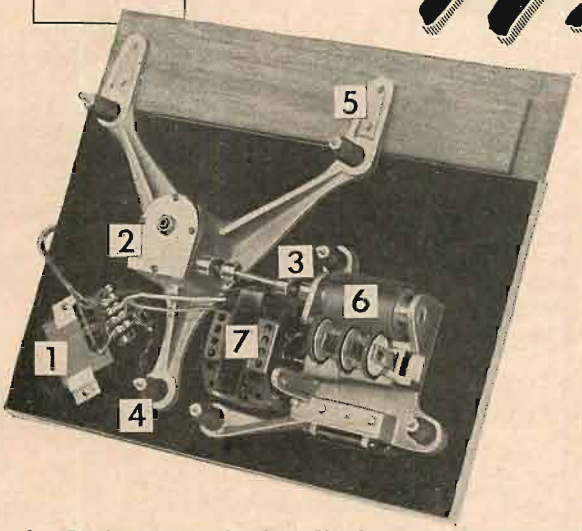

The 710-A incorporates major new contributions to turntable engineering. These include: dual-stage mechanical and torsional filtering, expanded-scale optical stroboscope, Vernier speed drive and integral connection of pickup-arm mounting-board to main turntable bearings.

Revolutionary NEW design

1. **Expanded scale optical stroboscope,** with electronic peak pulsing for greatest clarity, is visible even while record is playing, for exact speed control at all times.

2. **Precision helical drive gears,** of hardened steel and nylon, for smooth silent flow of power to turntable. Gears housed in an oil-filled transmission for quiet trouble-free operation.

3. **High-compliance torsional filtering** reduces annoying speed variations, such as wow and flutter, to less than 0.1%, far below audibility.

4. **Dual-stage mechanical filtering** between motor and turntable reduces motor rumble to more than 60 db below recording level, an outstanding engineering accomplishment.

5. **Integral pickup-arm mounting board,** accomodating all leading pickup arms, is rigidly connected to turntable bearings by a heavy aluminum casting. This eliminates acoustic feedback and other undesirable vibration differences between pickup arm and turntable.

6. **Vernier speed drive** with special long-life neoprene idlers permits separate adjustments of 33⅓, 45, and 78 rpm speeds by ±5% to match the pitch of accompanying musical instruments. Convenient push-button selection of each speed and OFF position. Unique clutch permits cueing turntable.

7. **Heavy-duty induction motor,** with dynamically balanced-rotor and extremely low external hum field, designed specially for this turntable.

Prices *710-A Turntable, finished in stainless steel with mahogany pickup-arm mounting board. $102.00*Net* **West Coast Prices: 710-A $107.10*
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Revolutionary NEW design

Frequency Response Circle Diagrams

OLAN E. KRUSE*

The derivation of circle diagrams relating frequency response to time constants of various common circuits.

A CIRCLE DIAGRAM METHOD relating the frequency response of a resistance-capacitance-coupled amplifier to the time constants of the circuit has been developed.[1] The method employs the intersections of two families of circles. The circuit time constant is the parameter of one family of circles and frequency is the parameter of the other. In this paper two circle diagrams are developed; one relates the frequency response to the circuit time constant for series R-C and parallel R-L circuits, and the other relates the frequency response to the circuit time constant for series R-L and parallel R-C circuits.

Series R-L and Parallel R-C Circuits

Consider the circuit of (a) in *Fig.* 1. The ratio of output voltage to input voltage is

$$\frac{V_o}{V_i}=\frac{R_l}{R_g+R_l}\cdot\frac{R_g+R_l}{(R_g+R_l)+j\omega L}. \quad (1)$$

Let $R=R_g+R_l$. Then

$$\frac{V_oR}{V_iR_l}=\frac{1}{1+j\omega\frac{L}{R}}. \quad (2)$$

Letting $T=\frac{L}{R}$ (this is the circuit time constant) and rationalizing the denominator, Eq. (2) becomes

$$\frac{V_oR}{V_iR_l}=\frac{1}{1+\omega^2T^2}-j\frac{\omega T}{1+\omega^2T^2}. \quad (3)$$

Multiplying both members of Eq. (3) by T and introducing the coordinates x and y gives

$$\frac{V_oR}{V_iR_l}T=x+jy=\frac{1}{1+\omega^2T^2}T-j\frac{\omega T}{1+\omega^2T^2}T. \quad (4)$$

From Eq. (4) it follows that

$$x^2+y^2=\frac{1+\omega^2T^2}{(1+\omega^2T^2)^2}T^2 \quad (5)$$

or

$$x^2+y^2=\frac{1}{1+\omega^2T^2}T^2. \quad (6)$$

Noting Eq. (4), it is seen that the right member of Eq. (6) is xT, and so Eq. (6) may be written as

$$x^2+y^2=Tx \quad (7)$$

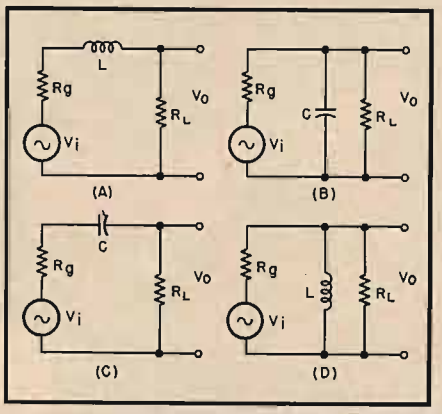

Fig. 1. The series and parallel L-C and R-C circuits for which the circle diagrams are useful.

Transposing Tx and adding $\frac{1}{4}T^2$ to both members of Eq. (7) gives

$$(x-\tfrac{1}{2}T)^2+y^2=\tfrac{1}{4}T^2. \quad (8)$$

This latter equation is that of a family of circles with parameter T, centers on the x-axis $\frac{1}{2}T$ units to the right of the origin, radii equal to $\frac{1}{2}T$, and passing through the origin. Each circle may be thought of as a "constant-T" circle representing the path of operation of all series R-L circuits having a circuit time constant corresponding to the T of the circle. Since $T=\frac{L}{R}$, it follows that each series R-L circuit operates on a definite "constant-T" circle.

A set of "constant-ω" circles for the series R-L circuit will be derived, and the combination of "constant-T" and "constant-ω" families will prove to be of value in analysis and design, both qualitatively and quantitatively. From the definition of phase angle ϕ and Eq. (4),

$$\phi=\arctan\frac{y}{x}=\arctan(-T\omega) \quad (9)$$

from which

$$T=-\frac{y}{\omega x}. \quad (10)$$

Substituting Eq. (10) into Eq. (8) and simplifying yields

$$x^2+\left(y+\frac{1}{2\omega}\right)^2=\tfrac{1}{4}\left(\frac{1}{\omega^2}\right). \quad (11)$$

Since ω is the parameter in the family of circles given by Eq. (11), the circles will be referred to as "constant-ω" circles. The circles have radii equal to $1/2\omega$, they pass through the origin, and they are centered $1/2\omega$ units below the origin on the y-axis.

Figure 2 is a fourth-quadrant plot of Eqs. (8) and (11) covering typical time-constant and frequency ranges (for convenience the frequency is plotted instead of ω, use being made of the relation $\omega=2\pi F$) and showing radial lines indicating phase angles and ratios $\frac{V_o}{V_{o.M}}$. $V_{o.M}$ is the maximum possible value of V_o; that is, it is the value of V_o when the reactance of L is zero (d.c. case).

As mentioned, this circle diagram is helpful both qualitatively and quantitatively. As an example of its quantitative use assume a series R-L circuit with a time constant of 1432 microseconds. Let the problem be to find the frequency at which the phase angle between input and output is 60 deg. Following the "constant-T" circle (with $T=1432$ microseconds) around to the 60-deg. phase-angle line, it is found that the intersecting "constant-ω" circle represents a frequency of 200 cps. This 200 cps is, of course, the answer asked for. A few minutes study of the diagram will suggest several ways in which it may be used in both design and analysis.

The diagram drawn in *Fig.* 2 is not restricted to the ranges of T and F indicated. Any circle centered on the x-axis has a diameter of T units, while a circle of equal diameter on the y-axis has a diameter of $1/\omega$. It follows, therefore, that T and F are reciprocally related; that is, $T=(1/2\pi)(1/F)$. Thus, either the T or the F values may be multiplied by 10, 100, etc., while the other parameter is multiplied by 0.1, 0.01, etc., and the ranges of T and F proportionately changed.

It will be shown that *Fig.* 2 is also applicable to parallel R-C circuits. In (b) of *Fig.* 1

$$\frac{V_o}{V_i}=\frac{-j\frac{R_l}{\omega C}}{R_g+\frac{-j\frac{R_l}{\omega C}}{R_l-j/\omega C}}\cdot \quad (12)$$

Mutiplying numerator and denominator of Eq. (12) by

$$\frac{R_l-j/\omega C}{R_gR_l}$$

and rearranging, Eq. (12) may be written as

$$\frac{V_o}{V_i}=-\frac{R_l}{R_g+R_l}\cdot\frac{\frac{j}{\omega C\left(\frac{R_gR_l}{R_g+R_l}\right)}}{1-\frac{j}{\omega C\left(\frac{R_gR_l}{R_g+R_l}\right)}}\cdot \quad (13)$$

---

* *Dept. of Physics, Stephen F. Austin State College, Nacogdoches, Tex.*

[1] O. E. Kruse, "Circle Diagrams for Resistance-Capacitance-Coupled Amplifiers," AUDIO ENGINEERING, Feb., 1953.

THE BRITISH INDUSTRIES

Audio Forum

* C. G. McProud *Discusses* Guild Production *vs.* Mass Production

CGM: Mr. Carduner, we are pleased to be the medium for your series of monthly open discussions of quality in high fidelity equipment. We've often written on the subject in the Editor's Report, and I feel that the series you plan is especially pertinent to the readers of Audio Magazine. What will the topics be . . . and whom do you plan to have discuss them?

LC: Each forum will be a frank and open discussion of one vital part that quality plays in high fidelity. The men and women who will discuss these topics will be expert engineers, as well as artists in the musical field. There will be columnists and also editors to express their opinions, besides men in the sales end of the business. In fact, we even intend to invite some of our competitors in the manufacturing end of the industry.

CGM: I am confident that these discussions will have a great deal of value in clearing up misunderstandings in the public mind about the true meaning of high fidelity.

LC: That is our primary purpose. There is a good deal of misuse of the term high fidelity, and we who are in the business would like to try to define it in terms of quality, even though it is difficult to set measurable standards.

CGM: That's very important, because we all talk about quality as though it were like a toolmaker's "go-no go" gauge, but it is not

The Audio Forum

true high fidelity starts with the original conception of the unit. The designer must start with "reaching for the moon" and trying to attain total reproduction within human hearing range . . .

CGM: . . . even though it has not yet been attained—as we both know. Although equipment does presumably cover the *range* of hearing, it is accepted that certain missing overtones and undertones are still necessary to get perfect quality duplication. Yes, design is vitally important—but I would say that quality control is equally or even more so.

LC: Don't I know it! There are some high fidelity products today where supervision and inspection take more man hours than actual construction.

CGM: I know that is true, even though many people would find it hard to believe. Some of our friends in the business have said that such quality control is the real reason why fine high fidelity equipment can never be mass-produced.

LC: Well, Mac, how do you feel about this?

CGM: I don't happen to know any mass-produced product that approaches the quality or standards of what we call "Guild" production . . . to build it as fine as you know how. That doesn't say it can't be done—but there would have to be some radical changes in methods and inspection before it could happen.

LC: Yes, but won't those innovations be so costly that there would be little if any difference in the ultimate price to the consumer?

CGM: I certainly agree with you if we are talking about complete, on-the-line, under-one-roof manufacturing. By the time they are marketed, these "in-a-cabinet" sets can be far more costly than even better components assembled in the home by the user, who purchased them from a parts jobber or high fidelity dealer. I certainly feel that this opens up a very interesting and informative field of exploration, and I know that your future discussions will bring it out in greater detail. Our editorial staff is looking forward to these British Industries Forums with great interest.

LC: Thank *you,* Mac, for helping us get off to such a good start. We believe that the readers of Audio Magazine are amongst the most influential people . . . the customers with whom the whole high fidelity industry started. We have always counted on them to represent the true facts to their friends who may not be so well informed.

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* *An interview between C. G. McProud, Editor and Publisher of Audio Magazine, and Leonard Carduner, President of British Industries Corporation, New York BIC is an American company which offers you Britain's finest audio equipment . . . fully guaranteed, with service and spare parts available.*

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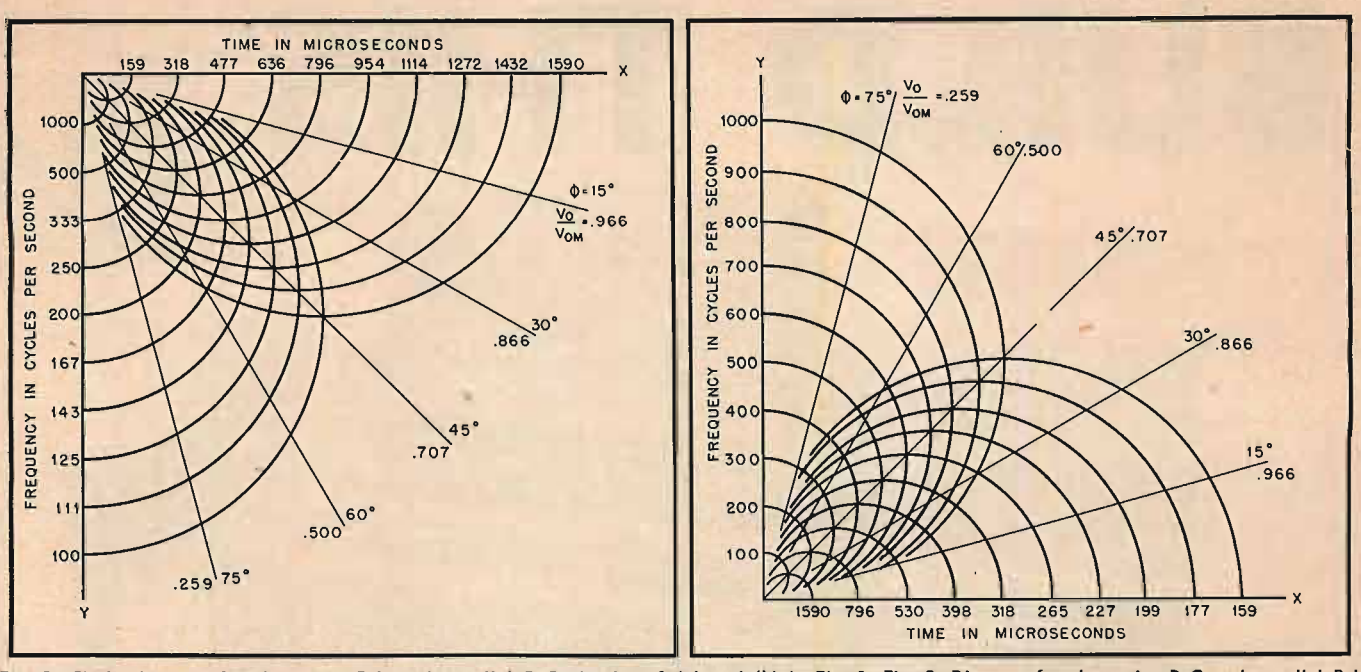

Fig. 2. Circle diagram for the series R-L and parallel R-C circuits of (a) and (b) in Fig. 1. Fig. 2. Diagram for the series R-C and parallel R-L circuits of (c) and (d) in Fig. 1.

Let $R=\frac{R_gR_l}{R_g+R_l}$, and then $T=CR$. Then

$$\frac{V_o}{V_i}=-\frac{R_l}{R_g+R_l}\cdot\frac{\frac{j}{\omega T}}{1-\frac{j}{\omega T}}\quad(14).$$

Multiplying the numerator and denominator of the right member of Eq. (14) by ωT and then rationalizing the denominator results finally in

$$\frac{V_o}{V_i}\left(\frac{R_g+R_l}{R_l}\right)=\frac{1}{1+\omega^2T^2}-j\frac{\omega T}{1+\omega^2T^2}.\quad(15)$$

Eq. (15) is identical with Eq. (3) and so it follows that the mathematical journey from Eq. (*15*) to a circle diagram will lead to the same circle diagram derived for the series R-L circuit. Thus, *Fig.* 2 is applicable to both the series R-L and parallel R-C circuits, with, of course, appropriate interpretations of the time constants. In the application of the circle diagram of *Fig.* 2 to the parallel R-C circuit, V_{oM} is the output voltage when the reactance of C is infinite (d.c. case).

Series R-C and Parallel R-L Circuits

In the circuit of (c) in *Fig.* 1

$$\frac{V_o}{V_i}=\frac{R_l}{R_l+R_g}\cdot\frac{R_g+R_l}{(R_g+R_l)-j/\omega C}.\quad(16)$$

Let $R=R_g+R_l$. Then

$$\frac{V_oR}{V_iR_l}=\frac{1}{1-\frac{j}{\omega CR}}.\quad(17)$$

Letting $T=RC$, rationalizing, and rearranging, allows Eq. (*17*) to be written as

$$\frac{V_oR}{V_iR_l}=\frac{\omega^2T^2}{1+w^2T^2}+j\frac{\omega T}{1+w^2T^2}.\quad(18)$$

Mutiplying both members by T^{-1} and introducing the coordinates x and y, gives

$$\frac{V_oR}{V_iR_l}T^{-1}=x+jy=\frac{\omega^2T^2}{1+\omega^2T^2}T^{-1}+j\frac{\omega T}{1+\omega^2T^2}T^{-1}.\quad(19)$$

From Eq. (19) it follows that

$$x^2+y^2=\frac{\omega^2T^2}{1+\omega^2T^2}T^{-2}=xT^{-1}.\quad(20)$$

Eq. (20) may be put into the form

$$(x-\tfrac{1}{2}T^{-1})^2+y^2=\tfrac{1}{4}T^{-2}.\quad(21)$$

which is the equation of a family of circles of parameter T, centers on the x-axis $\frac{1}{2}T^{-1}$ units to the right of the origin, has radii equal to $\frac{1}{2}T^{-1}$ units, and passes through the origin. Each "constant-T" circle represents the "path" of operation of a series R-C circuit having the time constant T.

Again, in order to make the "constant-T" circles useful, a set of "constant-ω" circles will be obtained. From the definition of phase angle ϕ and Eq. (19),

$$\phi=\arctan\frac{y}{x}=\arctan\frac{1}{\omega T}.\quad(22)$$

From Eq. (22)

$$T^{-1}=\frac{\omega y}{x}.\quad(23)$$

Substituting Eq. (23) into Eq. (20) and simplifying, yields

$$x^2+(y-\tfrac{1}{2}\omega)^2=\tfrac{1}{4}\omega^2.\quad(24)$$

Eq. (24) is the desired family of "constant-ω" circles. These circles have their centers on the positive y-axis and removed from the origin a distance $\frac{1}{2}\omega$. They have radii equal to $\frac{1}{2}\omega$, and, so of course, pass through the origin.

