AUDIO ENGINEERING

DECEMBER
1952
35c

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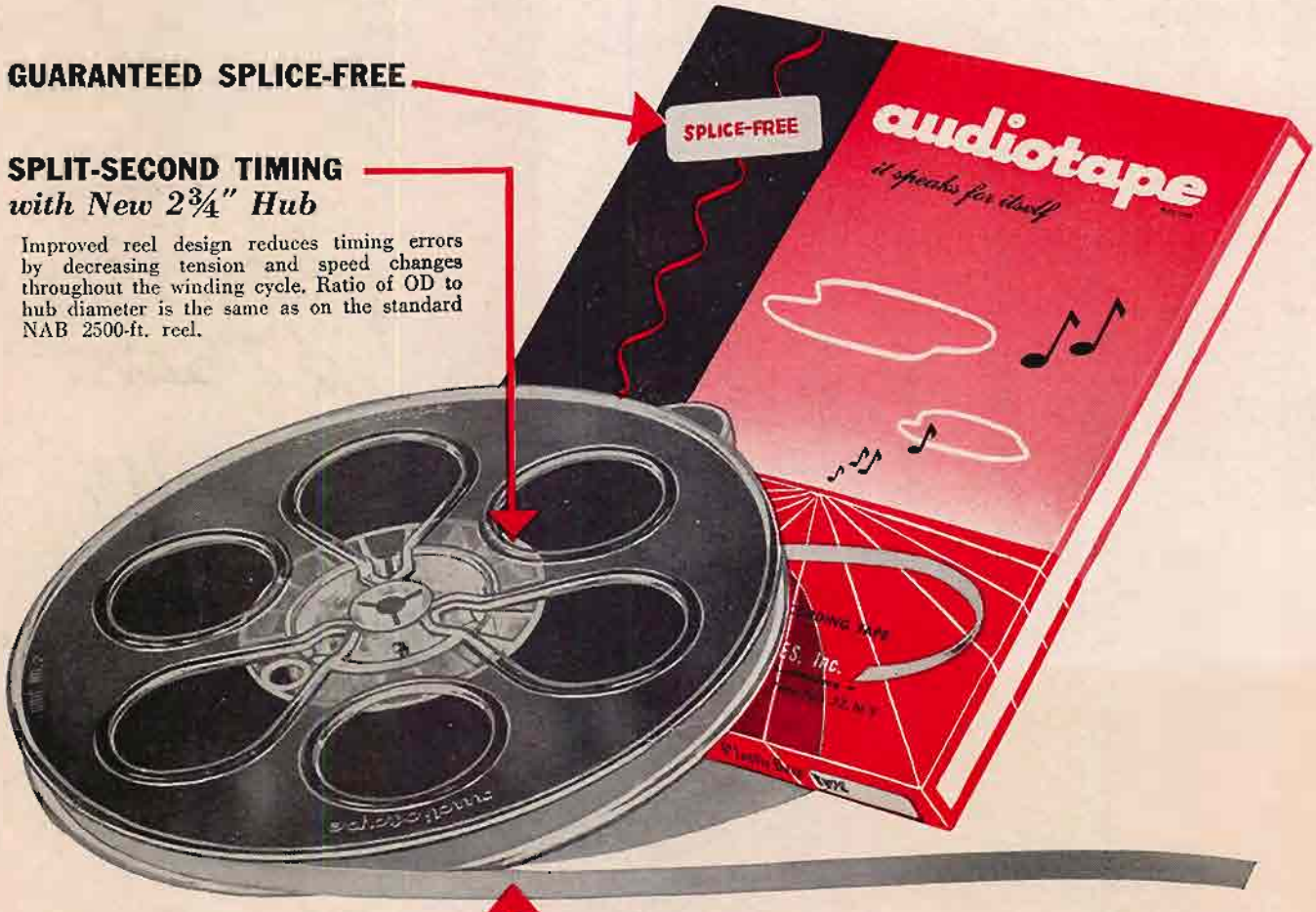
Improved reel design reduces timing errors by decreasing tension and speed changes throughout the winding cycle. Ratio of OD to hub diameter is the same as on the standard NAB 2500-ft. reel.



PERFECTED ANTI-FRICTION PROCESS. Reduces head wear—eliminates annoying tape "squeal" — prevents "tackiness" even under extreme temperature and humidity conditions.

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CONTENTS DECEMBER, 1952 Vol. 36, No. 12

COVER

View of the interior of the Chicago Amphitheatre showing the mounting of the loudspeaker gondola used with the Connsonata organ installation for the two presidential nominating conventions held there last July. Consisting of three separate channels fed by a multiamplifier system, this type of installation—described by Serge L. Krauss and Karl Kramer beginning on page 15—eliminated the need for an expensive and almost impossible pipe organ installation to provide this traditional type of music. The organist shown in the insert is William McMains who, with Harold M. Anderson, furnished the music throughout the two hectic weeks.

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

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at 10 McGovern Avenue, Lancaster, Pa., by Radio Magazines, Inc., Henry A. Schober, President; C. G. McProud, Secretary. Executive and Editorial Offices: 204 Front St., Mineola, N. Y. Subscription rates—United States, U. S. Possessions and Canada, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U. S. A. Entered as Second Class Matter February 9, 1950, at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

AUDIO PATENTS

RICHARD H. DORF*

VOLUME compressors are not usually used in high-quality home reproducing equipment but they are very definitely needed in other systems, such as broadcasting and recording, where the normal dynamic range of program material must be compressed to fit the capabilities of the recording or transmission medium. Theoretically, the ideal compressor varies its gain instantly in exact accordance with signal level, with only sufficient delay to integrate at the lowest audio frequencies to prevent the action from following the contours of individual audio cycles.

Unfortunately most compressor designs do not allow that because a sudden change in level, such as would occur with the ideal compressor. produces a steep-wavefront transient resulting in a momentary cutoff of signal. The sound is quite objectionable, and most designs compromise by providing a longer delay, so that the changes in gain are comparatively slow. That delay, however, defeats in part the purpose of the compressor. A sudden signal peak can easily go through the system at full amplitude, with compression beginning after the damage has been done.

Another fault with most designs results from the use of a variable-mu pentode as the control tube, with controlling bias derived from rectified and filtered signal taken from later stages. As the controlling bias varies, so does the control-tube screen voltage, often taking it out of the region of maximum curvature of the tube characteristic and reducing the control action.

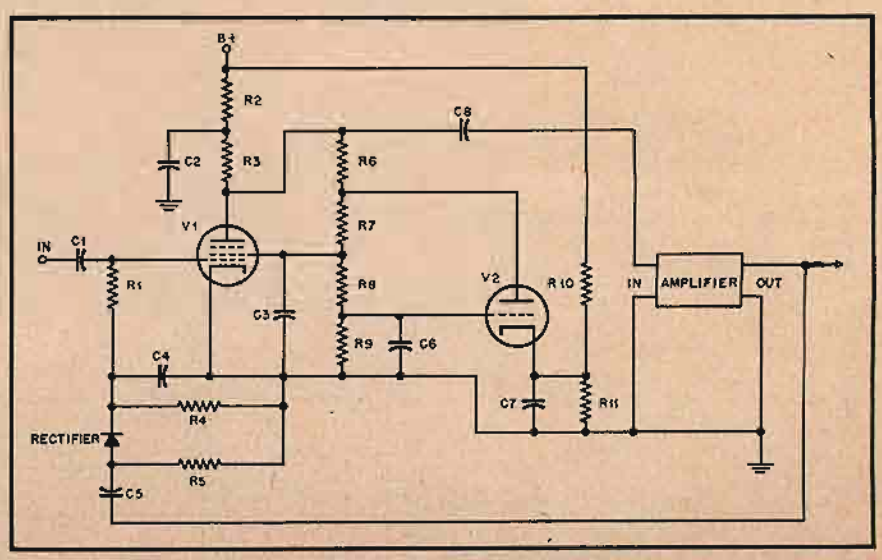
** 255 W. 84th St., New York 24, N. Y.*

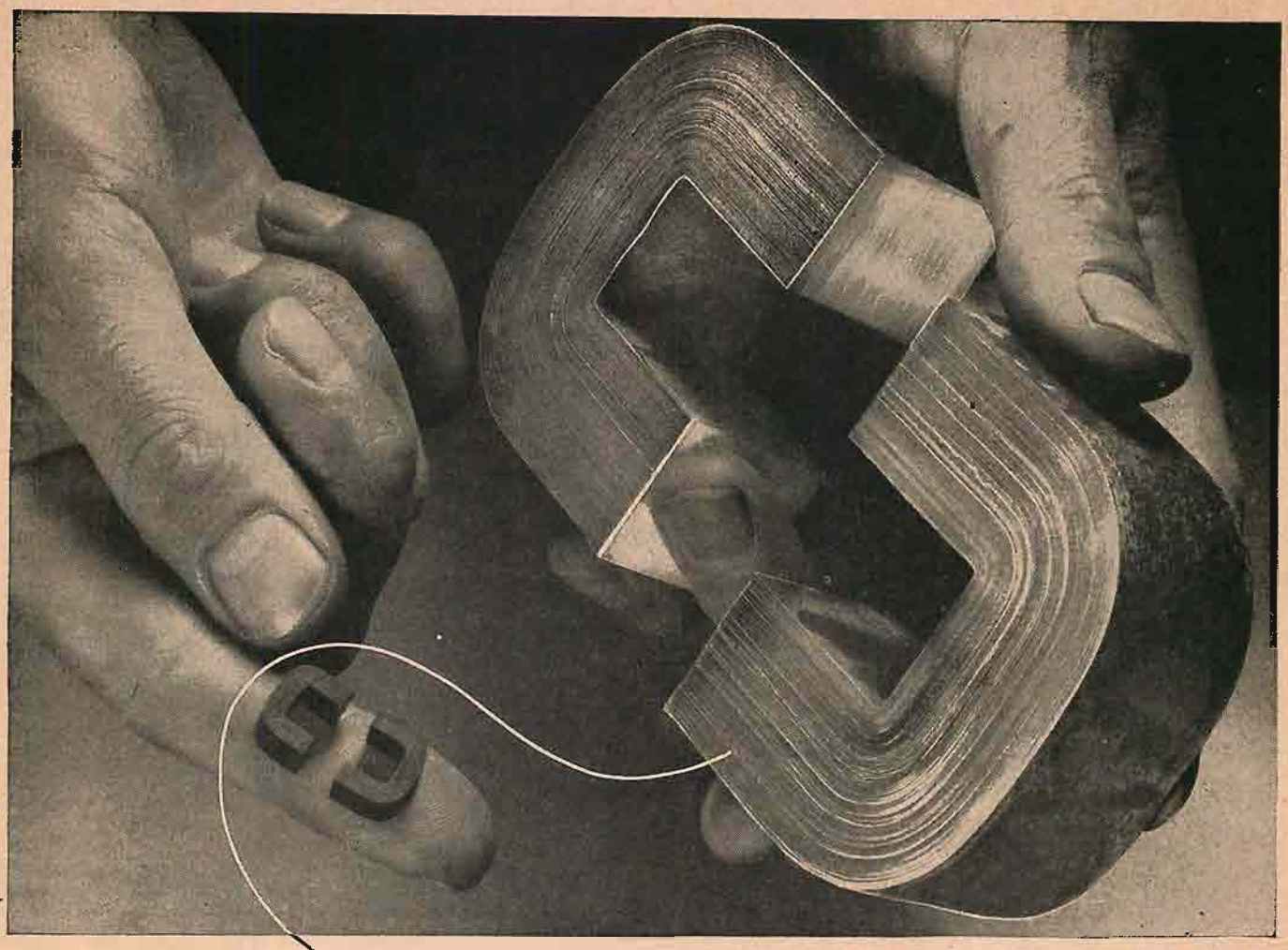
Both these major difficulties seem to have been solved by David E. Roberts of Chicago, Ill., in his patent No. 2,596,510, assigned to Motorola. The patent describes the compressor shown in the diagram, which is said to allow very fast action without clicks or thumps and has a stabilized screen circuit. The principle allowing the fast action is the clipper tube V_2. The undesirable transient has a level many times greater than that of the signal. V_2 clips the transient and removes the thump without disturbing the desired signal. It also stabilizes the control-tube screen.

Input signal goes to the grid of V_1 (which is a variable-mu pentode) through conventional blocking capacitor C_1. R_1 is the grid leak, bypassed to ground by C_1. Signal from a later stage of the amplifier is fed through C_3 to a fairly conventional rectifier and filter circuit which includes R_4 and R_5 as well as C_4 and C_5. This serves to produce d.c. and to reduce the ripple to a frequency below the audio band. Thus, while the d.c. will rise and fall with over-all signal level, it cannot rise and fall with individual audio cycles. The d.c. output of the rectifier-filter is applied to the grid of V_1 through R_2 and controls the tube's gain. So far the idea follows standard compressor practice, except that the time constant of the d.c. filter is as short as possible to allow fast compression.

R_3 is the V_1 plate load resistor and R_6-C_6 is a power-supply decoupling network of the usual kind. The output signal of V_1 is fed through C_8 to the following amplifier.

[Continued on page 45]





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LETTERS

The Ravanastron

SIR:

Wishing to contribute with additional enlightenments concerning the Ravanastron—the forerunner of the violin—mentioned in the article by Mr. Albert Preisman in your September issue, we ask permission to quote the well known work of Albert Lavignac[1] *"La Musique et les Musiciens,"* 1919 edition, in which the author states:

"I have had the occasion of hearing the Marquis of Tseng, then ambassador from China in Paris, playing a Ravanastron, or Chinese violin, of my property. The instrument is peculiar in the fact that the bow remains constantly tied to, i.e., interlaced between the two strings, which are tuned in fifths. To play the Ravanastron one has to move the bow backwards or forward, rubbing it against either string.

"Saint-Saëns heard the Ravanastron at will in China, even trying to play it, but without success. He finds a charm in this primitive instrument, 'essentially Chinese,' to which the listeners quickly adjust themselves. Saint-Saëns wrote to me: 'It is often barbaric but not discordant.' "

We wish to add that the drawing which illustrates Mr. Preisman's article, besides showing the bow detached from the instrument, fails to include the bridge upon which the strings rest and which transmits their vibrations to the membrane of the sound box. The Ravanastron has all the essential elements of the violin, namely: strings made of gazelle guts, bridge, sound box, finger board, pegs, and bow.

PERY DE CAMPOS
FRANCISCO M. D. LEAO
Sao Paulo, Brazil

[1] Albert Lavignac, professor of Harmony at the Paris Conservatory. See Grove's *Dictionary of Music and Musicians.*

Stylus Force or Stylus Pressure?

SIR:

It seems to me that writers who discuss stylus and record wear confuse the terms "force" and "pressure." The force of friction which may dislodge particles from either the stylus or the record is that portion of the weight of the pickup arm that is supported by the stylus, multiplied by the coefficient of friction. This coefficient is determined by the nature of the record surface and the speed of the turntable. Obviously the only numerical values we know are the turntable speed and the weight of the arm assembly. That it is absurd to assign a value to the pressure can be shown by the following consideration:

Assume a perfect record and a perfect stylus. Then the stylus rests in the groove along a line normal to the groove, the area of which approaches zero as a limit. Since the pressure is equal to force divided by area, the pressure approaches infinity as long as the arm assembly weighs anything at all. Assume a little wear and the pressure is anything between zero and infinity.

ERVIN J. LAGER
221 South Tenth East,
Salt Lake City, Utah.

These Complex Fruddians

SIR:

I do not know whether you value readers' opinions (*definitely.* ED.) or even have the time to read them. However, I will state that I frankly can do without such articles as "The Frudd Audio System." It doesn't strike me as even humorous and the rest of your material is so very good. Even the ads are informative.

THOMAS W. CRANE,
31 Haven Road,
South Portland, Me.

SIR:

After reading the item about the Frudd Audio system, I must protest. This type of humor is too close to a very considerable percentage of your more serious efforts. Consider the following examples:

Your November cover is a classic. The equipment would undoubtedly have even higher fidelity if the tuning knobs were located on the bottom of the box.

Recently you have published a humorously-large number of articles on the Williamson amplifier. The one by Kiebert in the August issue is an outstanding example. After bringing this amplifier up to date, Kiebert gets 7.23 watts output at 1 per cent distortion without feedback and 8.8 watts with feedback. Williamson (*Wireless World,* May 1947) got 16 watts output at 1 per cent distortion without feedback and at 0.15 per cent distor-

tion with feedback. Kiebert claims to have improved the noise level of the amplifier by 12 db by using a wire-wound resistor in the plate circuit of the first stage, but that no significant change resulted from the same procedures in the following phase-splitter stage. This is funny, because the audio levels are about the same in both stages. In any case, he must be talking about noise levels which are humorously below the point of significance.

In conclusion, let me say that I find every issue of your magazine interesting and entertaining much more so than that other well known New York humor magazine called "------."

HARVEY KEES,
3312 Lake Drive,
Evansville Indiana

SIR:

This letter is being written to compliment Mr. D. B. Frudd on his article in the November issue of Æ.

We are enclosing our latest bulletin on the Tri-Stable Two-Stage Caloriferer with Biased Viewpoint Adjustment which might prove of interest to you.

R. T. FISHER, Pres.,
Sigma Instruments, Inc.,
70 Pearl St.,
So. Braintree,
Boston 85, Mass.

SIR:

I noted the little item on the Frudd System with a big grin on my face. It created quite a bit of comment here among the wheels at Hazeltine. We thought it was pretty good. Shades of the Flewelling System—may both he and his system rest in peace. . . .

TED POWELL,
42 Nassau Road,
Great Neck, N. Y.

SIR:

After reading with interest Dr. D. B. Frudd's article on the epitome of audio systems, I proceeded with the construction of an amplifier to his specifications. Having just completed and tested this instrument, I wish to offer a few comments thereon. . . .

Regarding the construction itself, I felt that merely a solid aluminum chassis would not provide the ultimate stability for which all audio enthusiasts thirst. Therefore, I tried a large steel block mounted upon concrete piles, with gratifying results. To those readers who do not wish to smelt steel to order for the amplifier, I suggest the use of the motor block from an old automobile engine. . . . .

Bernard A. Engholm,
Oak Ridge National Laboratory,
P. O. Box P.,
Oak Ridge, Tenn.