Fig. 3 is a first-quadrant plot of Eqs. (21) and (24), with appropriately chosen ranges of T and F, and, as in *Fig.* 2, with radial lines indicating the phase angle and the ratio $\frac{V_o}{V_{oM}}$. Here V_{oM} is the output voltage when the reactance of C is zero (infinite-frequency case). The interpretations and uses of *Fig.* 3 are analogous to those of *Fig.* 2, and no new explanation in that regard seems necessary. It is worth mentioning, however, that T and F are reciprocally related the same as in *Fig.* 2, and so the diagram is again not restricted to the ranges of T and F given in the diagram but may be extended to include any range by the method described for *Fig.* 2.

For the parallel R-L circuit shown at (d) Fig. 1 and without going through the algebraic details,

$$\frac{V_o(R_g+R_l)}{V_iR_l}=-\frac{\omega^2T^2}{1+\omega^2T^2}+j\frac{\omega T}{1+\omega^2T^2}\quad(25)$$

where T is the time constant

$$\frac{L}{\frac{R_gR_l}{R_g+R_l}}.$$

Now Eq. (25) is identical in form with Eq. (18) except for the minus sign preceding the real part of the right member. However, the algebraic steps involved in proceeding from Eq. (25) to a "constant-T" family of circles involves squaring this negative term and so Eq. (*21*) represents the set of "constant-T" circles for the parallel R-L circuit. Likewise, a derivation of the family of "constant-ω" circles will show that the negative sign does not alter the final result which is identical with Eq. (24). It follows that *Fig.* 3 is just as applicable to the parallel R-L circuit (with appropriate time constant) as to the series R-C circuit.

Present literature is not lacking in design and analysis procedures for the circuits discussed. However, the circle diagram method presents a fast and convenient approach with an over-all frequency response picture (for all time constants) on a single diagram. From a tutorial standpoint much understanding of frequency response can be gained by a few minutes study of the diagrams.

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This instrument consists of twelve tone generators, each coupled to a string of octave dividers to provide a total of 84 notes — giving the basic 8-foot pitch over the 61 keys of the two manuals, as well as the 4- and 16-foot pitches required to permit normal organ registration. The generators and dividers operate continuously, and the outputs are channeled to the key switches on both manuals and pedals. Seven stops are provided for the Great manual, nine for the Swell, and three for the pedals, and couplers are provided as in usual organ practice. Engraved stop tablets give you true organ tones directly, and the stops can be mixed in numberless combinations to build up any tone you wish. The output from the organ proper is approximately 2 volts, permitting the use of your present high-fidelity amplifier and speaker system, or an amplifier may be permanently installed in the console, requiring only that the speakers be externally located. The sound volume is limited only by the amplifiers and speakers used.

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These specifications show in detail why the Schober Electronic Organ is a fine A.G.O.-standard instrument, its music — classical, romantic, popular, secular, ar religious — expressive and appealing.

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Big-organ pedal clavier has full 32 notes, is concave and radiating for easiest playing.

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Output of 2 volts can be connected by long cable to any standard power amplifier or home music system control center, and haaks in like a tuner or a tape recarder.

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Schober Electronic Organ is a fine A.G.O.-stand-

ic Organ YOURSELF!

Now you can achieve your desire of desires — a fine Electronic Organ in your home. No longer must the element of cost prevent you from enjoying the supreme satisfaction of owning an instrument of unsurpassed quality. If purchased factory-made, a comparable electronic organ would cost almost three thousand dollars. Build it yourself, section by section — each step is simple enough for the complete novice — and you save more than one half the cost.

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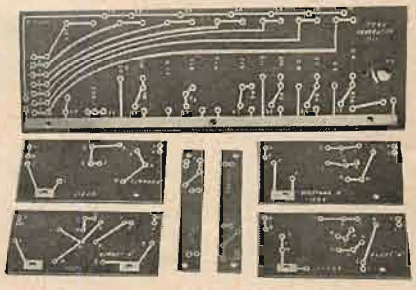
Construction of a modern Electronic Organ is not complicated nor particularly difficult – far simpler, for example, than a television receiver, and many thousands of them have been assembled by inexperienced constructors. The Schober Electronic Organ has been engineered to ensure successful completion by anyone who can handle a screwdriver. Wiring has been simplified by the use of 130 printed circuits so that the assembly consists of placing components in holes. For example, the tone generator chassis shown at the left employs four tubes, 22 capacitors, 9 resistors, 7 transformers, and an oscillator coil, yet requires less than three feet of wire! Most of the work has already been done for you. The instructions even tell you which way to twist a wire around a terminal, and every step is described so thoroughly that the parts go together in the right order almost automatically. Every part is furnished – every screw, nut, washer, resistor, capacitor, transformer, the console, keys, pedals, wire – everything you will need except the simple tools. This is a kit you will *enjoy building*.



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You may work as fast or as slow as you like – buying the individual sections as you go along. You can start with one tone generator costing only $22.50, and as you complete one you can order another. Twelve are required, one for each note of the scale, and each tone generator provides seven octavely related notes. Other sections are similarly low in cost – the power supply is $36.00, pedal switch assembly $14.25, filterboard $17.75, Great stop filters $15.25, Swell stop filters $18.25, Pedal stop filters $6.75, preliminary amplier $31.50, and so on. Each section comes with its own instruction sheets, and with your first order you receive the basic kit-building instructions in a loose-leaf binder, which becomes a complete service manual when you are completed. You can order only one section, or as many as you wish.

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Equipment Report

New Tech-Master Preamplifier Kit—Rek-O-Kut Rondine Turntables—Pentron CT-1 Tape Recorder

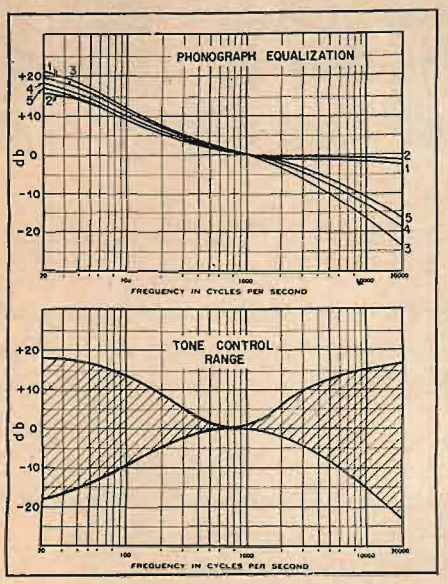


Fig. 1. Performance curves for the new Tech-Master preamplifier-control-unit kit.

We HAVE JUST had the opportunity of seeing the new Tech-Master Preamplifier Kit in pre-production stages, with the assurance, however, that the final version was to be essentially like the one we saw. This unit has been completely redesigned from the earlier model, and is self-powered, compact, and quite adequate for the home music system in spite of its low cost, particularly when the user does feel that he has to accommodate twenty or more recording characteristics.

The new preamplifier, the schematic of which is shown in *Fig.* 2 as gleaned from the chassis itself, consists of a 12AX7 preamplifier stage, using feedback equalization, a 12AU7 voltage amplifier to provide sufficient gain for the tone-control network, and a 6C4 cathode-follower output stage. A selenium rectifier supplies plate voltage, which is well filtered by the use of three electrolytic capacitors. Equalization is provided for five curves—two with essentially flat high ends and three with different rolloffs. Five turnovers are available—positions 1 and 2 are for 78's, with 500- and 300-cps turnovers respectively coupled with the flat high end to provide equalization for domestic and foreign 78's. Position 3 has a turnover of approximately 500 cps, coupled with a 16-db rolloff at 10,000 cps to make it suitable for Columbia LP's and similar curves. Position 4 has a turnover of 400 cps and a rolloff of 13 db, which is indicated for the Old AES curve, but which is roughly suitable for the RIAA and NEW ORTHO curves. Position 5 has a 300-cps turnover and a rolloff of 10 db, which approximately matches the ffrr curve. It will be noticed that there is no bass rolloff, which is specified in the LP and RIAA curves, but any touching up in this region can be accommodated by the bass tone control.

The preamplifier stage is followed by the selector switch and the volume control, the high-level inputs being fed to the switch contacts. Three such inputs are provided, and each has an isolating capacitor between the input jack and the switch. A shorting bus on the switch grounds all unused inputs so there is no cross talk between circuits.

The volume control—shown here as uncompensated, but to be a loudness control in the production model—feeds the grid of the first section of the 12AU7, and its output drives the tone-control network. The second section of the 12AU7 feeds the cathode-follower output stage. The output from the unit is fed through an integrally-mounted shielded lead terminating in the usual pin plug.

Construction

The chassis construction is relatively compact, and the slanting mounting at the rear permits the removal or change of tubes without taking the chassis out of its housing. The selenium rectifier and the power transformer are both mounted above the chassis, and the heater leads from the tranformer are led first to the 12AU7, thence to the 6C4 below the chassis. Another pair of leads go from the 12AU7 heater terminals through holes in the chassis and along the top to another hole adjacent to the 12AX7 preamplifier, thus removing one possible source of hum from the low-level section of the unit.

From left to right, the controls are: phono equalization, selector switch, volume control and power switch, treble tone control, and bass tone control. This observer has a strong preference for the locating of bass and treble tone controls in the same order as they would be expected on a piano keyboard (which this observer makes no pretense of playing), but this is a minor objection, and if it were shared by the constructor it is probable that they could be rearranged. This would depend, of course, on the designation on the housing, but if the chassis were to be mounted in another cabinet even this problem would not be troublesome. The layout of the parts and wiring is simple and straightforward, and the kit appears to be one which would be easy to construct, even by a person not experienced in such work.

Performance

Figure 1 shows the performance curves as measured on the pre-production model. On the small scale at which these curves are plotted, it would appear that there is not much difference between curves 3, 4, and 5, nor much between 1 and 2. However, in use there is considerable difference in the way the reproduction sounds, and the correct one of the three LP curves is readily selectable simply by listening to the output.

The tone control curves will be recognized as normal for this type of circuit, and they follow the "hinge" principle—that is, the deviations from flat response begin to take effect as though the curve were hinged about the center frequency, which in this unit is approximately 750 cps. It will be noted from the curves that the bass and treble boost are about the same—17 db—and that approximately the same figures apply to the bass and treble cut curves, with a slight increase in cut at the high end.

A 1-volt output from the unit is obtained from an input of 0.25 volts on the radio, tape, and auxiliary inputs, and from an input of .0065 volts (6.5 millivolts) at the phono input, both measured at the maximum setting of the volume control. At this setting, the hum voltage is only 30 db below 1 volt on the phono input, and approximately 50 db below 1 volt at the high-level inputs. This is slightly below the desired minimum, but an improvement might be obtained by the return of the heater center tap to a point in the circuit which was, say, some 10 to 20 volts above ground. However, it must be noted that the volume control would seldom be used at its maximum position, and the hum level would be reduced accordingly.

Distortion measurements indicate that the unit is well within allowable limits for a preamplifier-control unit. At the normally required maximum of 1 volt output, the IM distortion (using 60 and 7000 cps at a ratio of 4:1) is only 0.6 per cent, reducing to 0.45 per cent at 0.75 volts output. At 2 volts, the IM distortion is 1.25 per cent; at 5 volts it is only 2.6 per cent.

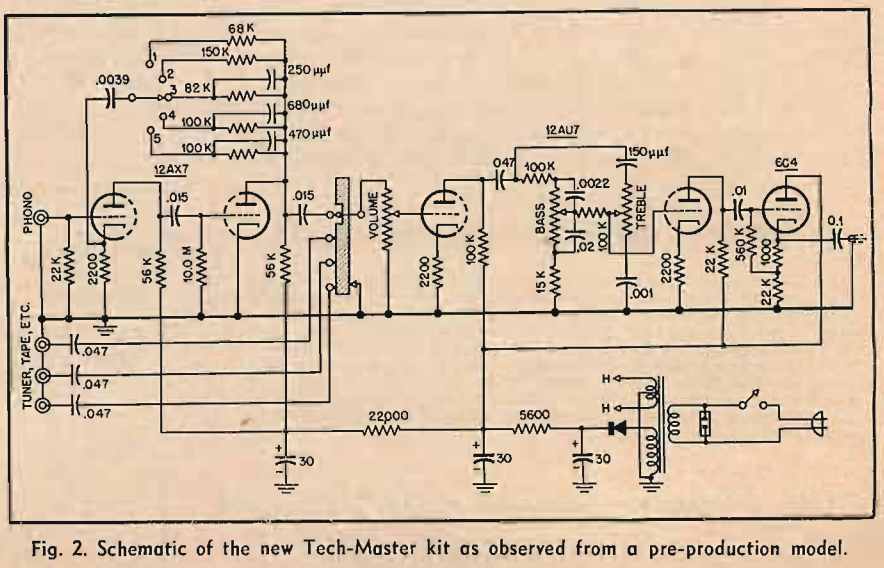
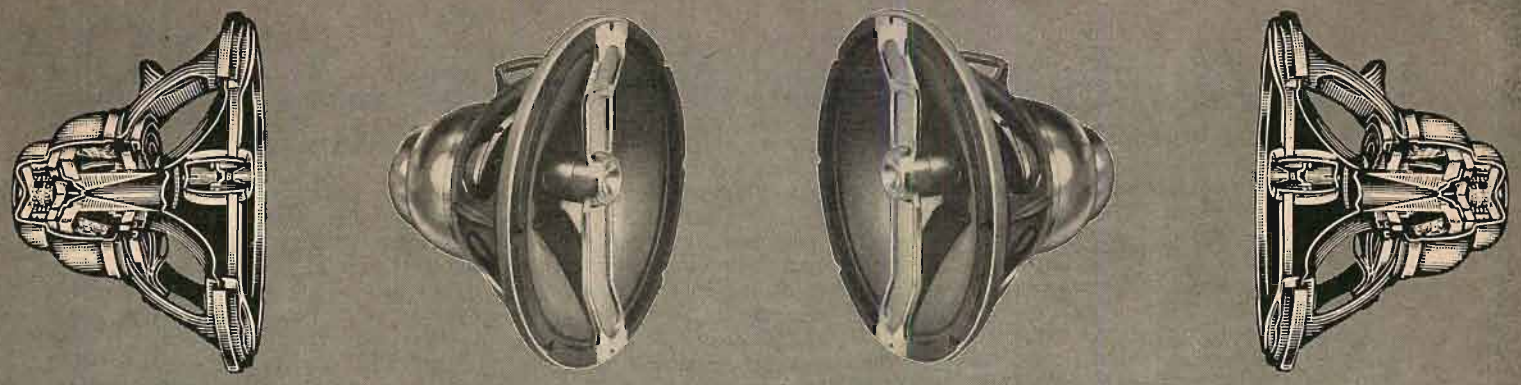


Fig. 2. Schematic of the new Tech-Master kit as observed from a pre-production model.



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REK-O-KUT "RONDINE" TURNTABLES—B-12H, B-12, and L-34

These three units have been introduced within the last few months, and measurements on the performance have just been made—within the limits of the facilities available. To explain this, let us discuss the measurement of rumble in a turntable.

This would seem to be a very simple measurement at first look, but it is not as simple as it appears. The logical method of making such a measurement is to play a frequency record of known velocity—for this purpose we have considered the practical stylus velocity as 20 cm/sec, although many records have been measured with velocities as high as 30 cm/sec. After taking this measurement, using the output of an equalized preamplifier as the reference point, the next step is to make a measurement of the output when playing an unmodulated groove. Since the difference is likely to be more than 40 db in a good turntable (as a minimum) the effect of high-frequency noise must be taken into account. This can be eliminated by connecting a capacitor across the output, reducing the high-frequency noise, but also making a change in the 1000- or 400-cps reference level.

By proper choice of capacitor, however, the effect on a 400-cps reference level used in our measurements can be reduced to a minimum while the high-frequency noise is reduced by some 20 db. For a standard level, we used the "+12" band on the Dubbings frequency record, since this band has a stylus velocity of 10.3 cm/sec. This gives a reference which is approximately 6 db below 20 cm/sec (exactly 6 db below 20.6 cm/sec) and this is considered close enough for measurements of this type.

After making the reference measurement by noting the voltage output from the preamplifier while the standard band is playing, the next step is to measure the output while playing an unmodulated groove. And here is where the trouble comes. At first, a level difference of only 33 db was noted. Since this was considerably below published specifications, the turntable was stopped and the stylus placed on a rubber stopper which was, in turn, placed on the turntable frame. When the output was measured, it was again 33 db below the reference. Obviously something was wrong. It was found that acoustic noises in the room were causing the turntable mounting panel to act as a microphone diaphragm, so steps were taken to reduce noises to a minimum, the mounting panel was fastened tightly to a one-inch plywood board, and the whole unit covered with a heavy padding blanket. With this treatment it was possible to measure a difference of 58 db between the reference voltage and the signal output from the preamplifier with the stylus resting on the rubber stopper and the motor not running. With the motor turned on, the difference became 54 db, and when playing the unmodulated groove, it was 51.

This experience is given to show how many factors influence the performance of a high-grade turntable, for this was with the B-12H—the Deluxe model with the hysteresis motor—a unit which is rated at better than 50 db below average recording level. It is not certain how much of the noise was contributed by the amplifier itself, but in any case it must be stated that at normal playing level there is no rumble heard in a high-quality speaker system with unmodulated grooves.

Similiar measurements were made on the B-12—which is the same as the B-12H except for the motor—with a resulting level difference of 44 db. The L-34 showed a difference of 38 db, and with both of the latter units, a slight rumble could be heard with the amplifier set for normal playing level. Using a typical commercial loudspeaker and enclosure, no rumble was heard on any of these three units—which was to be expected, for the "standard" test loudspeaker has good acoustic output down to about 24 cps, and is a critical test for any reproducing system.

The B-12H, *Fig.* 3, is the top of this line and is one which anyone would be well satisfied with. Using the hysteresis motor, it is necessarily expensive, since the motor itself costs more than many turntables complete, but the additional cost is justified by the improved performance. The motor used is built to Rek-O-Kut specifications, and consists of 24 slots, double wound, which gives a continuous flow of power which is almost completely free of "pulses"—especially noticeable with a 2-pole motor and slightly less so with a 4-pole motor. The construction of the Rondine turntables employs a stepped motor pulley which drives an idler, which in turn drives the inside of the turntable. The idler is carried on a bracket, is isolated from the turntable frame by rubber shock mounts, and the bearing on the idler wheel is large enough to ensure true operation. The idler is a machined aluminum wheel with a bonded neoprene tire which is ground to a high degree of concentricity. The motor pulley—a piece of Micarta rod which is pressed onto the motor shaft—has three steps corresponding to the three turntable speeds, and it is ground after being assembled, using a large precision grinding wheel and with the motor itself turning the pulley during the grinding operation. This technique is employed to avoid any wobble in the pulley, and to ensure perfect concentricity.