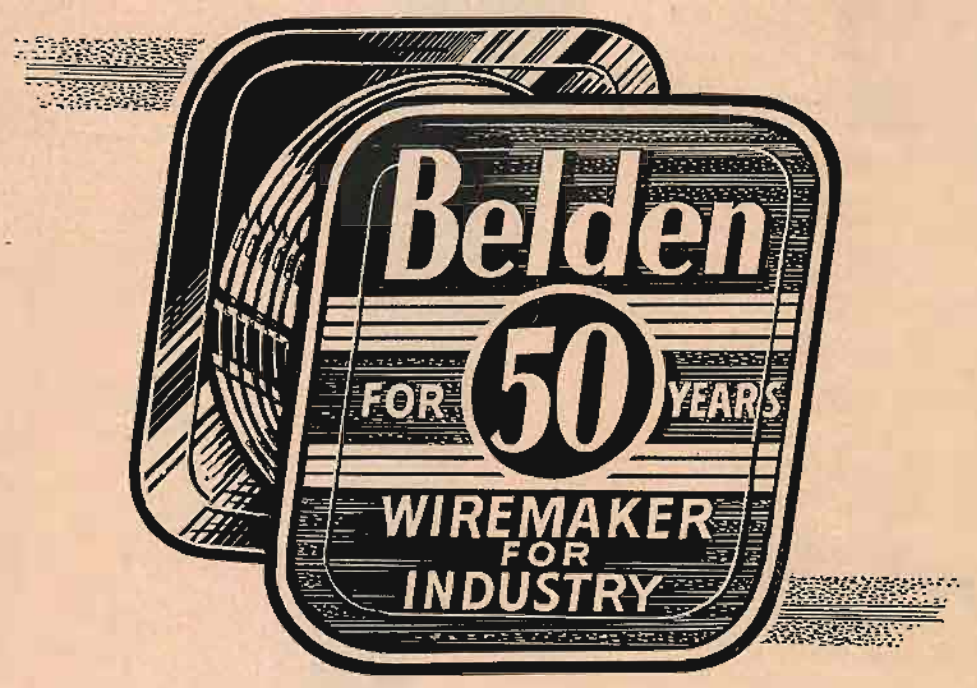
(One stage in each cylinder? Good shielding, that, ED.)

SIR:

. . . Aluminum was unavailable and I happened to use stainless steel, which I do not recommend as it is hard to work with the small hand tools, consisting of nail file and letter-opener, which were at my disposal. Actually I was so fatigued by this operation that when I found I had omitted cavities for the seventeen internal and three external loops I decided to simply wrap them about the chassis. This is not a neat job, but it serves very well, and is

[Continued on page 52]

1902-1952



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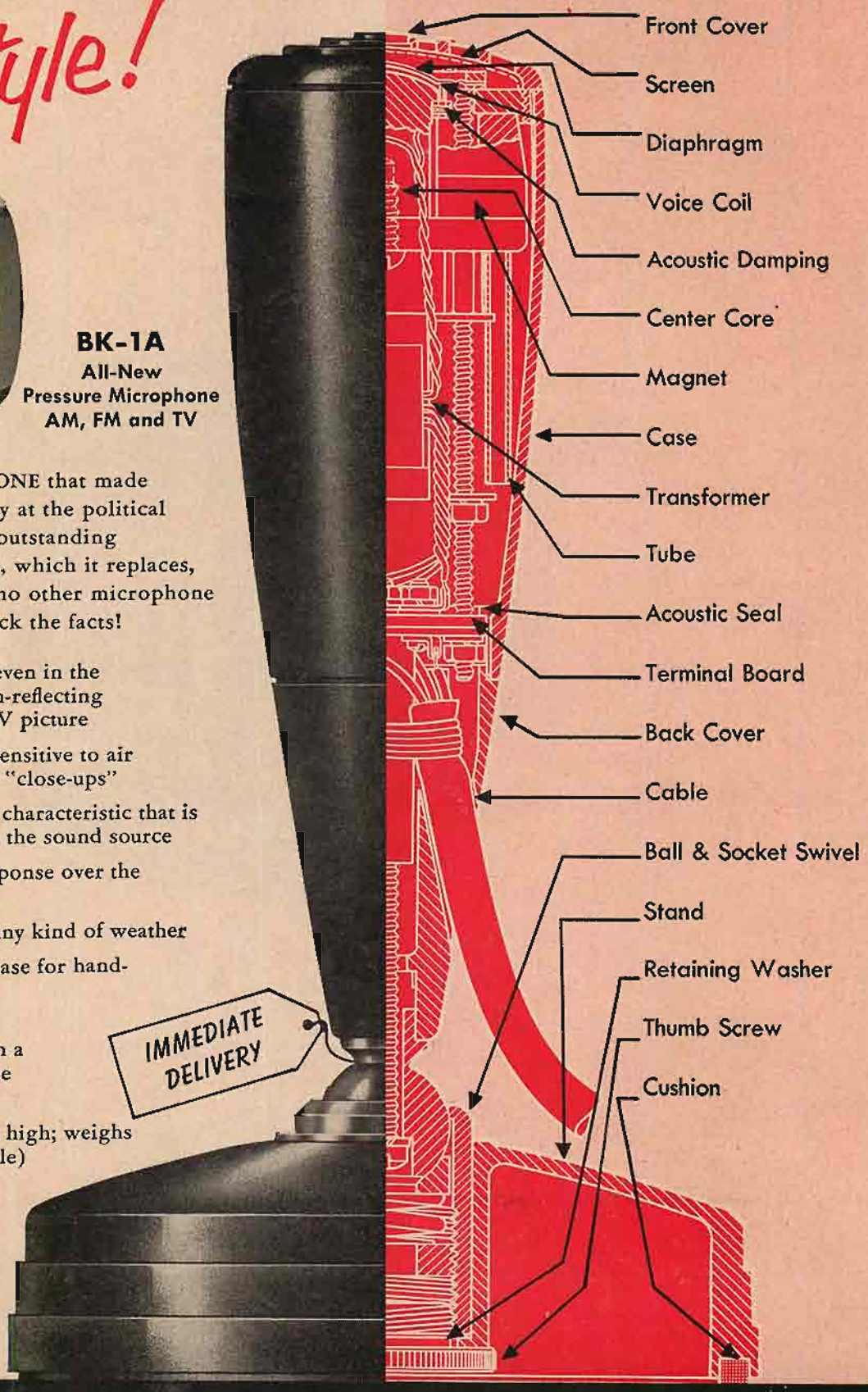

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NEW LITERATURE

• **Peerless Electrical Products Division** of Altec Lansing Corporation, 9356 Santa Monica Blvd., Beverly Hills, Calif., recently released a new 15-page transformer catalog which contains 50 per cent more product listings than the last previous issue. Also shown and described are the company's facilities for design and manufacture of Class A, B, and H transformers built to military specifications. Available on request.

• **General Electric Company,** Schenectady 5, N. Y., describes the basic characteristics and applications of copper-oxide rectifier stacks in a new two-color 8-page booklet designated GEA-5699A. Remarkably complete, the booklet contains charts, graphs, and tables which illustrate the characteristics, manufacture, circuit design, and function of copper oxide rectifiers.

• **DeMornay-Bonardi, Inc.,** 3223 Buton Ave., Burbank, Calif., is now distributing a 134-page catalog which combines listings of the company's microwave products with a great deal of worthwhile technical information on microwave engineering. Opening pages of the book graphically explain the basic concepts of microwave communication. Included are graphs, charts and drawings.

• **Communication Products Company, Inc.,** Marlboro, N. J., describes electrical and chemical properties of Q-max lacquer and cement in Bulletin 752, which will be mailed on request. Included are the results of studies which will be of exceptional interest to all engineers whose work calls for the use of viscous insulating solutions.

• **Stevens-Arnold, Inc.,** 22 Elkins St., South Boston 27, Mass., illustrates and describes a new line of d.c.-a.c. choppers in catalog sheet 289B which will be mailed on request. Choppers shown have a 10–500 cps frequency range, are equipped with gold contacts, and have a life rating based on 1½-volt-d.c. 1-ma contact operation. All ratings are nominal and may be exceeded by as much as 50 per cent without damage.

• **Tech Laboratories, Inc.,** Palisades Park, N. J., has just issued a new 38-page catalog describing the complete line of precision electrical resistance instruments and electronic devices as currently manufactured. The catalog is bound in a handsome loose-leaf folder, and describes attenuators, T-pads, potentiometers, matching networks, and gain sets, together with a number of measuring instruments useful in a communications laboratory. Copies will be furnished without charge to interested readers writing on company letterhead.

• **Bausch & Lomb Optical Co.,** 650 St. Paul Street, Rochester 2, N. Y., offers a brochure on optical instruments for quality control. This eight-page booklet is illustrated with photographs, drawings, and technical data, and describes the use of contour measuring projectors, stereomicroscopes, toolmaker's microscopes, thickness gages, and other optical instruments that may be used as separate units or built into present equipment for rapid inspection and measurement of a multitude of tooling and production items. Copies may be obtained without charge by requesting Catalog D-22.

• **Aircraft-Marine Products, Inc.,** 2100 Paxton Street, Harrisburg, Pa., offers two new illustrated booklets which present the highlights of the industrial films "All's Well That Ends Well" and "By the Millions." These pocket-size books are intended primarily for distribution to audiences preceding the showing of the films, but they are also useful and instructive in their own right. The first of these films demonstrates the use and application of solderless terminals with precision hand tools, and the second shows how solderless terminals in strips fed from reels can be applied to wire at rates up to 4000 per hour with automatic machines. Both the booklets and the films were prepared for distribution and presentation before meetings of scientific and technical societies, trade associations, industrial groups, and engineering and technical schools, as well as for customers and prospects. Requests for copies of the booklets and for further details regarding the films will receive prompt attention.

EDITOR'S REPORT

EXHALE

THE FOURTH AUDIO FAIR has come and gone, and those of us who were there throughout the four days can finally take a breather. With an attendance of slightly over 13,000 people—many of whom were there two, three, or even all four days of the show—there was anything but calm and quiet in the exhibit rooms and corridors of Hotel New Yorker. But we loved every minute of it.

We are pleased to note that a great number of the exhibitors reduced demonstration volume to levels which were more in keeping with that at which the average listener would employ in his own home. We also noticed that the disparity between the most elaborate systems and the more modest ones is less apparent than it was in past years, especially with average program material. When particularly fine program material was used, the differences were still noticeable.

The Audio Fair idea is certainly established as the logical method of demonstrating audio equipment—where sound is as important as sight. With this year's attendance exceeding 1951's by nearly 5000, the New York event may well be said to have "arrived."

Closely following on its heels will be the Audio Fair-Los Angeles, which takes place on February 5, 6, and 7 at the Alexandria Hotel in the City of the Angels. In some respects the Alexandria will be better than the New Yorker—its rooms are larger and the ceilings are higher. We are certain, however, that—better or only just as good—the Audio Fair-Los Angeles will be well attended, and will bring new interest in audio to the Pacific Coasters.

LOUDNESS CONTROLS

The time has come to discuss one feature of the loudness control that seems to have escaped general notice. A study of the Fletcher-Munson equal loudness contours will show that the ear is less sensitive to frequencies above about 3000 cps than over the range from 1000 to 3000, and that the curves for all levels are almost identical above this point. Some loudness controls have been proposed which correct progressively for this deficiency, on the assumption that as over-all level is lowered, the high frequencies should be increased in addition to the lows.

May we point out that the human ear is less sensitive to these high frequencies at *all* levels, and that it is with these same ears that we listen to live music. Thus if the music is reproduced with a flat system (above 3000 cps) it should be presented to the ear just as it is from a live source, since the F-M curves are almost exactly the same in the high-frequency range. We submit, therefore, that no correction should be applied to the loudness control except that for the low frequencies.

This observation is addressed to those who go for the idea of the loudness control, and may be overlooked by those who do not. However, we still prefer them.

AT LAST—THE R-J STORY

In last December's issue, we carried a story about the R-J speaker, but offered no constructional information. Since that time, the unit has become commercially available and because of this we have been unable to offer any further information—particularly regarding its construction. This is a matter which has caused some concern among several hundred of Æ's readers—as well as among our own staff.

We are firmly assured, however, that we will have the R-J story in time for the January issue, and we know that many of you will be pleased at this news. In fact, we are extremely pleased ourselves to be able to get off the hook on this particular subject. So look for a thorough exposition of the R-J speaker next month, in an article by William Joseph and Frank Robbins.

SUBSCRIBE JUST ONCE MORE—IF YOU WISH

Over a lunch at the Audio Fair, it was suggested that we should offer Life Subscriptions so that Æ's readers could avoid the necessity of renewing their subscriptions every so often. The first person we encountered after the discussion jumped at the chance, and while he was putting down his name, another joined up, followed shortly thereafter by a third "lifer." Since this idea seemed to be snowballing, a conference was deemed necessary with the Business Manager—who, after all, has to make ends meet each month—with the result that those of you who like Æ can now take advantage of this opportunity. For further details, we respectively refer you to the top of page 44. But before you turn the page, the Editors and Staff of Audio Engineering wish you

A Merry Christmas and A Happy New Year

AES News

Society Announces Award Winners, 24 Fellowships, 21 Sustaining Members

DURING THE EXTREMELY successful Fourth Annual Convention, held at Hotel New Yorker from October 29 to November 1 inclusive, the Audio Engineering Society announced the winners of the two annual awards—the Society's Award for outstanding service to the organization, and the John H. Potts Award for outstanding achievement in the field of audio engineering—and also made pubic the names of the twenty-four Fellow awards and twenty-one Sustaining Memberships.

The Society's Award was presented to Ralph A. Schlegel, the citation reading "for his devotion and efforts in originating and carrying on the important work of the office of Treasurer." Mr. Schlegel was first elected to the office of treasurer in 1948, and has served continuously since that time. The award, in the form of a certificate, was presented at the Annual Banquet of the Society, held on the evening of October 30, at which Harold Burris-Meyer was toastmaster.

Also announced at the same time was the winner of the John H. Potts Memorial Award, which is given annually in the form of a plastic-embedded medal. This award was given "to Frank L. Capps, posthumously, for development and manufacture of high-quality sapphire recording styli. This award is double earned because his daughter, Isabel Capps, who receives it, has carried on his work and has herself made many valuable contributions to this art." Miss Capps, herself a member of the Society since its formation, accepted the medal and citation, both of which were presented by John D. Colvin, a member of the Awards Committee who acted on behalf of Chester A. Rackey, committee chairman, who was on the Pacific Coast on business.

Fellow Awards

The list of Fellows created at the Convention is as follows:

W. LINDSAY BLACK, for his work in broadcast audio transmission systems, standards, and measuring techniques.

H. BURRIS-MEYER, for his work in the application of audio sound effects in theatrical production.

ISABEL CAPPS, for her work in development and manufacture of high-quality recording styli.

JAMES Y. DUNBAR, for his work in design of acoustic treatment, soundproofing, and vibration control.

PRICE E. FISH, for his work in the application of magnetic tape recording to radio broadcasting.

ERNEST W. FRANCK, for his work in the development of high-quality lacquer recording blanks and magnetic tape.

LEWIS S. GOODFRIEND, for pioneering in development of audio engineering courses and for his work on artificial reverberation.

JOHN K. HILLARD, for his work in film recording and reproduction and for development of intermodulation testing techniques in film recording.

WILLIAM F. JORDAN, for his pioneering and continued activity in newsreel recording operations.

SAMUEL F. LYBARGER, for his work in development and standardization of hearing aids.

JOHN T. MULLIN, for his work in promotion, development, and practical application of magnetic tape recording.

DR. HARRY F. OLSON, for his extensive research and development in the fields of acoustics and audio engineering, and for authorship of leading texts on these subjects.

NORMAN C. PICKERING, for his work in development and manufacture of high-quality disc reproducing equipment and for investigation in intermodulation testing.

JOHN PRESTON, for his work in research and development of microphones and loudspeakers.

ALBERT A. PULLEY, for his work in development and practical application of commercial recording and pre-processing techniques.

RICHARD H. RANGER, for his work in the general field of audio engineering and the development and design of magnetic tape recorders.

HILLEL I. REISKIND, for his work in development and design in the general field of disc recording and production processing.

CARLETON R. SAWYER, for his work in development of film, disc, and magnetic tape recording systems.

HERMON H. SCOTT, for his work in development and manufacture of sound level meters and audio noise suppressors.

J. P. SMITH, JR., for his work in design and development of audio attenuators and measuring equipment.

S. EDWARD SORENSEN, for his work in system design in disc and magnetic tape recording.

W. EARL STEWART, for his work in design of commercial high-quality audio equipment and systems.

MYRON J. STOLAROFF, for his work in development and design of high-quality magnetic tape recording equipment.

WILLIAM J. TEMPLE, for his work in the science of speech.

Sustaining Members

During the past year, a number of manufacturers and distributors have contributed substantial sums to forward the work of

[*Continued on page 51*]

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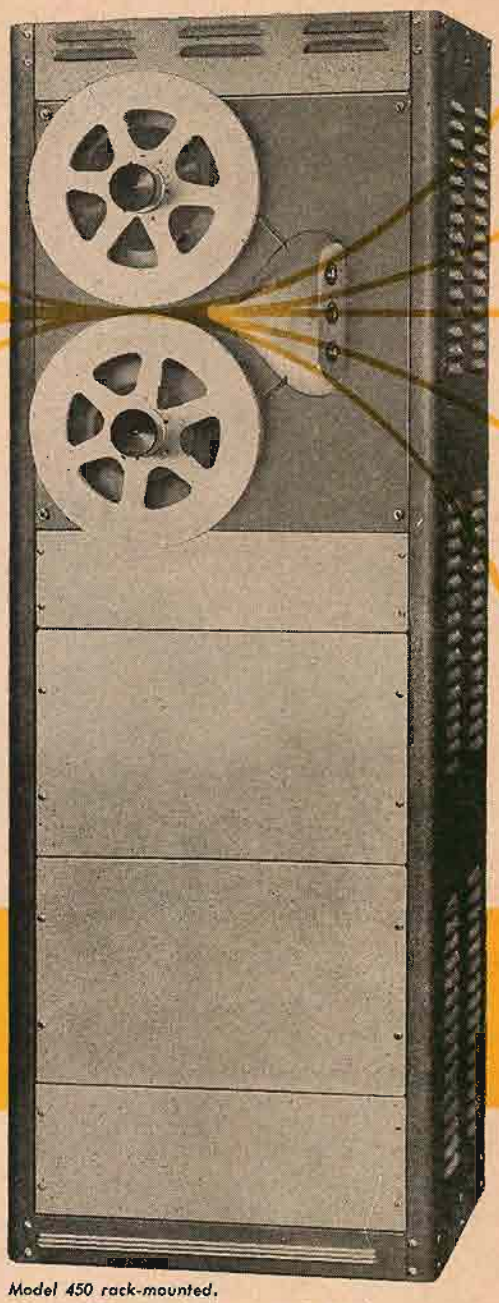

Model 450 rack-mounted.
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- ***Requires no attention during operation***
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The new AMPEX 450 gives you hours of high-quality background music delivered at *lowest cost per hour* of any musical reproduction system. With the AMPEX there are no interruptions, no records to change and no attendants since it *needs no attention* during operation. It plays at the touch of a button and keeps on playing for as long as eight hours without repetition. Because tape doesn't lose quality with repeated playings, music is always scratch-free and pleasant, with less background noise and distortion.