The entire unit is mounted on a cast aluminum deck which is ribbed to provide greater rigidity, and it mounts in a rectangular cutout with eight screws to further solidify the mounting. There is adequate space to mount an arm on the base, but if the turntable is to be used with a studio-type arm to accommodate 16-in. transcriptions, the longer arm must be mounted on the outside.

A built-in retractable hub is provided for 45-rpm records, and it is held below the surface of the turntable by a bayonet-type catch. To release it for operation requires only a quarter turn with the fingers. A stroboscope is permanently located on the turntable, and a pilot light is provided to indicate when the motor is on. The speed selector switch starts the motor when it is placed into any of the three positions, and when turned to an off position it retracts the idler from contact with the motor pulley and from the inside of the turntable. The main turntable shaft is heavy, fitted with oil grooves, and runs in a well which is fabricated from one solid casting. The thrust is taken by a hardened ball at the bottom of the shaft well. The fit between the shaft and the well is so close that removal of the shaft is always accompanied by a "pop" like a champagne cork.

The workmanship on this unit is excellent, and simply by looking at it one would be impressed with its ability to do a good job. A turntable of this type is a new experience to those who have not been accustomed to broadcast equipment, and is sure to prove a lasting enjoyment.

Model B-12 is similar in all respects except the motor, which is a 4-pole unit of relatively heavy construction. As would be expected, there is slightly more rumble, and the long-time speed accuracy is not as high, but except for the most critical applications this model would be completely satisfactory.

The model L-34, is an improved version of the LP-743 in appearance, but the idler mechanism has been simplified by eliminating the 78 speed, and has been made heavier for quieter and more lasting operation. The mounting plate is smaller, but the workmanship is of the same high quality as the more expensive models. It features the same retractable hub as used on the B-12 and B-12H, and the stroboscope shows only two rings, since the third is not necessary.

Turntables of these types are a pleasure to use—there is no wobble, a minimum of rumble, and very low flutter. A listening comparison easily shows the difference in performance.

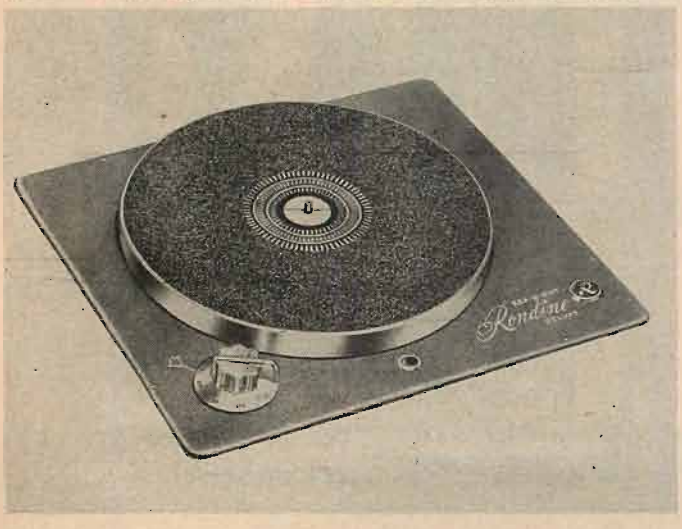

Fig. 3. The Rondine Deluxe B-12H turntable. The B-12 is identical in appearance.

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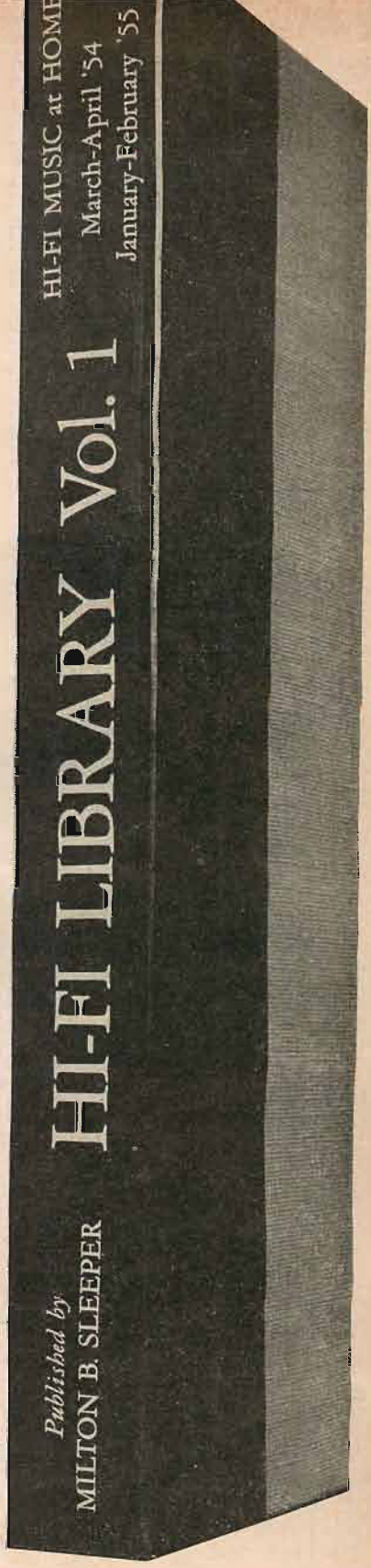

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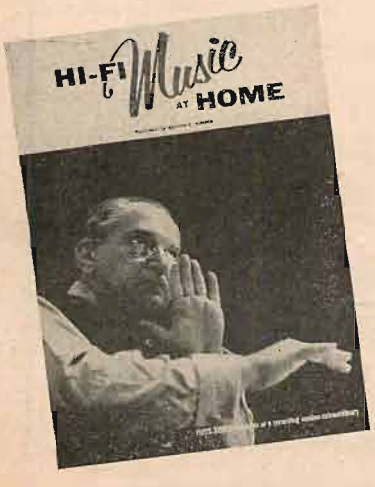

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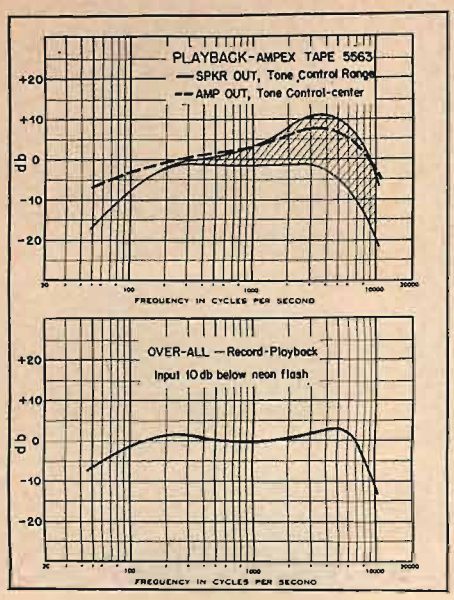

Fig. 5. Performance curves for the Pentron CT-1 tape recorder.

PENTRON CT-1 TAPE RECORDER with MONOMATIC CONTROL

This recorder is an interesting unit primarily because of its mechanical features. The Monomatic Control operates somewhat on the manner of a foreign-car gearshift—since it has six positions, two of which require the operation of an interlock button. From *Fig.* 6, it will be noted that the lever works into a number of slots, and that it moves from side to side in addition. When vertical, the unit is at rest; pushed to the right and forward starts the rewind operation; to the left and forward provides a fast-forward speed. The center slots give play and record at 7½ and 3¾ ips respectively, with the button on top of the control being depressed before the lever can be placed in either of the record positions.

Both radio and microphone inputs are provided, and two outputs are available—one labeled AMP at a high impedance ahead of the tone control, the other paralleling the loudspeaker. *Figure* 7 shows the overall schematic.

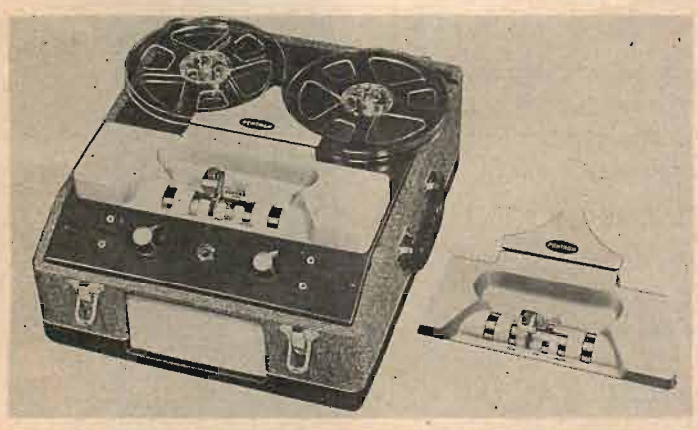

Fig. 6. The Pentron CT-1 recorder, with Monomatic Control.

The performance curves are shown in *Fig.* 5. Using an Ampex standard frequency tape, the output with two settings of the tone control are shown from the low-impedance or SPKR jack, and from the amplifier output jack with the tone control in the mid-position. (There is a slight effect on the response curve in the AMP output, only about 3 db at 8000 cps.) It will be noted that a fair response can be obtained from the standard tape over the range from 100 cps to 10,000—the slight boost at the high end can be compensated by any usual tone control.

The record-playback curve—made by introducing a flat signal into the RADIO input, recording onto the tape, and measuring the output at the AMP jack—shows good response up to about 7000 cps, which would be adequate for average home use, although not up to the standards dictated by the music-lover who wanted a wider frequency range. This is a low-priced machine, however, and can not be expected to give the performance of a machine costing ten times as much. For reproduction of recorded tapes through a music system, however, the response is satisfactory up to about 10,000 cps. An input signal of 0.62 volts is sufficient to give full recording level at the RADIO input, while a signal of 12 millivolts is sufficient from the microphone jack.

Rewind time was measured at 105 seconds for a 1200-foot reel, and the fast forward time for a full reel was measured at 130 seconds. No measurements were made at the 3¾-ips speed, since no change of equalization is provided, and this speed is not considered as standard for music recording. For speech, however, it gives satisfactory reproduction.

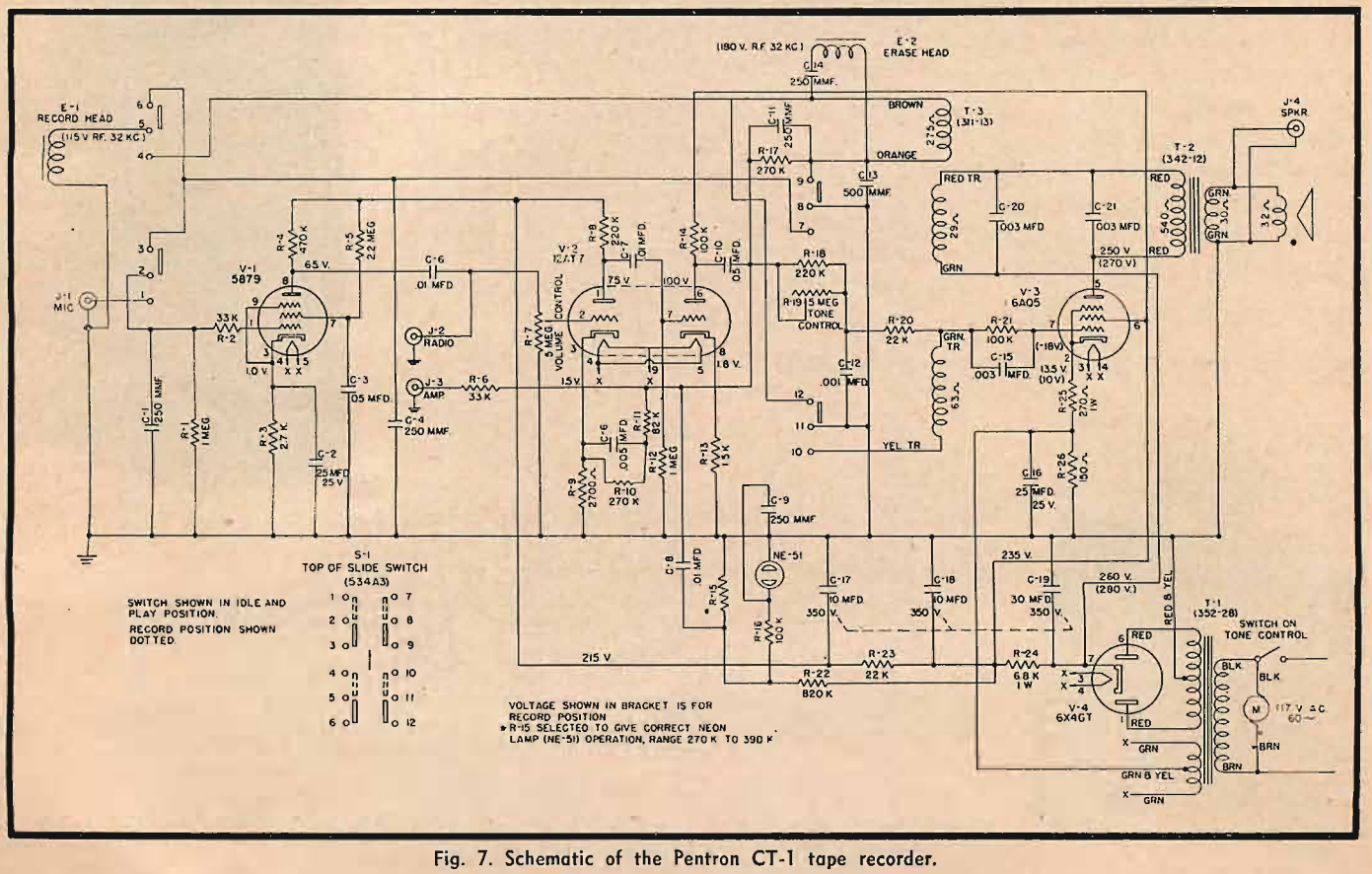

Fig. 7. Schematic of the Pentron CT-1 tape recorder.

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EDWARD TATNALL CANBY*

TAPE AND DISC

FIRST, some off-the-shoulder remarks concerning the business of tape reviewing. The title of this department doesn't imply that "records" are necessarily discs, though discs have been its preoccupation these many years. Tape is a medium for the propagation of recorded music, as is disc. The physical difference is more fundamental but otherwise pretty much like that between 78 disc and 45 or 33—and, you will remember, there was a time when much fuss and feathers was expended upon comparisons between 78's and LP's, and—bless me—between LP's and 45's!

Right now, we lump LP's, 45's, and a 78 once in a blue moon, together under the title of "records." We are still interested in technical differences, physical differences, of course. But among the three disc speeds these once overwhelmingly interesting divergencies have become so unimportant—quite rightly—that we scarcely consider them any more.

Yes, tape is an exciting new medium, its possibilities, virtues, and faults are not yet thoroughly evaluated, by the manufacturers themselves—much less the public. And so tape *vs.* disc is a "live" issue right now.

Therefore, I suppose, we should rush into print with a Tape Department. I rather think we won't—at least not permanently. Because tape, too, will become reasonably self-evident in its virtues and defects fairly soon, and because tape is only a medium and, though it merits attention as such, that attention in the end shouldn't be any more specialized than the attention we now give to LP as a pure medium in itself. In the end, the major interest in any recorded medium is content—not only the music or other sound itself but, of course, the "fi" as well. Tape or disc.

As things now stand, it appears that a good proportion of taped material will duplicate the same offerings on disc. This is a familiar *situation*—we had it with LP *for some* years. (We simply ignore the joint LP-45 issues these days since the differences and similarities in the LP and 45 editions can be more or less taken for granted.)

Therefore—do we review the tapes for their content—often music that is already "old" on LP—or for their tone quality? Do we review new tapes (not available on disc) for content in relation to that of other material available on tape? On disc?

You can see the problems, and you may guess the answer to them, as of this department. We will do what we did in the past, during the LP revolution: treat all records as *records*, categorize them in whatever way that seems useful at the time, whether it is Beethoven and Mozart, Concertos and Quartets—or Tapes and Discs.

We'll cover the technical necessities similarly, as proves useful, and we'll facilitate things by our usual use of some "key" indications. Tape records will be designated, by a symbol as well as in words. Speeds, single or half-track, etc. will also be indicated when it seems necessary. Already, the half-track or double-track—take your choice—tape at 7½ ips seems likely to be standard for quality tapes and will be assumed in the absence of other indications.

KEY (DISC AND TAPE):

*	Outstanding recorded sound for the type of material.
a	Faulty alignment (tape).
c	Close-to, sharp-edged miking but in good liveness.
D	Dead studio-type recording.
L	Big liveness.
LL	Recorded level unusually high.
o	From older 78 rpm discs.
p	Good piano sound.
ss	Solo forward, accompaniment in background.
⚙⚙	Stereophonic ("binaural") tape record, two channels.
⚙	Tape record.
x	Some harshness, graininess in the sound.
7½SV	Stereophonic vertical-(stacked)-head tape, at 7½ ips.
7½SS	Stereophonic staggered-head (1¼") tape at 7½ ips.

All of which may not be as spectacular as the Gods of publicity might wish! We know that everybody and his brother now has a Tape Department and enthusiasm runs high. But we're sure in the long run you'll respect us more for treating tape realistically as what it is—a superb new medium for recorded sound. Period.

Tapes to Taste

⚙ **Tchaikowsky: Symphony #6 ("Pathétique").** Philharmonia Orch., Cantelli.

⚙ **HMV HTA 3**

First, a British tape, made and issued in Britain and kindly furnished us (via the West Coast!) by an AUDIO reader for our inspection. He says it came with a reel that does not fit our machines; he rewound it on a U. S. plastic. The recording is available here on disc as LHMV 1047, RCA-pressed, a good performance if a trifle hard-lined in the more frenetic passages of this nerve-wracking symphony.

The earliest question to arise is equalization. One must be careful in judging a recording curve (tape or disc) by ear; many factors go into the final sound including, as a very important part, the type of mike setting and the acoustical surroundings. A close-up "stunt" microphoning accentuates the high sounds and may seem to create a high "boost" in the listening; whereas a distant single-mike technique can so soften the edge of the sound that one can suspect, wrongly, a recording curve weak on highs. So it is here. I am reasonably sure that the original sound of this recording had much of the soft, unobtrusive quality evident in this tape.

The recording is made, we read in the cover information, "according to the world standard C.C.I.R. characteristic." There is still much confusion as to what this and other "standard" characteristics mean in actual practice. Playback characteristic—or over-all record-playback flatness, the two curves added together? In this particular case you will find that the effect of the present tape is very unlike that of most of the RCA tapes (below), with a far less pronounced high end, a general mildness. I found that a slight boost of the highs over normal Ampex playback and a trace less bass, produced a good balance. This is not a spectacular tape, and I am dead certain that the reasonable British had no intention that it should be otherwise. Just a good tape for listening to music.

One debit—very considerable tape hiss. Could be in the recording (in the copying) or possibly due to the track being slightly off-standard in positioning. I doubt this last. Alignment is perfect.