The Model 450 is engineered to rigid AMPEX standards and is capable of deljvering thousands of hours of service with no breakdowns and minimum maintenance.

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- Automatic reverse control available as an accessory permits full eight hour program without interruption.

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MAGNETIC RECORDERS

AMPEX ELECTRIC CORPORATION
934 CHARTER STREET • REDWOOD CITY, CALIF.

It splits seconds even faster

New wire spring relay. Older relays had flat metal springs and 70 parts to be handled, compared with 12 in the new model. Relays operate by means of an electromagnet which responds to high-speed pulses.

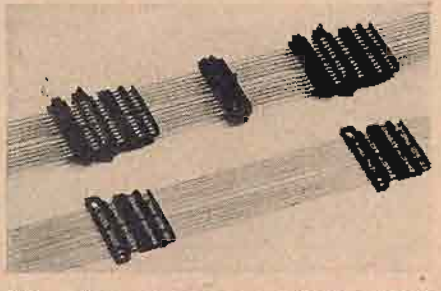
In a split second, relays, which are high-speed switches, set up dial telephone connections. Then they are off to direct the next call. Yet even this speed is too slow for Bell Laboratories scientists in quest of still faster switching.

Scientists and engineers devised a new relay – the wire spring relay – and worked out the production problem with Western Electric, manufacturing unit of the Bell System. This is twice as fast, uses less power and costs less to make and maintain.

With speedier relays, switching can be done with less equipment . . . and calls go through faster. The wire spring relay is a practical example of how Bell Telephone Laboratories and Western Electric pool their skills to improve telephone service while keeping its cost down.

New relays must be able to operate one billion times—equal to once-a-second for 30 years. Employing a sound recorder as a precision vibrator, Bell scientists learned to evaluate the effect of sideways motion on relay life. Such rubbing motion is limited to one-thousandth of an inch in the new relays.

Dynamic Fluxmeter, developed by Bell Laboratories, indicates flux build-up in intervals of 25 millionths of a second. Precise information like this was essential to higher speed operation.



Relay springs as they come from Western Electric molding machine, before being cut apart for use. Molding technique saves time and money . . . makes possible the maintenance of precise adjustment.

Bell Telephone Laboratories

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS

Nominating Convention Organ Installation

SERGE L. KRAUSS* & KARL KRAMER**

Providing a high-power organ installation to be used only for two weeks presents some rather unusual engineering problems—which were solved readily by use of electronic and electro-acoustical equipment.

THE PRODUCTION OF MUSIC for large audiences has been greatly facilitated by the development of the modern electronic organ and wide-range, high-efficiency loudspeakers. The Connsonata organ installation for the recent presidential nominating conventions in Chicago is an excellent example of the type of performance that can be attained with this combination.

The International Amphitheater, site of the conventions, had no organ of any kind, and the Connsonata was selected to fill the need for this traditional type of music. The auditorium capacity is twelve thousand people; in addition to the permanent seating space (main floor and balcony) there is a clear central floor space (arena) 123 by 236 feet that was used for the main speakers' platform, press, and delegate seating. The clear height over this space is 73 feet. It was apparent that in order to dominate, supplement, or over-ride with music the "noise" level occasioned by the customary enthusiatic demonstrations of so many people in so large a room, considerable undistorted acoustic power would be required.

The temporary installation on short notice of a pipe organ with sufficient power for this purpose would have indeed been an enormous project. The single problem of space for such an organ would probably have precluded its use. In contrast to this possibility was the use of a modern, flexible and easily portable electronic organ, with its tone generators enclosed in the organ console and with only loudspeakers and their associated amplifiers as additional equipment for meeting the requirements of the large auditorium.

The floor space allotted for the installation of the organ console and bench and the speaker amplifiers was limited to less than 45 square feet. It is interesting to note that there was room enough left over in this small space for a number of chairs. The reproducer assemblies were suspended from the ceiling in the middle of the auditorium and did not detract from the seating capacity.

The Connsonata used was a standard stock model 2C2 with separate manual and pedal audio channels; the specifications are given in Table 1. Independent channels are advantageous in that the speakers can be designed for maximum efficiency in the spectrum covered. The pedal tone spectrum is from 32 to a few thousand cps and each manual spectrum is from 64 to above 12,000 cps. Having a separate pedal channel avoids the application of tones in the octave from 32 to 64 cps on the manual speakers and thus keeps the "Doppler" distortion at a minimum. With independent manual channels the amplifier-reproducer equipment can be divided in proportion to the sound power necessary for the desired musical balance for the type of music played. It is also possible, with separate manual channels, to provide an effective echo organ feature by switching the

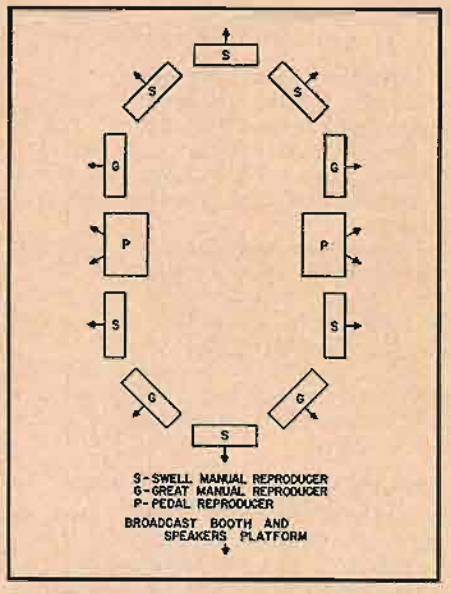


Fig. 1. Plan of the reproducer gondola showing the arrangement of the various speakers.

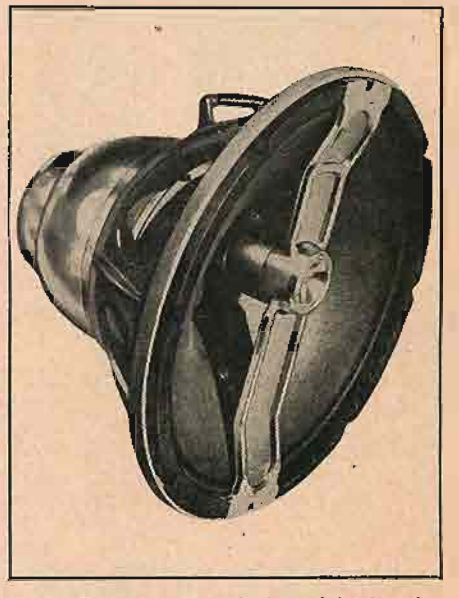


Fig. 3. Triaxial unitary 3-channel loudspeaker system.

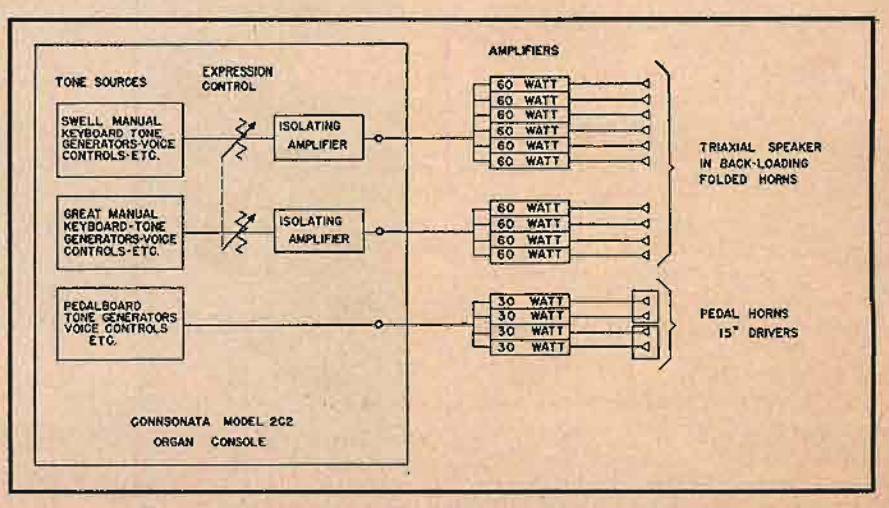


Fig. 2. Block diagram of the complete organ reproducing system.