⚙ **Tchaikowsky: Swan Lake.** Philharmonia Orch., Irving.

⚙ **RCA Bluebird TB 4**

Aha! Same orchestra, same British company (EMI) but an RCA American tape release. The common origin is evident: one hears roughly the same sort of mike pickup, though this seems to have more reverberation than the Symphony above. But the RCA tape is a better one—on the Ampex at least. It has altogether a shinier, cleaner over-all sound; there is no desire on my part to boost the highs even a trace, here, and the bass seems better balanced too, by a slight degree.

The difference? Impossible to guess as to the exact causes. It occurs to me that perhaps the British tape itself, a reddish tape quite unlike any of ours in appearance, might have to do with the differences in sound. Bias setting different? Just a guess. In any case, the RCA tape has an immediate rightness, as played on Ampex, that tells volumes as to its processing and the thinking behind it.

Still some tape hiss, though less than in the HMV. (The disc equivalent is Bluebird LBC 1064.)

Be assured that (as will virtually always be true with a well-made tape) both of these sound better—played on good equipment—than the best hand-picked LP record of the same. But the cost is a lot more.

*L⚙ **Tchaikowsky: Aurora's Wedding.** Leopold Stokowski and His Symphony Orch.

⚙ **RCA Victor TC-1**

(May I suggest right here that a lot of record buyers, not to mention record reviewers, will soon be as sick of looking up disc equivalents for tapes as they were sick of sleuthing around for 78-r.p.m. equivalents of LP's, back in 1949. Suggestion: why not be straightforward and put the corresponding disc number right on these duplication tapes? Everybody knows there are disc equivalents, or should, and everybody knows that tapes are better, or should be! This one—I've just looked it up—is RCA's LM-1774.)

Here is the all-American product, American-recorded, and it's a beautiful tape, with full, clean wide range on Ampex-type playback. Not a new recording though technically quite up to par; its chief technical characteristic is also that of the equivalent disc, the odd sonorities and vast reverberation that Stokowski achieved with his novel recording arrangements. This tape, if like others, probably featured many mikes and an orchestra widely separated into distinct groups, the whole blended for the over-all effect.

Wonderful material for tape quality—it's fine music but also pretty good semi-background material in the best sense; it has lots of sound well suited to hi-fi, without being in any way sensational and freakish in this respect. Good.

There's no doubt at all about the very high over-all quality of these RCA tapes and not even the shadow of a doubt as to their superiority—played on high quality equipment—over their LP equivalents as played on best quality disc equipment. Maybe after six months or so I'll be able to quit saying this for good. It's inherent in the tape medium and so self-evident.

⚙⚙ᶜ**Strauss: Also Sprach Zarathustra.** Chicago Symphony, Reiner.

⚙⚙ **RCA Victor TCS 1 (7½SV) or TCSD 1 (7½SS)**

This is RCA's first offering in sterophonic tape, made specifically for loudspeaker use and unsuited to binaural earphone listening. Two simultaneous tracks in the same direction, made through two separate mike-amplifier record systems. RCA offers the tape in two forms, for stacked (vertical) head playing and for staggered-head playing, at a distance of 1¼ inches. My equipment is the latter, unfortunately; I received the former, and so I have played only one track, on the half-track Ampex.

I note only that the tape, first, costs you double because it plays only half as long, in one direction only, and second, the mike positioning here is very close and sharp—evidently RCA's pair of stereophonic mikes were placed considerably closer to the orchestra than the mikes for the standard (monaural) recording, a result of the necessary stereophonic set-up, each mike giving a lop-sided picture of the orchestra with one half of it closer than the other half. (For clear separation, in a resonant hall, close placement was evidently felt to be necessary.)

Note that a good many recording sessions are now done—just in case—with both standard and stercophonic arrangements, each independent of the other. The stereophonic ("binaural") mikes are usually placed very differently, though nobody is any too sure yet just how it should best be done. The LP version of this tape (one half of LM-1806) was almost certainly made through a quite different mike arrangment than this tape with a very different balance and liveness. Performance probably identical.

LL⚙ **Rodgers: Victory at Sea (Suite).** NBC Symphony, Robert Russell Bennett.

⚙ **RCA Victor TC-5**

track, on the half-track Ampex.

time-phase accuracy. Thus data

memory drum. Interlaced arrangement pro-

The channels, engineering and otherwise, through which this type of semi-pops music goes before publication are evidently different than those for the more highbrow stuff. A gorgeous hi-fi tape if you like the music, but the levels are very much higher, by my Ampex meter, than the levels more or less standard on the other RCA tapes. This one "hits the pin" steadily. The rest peak neatly at near the zero mark. (Ampex 600 playback level is fixed—no volume control.) Not an important difference since serious over-peaking is avoided, in the sound.

*⚙ **Brahms: Piano Concerto #2.** Boston Symphony, Munch; Arthur Rubinstein.

⚙ **RCA Victor TC-5**

I didn't get to review the disc version of this (LM-1728) and am glad to hear it in this optimum version on tape. The Munch reading of the Brahms orchestral part is unusually lovely, passionate but with a silky, lyric quality in the strings, a beautiful sense of wave-like dynamics (particularly effective on tape). Rubinstein, however, plays with his customary muscular brilliance, too often on the ugly, hard and unlyric side. His solo Brahms (piano solo) in recent RCA dises has been excellent; but though there isn't a technical flaw to be found in his playing here—he is a master pianist, after all—I *don't think you'll find* that the piano and the orchestra are ideal partners in the enterprise.

The usual big rather distant liveness of the Boston recordings, presumably in Symphony Hall.

⚙ **Janos Starker Cello Album, vol. 1. (Boccherini: Concerto in B Flat; Mozart: Cello Concerto; Corelli: Sonata in D minor; Vivaldi: Concerto in D.** (Last two with piano accpt.) Janos Starker; Castle Hill Festival Orch., Pilzner. Marilyn Meyer, pf.

⚙ **Connoisseur D-104**

This corresponds to Period LP-579, at least as to the two main concertos. Livingston has launched (see "Audio ETC") an ambitious and potentially excellent arrangement whereby tapes of a number of smaller record companies will be released on a combined label.

There's nothing wrong with the idea except the results so far—or lack of same. It's early in the game, and time will doubtless allow the Livingston people to catch up with their own publicity. So—keep an eye on the future of this Connoisseur label. Meanwhile—

The Starker album is one of those cello specials that give non-cello fans the creeps. Here are two cello war-horse concertos excellently played by Mr. Starker, to be sure, but with an orchestral backing that I am tempted to call wretched, by professional standards. The two extra items are typical solo recital fare, piano accompaniment replacing in one case the proper harpsichord and second cello, in the other an entire orchestra. For anybody but a cello fan this is just plain nonsense on records—disc or tape. (But if you like cello music, this may be for you after all.)

Equalization is, according to the album information, to the NARTB characteristic and warning is given that boosted highs must be rolled off. But, curiously, I found that the tape itself needed a fair boost in the highs on the same Ampex that played the RCA tapes ideally; moreover, the bass must be rolled off very severely on the same playback, or the cello growls like a walrus. Allowing due leeway for mike placement and the rest, it still seems clear that these tapes and the RCA's are not recorded according to the same playback characteristic. But the RCA tapes also are categorically stated to be NARTB. So here we go again!

With the above adjustments, this tape is good in sound. No complaints on that score. Alignment is correct—that doesn't account for the relatively weaker highs. The answer, as best I can figure it, must be in the continuing confusion over a tape playback curve, one half of the record-play cycle, as opposed to an over-all record-playback "curve" that is flat to stated tolerances. Every recorder has that. (Or should have.)

Every recording curve has a matching playback curve and the two must add together to flat response, as closely as tolerances require. But that is no substitute for the all-important uniformity in one half of the cycle—either half—that evidently

is yet to be achieved in the industry. How about a "T.I.A.A." curve to complement the present widely accepted R.I.A.A. curve for disc records? T for tape, R for record (disc).

(The above is the only Livingston-Connoisseur tape received before press time for this issue; others are expected that will have a more representative interest for the general reader.)

(No A-V tapes so far received for review. We expect them momentarily.)

ALL ⚙ Sorkin Symphonette. (Vivaldi: Concerto-Grosso in D Minor. Mozart: Eine Kleine Nachtmusik. Bach-Stoessel: Prelude in E. Tchaikowsky: Serenade for Strings, op. 48. Bolzoni: Minuet.)

⚙ Webcor 2923-3

This is the only "original" tape in all of these here discussed—that is, it contains material not available on regular LP disc. As can be seen from the title, it falls into the semi-background "program" category that is so evident in tape offerings now.

For those who are looking for this kind of material, the present tape has its attractions; for the man who is interested individually and severally in these diverse works, from the early 18th to the late 19th centuries, the program is arbitrary and the playing depends on the piece.

This is a competent string group and we have here a typical list of string-group repertory music—like the typically cello program on the tape preceding. The Vivaldi is played with vigor but as a chamber work, like an enlarged string quartet, minus the harpsichord continuo accompaniment and the typically big sound that those who know Vivaldi now expect. The Mozart is played expertly and the string ensemble is right for it; the Tchaikowsky, a bigger and longer string piece, is adequately realized. The Bach arrangement and the Bolzoni Minuet are in the nature of encore pieces, as here offered.

In other words, as a disc record this would scarcely merit a line or two of comment, in the flood of more interesting discs that continues to be issued month by month. As a tape, it gets out-of-the-way consideration—for the present. That is only stating the situation as we must begin to look at it now. For tape must sink or swim on its own merits as to content.

(Unless, of course, we assume that tape is a highly specialized de luxe medium fit mainly for specific uses such as discreet background, super-hi-fi sound and the like. Heaven forbid this! I, for one, propose to listen to tape exactly as it is presented to me—a new medium for recorded sound.)

Technically, to return to Webcor, I'm sorry to have to state that this record is the mate of that reviewed in the November issue, evidently out of the same engineering train of events. The sound is only so-so at best (according to tape standards of excellence, of course), the level is extremely high, with some overloading, and again there is a serious problem of equalization; the highs need boosting and the lows rolling off for Ampex-type playback, nor are the highs very convincing even when equalized.

But a more serious fault is poor alignment, as far as I can observe. Played on my machine, the first track is correctly aligned, but the second track is badly out of alignment with consequent distortion and loss of highs. Perhaps it was an unlucky accident such as happens to all of us; but it has to be reported.

(Yep, my machine could conceivably be itself out of alignment—but note that these two tracks are not aligned to each other. That will show up on any machine except, perhaps, one that just happened to be misaligned exactly equidistantly from both tracks. Unlikely chance.

* * * * *

I'd better say as a postscript to this tape review that I do *not* propose to remain the ogre among record reviewers for any longer than I have to! As noted in "Audio Etc.", this seems to be a time of such enthusiasm in the publicity departments that we who have to comment on things find ourselves more or less automatically in the rear guard, damning with what is bound to be relatively faint praise, after publicity gets through.

when equalized.

POWER for the FAIRCHILD

I am sure that this is a temporary condition. Nobody knows better than I do how good tape *can* sound, in its proper place. The tape record was a foregone conclusion when tape first appeared and, as already mentioned elsewhere, you'll find it discussed in these columns at length 'way back in 1950 and 1951. It was a bit earlier still that another magazine refused a column about tape in my weekly department on the grounds that it hadn't enough *general* interest. I still have it on file.

So, though I'm sure that disc isn't going out for good either next week or next year, I'm equally certain that tape records are going to spread, expand, and most of all, improve, until at least a goodly proportion of the present enthusiastic claims will have actually been fulfilled. Tape, therefore, will be regularly reviewed from here on, as it apears, without special fanfare.

Discoddities

L **Mitchell Miller, Oboe.** (Mozart: Concerto K. 314, J. C. Bach: Andante. J. S. Bach: Adagio; Arioso. Mitchell Miller; Saidenberg Little Symphony.

Columbia ML 4916

Another "solo recital" record but with more general interest. Miller is top "pops" man at Columbia, a honey-smooth oboe man too; all these works sound alike, warm, smooth, bathed in big liveness. None is outstanding in its own field. Several are arrangements.

o **Christmas 'Round the World.** Choral arrs. by Canteloube. Group des Ch. Trad. de Paris, Orch. des Champs Elysées, M. Honegger.

Westminster WL 5372

Any time of year this is a "find" for all who remember the unique "Songs of the Auvergne", French songs set by this same Canteloube in sweetly perfumed but ultra-musical orchestral arrangements. These are immediately similar though some are for chorus unaccompanied, a few with solos. Ultra-French—including "Le Premier Jour de Noel" (First Nowell) and "Mon Beau Sapin" (O Tannenbaum)! Evidently from 78 discs—quality OK for good listening.

c **Mozart: Eine Kleine Nachtmusic, K. 525; Ein Musikalischer Spass, K. 522.** Vienna Konzerthaus Quartet with double bass, two horns.

Westminster WL 5315

A very musical and Viennese performance of the familiar "Little Night Music"—only five instruments, but with big liveness—and its opposite number of the same period, the Musical Joke, a delightful bit of music in spite of a collection of every technical mistake in harmony, counterpoint and composition that the worst music student could commit! Nobody but Mozart could write mistakes so beautifully. Played a bit too seriously here for my taste, as though the mistakes weren't there. They are.

* **Antheil: Ballet Méchanique (1924). Henry Brant: Signs and Alarms (1953); Galaxy 2 (1954).** N. Y. Percussion Group, Surinach; Henry Brant and Chamber Group.

Columbia ML 4956

Phew! This rates at least a column of comment. Briefly, here are two radical experiments in musical construction with new sounds, one from 1924, violently "modern" but—amusingly enough—wholly a product of the now familiar Roaring Twenties and as "dated" stylistically as an early blues song—and the other from the day before yesterday and doubtless as typical of the New sounds of the Fifties. Both are violently hi-fi (though not intentionally as far as the composers are concerned) both produce odd and wonderful noises, either one will blast you or knife you effectively right out of your seat. Exciting listening.

The Antheil, a celebrated if seldom-heard piece, uses airplane propellers as one of its noisemakers;

an enthusiastically angular piece in the boiler-room tradition. Brant's two works for "chamber" group—about as chamberish as a loud brass band—produce strange, jazzy atonal blats and fragmentary slides from ordinary instruments, super-high-power; a clear jazz influence, gone modern, the whole beautifully organized. A provocative and interesting shocker of a disc.

*** Full Dimensional Sound—Further Studies in High Fidelity.** Assorted excerpts, notes by Charles Fowler.

Capitol SAL 9027

If you must have hi-fi demonstration, Capitol provides the sanest and best means for it in this series—this is number two. The excerpts are short but complete, one side pops, the other classical (the ear won't hear any very great difference, for that matter); each is on a band and no sudden fading-in or out. The continuity (if you don't mind jumping wildly from Villa Lobos to Yma Sumac to Brahms and back) is outwardly well done—Brahms even matches Stravinsky in key in one juxtaposition.

The recording is super-hi-quality and audibly so; it's packaged in heavy sealed plastic and Mr. Fowler's notes are enthusiastic and detailed—we are warned to read them first, for fullest enjoyment of the fi. The record has much of the quality of tape itself, the greater clarity, the shining detail work, the ultra-quiet background; indeed it represents a kind of three-quarter point between regular disc and regular recorded tape, and the price is midway between, as well. We could use more "standard" discs of this specially-prepared sort.

A happy alternative to Westminster's competing Lab series, which deals with whole works especially recorded for hi-fi.

Saint-Saëns: Carnival of the Animals. Ibert: Divertissement. Concert Arts Orch., Slatkin. Victor Aller, Harry Sukman, pfs.

Capitol P 8270

D Saint-Saens: Carnival of the Animals. P Debussy: Petite Suite (2 pfs.). P Ravel: Mother Goose (2 pfs.) Chamber Ensemble, Izler Solomon; Bartlett & Robertson, pfs.

M-G-M E 3114

It's getting to be a hard, hard world! Somehow even a sweet, humorous piece like this little Carnival now has to be made tough and steely in the playing before it'll sell, it seems.

The Capitol version is good in style and in recording but both the orchestra and the pair of pianos play with shotgun intensity and very little of the easy, leisurely humor that's inherent in this well-made and gentle French satire. I don't find it a bit funny. The more modern Ibert Divertissement, a jazzier satire, comes through much better and more suitably under the same treatment. It's good.

As for the M-G-M Carnival (in the original small chamber ensemble version), it's recorded in a frighteningly dead closet of a studio with all the unbuttoned humor of a court martial. All the notes are there, with virtuosity—but these must be litle men from Mars playing, with baleful eyes and radomes on the tops of their heads. Gives me the shivers.

But I'll have to hand it to Bartlett and Robertson for their work on the obverse, in the two-piano originals of the Ravel and Debussy pieces. Perhaps the music isn't quite as sensitively perfumed as it might be ideally, but this smooth, suave performance is in good taste and not overly hard-surfaced. Perfect teamwork, of course, and very good piano recording. (Why do two pianos so often record more graciously than one? Because the mikes necessarily must be at a greater distance in most such recordings?)

*** American Bird Songs, Vol. 1. Second Issue. Cornell University Records (1 12" LP)**

Oddly enough, this is the second LP in the famous bird song series; the first was Volume 2. The original Volume 1 came out on 10-inch 78's in 1942; Volume 2 came out later on fancy red plastic 78's at a fabulous cost, then, belatedly, was transferred to LP. Now the old volume 1 has been redone with many new (tape) recordings for its LP version.

As always, the pleasant voice of Dr. A. A. Allen introduces the sixty birds here recorded.

Good continuity, one bird tape merging into the next with commentary "over" the sound. Excellent recording—but the level is, necessarily, abnormally loud for birds. For best playing: turn volume very low and listen to the record from another room. Then the birds are astonishingly realistic and natural.

Strange To Your Ears. The Fabulous World of Sound with Jim Fassett.

Columbia ML 4938

Mr. Fassett has for some time been filling occasional Sunday intermission periods in the New York Philharmonic broadcasts over CBS with various audible experiments in tape finagling; this disc brings the process into sharper focus and, I hear, is the basis of a guessing contest with prizes: all you have to do is to identify the strange sounds played on the last band of side two under various tape-inspired distortions—slow speed, fast, backwards, etc.

Mr. Fassett's approach is a bit on the ponderous side and, as the saying goes, a child could understand it all. It's not exactly an intellectual feast. But for nationwide distribution this is no doubt a necessity; just keep it in mind when you take your next IQ test. The sounds are extraordinary and for those who haven't played around with tape they'll be revealing and amusing. Canaries singing bass, duets between a high-pitched tuba and a double-bass flute, babies gurgling in deep baritone and so on.

(A wee bitty secret: if you want to win that contest, supposing that it's still on when you read this, just put your record turntable into neutral and spin it by hand fast or slow, frontwards and backwards, for each of the mystery sounds. You'll spot some of them pretty quickly!)

x **Young Violinist's Editions.** Supervised by Theodore and Alice Pashkus.

Remington LP (A series)

If you want to know How Violinists Get That Way, here's your answer, audibly and visually. This is one of those celebrated Methods that have dominated professional music training for centuries; the Pashkus system has helped turn out big fiddlers and is endorsed by people like Menuhin. (There are piano Methods, Singing Methods and a Method for just about any other instrument you can name, in the same vein.)

These discs have on one side complete performances, violin and piano (substituting for orchestra, often and on the reverse is the piano accompaniment for your own playing. But a tricky innovation has, instead of no solo part at all, a very faint echo of a violin playing in the background—just enough to put the wandering fiddler back on the track again if he gets lost in midstream. Also included are fat piano-violin scores, violin music, and, needless to say, a very fat and terrifying book of "preparatory exercises" constituting a portion of the Method itself. Don't even look at them unless you have ambitions towards stagehood with your fiddle.

A final mention might be made of the one missing element here—music. The stuff that is offered on these records, training pieces for the young violinist, is largely the most deadly, ninth rate insipid pseudo-Paganini hogwash you'll ever hear. Moreover, it is grossly out of date, representing mainly the bad lands of violin styling as of about 1860, will prepare no violinist for anything musically beyond Kreisler's Humoresque.

That's how violinists Get That Way. It's a wonder they survive as well as they do. How are violinists (or singers, or oboists, or harpists) ever to learn anything about music itself and how to play it? Pick it up hit-or-miss, between sessions with the Method.

* **Music for Harp.** (Casella: Sonata for Harp. Respighi: Antique Airs and Dances. Donizetti: Harp Solo, "Lucia", Act I. Laura Newell.

Philharmonia PH 109

Well, some musicians do survive and go on to higher things, musically. Harpists have their methods—and their private literature, for harpists' ears alone; this lady player goes beyond, into music of general interest here, as well as in earlier recordings. Not prodigious music, but good stuff and a lot more than typical harp background stuff. A sensitive and atmospheric player who can produce strong sounds when she wants to, as well.

Looking 'Em Over

(Note: Tape record reviews took up space that might have gone into this round-up section; more of it next month. E.T.C.)

SCHUBERT

x **Schubert: Symphonies #3, #6.** Orch. Conc. Colonne, Sebastian.

Urania URLP 7137

Big, rather brassy French playing, musical but cold and glittering, of these two warm little symphonies. Too hard, un-Viennese.

c **Schubert: Symphonies #4, #5.** London Philh., Dean Dixon.

Westm. WL 5274

Dixon's readings are honest, straightforward, a bit clumsy; this is his best Schubert yet, aided by Nixa's best British hi-fi recording, not too extreme here.

(For the other two early works, numbers 1 and 2, see last month's review of Beecham's Columbia recording.)

*ss **Schubert: Die Schöne Mullerin.** Dietrich Fischer-Dieskau, bar., Gerald Moore, pf.

LHMV 6

The familiar set of Schubert songs sung by a communicative baritone, with a fine pianist. These songs are easier for most of us as sung by a woman, but this is actually the more correct way. Picture for framing: Vermeer's The Cook.

x **Schubert: Quartet in D mi. ("Death & Maiden"); Quartettsatz in C mi.** Barchet Quartet.

Vox PL 8810

A good performance of late Schubert, not as high-powered nor as accurate as the Budapest's (Columbia) but thoroughly musical and expressive. Recording a bit harsh.

COMING EVENTS

Mar. 21-24—Radio Engineering Show and I.R.E. National Convention, Kingsbridge Armory, New York.

May 16-19—Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago.

Apr. 27-29—Seventh Region Technical Conference and Trade Show, I.R.E., Hotel Westward Ho, Phoenix, Arizona.

May 24-26—NARTB Broadcast Engineering Conference and the Annual Convention. Washington, D. C.

May 26-27—Electronic Components Conference, Los Angeles, Calif.

Aug. 24-26—Western Electronic Show and Convention, I.R.E., Civic Auditorium, San Francisco, Calif.

Sept. 30-Oct. 2—The 1955 High Fidelity Show, Palmer House, Chicago.

Oct. 13-16—The Audio Fair, Hotel New Yorker, New York City.

Oct. 21-23—New England High Fidelity and Music Show, Hotel Touraine, Boston, Mass.

PHONO PICKUPS

(from page 25)

resonances which influence the frequency response. The usual effect of these resonances is to produce peaks in the electrical output of the pickup. The location and amplitude of these peaks are a function of the physical and mechanical constants of the pickup, tone arm, and record material as well as the degree of mechanical damping which may have been added to the moving system.

The first of these resonances is known as tone arm resonance and occurs at some low frequency, usually between 10 and 50 cps, where the lateral compliance of the stylus suspension and the effective lateral mass of the pickup and tone arm combine to produce a resonant mechanical circuit. The second resonance is the stylus-to-groove resonance and occurs at a much higher audio frequency, usually 8 to 18 kc, where the effective stylus mass resonates with the compliance of the record material. These mechanical resonances are analogous to parallel resonance in a tuned electrical circuit. In both cases, a condition of resonance results in increased output voltage and a high value of driving-point impedance. This high driving-point impedance is manifested in a pickup by a tendency for the stylus to jump grooves at tone arm resonance and to climb the sidewalls of the grooves at stylus resonance That is, the mechanical impedance of the stylus tip increases at the frequencies of tone arm and stylus resonance, and the record groove must "work harder" to drive the stylus.

In designing a hi-fi pickup, it would obviously be desirable to choose the system constants so that all mechanical resonances would occur either below or above the limits of the audio frequency range. That this is not realized in actual practice, however, is due to the fact that the requirements of mechanical stability and finite physical size in a pickup impose a practical irreducible minimum on the mass and stiffness of a moving stylus. (It should be borne in mind that unlike other components in an audio system, a pickup is subject to abuse by heavy-handed operators, well meaning children, errant record changers, cracked and deformed records, household pets, and so on.)

Fortunately, the effects of mechanical resonances can be mitigated by judicious application of mechanical damping, and this is the current practice in all known commercial models of hi-fi pickups. The damping material may be any one of several viscuous materials and may be in the solid, semi-solid, or liquid state. Viscolloid, elastomer compounds, silicone grease, lanolin, and silicone oil are commonly used.

Figure 1 shows the frequency response characteristics of two commercial models of hi-fi pickups. The response curves were taken under open-circuit conditions, and by a method whereby the response of an "ideal" pickup would be represented by a horizontal line. The departures from an ideal condition can readily be seen in *Figure* 1. The rise in the low-frequency response is due to tone arm resonance and low-frequency stylus damping; the high-frequency peaks are the result of stylus-to-groove resonances.

The frequency response of a pickup may easily be determined under actual operating conditions in the home with the aid of the New Orthophonic test record which has been made available by the RCA Victor Record Division. This test record may be used in conjunction with the furnished calibration curve to check the response of a pickup alone, or it may be used to determine whether a pickup is properly equalized in a disc reproducing channel. If desired, the range of test frequencies available from this record may be extended in both directions by reproducing the record at turntable speeds above and below that at which it was originally recorded.

Tracking Capability

A most useful objective measurement on the performance of phonograph pickups is determination of the tracking capability. It is of no avail to build a wide-range pickup for hi-fi reproduction unless this pickup is also capable of tracking a modulated groove without introducing a serious amount of distortion. Listening tests have shown that the

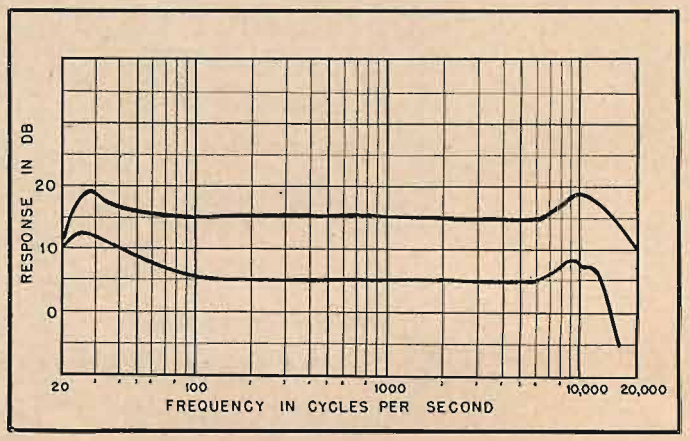


Fig. 1. Frequency response curves taken on two representative high-quality pickups. Flat response would be indicated by a horizontal line.

amount of distortion which may be deemed tolerable in an audio system decreases progressively as the frequency range of *the system is* broadened.

The tracking capability of a pickup is commonly expressed in terms of its generated intermodulation distortion. The significance of intermodulation distortion measurements stems from the fact that the ear is quite sensitive to the spurious signal components which result from intermodulation between two or more tones. A close correlation is thus achieved between laboratory measurements and subjective listening tests.

Intermodulation distortion may be measured by reproducing a test record containing several bands of a two-frequency signal recorded at various levels. The two frequencies which are mixed to produce this signal are 400 and 4,000 cycles. The ratio of the recorded 400-cycle level to the recorded 4,000-cycle level is maintained at 4:1. The electrical output from the pickup under test is fed into an intermodulation distortion analyzer, and the extent to which the 4,000-cycle "carrier" tone has been modulated by the 400-cycle tone provides a direct measurement of the nonlinear distortion due to pickup tracking.

As was found to be true of the frequency-response characteristic, the intermodulation distortion generated by a pickup is influenced by mechanical resonances and the manner in which the pickup is mechanically damped. It is an unfortunate property of damping materials that they tend to introduce nonlinearity into the moving system, particularly under conditions of high-amplitude stylus displacement.

Curves of intermodulation distortion versus recorded signal level are shown in *Fig.* 2 for two hi-fi pickups currently being produced. The up-turn of the curves in the region of high recorded levels is normal and of little consequence inasmuch as these higher levels are not encountered in fine-groove disc recordings. It should be noted here that the distortion generated by a phonograph pickup is not of a "microscopic" nature as in the case of audio amplifiers. This statement is not put forth as an apology, for the design of a pickup is a most arduous and painstaking endeavor. It is just the nature of the beast that a phonograph transducer will introduce some distortion into an audio channel.

A fair estimate of a pickup's tracking capability may be made in the home simply by listening for audible distortion while the pickup is reproducing an intermodulation test record. If the pickup is tracking properly, only the two tones originally recorded will be heard from the loudspeaker. Poor tracking, however, will cause spurious sum and difference tones to be generated and these are easily detected by ear. An oscilloscope for observing the reproduced waveforms is also very valuable, but with a little experience the aural method of distortion analysis produces satisfactory results.

Subjective Evaluation of Pickups

In the final analysis, of course, it is the quality of the reproduced sound which is of paramount importance in appraising the performance of any phonograph pickup. Although the results of a listening test can only be expressed in terms of subjective sensations experienced by the listeners, these results generally bear a close relationship to those which may be predicted on the basis of laboratory measurements.

In concluding this discussion, two suggestions will be offered which may be of value to the owner or prospective buyer of a hi-fi pickup who wishes to gauge the performance of a pickup by means of a listening test. First, a check on the mechanical design of the moving system in the pickup can be obtained by switching off the playback amplifier and reproducing a record containing high levels of modulation. Any pickup which produces an excessive amount of acoustic "needle talk" should be viewed with suspicion, since the factors responsible for high "needle talk" also appear to be responsible for accelerated record wear.

Second, experience has shown that an A-B type of listening test, wherein two pickups are switched back and forth into the playback channel, is far more significant than a simple listening test on one fixed system. This procedure effectively minimizes the variables which are introduced by the rest of the audio system. In particular, loudspeaker characteristics and room acoustics may cause a listening test on a fixed system to be misleading or inconclusive.

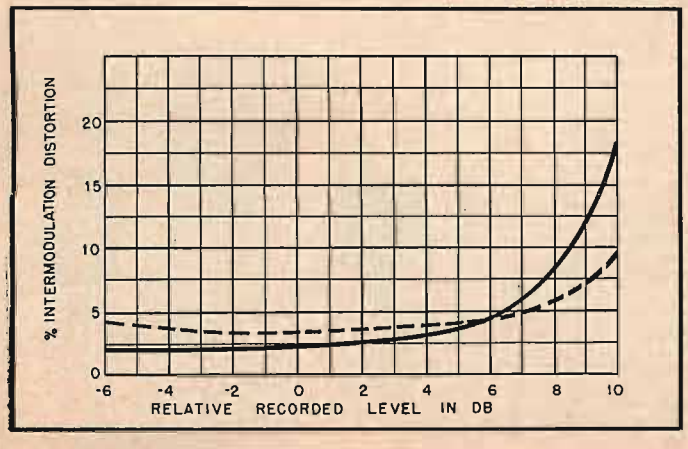


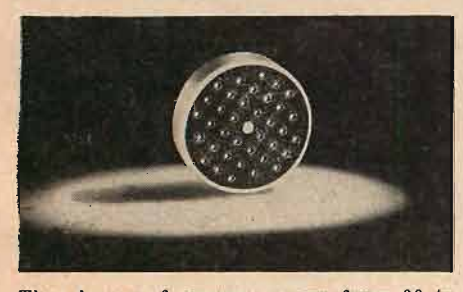
Fig. 2. These intermodulation curves on two good pickups show that pickup distortion is far from negligible.

NEW PRODUCTS

• **"Secret" Tape Recorder.** Investigative work of many kinds will be facilitated through use of the new Secret Recorder which was recently put into full-scale production by Amplifier Corp. of America, 398 Broadway, New York 13, N. Y. Operated entirely by battery, the recorder offers excellent fidelity considering its small size. It is ingeniously camouflaged in an average-size leather briefcase which may be opened, carried, or put down without revealing the recorder in operation. The entire unit weighs only 11¾ lbs. and measures but 16" long × 12½" high × 4½" wide. The recording microphone is built-in. The unit records continuously for 90 minutes at a tape speed of 1⅞ ips using long-play tape. A 5-in. reel accommodates three hours of dual-track recording. Included in the recorder is a built-in preamplifier for headphone playback. Recorded tape may be played back on any standard machine operating at 1⅞ ips. The low-drain motor is powered by five replaceable mercury batteries, and the

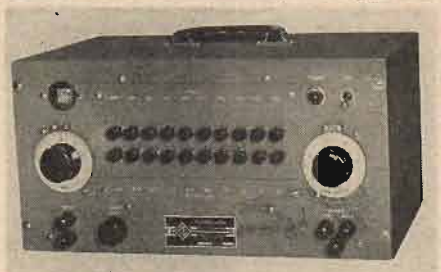
amplifier is powered by standard dry-cell batteries. Electrical re-wind transfers an entire spool of tape in less than two minutes. Descriptive literature will be supplied upon request to the manufacturer. **M-8**

• **Crystal Microphone Cartridges.** Manufacturers of recording equipment and public-address systems will find interest in the new Ronette piezo-electric "Filtercel" microphone cartridge which employs a patented acoustic filter network that permits factory pre-adjustment of the response curve. Damping imposed upon the diaphragm by the filter reduces resonances to a minimum. Filtercel units have a sensitivity at 1000 cps of 2.2 to 2.6m/μbar.



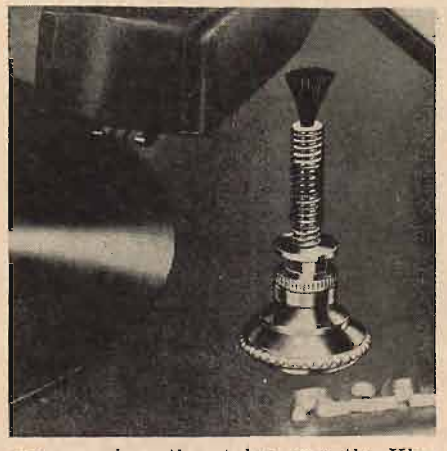
They have a frequency range from 30 to 7500 cps and can be supplied with almost any variation in frequency curve desired. Diaphragms are of annealed aluminum. The cartridges are fully guaranteed for use in tropical countries! Made in Amsterdam, Holland, the Ronette Filtercel is imported exclusively by Ronette Acoustical Corporation, 135 Front St., New York 5, N. Y. Technical data will be furnished on request. **M-9**

• **Push-Button Test Oscillator.** Any of 19 different pre-selected frequencies in the range from 20 to 20,000 cps may be chosen by push-button controls on the Model TO-100A Test Oscillator manufactured by Teletronics Laboratory, Inc., 54 Kinkel St., Westbury, N. Y. A deviation dial permits calibrated deviation from the center frequencies up to ±10 per cent. Output fre-



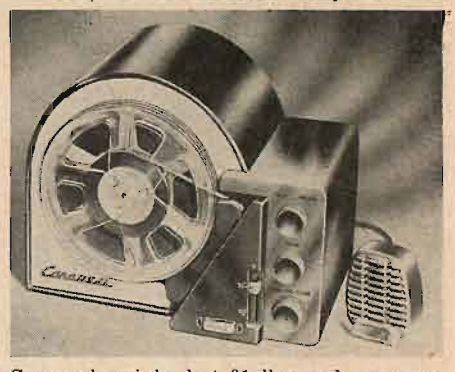
quencies include those recommended by the FCC for distortion measurements on broadcast transmitters. The output amplitude of the oscillator is calibrated from 1 to 25 volts open circuit from a 600-ohm source. Waveform distortion at 18 mw output is less than 0.25 per cent above 100 cps and less than 0.5 per cent below 100 cps. Facilities are provided for calibrating an external signal of unknown frequency by means of a zero-beat indicator. Factory modifications can be made to extend the frequency range to 100 kc. **M-10**

• **Changer Needle Brush.** Known as "KLee-NeeDLE," this device automatically removes dust and lint which accumulates around the stylus of automatic record changers. The accumulation is removed each time the changer cycles, and in the



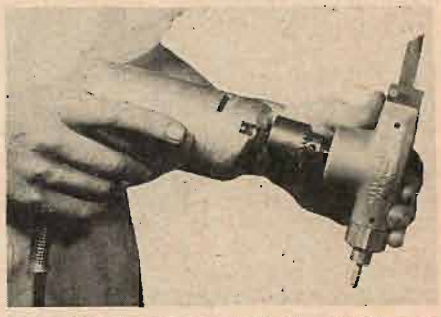
process wipes the stylus over the Klee-NeeDLE brush. The unit is adjustable in height and fits most record changers. It is fastened to the changer by means of pressure-sensitive adhesive. Robins Industries Corp., 82-09 251st St., Bellerose 26, N. Y. **M-11**

• **Unique Tape Recorder.** Coaxial mounting of supply and take-up spools is only one of many unusual features which characterize the TRI-FY Carousel, a dual-speed tape recorder recently placed on the market by Tape Recorders, Inc., 1501 W. Congress St., Chicago 7, Ill. The Carousel accommodates all standard reels up to 10½ in. and will play up to eight continuous hours before repeating itself automatically and endlessly. Finger-tip control varies recording speed from 3 to 8 ips, with calibrated stops at 3¾ and 7½ ips. Frequency response is said by the manufacturer to be 50 to 12,000 cps at the higher speed, and up to 6000 cps at the lower. Flutter and wow are stated to be less than 0.3 per cent. Among other features are high-speed rewind and fast forward, and an all-triode amplifier. The



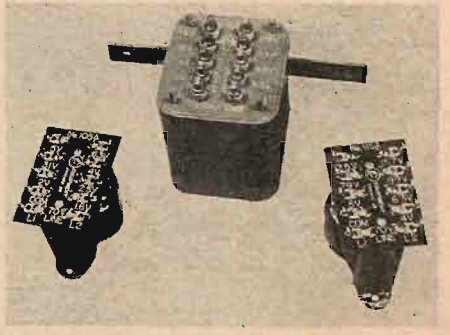
Carousel weighs but 21 lbs. and measures 10" × 12" × 8½" minus spools. In addition to its value as a standard home tape recorder, it offers definite advantages as a source of background music for industries and public places. **M-12**

• **Portable-Electric-Drill Accessory.** Hefty Holer is a compact tool attachment which makes a power jig saw and nibbler out of



any portable electric drill. It may be used to saw wood, plastic, plasterboard, or any other structural material, or to cut metal of any kind in pipe, rod, or sheet form. When used for sawing it requires no starting hole. The unit will nibble sheet metal, metal lath, wood, plastic or composition, requiring only a quarter-inch starting hole. Manufactured by Little Beaver Industries, 38809 Mentor Ave., Willoughby, Ohio. **M-13**

• **Matching Transformers.** Line-to-speaker matching transformers for sound systems utilizing 70-volt distribution techniques are now available from Electronic Communication Equipment Company, 1249 Loyola Ave., Chicago 26, Ill. Three sizes are being made for feeding individual speakers or banks of speakers requiring up to 5, 15, or 50 watts. Efficiency of the transformers is 90 to 95 per cent. Models are available for either indoor or outdoor applications; the outdoor types are her-



metically sealed and require no additional weather protection. Full specifications may be obtained upon written request to the manufacturer. **M-14**

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UNIVERSITY *Classic*

MULTI-SPEAKER SYSTEM

Offering theatre quality for the home, this system incorporates some of University's outstanding engineering achievements. The Classic utilizes the famous C15W 15-inch Woofer, the Cobrafiex-2 Mid-range Horn and Driver and the new HF-206 Super Tweeter. The N-3 Crossover network, and 'brilliance' and 'presence' controls complete the system. The enclosure is a newly designed folded, front-loaded horn type, which operates the Woofer as a compression driver. Due to this design, the acoustic performance of the Classic is independent of the walls and floor of the room. Simple in styling, the Classic blends with any decor, and it may be used either as a lowboy or highboy console. The base is adjustable for this purpose. Nominal impedance is 8 ohms, power handling capacity: 50 watts.