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** *Technical Service Manager, Jensen Manufacturing Company, Chicago, Illinois.*

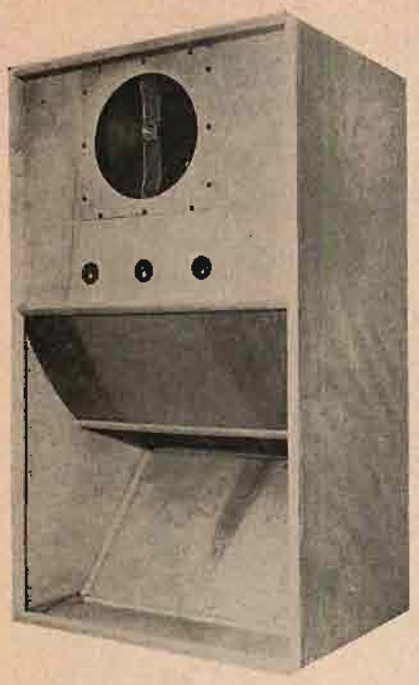

Fig. 4. Complete assembly of speaker unit in back-loading cabinet for use as manual reproducer.

swell manual channel to reproducers located at a distance from the main reproducer.

The possible number of individual, non-interlocked fundamental tones produced simultaneously by an organist on each playing manual exceeds 60. In addition, many harmonics of these tones are present in the pulse (string) signals. The instantaneous peak power of such a complex signal is several times the average power, so the amplifiers used must be capable of handling these high signal peaks without distortion. The amplifiers used for the convention installation were operated at approximately one third their normal continuous undistorted power output capacity. To keep the power requirements within bounds, efficient reproducers are essential for large installations.

The initial decision was to install the loudspeakers at the end of the auditorium behind the speaker's platform and facing most of the audience. Installation of the radio-television control booth in this location prevented this and resulted in choice of a central location near the ceiling. The loudspeaker array is shown in *Fig.* 1. Six reproducers were assigned to the swell manual channel and four to the great manual channel. Each manual reproducer was excited by an amplifier of 60-watt rating. The two pedal horns each had two driver units and each driver unit was excited by an amplifier of 30-watt rating. A block diagram of the installation is shown in *Fig.* 2.

The application of individual amplifiers for each reproducer allows the use of stock amplifiers with tube complements that are readily obtainable. The maintenance of such a system is simple, for in case of a component failure only a small fraction of the system is disabled and repairs can be made without disrupting the program. The reliability of the installation under discussion was proven in that no maintenance at all was required throughout the two strenuous sessions.

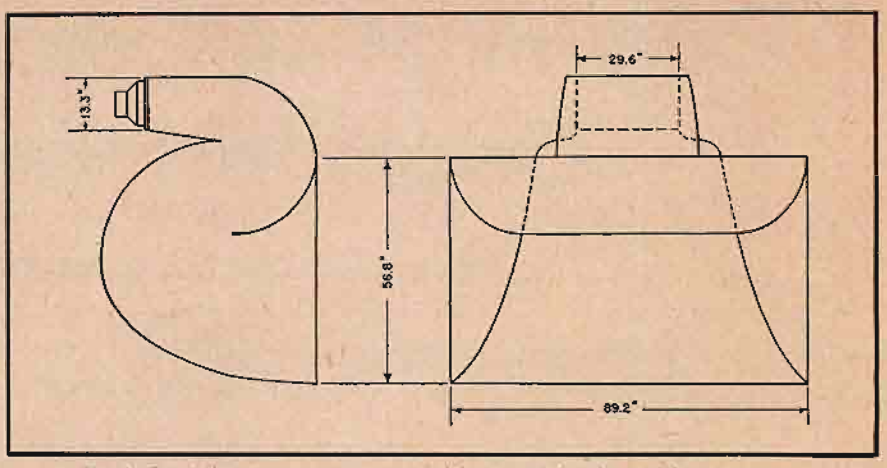

Fig. 5. Specially constructed exponential horn used for the pedal reproducers.

Interference with broadcast facilities was avoided by arranging the loudspeakers so that little sound energy was radiated directly toward the control booths. Conversely, the organ installation was checked for possible influence from pack transmitters, television signals, etc., and was found completely free from pickup.

Great and Swell Manual Reproducers

All ten of the reproducers assigned to the great and swell manuals were identical multiple-channel loudspeaker systems. Each was comprised of a Jensen G-610 Triaxial 3-channel unitary loudspeaker system[1] installed in a large back-loading folded horn.[2] *Figure* 3 shows the unitary loudspeaker system and *Fig.* 4 shows this Triaxial speaker installed in the horn to form the complete reproducer.

As the name implies, this type of horn loads the back of the 15-inch direct-radiator diaphragm up to a frequency of about 300 cps. Above this point the horn radiation is negligible but radiation from the front of the same 15-inch diaphragm occurs with high efficiency. For frequencies above 600 cps the constant resistance dividing network diverts the electrical input to a compression-type

[1] Karl Kramer, "A three-channel loudspeaker." *FM-TV Radio Communication*, Sept. 1951, p. 40.

[2] "A back-loading folded horn for 15-inch loudspeakers." *Jensen Technical Bulletin No. 1*, available without charge from Jensen Manufacturing Company, 6601 South Laramie Avenue, Chicago 38, Illinois.

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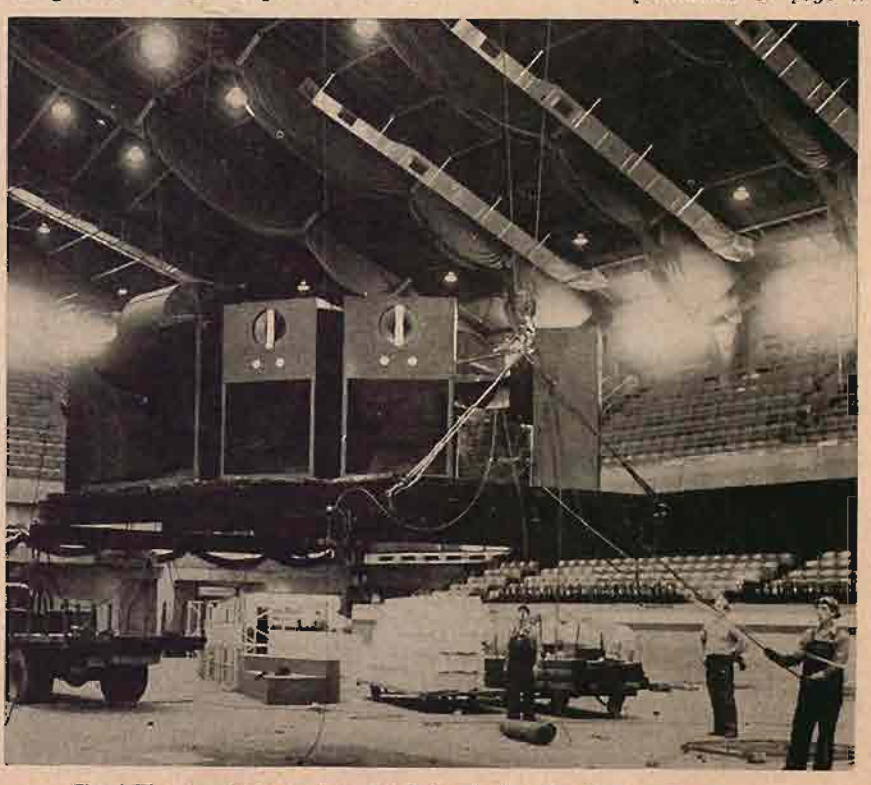

Fig. 6 The reproducer gondola just before hoisting to its operating position.

A Discussion of Dividing Networks

J. P. WENTWORTH*

Presenting two simple dividing networks—one of which provides a connection point for negative voltage feedback which will equalize over-all amplifier-speaker response.

IT IS GENERALLY ACKNOWLEDGED that a single loudspeaker unit can not reproduce optimally the entire audible frequency range. For clean reproduction of high-fidelity music, at least two speakers are required, each transducing signals in a limited frequency band. To insure that each speaker receives only signals within its own frequency range, it is customary to use a dividing network or networks to distribute the signal among the speakers.

Perhaps the neatest way to accomplish such signal distribution would be to separate the frequency bands at a low power level, and to use an individual power amplifier for each speaker. However, since the output stage and transformer represent a considerable part of a high-quality amplifier, in terms of cost, power consumption, and weight, it is usually more expedient to make the separation at the secondary side of the output transformer.

An ideal multispeaker system would give the impression that the sound emanated from a single super-speaker, which was able to handle all frequencies. To accomplish this aim, the dividing network should satisfy the following criteria:

1. The network must so distribute the signal among the speakers that the acoustic power output at every frequency is the same as that radiated by the single hypothetical ideal speaker.
2. All frequencies should be radiated with the same phase relationships as those that would exist in the case of the single ideal speaker. This objective is a rather minor consideration in minimizing phase distortion; however, if inverse feedback voltage is to be taken from the speaker voice coils, it becomes a requirement of paramount importance.
3. The speaker system should present to the amplifier a constant and purely resistive impedance, in order to minimize distortion in the output stage of the amplifier.
4. In the interest of economy of power, it is desirable that the network be nondissipative; i.e., that it be made up of purely reactive impedance elements.
5. In order to provide effective damp-

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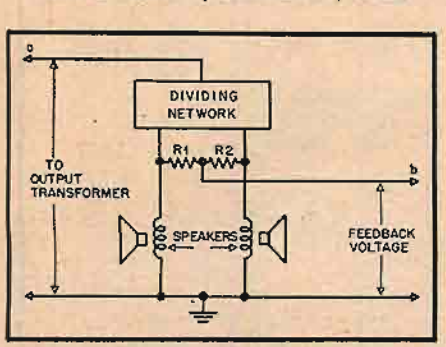

Fig. 2. Circuit arrangement for obtaining feedback voltage from voice coils of two-speaker system.

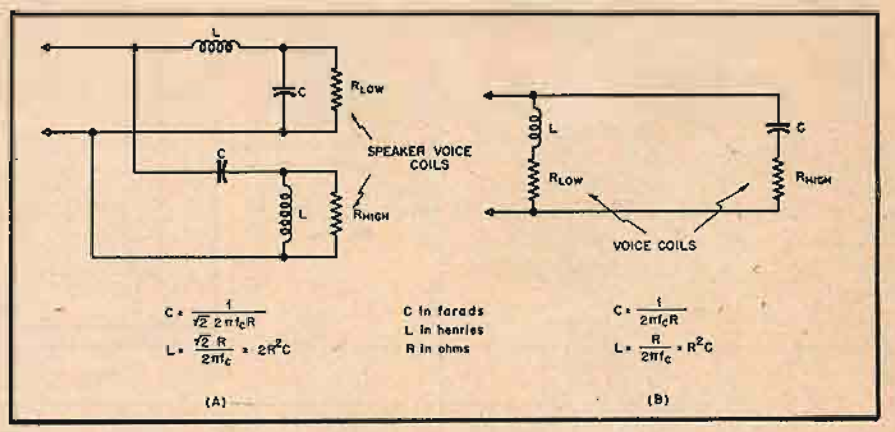

Fig. 1. (A) Parallel network, constant resistance type, giving a cut-off slope of 12 db per octave; (B) Half-section network giving cut-off slope of 6 db per octave.

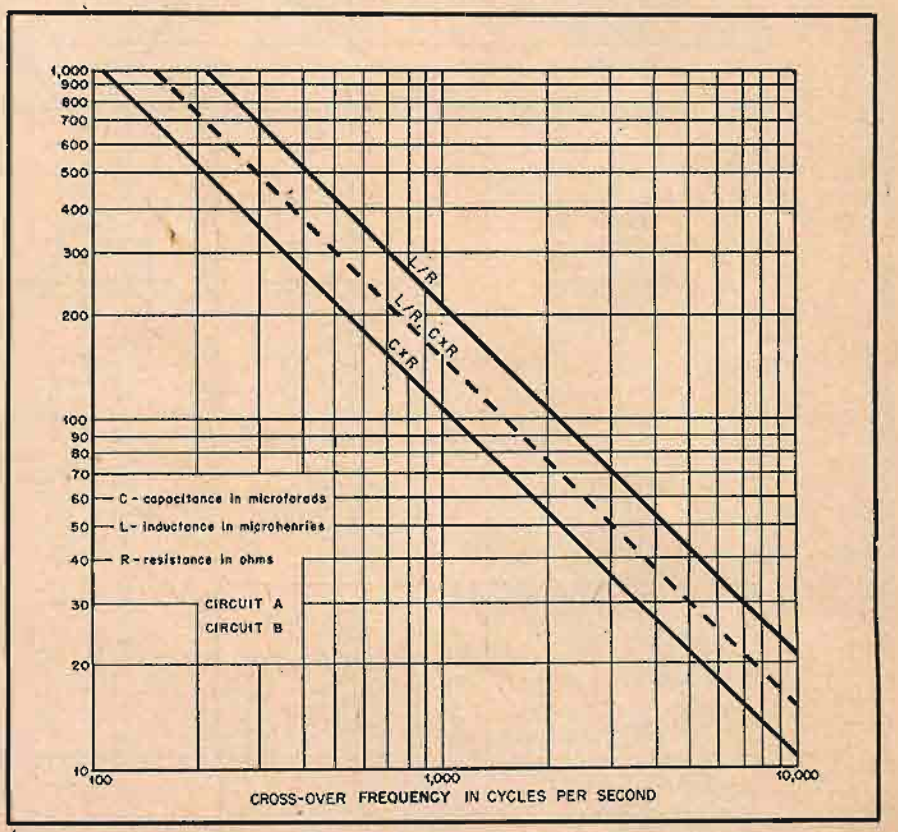

Fig. 3. Chart for determining values for L and C in networks of Fig. 1.

Simplified Equalizer Design

GEORGE A. DOUGLAS*

Charts and tables to reduce complication—and construction hints to ease building.

In applications requiring exact modifications of the audio spectrum, constant-resistance equalizers are capable of doing the job with maximum efficiency and convenience. The correction of cutter peaks and tape droop at the high end, the incorporation of pre-emphasis, and numerous other alterations of response can readily be accomplished with the design data that follows, and which involves only simple arithmetic to calculate values of components; or, with the use of a reactance chart, a few steps of multiplication.

Figure 1 shows the four configurations with their transmission characteristics used to cope with the equalizer problems commonly met in audio work. The circuits of (a) and (b) are shelf suppressors, or conversely, low and high boost; (c) and (d) are peaking equalizers. As it is inadvisable to use more than 20 db of attenuation in a single equalizer, it will be seen that the shelf suppressors serve where a gradual curve is required not exceeding 6 db per octave. Networks may be cascaded to obtain a steeper characteristic, but this requirement is usually met by applying (c) or (d), in which case it is possible to control the slope.

The first step in the design of an equalizer is to draw on logarithmic paper the actual and desired response of

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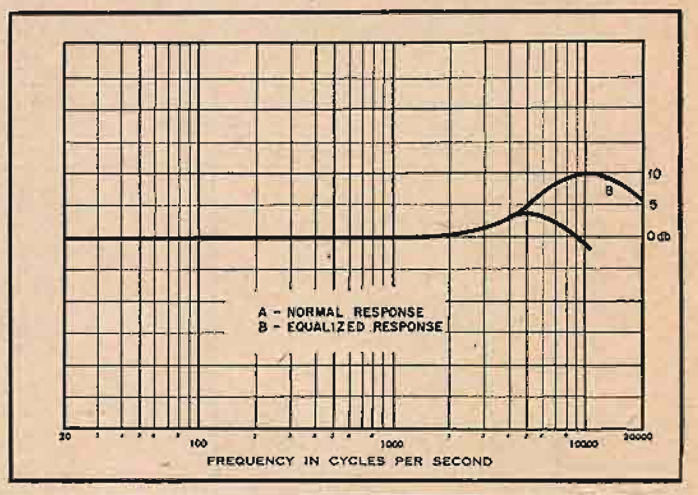

Fig. 2. Method of adding pre-emphasis to recording characteristic to eliminate a cutter peak, for example. Curve A represents normal response, while curve B represents desired response. The required equalization is represented by the difference between the two curves.

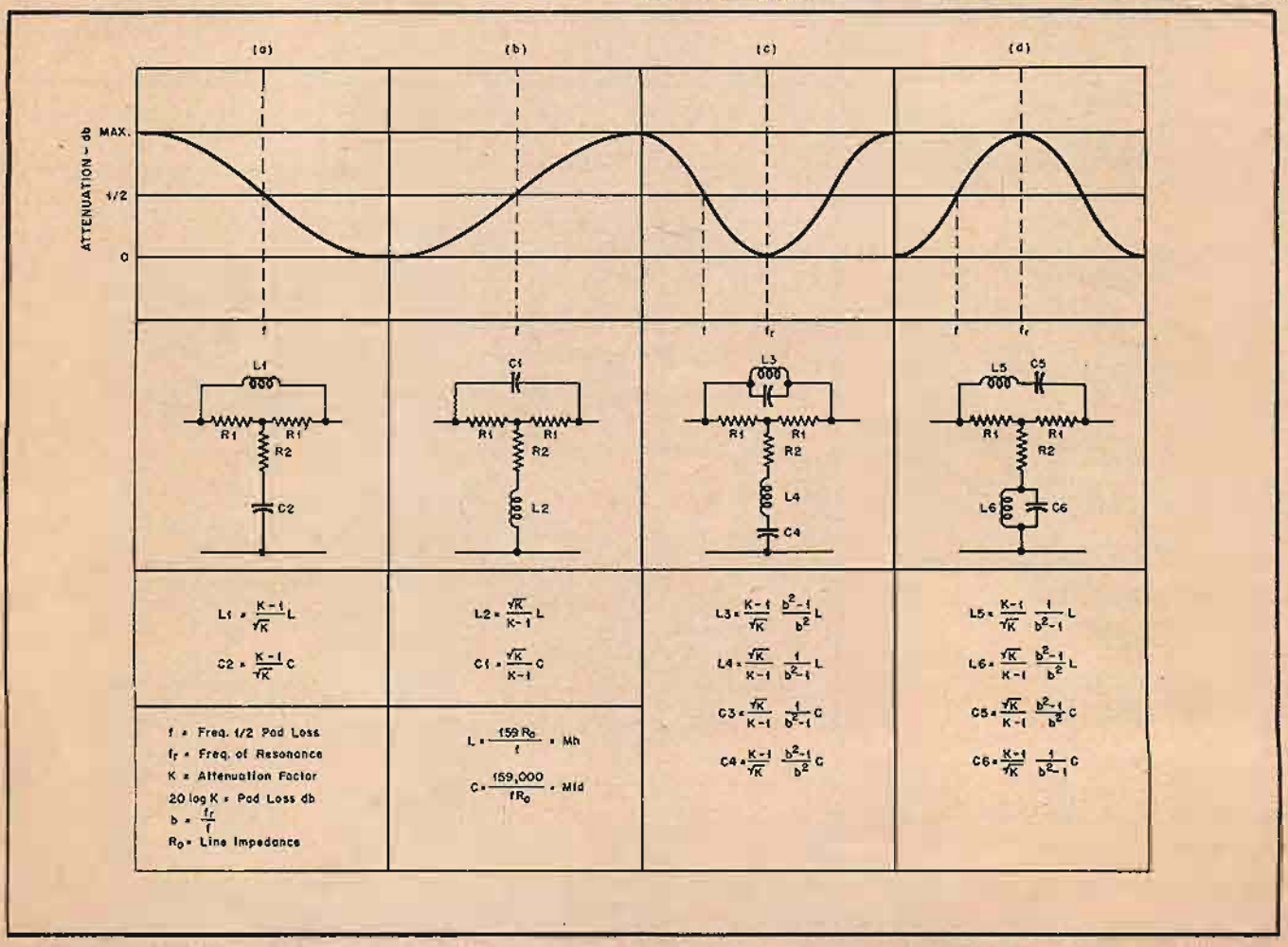

Fig. 1. Chart showing the configurations of four different types of equalizers, together with formulas for determining the reactive elements.