Complete and assembled..... **$395.00**

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MIRAPHON

XM110 MANUAL PLAYER

This outstanding three-speed manual player incorporates a specially designed four pole motor with a high constant speed factor reducing wow to a minimum. The motor is mounted in vibration-free, low rumble, ball bearings and is totally shielded to prevent magnetic hum pickup. The tone arm and turntable are suspended on ball bearings. This suspension of the tone arm provides high lateral compliance and good tracking performance. Tone arm resonance is reduced to a minimum through the use of damped plastic mouldings. A plug-in head is furnished to accommodate any choice of cartridge. A finger-tip adjustment permits setting stylus pressure.

Less cartridge..... **$37.50**

New PICKERING

TURN-OVER CARTRIDGE Model 260DS with Diamond and Sapphire Styli

Following the enthusiastic acceptance of the Model 260DD Dual Diamond Cartridge, Pickering now announces the Model 260DS with Sapphire stylus for standard and Diamond for microgroove. Both cartridges are otherwise identical.

Response is smooth and clean from 20 to 20,000 cycles. Lower moving mass and higher compliance provides excellent tracking at low stylus pressure, and good transient response. These and other design features result in lower harmonic and intermodulation distortion. The Model 260DS fits most pickup arms and operates directly into conventional low-level preamp inputs.

Model 260DS — Diamond-Sapphire..... **$48.00**
Model 260DD — Dual Diamond..... **60.00**

New ELECTRO-VOICE Model 666

Super-Cardioid Dynamic Microphone

A wide-range, unidirectional microphone with a single moving element and featuring unusually high front-to-back discrimination. Frequency response is uniform from 50 to 13,000 cycles. The output impedance is 50 ohms with internal provision for easily adjusting to 150 or 250 ohms. Output is —57 db (Ref. 0 db = 1 mw/10 dynes/cm2).

The Model 666 is ideal for TV, radio, recording and other applications calling for high quality, and can be used with boom, floor and table stands, and other microphone mounts. Weighs only 11 ozs.

Complete with Stand Coupler and 20-ft., 2-conductor cable with Cannon UA-3-11 connector..... **$147.00**

Model 366 — Boom Shock-Mount..... **24.00**
Model 420 — Table Stand..... **12.00**

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MOHAWK Midgetape

The World's FIRST Battery-Operated Cartridge Loaded POCKET TAPE RECORDER

Perfected after years of engineering and research by the Mohawk Business Machines Corporation, this tiny pocket-sized recorder operates anywhere . . . car, plane, on ship or train. Has many uses — in business conferences, contacts with field offices and salesmen, and business talks, on-the-spot interviews, court proceedings, accident reports, public opinion polls, etc. Men on the road can record sales and other data, pop out the cartridge and mail to the head office for transcription. Cartridge-packaged tape, eliminates tape threading. Cartridge capacity for one full hour of recording at 1⅞" tape speed. Indicator tells remaining recording time. Manual device rewinds tape in less than one minute and conserves battery life. Has simultaneous erase and record for reusing tape cartridges. Automatic Volume Control assures proper recording level at all times. Has settings for long range and normal recording pickup. Available accessories include: Wristwatch mikes, throat mikes, shoulder holster carrying case and two-way telephone recording adapter. Owner registration by serial number, plus unusual and valuable service to owner. Measures only 8½ x 3⅞ x 1⅞ inches and weighs only 3¼ lbs.

Complete with one cartridge of tape, microphone, earphones and batteries..... **$229.50**

New FAIRCHILD AUDIO UNITS

The Balanced-Bar PREAMPLIFIER Model 240

The new Fairchild 240 was developed after extensive engineering research and elaborate listening tests. Out of these has come a new idea in high fidelity amplification. The 240 has combined studio quality design, layout and wiring with attractive external styling suitable for use in any decor.

Three high level inputs are provided for radio, tape and auxiliary. One low level input is designed for use with magnetic cartridges. A cathode follower output permits long leads to main amplifier. An additional low impedance output is provided for use with tape recorders. Eight record equalization positions cover all commercial recording characteristics.

Front panel controls include: input selector knob, balanced-bar bass and treble controls, volume control and listening level selector switch. The latter is a specially designed circuit that gives the advantages of the 'loudness control' without its many disadvantages. Frequency response extends from 20 to 20,000 cycles ± 1db. Harmonic distortion is less than 1% at 1 volt. Power supply is self-contained with DC furnished to all tube heaters.

Complete with tubes..... **$98.50**

50 Watt AUDIO AMPLIFIER Model 260

A professional-type amplifier so stable that it is guaranteed not to ring at any level, even where two-way or three-way speaker systems are used. Full undistorted power is available for crashing crescendos and other transients which often overload ordinary amplifiers. The Fairchild 260 is a single, compact unit, easy to install almost anywhere. Exclusive Balance Control permits aural checking and adjusting of output balance at any time. There is also provision for measuring and balancing cathode current in output tubes. A damping factor of 9 was chosen after extensive research. Has adjustable bias supply for achieving lowest possible distortion. Intermodulation Distortion: Under 0.3% at 45 watts, 1.5% at 50 watts. Harmonic Distortion: Under 0.1% at 45 watts, 0.5% at 50 watts. Frequency Response: within 0.5 db, 20 to 60,000 cps. Full 50 watt output with 0.9 volt input. Controls: Master Gain, Bias Adjust, AC Balance, Test Jack. Output: 4, 8 and 16 ohm terminals. Uses specially designed output transformer and 1614 output tubes in push pull.

Complete with tubes..... **$149.50**

HARVEY RADIO CO., Dept. A-3, 103 W. 43rd St., New York 36, N.Y.

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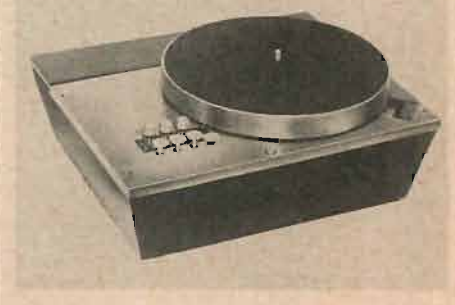
Super-Cardioid Dynamic

any level, even where two-way or

• **Hi-Fi Amplifier Combination.** A preamp-equalizer-control unit and a matching power amplifier are the latest items to be added to the line of sound equipment manufactured by Webster Electric Company, 1900 Clark St., Racine, Wis. The

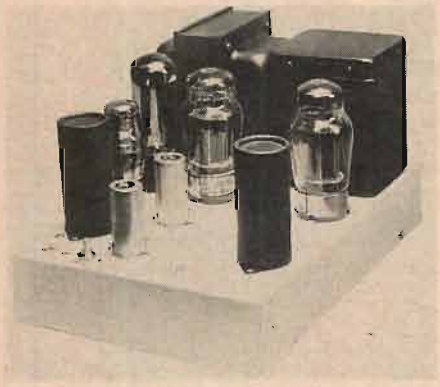
Model 97-0 control unit is provided with a 6-position input selector, equalization controls which provide 25 combinations of settings for various types of recordings, separate bass and treble controls with boost and cut of 15 db, and a special filter control for minimizing scratch in old or worn records. The unit also includes a master gain control and a loudness control. Frequency response is 20 to 20,000 cps ±1 db. The matching Model 96-10 10-watt power amplifier is flat within 0.5 db from 20 to 22,000 cps at full rated output. Harmonic distortion is 0.75 per cent, also at full output. Noise level is down 80 db. Requests to the manufacturer for further information should specify Bulletin R8A1. **M-15**

• **Scott Turntable.** Unusual operating convenience is provided by push-button selection of speeds in the new Type 710-A Stroboscopic Turntable recently introduced by H. H. Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass. Designed for professional as well as home use, the unit operates at 33-1/3, 45, and 78 rpm, with each speed adjustable by ±5 per cent. Wow and flutter have been reduced to less



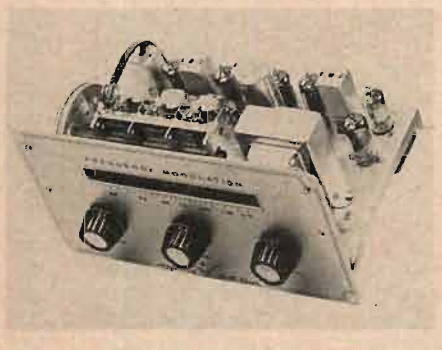
than 0.1 per cent, and rumble is more than 60 db below recording level. Installation is simplified by the fact that the stainless-steel turntable board can be mounted directly on a cabinet without additional vibration isolation. An accessory mahogany base is available where cabinet mounting is not desired. A free technical bulletin will be mailed upon written request to the manufacturer. **M-16**

• **Altec Lansing Hi-Fi Amplifier.** Exceptional in both performance and appearance, the new Altec preamp-control unit and companion power amplifier introduce a number of advanced features in audio design. The self-powered Type A-440A control unit has two low-level and three high-level inputs with individual gain controls, choice of compensation for 25 recording characteristics, separate wide-range bass and treble controls, and selection of either conventional volume control or loudness control. It is housed in a



handsomely-styled cabinet with a hinged door which, when closed, conceals all controls except the one for adjusting volume. With the door open all controls are accessible, and the inside of the door contains information on various recording characteristics. The A-340A power amplifier delivers 35 watts with less than 0.5 per cent distortion and has a frequency range of 5 to 100,000 cps within ±1 db. It is equipped with a variable output-impedance control and a gain control. Altec Lansing Corporation, 161 Sixth Ave., New York 13, N. Y. **M-17**

• **FM Tuner Kit.** An economical approach to a high-fidelity music system may be found in the new Model V-9 FM tuner kit which is being sold direct to users by the manufacturer, Approved Electronic Instrument Corporation, 928 Broadway, New York 10, N. Y. The unit is self-powered and covers the range 88 to 108 mc with bandwidth of 200 kc. Circuitry includes 2



limiters, discriminator, and a tuned r-f stage. Sensitivity is 10 microvolts for 20 db quieting. The kit is supplied complete with a. c. power supply, all tubes, and pictorial and schematic diagrams. Complete information is available from the manufacturer. **M-18**

FM TUNER

(*from page 24*)

layout to fit special conditions are possible, of course, but it is recommended that the four i. f. and limiter stages be run in a straight line if possible to avoid regeneration, which may show up as a narrowing of the i. f. bandwidth and consequent distortion. The i. f. transformers specified are designed for mounting on 1/16-in. material, so that it is necessary to modify the shield-cans as shown in *Fig.* 5 (B) in order to mount them on the ⅛-in. chassis. The Meissner i. f.'s can barely be mounted on the ⅛-in. chassis, as can the Miller units using Meissner mounting clips, although a far sturdier job results from the modification shown. The template shown in *Fig.* 6 (B) and used for marking the new mounting slots is made from the can of a discarded i. f. transformer. The 262.5-kc model, whose can is identical to that of the 10.7-mc model, abounds in the trash receptacles of radio-repair shops due to leaking windshields and ventilators in automobiles. With a pair of tin snips the old can is split in half longitudinally; the lower one inch of one half is cut off and pressed flat, and is cut and bent according to the drawing to make the template, whose purpose is to mark the new slots on the new shied cans, 1/16 in. below the original ones. A simpler but less attractive method of mounting would be to mount the i. f. transformer on the mounting adapter plate furnished with each unit, and mount the adapter plate in turn in a 15/16-in.-diameter hole in the chassis. Although the shielding would be less nearly perfect, it might work. The cans should be removed from the new i. f. transformers for marking and cutting. The template is slipped on the new can, the outline of the new slot scribed, and with a small trianglar file the metal inside the line is filed away. All filings should be blown from the can before reassembly.

While the construction of this tuner is somewhat simpler than that of a tunable one, it is not a project for the novice constructor. Any experienced radio builder should be able to complete it without difficulty, and an experienced constructor of high-gain audio equipment, by pretending that the wire for signal leads cost about $100 per inch, should be able to duplicate it without undue hardship.

The alignment is quite straightforward, and is preferably accomplished with a sweep-signal generator, an accurate marker generator, and an oscilloscope. A 10.7-mc crystal marker will be found of great help. Point-by-point alignment without a sweep generator is also satisfactory, providing sufficient attention is paid to making the i. f. bandwidth a full 200 kc to avoid peak clipping under full deviation.

To those not familiar with crystal oscillators, it should be mentioned that alignment of the oscillator consists of tuning the slup of L_4 until oscillation is strongest, as indicated by maximum grid bias measured with a d. c. v.t.v.m., or by minimum screen current, measured by a voltmeter connected through isolating resistors across R_{20}; then back off the slug about a quarter turn in the counterclockwise direction. The quadrupler plate circuit is tuned for maximum gain in the mixer stage as indicated by maximum first-limiter grid current with a weak signal tuned in. The v.t.v.m. is connected across R_{17} this time.

If the crystal is of the proper frequency, and if the i. f. has been accurately aligned, the average d. c. voltage at the output of the discriminator (across C_{32}) should be zero with the desired station tuned in. If it is otherwise, the i. f. system should be realigned.

The cost of the parts for this tuner was about $60 net, although certain economies may be effected by the use of surplus components. Substitution of less expensive tube types is possible without too serious impairment of performance. In any case, it beats cheap tuners (and most expensive ones), costs far less than many, and the escape from bad music is worth almost any price!

COIL TABLE

L_{1A}: 3 turns #18 enam. ⅜-in. i.d., close-wound.
L_{1B}: 8 turns #18 enam. ¼-in. i.d., close-wound, tapped 1½ turns from ground.
L_2: 5 turns #18 enam. ¼-in. i.d., 7/16 in. long.
L_3: 5 turns #18 enam. ¼-in. i.d., 7/16 in. long.
L_4: 13 turns #18 enam. (incl. terminal lugs, 1 turn ea.) ⅝ in. long, on CTC LS3 slug-tuned form.
L_5: 8 turns #18 enam. ¼-in. i.d., 7/16 in. long.
L_6: 10 turns #18 enam., bifilar wound.
Note: For low end of band add about 1 turn to all coils except L_6.

PATENTS

(*from page 2*)

capable of inventing who don't—simply because they can't think of anything to invent. Absurd? Not at all! The U. S. government has for a long time been issuing and revising a long list of inventions that need to be made for military purposes, in the hope that some inventor will see on the list a subject that interests him and go to work.

I am convinced that there is a multitude of people who have at one time or another though of functions they would like to see performed, gadgets they would like to have, problems that need inventive solution, which they themselves cannot solve for one reason or another. I am equally sure that readers of AUDIO must have in mind uses for possible inventions in the field of audio and that other readers can make these inventions if the need is shown.

We therefore invite you to put down on paper anything that occurs to you along these lines and send them to this column. Tell us what you think somebody ought to invent. We will include good "ought to invent" ideas in future columns, in an attempt to stimulate someone to invent them.

The ideas should include anything in or related to audio—sound transmission, recording, reinforcement, reproduction, control systems using audio frequencies, electronic music, anything at all in which audio might play a part. Tell in as much detail as you like why the invention is needed and, if you don't care to conceal them, any possible approaches that have occurred to you. If you have actually tried anything let us know what and why you think it was unsuccessful; all this will give leads to others.

Please note that this is *not* a contest; there is no prize and no closing date—simply write whenever something occurs to you. Also note that if someone invents something incorporating one of your ideas published in this column, you are not entitled to any remuneration.

Please do me two favors. First, if you can find a typewriter, use it rather than pen and ink when you write. Second, address me personally at the address in the footnote under the first column of this article. Editor McProud enjoys receiving mail at the AUDIO offices, but he simply hasn't the time to handle even as much as he does.

Perhaps one of the patents available from The Commissioner of Patents, Washington 25, D. C., for 25 cents will some day be yours or one you sparked!

AUDIO ETC.

Edward Tatnall Canby

1. Tape—Growing Pains

For some tape record reviews, see "Record Revue," p. 42; herewith a current look-see at the developing tape situation.

The last place in the world that you will find stuffy conservatism is in this department, which prides itself (and its earlier incarnation as part of the older "Record Revue" pages) as the acme of optimism. Anything new and exciting in audio, records, recorded music, belongs here if it has a chance of usefulness and a reason for success—present or future.

And so I tread on delicate ground when I find myself, these last months, playing a conservative tune about tape records. I know the advantages of tape quite intimately, as I do those of records; both get a weekly work-out in my establishment that can match the most ardent fan's operations, and I don't do it all for fun, either. I've been blessed with most of the advantages and cursed with most of the traps and snares in both mediums! And so I am all for tape and for tape's clear advantages over disc in potential sound quality and in durability under heavy use.

But I know, too, how a new commercial development gets launched these days. We've all seen how hi-fi hit the big-time and with what sort of, shall I say, enthusiastic promotion. Unfortunately, tape records are now subject to this time-honored phase of American salemanship and I'm not happy about it.

"Independent Labels Move To Invade Tape Field!" shouts a recent press release. "The swift expansion of the pre-recorded tape library and its surprising enthusiastic acceptance by the high-fidelity fraternity has encouraged many of the independent record companies to enter this relatively unexplored market."

True, no doubt, if we take this with a wee bitty grain of salt. The independent labels are indeed currently "invading" this relatively unexplored market. There is, let me assure you, plenty of exploring yet to be done. More of that anon. Nobody minds a bit of honest enthusiasm. But when a misleading impression begins to get around, then things aren't so good.

I'll admit that the American people are pretty well attuned to their own system of publicity and they ordinarily don't fall too hard for high-power claims. It's clear by now to any duffer that hi-fi at $8.98 isn't quite the same thing as hi-fi at $800 and so we have a semblance of an even keel in that department already, claims or no.

But tape is another story. People don't know enough about it yet. I am honestly distressed when I receive letters from otherwise intelligent people asking whether they'd better give up the idea of a new hi-fi phonograph, to replace their ten-year-old 78-r.p.m. Victrola, since they hear that nobody is going to use discs anymore. Hadn't they better buy a tape machine instead so they can play the new tapes?

That is plain poppycock, as of now, and it'll be poppycock for 95 percent of our music listeners for as many years to come as I dare imagine.

For the Record Collector's Information

I'm in danger of repeating myself—as is bound to happen after eight years of sounding off on Audio in general—and so I refer you, first, to this department of last August, 1954, under the title "Tips and Tapes," for most of what I'd like to say all over again here in regard to the value of tape and tape records for the *informed* audio amateur. But we're branching out now far beyond the informed, towards the uninformed "masses." And these respectable gentry, many of whom read this department, should understand three basic facts about recorded tape. Economy-wise, two of these factors are inherent in the tape process as compared to disc.

A. Cost of taped records. As pointed out in August, and confirmed by succeeding events, the cost of quality tape (at 7½ ips but with the new and commendable wide-range spectrum) has been running anywhere from twice to four times that of the same music on disc. The recent disc price cuts may or may not have been sparked by the threat of tape; I doubt it myself. But anyhow, they have left the tape record, as of this writing, out on a price limb. Unless tape records have been cut since this writing, the price differential is now nearly 4 to 1 in some cases. Phew!

There's no doubt that tape prices can come down, with greater production. But as pointed out in August, not only is it unlikely that tape will ever be as cheap as disc, minute for minute, but even if that becomes feasible, the price of tape (as a legitimate luxury item) will in all likelihood be held above that of competing disc by the many producers who are or will be in on both sides of the fence. Nobody wants to price his own products off the market.

Thus tape offers better quality sound than disc at a higher cost—much higher right now—and the cost is not likely to come down very far for awhile, as compared to music on disc. Period.

B. Cost of tape reproduction. But the tape itself is merely the first and more obvious factor in taped sound.

It seems to me that in spite of the improvements of the last five years in moderate-priced tape equipment, there is a serious gap right now between the facts of

** 780 Greenwich St., New York 14, N. Y.*

the matter and the impression the public is building up for itself.

Hi-fi tape *reproduction* is inherently more expensive than hi-fi disc reproduction. 2 to 1 is a modest figure; better put it at 3 to 1, or more. I think it is only honest to suggest that if you wish full sound value from the best current recorded tapes at 7½ ips, you must spend a minimum of $300, for a full tape machine, or perhaps $200 for the equivalent in tape playing mechanism minus the recording feature.

The very fact that the best of the new tapes are so excellent in quality makes this all the more necessary to understand. The higher the tape fi, the fancier must be your equipment to get the best of it.

The "semi-professional" tape recorder that falls into the $300 price range and on up to $550 or so is now enjoying a well deserved boom, as people begin to understand that here, indeed, *is* the minimum for real hi-fi tape sound. At this price, and not below, you may enjoy the high standards now possible on recorded tape at the slower speed. (You'll find a long discussion of this in the "Record Revue" of August and September 1950, concerning the then-new Ampex 400 with new heads that recorded to 15,000 cps at 7½ inches—now standard in all Ampex models including the portable 600.)

The lower-priced machines, to be sure, have been making long strides upwards in the direction of these high standards. We can hardly criticize them for somewhat lesser perfection, at a lower price. Far from it. The criticism rests entirely in the aforesaid impression, so widely held, that the lower-priced machines will play the new hi-fi tapes for all they're worth. That isn't quite true. A few lower-priced machines will play them with remarkably good quality, if not quite tops. (An equivalent in disc playing might be the sound from the best of the new ceramics—remarkably good—as compared to a high-quality magnetic cartridge.) But, even so, how durable can these machines be made, at a "low" price, at $150, $100, $75? As I say, tape reproduction is inherently expensive, any way you look at it.

Don't ever forget that you can buy a disc changer complete with installed GE cartridge and jewel points for as low as $35, and manual players come for a good deal less. (No tape machine short of the professional is as "automatic" as the simple manual disc player with automatic stop, plus in some models automatic arm return and even arm set-down.

Keep in mind, moreover, that you now may have a Columbia three-speed record player attachment complete with arm and the very good Ronette cartridge, two sapphire points, for the huge sum of $18! Operated through a good hi-fi system it will give you most of the fi on a good disc, though perhaps with a bit of extra rumble and wow thrown in. Tape playback equipment can't compete on these levels.

The tape-*vs*-disc "crossover point" for optimum sound value in the reproduction lies high up in the price scale. For pure hi-fi sound, don't dabble in tape at much below my hypothetical figure of $300 for a complete tape machine—and don't blame the manufacturers of equipment below this price, either. They're doing pretty well—at a price.

Of course, for the general music lover, the man who isn't out for pure sound quality by itself, the ultimate in sound quality is less important. Granted that for most of us there are many other features of tape that may count, too. And note well that even with relatively imperfect repro-

duction tape sound has a peculiarly pleasing quality, a Certain Something, a smoothness, which, as described at length last August, is undoubtedly due to the complete absence of metallic, mechanical stylus vibration. It's noticeable to any ear almost instantly, and this feature comes through even on the cheaper machines. Other things being equal, this unique quality of tape sound is of very great importance to almost anybody, hi-fi fan or musician, who collects recorded music.

(But don't forget the problem of durability-at-a-price. You may like your low-priced machine today; will you like it as much next year?)

C. Repertory. I mentioned three factors, the first two, above, being inherent in the tape medium. The third is the stuff available on tape, the sound itself. For a better look at this, you can jump from here to the "Record Revue" where it more properly belongs, on p. 42 this issue.

Suffice to say that as of this moment the tape record repertory is back where records were about 1930. Music on tape, to judge from current offerings and catalogues, is still in the hands mainly of those who don't know very much about music repertory. Few are clear yet as to what they are trying to offer—background, foreground, potpourri, specialty, hi-fi, or whatnot. And the *total* repertory available, in spite of optimistic publicity, is still simply microscopic.

Anybody's "fault"? Of course not. All of this is merely the normal process of early growth and we're merely heading into the normal period of trial-and-error growing pains. Of course repertory is small, to begin with; of course it won't compare in scope or size to that available on disc for a long, long time, possibly never. I merely point out these facts to those who may have misled themselves into ignoring the obvious and legitimate infancy of a new market.

As always, all you have to do is to apply the normal mental discount to any and all publicity. It's expected of you, I'm sure. Common sense should arm every record collector with enough caution to keep from falling overboard into recorded tape. Much better to explore with a couple of cautious toes, and feel your way soberly towards what, in the long run, will be a very worthwhile development.

* * *

I give you merely one example to indicate the present rudimentary state of musical thinking in the tape record business.

Last summer's A-V catalogue, now in front of me, includes a substantial classical section, of items taken from the Remington catalogue if I am right. (From the original Remington tapes, of course.) As of the summer of 1954 these classical items were listed according to the same lump system as the numerous pops and background items. There were "Organ Reveries," "Moments in Music," "Musical Varieties"—and, finally, "Concert Classics," some twenty five separate tapes with everything from Brahms to Verdi, listed merely as so many classical "programs."

In the latest A-V catalogue these same tapes reappear. But—brilliant idea—it occurred to somebody that the music should be *listed by composer.* And so for the first time we find Beethoven and Mozart and Prokofieff listed under their own names—instead of "Concert Classics"!

That's what I mean by 1930 thinking.

2. Sample Records

You'll forgive me if I refer once more to a back issue of this department, in reference to the following small item in a Capitol Records release of last fall which you may find interesting.

"In order to assure 'mint' condition of the record to the ultimate user, Capitol is offering a unique sample service to the record merchant at one third the wholesale price of each record so desired. The samples differ in no way from the regular stock and each such record may be exchanged for a new one at no further charge whenever its usefulness may have been impaired."

Now kindly look on page 46, third column, AUDIO, May 1953, RECORD REVUE." *"Demonstrators"* is the sub-heading. The suggestion is substantially as above. I thought then that the sample record was a logical and feasible offshoot of the sealed record and I wish Capitol the best of success. (Also anybody else who may have tried the same without my knowing about it.)

It's worth noting, historically, that back in 1953 virtually all LP records were still sold without inner protection, inside the cardboard envelope, and it was then that the returned-record "racket"—it was nearly that—reached such proportions that unfavorable publicity, including my own, began to have its effect. I gather that now, almost two years later, the situation is clearly improved. Restrictions on "trade-in" and trial records are more literally applied, and new inner liners of various sorts, paper and plastic, the increased use of closed boxes, plus such helpful minor alterations in the records themselves as RCA's raised outer edge, and in the casing, as in Columbia's new double cardboard container, all help to lessen the evils of record damage before final sale.

Even the sealed record—which many thought entirely impracticable two years ago, seems to be with us for good. But the general improvement in other areas has made complete sealing less imperative than it was two years ago. The various compromises now being worked out seem to offer the most generally satisfactory solution to the problem, with factory-sealed records a semi-luxury for those who appreciate it enough to pay extra.

3. Long Play Tape

By now everybody must have seen the ads for several brands of the new longer-playing tape. (It doesn't play any longer, of course, but being thinner, more of it can be put on a reel.) I've had a chance to work with some and hereby pass on a few good amateur reactions.

Other things being equal, a tape that will give half again as much playing time per reel is really something! Around fifty minutes at 7½ ips on a standard home 7-inch reel, instead of just over a half hour; and with double-track you can cram almost two hours on a single reel. But just how equal are "other things"?

First, as to price, I gather that you'll pay about the same per foot and per minute. No significant premium for this special privilege of longer playing. Good.

Second, as to sound quality, though there evidently are slight technical differences in response (for optimum response in professional work some bias change is recommended in at least one brand), in usual home and semi-professional use the standard and long-play tape are to all intents and purposes interchangeable. I patched sections of the two together in a broadcast and found no noticeable difference. That's important for us all. The high-*output* tapes, for instance, are quite radically different in response (intentionally) and one cannot blithely go from standard to high-output tape in one recording. I'm sure it has been done many a time, by mistake.

Same price, same sound, fifty percent more play per reel. Are there *any* disadvantages? What about the thinness of the tape? Does it break more easily? How does it handle?

That's the crucial point of difference, needless to say. And there would seem to be different approaches involved. Minnesota Mining achieves thinness via a new thinner oxide coating. Audiotape, Reeves Soundcraft, and Irish use the stronger Mylar base, spread thinner. I've tried only Minnesota so far and can report that without question it requires somewhat more careful handling, as might be expected, though in normal use, not counting slips and mistakes on the operator's part, it is entirely OK.

I'd suggest two things. First, this tape is more limp and soft than the standard. That means it's somewhat harder to thread, it folds, catches, tangles more easily, will require more precise and careful hand motions on your part as operator. If you are habitually a precise worker, if you don't break glasses in the kitchen sink when you wash them, then this will mean little to you. But for those with more hasty and impetuous fingers—be prepared for a bit more trou-

ble with this tape than with standard. If you're already a habitual tape fouler-up, look out!

Second, when things go wrong mechanically the thin tape is naturally a greater risk. Any amateur knows how often accidents happen that aren't supposed to. Tape tangles inside the reel, between the rolled tape and the sides; a length of it gets accidentally stepped on, or catches in some projection (like the levers on my typewriter, which are always catching tape loops); the rewind or fast forward gives a sudden jerk. In all these cases, damage will be somewhat greater with thin tape than with standard, and it can hardly be helped.

But thin tape plays half again as long, for the same space and the same cost-per-minute. Enough said! If you need the longer play, the new tape is a terrific blessing. If not, stick to the older standard thickness.

(We have used extensively the long-play tapes using the Mylar plastic base which achieve thinness by making the base only .001 in. thick instead of the customary .002 in. The Mylar appears to be indestructible by any ordinary means—a sheet of it .001 in. thick cannot be torn with the hands except perhaps by those who train on telephone books. In use the tape has not been torn or even significantly creased by such normally disastrous *faux pas* as instant switch from 7½ to 15 ips with a slack tape loop, forcible removal from between reel rim and spooled tape, or various yanks and tangles to which it has been subjected. It is proof against the most amateur and inept handling. Furthermore, it seems, if anything, slightly stiffer than standard tape, making it easier to handle and thread. Ed.)

Ampex 600

Speaking of tape and long-play, the Ampex 600 portable stands to benefit no end from its introduction. That relatively tiny semi-professional recorder does not take the big professional 10½-inch reels and was limited to a half-hour of continuous recording per track, until now. I used it for the full fifty minutes a week or so ago, on one track of one reel, and was very, very happy.

There are times, in recording concerts, lectures, unrehearsed events, when a reel change is just plain impossible for long periods. A fifty-minute stretch is long enough to cope with just about everything you'll ever run into and the reel-change on the Ampex is very handy and quick, the rewind silent enough for any location (unlike some others, which make a considerable noise). The slight inconvenience of the necessary more careful handling of long-play tape is a small price to pay for this extended playing time. It pretty much removes what, to my mind, was the only serious objection to the Ampex 600 as a home and semi-professional hi-fi recorder with unparallelled portability.

I've been using the 600 (as mentioned in an earlier issue) as my standard for double-track recorded tapes. Now, with the

addition of the low-impedance mike kit Ampex offers (standard equipment is a high-impedance input) I've doing some recording as well. I must say I'm really delighted at the performance of this mity mite, in the sort of portable situation that my recording almost always involves.

For the first time, last week, I was able to walk—not stagger—into an informal recording session of the 140-voice Dessoff Choir with my entire equipment in my two hands. I had already walked a couple of blocks from my parked car, without even a stop for breath. In one hand was a small bag with Altec mike and power supply plus 50 feet of extra cable, and earphones; in the other, the little Ampex suitcase. The mike bag was the bulkier of the two.

Last year it took me about seven trips to unload—and seven to reload, plus more trips at home, through two outer doors, an elevator and an inner door! That sort of thing is unpleasant for anyone who must work on his own without a corps of helpers, yet must have top quality tape too. The Ampex 600 is almost too good to believe, for that sort of work.

But this isn't the end of my account. The 600 has a built-in mixer with two inputs, mike and high-level, plus pots for each; like all Ampexes it uses the three-head system and you can monitor your tape itself from the output, as it is recorded.

The chorus in question was rehearsing in a small hall, hardly big enough to cram all the people in, with low ceiling, plaster walls. I couldn't get more than fifteen feet away at best, and the sound was dead, unbalanced, hard. Solution, for better recording: feed the 600 output into the high-level input for a built-in synthetic reverberation. Adjust to requirements via the high-level input volume control.

To be sure, I overdid it at first, and got some very odd oscillations—the high end gets out of control before the low end and your "echo" rises to a hissing waterfall of horror-chamber noises. When the conductor tapped on his music stand the taps echoed off into space like one of the new "musique concrète" electronic scores!

But when the proper level had been determined, I got a very considerably improved musical sound over the direct recording, and it was all done simultaneously with the recording itself. Neat feature.

A couple of minor reservations occur to me, concerning this otherwise extraordinary little machine. First, the wonderfully ingenious single-motor system, for record, fast forward and rewind, is interlocked for safety and is excellent for "rocking" back and forth, locating passages, skipping and all the rest. But, at least on my machine, it has one tiny but dangerous weakness. I'm not sure that I've pinned it down, but it is possible—and I've had it happen several times—to create a horrid snarl of tape when, as far as I can figure it the record-play lever is actuated before the tape has completely stopped from fast forward or rewind. It happened too quickly for me to see, but the result, more than once, was a couple of feet of tape that looked like frayed and twisted hemp cord. Might be merely a mechanical adjustment needed.

Second, editing isn't too accurate on the 600. You can't see and touch the heads without dismantling the shielding covers. A marking pencil may be inserted in the slot, for an inch or so, and your mark will be more or less in the right place. But you'll find it hard to do trigger-tight editing—if you ever want to. (Double-track users don't edit at all, so this is not of first importance

and surely was so considered by Ampex in the designing.)

Thirdly, the continuously-running Ampex motor and capstan, standard on all Ampex machines, allows an almost instantaneous speed pickup to full speed without wow. A much appreciated advantage, but somehow or other that constantly-running motor gets on my nerves. Purely personal! It's built to run and run and you don't really have to worry about it, I know. (A few of the 600 models are a bit noisy in the running, though mine isn't at all objectionable.)

These are surely minor objections to a machine that is the ultimate answer for all those who want top quality—flat to 15,000 within very close tolerances—at 7½ ips and in *really* portable form. This is it.

(Referring again to my comments in "Record Revue", August and September 1950, you may find the long discussion there of the then-new Ampex 400 of considerable interest—since that relatively elephant-like portable was an intermediate step on the way to the present Ampex 600. In those articles you'll find a good deal about possible home and semi-professional use of a "portable" double-track top-quality machine such as the 400, as well as some discussion of recorded tape possibilities.)

4. Oddities to Titillate

A. Don't tell me we aren't ingenious around here. One of my favorite subjects for ingenuity is that pleasantly scented pressurized liquid, Stati-Clean, anti-static coating for plastic records. Last summer, in an emergency of minor proportions, I found it excellent for lubricating the hard-to-get-at parts of my lawnmower. (Yes, I know you can get pressurized 3-in-1 oil; but I wasn't anywhere near a store.)

Now I have a more pertinent use for Stati-Clean—as an anti-static agent. No, not for records. For neckties.

Bought me a batch of Dacron ties last summer, on the theory that a washable non-press-requiring cravat might be a good idea for the likes o' me. It was—as long as summer lasted. But then winter came along, and with it dry indoor weather. My Dacron ties promptly began to emit sparks every time I tied them. And pretty soon they took on that familiar dusty gray look that we all know so well, come winter, in our phonograph records. Brushes and dust-cloths, as with records, merely smeared the gray stuff around and built up larger charges. Most unsightly, I assure you.

The obvious answer, as the record jackets will tell you, was a wipe with a damp cloth. Worked fine—until the dampness dried off, whereupon I began picking up dust again, and the faster I walked and wriggled and rubbed those ties against the surrounding woolens, the faster flew the dust to my soiled neckwear! You can't carry around damp cloths in your pocket, nor can you protect your tie with a plastic envelope.

So . . . Stati-Clean. I was almost stifled by the overpoweringly pleasant perfume for the first few minutes, but after that all was well. It works. Now, please, Walco, my royalties.

B. One better on the now-famous Phila. Orch., the *"best high fidelity orchestra"*: Capehart has announced a new comprehensive line of high-fidelity equipment. It includes, of course, hi-fi changer, high-fidelity amplifier, speaker et al . . . and, to top it off, a selection of *high fidelity furniture*.

Pretty soon we'll be having high-fidelity chairs to listen from, and a hi-fi scotch and soda with every record.

ABOUT MUSIC

(*from page 16*)

necessary, of course, and supplied articles for new subjects, but by 1940, poor old Grove had become rickety. It happens in the best of encyclopedias. The symptoms—present, it might be added, at birth—were as follows:

1) *Disproportion.* Franck occupied more space than Bizet, Debussy, Fauré, Satie, and Ravel combined. Weber filled more pages than Richard Strauss, Puccini, Moussorgsky Chopin, Liszt, Rimsky-Korsakov, Couperin, and Borodin combined.

2) *Inadequacy.* GRAMOPHONE (PHONOGRAPH) was found under MECHANICAL APPLIANCES CONNECTED WITH MUSIC. It was the sixth and last on the list (preceded by Barrel Organ, Piano Mécanique, Piano-Organs, Musical Snuff-Box, etc., and Player-Piano) and was given all of half a page, with the following footnote: "For fuller description of the principles and action of the gramophone, see E. W. Scripture, *Elements of Experimental Phonetics.*" This, in 1940!

3) *Omission.* None of the following categories were provided for: Film Music, Therapy, Ear-Training, Radio Transmission, Sound, Primitive Music, and hundreds of others.

4) *"Out-of-date-ness."* The careers of a number of nineteenth century singers, in particular, were treated as if they were still on the contemporary music scene.

Grove had one important critical limitation. In his own words, when it came to music, he "would rather love than condemn." This philosophy not only affected his attitude towards the work, but towards the lives of his favorite composers. In Grove's own article on Beethoven, he wrote: "He was constantly in love . . . his taste was very promiscuous . . . but one thing is certain, that his attachments were all honorable, and that he had no taste for immorality. 'O God! let me at last find her who is destined to be mine *and who shall strengthen me in virtue.*' Those were his sentiments as to wedded bliss." Most proper, what!

When *Grove V*'s editor recently praised the 200 new contributors to the Fifth Edition, a "candid" friend remarked: "Well, yes, you really needn't know anything at all yourself." Sixty-six-year-old Eric Blom, however, required no ego-deflating. A distinguished scholar, critic, and administrator, Blom has been music critic to the *Manchester Guardian, Birmingham Post,* and is now chief critic of *The Observer.* He has written several books, including one on Mozart, and is a member of the British Council and the B.B.C. Music Panels. When Messrs. Macmillan & Co. commissioned him to edit a new edition of Grove's, Blom did not at first realize the enormity of his task. Some felt that the venerable Dictionary should be put to rest in the archives of the British Museum and a wholly new work be created. Aside from the frightening price involved in such a venture, Blom and Macmillan were of the opinion that the unique, genial qualities that make Grove's what it is, deserve to live on. Not that everything in the previous edition was to be retained. Blom set himself three objectives: demolition, restoration, and replacement. He began by systematically plowing through *Grove IV* from beginning to end, "marking each article to show roughly what should be done with it. The whole material was posted up on large sheets of blank paper with ample space for editorial markings. . . . Everything, from A to Z, was subjected to a cleaning-up process from the point of view of language, punctuation, typography, and uniformity of 'house style,' with the exception of such entries as had already been singled out for destruction and replacement." Painstakingly, Blom revised all material that had become out-dated in approach or in facts, although examples of the latter were rare.

By the time *Grove V* made its appearance last October, it was nearly twice the size of *Grove IV* (8,320 pages in place of 4,890), four million of its words were new, nearly all eight million were eminently readable, and its layout was striking and efficient. Most of the critical returns are in now, and, as Blom himself predicted, whatever errors or miscalculations he and his printers' readers may have failed to detect will "be discovered by some sorrowful well-wisher or gleeful ill-wisher after my work is finished and beyond repair." Considering the fact that Mr. Blom accomplished his editorial feat single-handed, we can forgive him these pecadilloes. For the perfectionist, patience. There's always *Grove VI.*

Corrected page proofs of the new Fifth Edition of Grove's Dictionary shows pains taken to ensure accuracy and prevent errors.

BOOK REVIEW

ELECTRONIC MUSICAL INSTRUMENTS, by Richard H. Dorf, Radio Magazines, Inc., Mineola, New York, 1954. vi + 326 pp. $7.50

Although electronic organs came into the market in the middle 1930's, widespread technical interest does not seem to have grown to large proportions until fairly recently, particularly the past three years or so, according to various sources.

The publication of *Electronic Musical Instruments* is well timed and should come as a welcome source of thorough and authentic information to a large reader list. The author has taken care to present a complete report on the electronic musical instruments which are generally available to the American public now, chiefly electronic organs.

His work covers its subject from the viewpoint of the layman unacquainted with electronic matters, or even musical instruments themselves, but further provides material adequate to anything but the most highly refined technical analysis by advanced engineers. His chapters introducing the fundamentals of electronic production of sound are easy to read and yet do not insult the intelligence of the most erudite.

The reader without technical background will quickly learn which paragraphs he should pass over lightly or omit entirely from his literary menu. These selections are freely peppered with scientific charts and circuit diagrams and can easily be identified. The purpose of the work therefore is manifold. Technical data on the several instruments is sufficient in most instances to furnish extensive detailed construction and design data to the engineer or service technician, although it is in no sense a regular service manual.

Mr. Dorf has given an excellent clarification of the great fundamental differences in principle among the several types of instruments available. The "lay" reader may be astonished to find that, rather than all "electronic organs" being approximately alike, they differ, in principle, almost as much as do an electric icebox and an electric clock, although both use motors.

He gives a wholesome group of suggestions and useful information for the man who wants to design and build an electronic organ for himself. From this writer's personal observations of a few quite competent gentlemen who have attempted such a program, however, advice would be given at this time—before forming a plan, consider finding a commercial "kit" instrument, and first try to examine one built by another enthusiast—or weight carefully the value of the time required to build one, against the sometimes attractively low prices of second-hand electronic instruments of established reputation available through the many dealers representing the several manufacturers. Another good source is the small or medium sized church which has enjoyed its electronic organ for a few years but feels ready for a change.

Organ-buying committees, even without technical background, can learn much through the examination of this compact and attractively composed symposium on one of America's newest, most active and growing industries.

—*David Walsh.*

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Industry Notes...

A new corporation known as **Tape Recorders, Inc.**, located at 1501 W. Congress St., Chicago 7, Ill., has begun operation as manufacturer of three new magnetic tape recorders to be merchandised as the "Tri Fy" line. Predicated on volume sales, all models will be priced competitively. Headlining the Tri Fy line is a recorder of coaxial-reel design which is said to be the only continuous-play tape recorder which will accommodate 10½-in. professional reels without need for special adapters.

A group of engineers, manufacturers, and representatives of the audio industry have formed a new organization known as the **Stereo-Sound Society.** Function of the group is to make available to the public the latest information regarding new developments in stereophonic recordings and equipment. Created as a non-profit organization the society was conceived by engineer John de Yeiser, who has been elected secretary. Other officers are: C. M. Brainard, chairman; Frank B. Koessler, vice-chairman, Harlan Thompson, treasurer. Requests should be mailed to the secretary at 6356 De Longpre Ave, Hollywood 28, Calif.

Industry People...

Lincoln Walsh, president of Walsh Engineering Company, Elizabeth, N. J., and designer of the famous Brook amplifier, is now engaged in the design and production of prototypes of electronic, magnetic, and electro-mechanical devices for manufacturers . . . **Frederick K. Hankinson** is the newly-appointed sales manager for the transformer department of Federal Telephone and Radio Company . . . **John Pamperin** has been appointed production manager of Helipot Corporation . . . **Richards W. Cotton** has returned to his duties as assistant to the president of National Company, Inc., after completing assignment at the Pentagon—continues as special consultant to the Secretary of Defense . . . **John Cashman,** president of Radio Craftsmen, Inc., announces that effective March 1 all Craftsmen products will be sold to users on a direct mail basis . . . **Richard Dorf** receiving many congratulations on the publication of his book, "Electronic Musical Instruments"—the most complete treatise yet to be published on how to build an electronic organ at home . . . **Irving Rossman,** president of Pentron Corporation, elated over reception accorded the Pentron "all-electronic orchestra" at the Los Angeles Audio Fair; the "orchestra" consists of a special Pentron Dynacord tape recorder equipped with 6-channel heads to achieve remarkable stereophonic quality. Demonstrations were conducted every half hour by **George Davis,** Pentron sales rep for the Los Angeles area . . . **Floyd Bell,** president of Bell Sound, Inc., made rounds of Manhattan jobbers with **Jim Pickett,** New York factory representative, to introduce the new Bell Model RT-75 tape recorder—reports enthusiastic response . . . **Herbert Borchardt,** president, and **Jack Karns,** executive vice-president, of Recoton Corporation, taking just pride in Recoton's spacious new plant in Long Island City, N. Y. . . . **Jay Carver,** advertising manager for Cabinart speaker and equipment enclosures, making personal delivery of Plexiglass models of Rebel speaker cabinets to leading New York dealers . . . **Carter Harman,** music critic and audio authority for Time magazine, completing an article on High Fidelity for early publication—will be a worthwhile boost for the industry . . . **Woody Gannett,** director of publicity for the Institute of Radio Engineers, going into high gear in preparation for the annual IRE convention scheduled for March 21 to 24 in New York. The staff of AUDIO will be on hand at 852 Audio Avenue. Looking forward to seeing you.

ADVERTISING INDEX

Announcing

THE MOST IMPORTANT MAGNETIC TAPE DEVELOPMENT IN SIX YEARS...

the irish FERRO-SHEEN process

DESTINED TO REVOLUTIONIZE THE MAGNETIC TAPE INDUSTRY

A completely new concept in the art of magnetic tape manufacture.

***FERRO-SHEEN* combines:**

- **A NEW Oxide and Binder Treatment**
- **A NEW Magnetic Surface Material**
- **A NEW Plastic Base**

. . . together in a new hot melt lamination process, resulting in the strongest bond, the highest uniformity of oxide particles, and the smoothest surface ever attained in recording tape manufacture.

This is how *FERRO-SHEEN* Improves Magnetic Tape:

EXTENDS FREQUENCY RANGE—Its mirror smooth surface permits vastly improved contact with the magnetic head; utilizing all the response available in the magnetic medium . . . all the highs . . . all the lows: Frequency is now limited only by the recorder you use.

REDUCED "DROP-OUTS" — Nodules and agglomerates that result in "drop-outs" are virtually eliminated.

DRASTIC REDUCTION IN HEAD WEAR — Absolutely no abrasion; it's friction free with "built-in-lubrication".

UNEXCELLED ADHESION — Oxide and film are almost homogeneous. No embrittlement with age — permanently plasticized.

***FERRO-SHEEN* is now available in Three New Tapes:**

1. **irish Sound-Plate Mylar #220**—The tough film tape pioneered by Irish . . . now on Mylar, Du Pont's new miracle polyester film. For all applications requiring the safeguarding of recorded material such as Tape Masters and Program Storage. Also recommended for broadcast remotes and other applications under adverse conditions of temperature and humidity: electronic photography —electronic computers, etc.

2. **irish Long Playing Tape #LP-6:00**— Up to six hours of recording on a standard 7" reel. Extra-thin, extra strength, because of its 1 mil Mylar base. Playing time is extended 50% over conventional tape.

3. **irish Shamrock #300**— Sets a new high in standards for professional recording. Protects those valuable magnetic heads. Extended frequency response. Higher output. Lower noise level. And many other excellent features that you will enjoy discovering.

ask for *FERRO-SHEEN* irish TAPE

The Finest Tape Your Recorder Can Use

Available at all leading sound dealers.

ORRADIO industries, inc.
Opelika, Alabama

American Pioneers in Magnetic Tapes

Export Division: Morhon Exporting Corp., New York, N. Y.
In Canada: Atlas Radio Corp., Ltd., Toronto, Ontario

THE STANDARD OF COMPARISON FOR OVER 20 YEARS

HIGH FIDELITY TRANSFORMERS

FROM STOCK... ITEMS BELOW AND 650 OTHERS IN OUR CATALOGUE B.

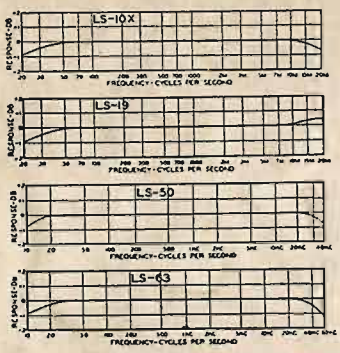
TYPICAL UNITS

LINEAR STANDARD series

Linear Standard units represent the acme from the standpoint of uniform frequency response, low wave form distortion, thorough shielding and dependability. LS units have a guaranteed response within 1db. from 20 to 20,000 cycles.

Hum balanced coil structures and multiple alloy shielding, where required, provide extremely low inductive pickup.

These are the finest high fidelity transformers in the world. 85 stock types from milliwatts to kilowatts.



LS-10X Shielded Input
Multiple line (50, 200, 250, 500/600, etc.) to 50,000 ohms . . . multiple shielded.

LS-19 Plate to Two Grids
Primary 15,000 ohms.
Secondary 95,000 ohms C.T.

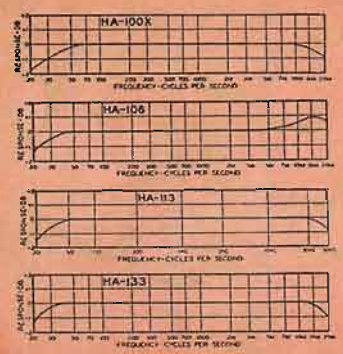
LS-50 Plate to Line
15,000 ohms to multiple line . . . +15 db. level.

LS-63 P.P. Plates to Voice Coil
Primary 10,000 C.T. and 6,000 C T. suited to Williamson, MLF, ul.linear circuits. Secondary 1.2, 2.5, 5, 7.5, 10, 15, 20, 30 ohms. 20 watts.

CASE	LS-1	LS-2	LS-3
Length	3⅛"	4-7/16"	5-13/16"
Width	2⅝"	3½"	5"
Height	3¼"	4-3/16"	4-11/16"
Unit Wt.	3 lbs.	7.5 lbs.	15 lbs.

HIPERMALLOY series

This series provides virtually all the characteristics of the Linear Standard group in a more compact and lighter structure. The frequency response is within 1 db. from 30 to 20,000 cycles. Hipermalloy nickel iron cores and hum balanced core structures provide minimum distortion and low hum pickup. Input transformers, maximum level +10db. Circular terminal layout and top and bottom mounting.



HA-100X Shielded Input
Multiple line to 60,000 ohm grid . . . tri-alloy shielding for low hum pickup.

HA-106 Plate to Two Grids
15,000 ohms to 135,000 ohms in two sections . . +12 db. level.

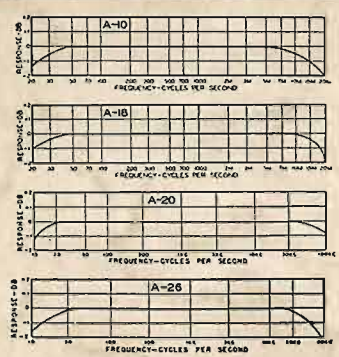
HA-113 Plate to Line
15,000 ohms to multiple line . . . +12 db. level . . . 0 DC in primary.

HA-133 Plate (DC) to Line
15,000 ohms to multiple line . . . +15 db. level . . . 8 Ma. DC in primary.

Case	H-1	H-2
Length	2⅜"	3-9/16"
Width	1-15/16"	2-13/16"
Height	3⅛"	3½"
Unit Weight	2 lbs.	5 lbs.

ULTRA COMPACT series

UTC Ultra Compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. The frequency response is within 2 db. from 30 to 20,000 cycles. Hum balanced coil structure plus high conductivity die cast case provides good inductive shielding. Maximum operating level is +7db. Top and bottom mounting as well as circular terminal layout are used in this series as well as the ones described above.



A-10 Line to Grid
Multiple line to 50,000 ohm grid.

A-18 Plate to Two Grids
15,000 ohms to 80,000 ohms, primary and secondary both split.

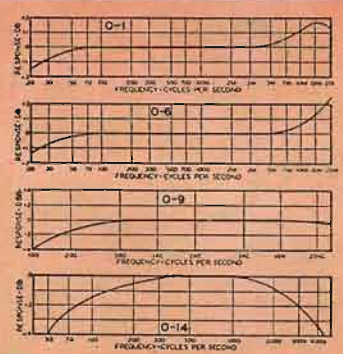
A-20 Mixing Transformer
Multiple line to multiple line for mixing mikes, lines, etc.

A-26 P.P. Plates to Line
30,000 ohms plate to plate, to multiple line.

A CASE	
Length	1½"
Width	1½"
Height	2"
Unit Weight	½ lb.

OUNCER series

UTC Ouncer units are ideal for portable, concealed service, and similar applications. These units are extremely compact ... fully impregnated and sealed in a drawn housing. Most items provide frequency response within 1 db. from 30 to 20,000 cycles. Maximum operating level 0 db. These units are also available in our stock P series which provide plug-in base. The O-16 is a new line to grid transformer using two heavy gauge hipermalloy shields for high hum shielding.



O-1 Line to Grid
Primary 50, 200/250, 500/600 ohms to 50,000 ohm grid.

O-6 Plate to Two Grids
15,000 ohms to 95,000 ohms C.T.

O-9 Plate (DC) to Line
Primary 15,000 ohms, Secondary 50, 200/250, 500/600.

O-14 50: 1 Line to Grid
Primary 200 ohms, Secondary .5 megohm for mike or line to grid.

OUNCER CASE	
Diameter	⅞"
Height	1-3/16"
Unit Weight	1 oz.

SPECIAL UNITS TO YOUR NEEDS

If you manufacture high fidelity gear, send your specifications for prices.

HFT

UNITED TRANSFORMER CO.

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