the equipment requiring modification or correction. This will furnish information to construct the transmission characteristic of the equalizer. On this curve note the design frequency on the transmission characteristic at the line of half the total attenuation. With the design frequency f and the impedance of the line in which the equalizer is to work, calculate L and C, or take their values directly from a reactance chart. L_1 to L_6 and C_1 to C_6 may now be ascertained by substituting in the equations figures taken from the accompanying tables.

For the shelf suppressors only Table 1 is used. The values for $\frac{K-1}{\sqrt{K}}$ and $\frac{\sqrt{K}}{K-1}$, and for R_1 and R_2 for an impedance of 1 ohm, are located opposite the degree of attenuation desired. For other values of R_1 and R_2, multiply by selected R_0. The data in Table 2 determines the slope of equalizers (c) and (d). The ratio in column 1 corresponds to f_r/f (the resonant frequency divided by the frequency of one half the attenuation). Opposite this are found the solutions of $\frac{b^2-1}{b^2}$ and $\frac{1}{b^2-1}$.

Example:

Curve (A) of *Fig.* 2 depicts a typical cutter response above 1000 cps. It is desired to design a 600-ohm equalizer for a recording characteristic with 10 db of pre-emphasis at 10,000 cps. Ordinarily the low-frequency shelf suppressor could be used, but in this case the cutter peak would be undesirably increased. It is apparent that the rising slope of the peak can be continued to the 10,000-cps, 10-db point; therefore the obvious solution is to design the equalizer with the configuration of (d) with a resonant frequency of 10,000 cps, and an attenuation[1] of 10 db. From the curve, the point of half the attenuation, or 5 db, is found at 7000 cps, the design frequency. L and C can now be ascertained:

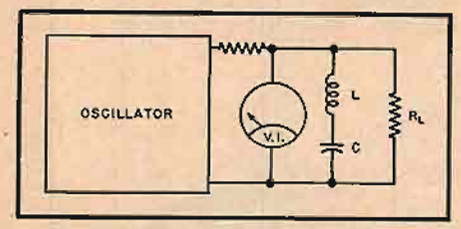

Fig. 3. Circuit arrangement for determining resonant frequency of LC combination.

[1] While the term "attenuation" usually refers to a loss, it has a slightly different meaning when used with an equalizer of any of these types. In the case of equalizers (c) and (d), attenuation refers to the difference in the transmission at the resonant frequency to that at frequencies remote from the resonant frequency. For those equalizers of types (a) and (b), attenuation refers to the difference in transmission at the two extremes of the frequency spectrum. In both cases, this "attenuation" is determined by the loss in the resistive network, which is normally referred to as an attenuator or pad.

$$L = \frac{159 \times 600}{7000} = 13.62 \text{ Mh}$$

$$C = \frac{159{,}000}{7000 \times 600} = .038 \ \mu\text{f}$$

Now, since

$$L_5 = L \frac{K-1}{\sqrt{K}} \frac{1}{b^2-1}$$

$$L_6 = L \frac{\sqrt{K}}{K-1} \frac{b^2-1}{b^2}$$

$$C_5 = C \frac{\sqrt{K}}{K-1} \frac{b^2-1}{b^2}$$

$$C_6 = C \frac{K-1}{\sqrt{K}} \frac{1}{b^2-1}$$

From the tables:

$$\frac{1}{\sqrt{K}} = 1.213 \qquad \frac{f_r}{f} = \frac{10}{7}$$

$$\frac{K-1}{\sqrt{K}} = .824 \qquad \frac{b^2-1}{b^2} = .512$$

$$R_1 = .520 \qquad \frac{1}{b^2-1} = .952$$

$$R_2 = .704$$

Substituting, we now have:

$L_5 = 13.62 \times 1.213 \times .952 = 15.7$ Mh
$L_6 = 13.62 \times .824 \times .512 = 5.8$ Mh
$C_5 = .038 \times .824 \times .512 = 0.16$ µf
$C_6 = .038 \times 1.213 \times .952 = .043$ µf
$R_1 = .520 \times 600 = 312$ ohms
$R_2 = .704 \times 600 = 423$ ohms

For many applications in the upper frequency range, r.f. chokes can be utilized, providing the d.c. resistance is not excessive. The photographs, *Figs.* 4 and 5, show a completed equalizer with 5-mh. coils of about 15 ohms. To provide proper inductance, select capacitor(s) of correct value for C in *Fig.* 3. Set the oscillator to the desired resonant frequency, with more inductance in the circuit than is needed, and remove turns until maximum attenuation occurs.

Coil resistance can be compensated for to some extent by including it in the pad. Thus, when an inductance appears in the shunt arm, its d.c. resistance should be deducted from R_2, and a resistor selected which has an actual

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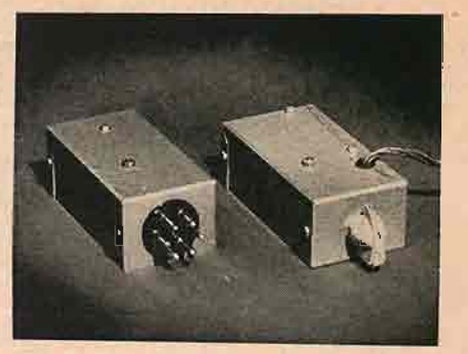

Fig. 4. Two equalizers constructed by the author—left, a plug-in unit employing a fixed amount of equalization, and right, a unit providing step-switch control of attenuation.

TABLE 2

EQUALIZERS

$\frac{f_r}{f}$	$\frac{b^2}{b^2-1}$	$\frac{1}{b^2-1}$
$\frac{10}{9}$	.187	4.348
$\frac{10}{8}$	.359	1.785
$\frac{10}{7}$	.512	.952
$\frac{10}{6}$	.637	.568
$\frac{10}{5}$	.750	.333
$\frac{10}{4}$	.840	.190
$\frac{10}{3}$	.910	.099
$\frac{10}{2}$	.960	.042

TABLE 1

EQUALIZERS

db	$\frac{K-1}{\sqrt{K}}$	$\frac{\sqrt{K}}{K-1}$	R_1	R_2
1	.113	8.833	.057	8.68
2	.232	4.307	.114	4.32
3	.345	2.902	.171	2.84
4	.468	2.135	.226	2.20
5	.586	1.705	.280	1.646
6	.709	1.410	.332	1.34
7	.826	1.193	.382	1.118
8	.949	1.053	.430	.946
9	1.082	.923	.476	.812
10	1.213	.824	.520	.704
11	1.356	.737	.560	.602
12	1.500	.667	.598	.536
13	1.644	.608	.634	.472
14	1.790	.558	.668	.416
15	1.949	.513	.700	.368
16	2.116	.453	.728	.310
17	2.285	.437	.752	.268
18	2.461	.406	.776	.246
19	2.654	.376	.798	.224
20	2.848	.351	.818	.202

Handbook of Sound Reproduction

EDGAR M. VILLCHUR*

Chapter 7—History of the Phonograph

The recording of sound has been of interest to inventors for nearly a hundred and fifty years, although means of reproducing it is only seventy-five years old. Some of the earliest instruments are described by the author.

IN 1877 THOMAS EDISON, for the first time in history, succeeded in reproducing sound mechanically from a recorded pattern. The inventor played back his own recitation of *Mary Had a Little Lamb* on an instrument that was ingeniously conceived, but which was largely modeled on a basic earlier design, one that had been used in sound recorders over a period of seventy years.

Thomas Young, the British physicist who introduced the modulus of elasticity in current use, described a device in 1806 which was able to make a graphic record of sound waves. The vibratory nature of sound was known, and the use of a time *vs.* pressure graph to represent sound vibrations was familiar to workers in acoustics. This device made such a graphic record automatically; the stylus was actuated by the sound itself rather than by the hand of a draftsman.

Young's description of the principle of sound recording is as clear and valid today as it was then, and it may serve us here:

"The situation of a particle at any time may be represented by supposing it to mark its path, on a surface sliding uniformly along in transverse direction. Thus if we fix a small pencil in a vibrating rod, and draw a sheet of paper along, against the point of the pencil, an undulated line will be marked on the paper, and will correctly represent the progress of the vibration."

The recorder in which this principle was first applied is illustrated in *Fig. 7—1*, a reproduction of the original copper engraving in the 1807 edition of Young's *"A Course of Lectures on Natural Philosophy and the Mechanical Arts."* The recording stylus *K*, which was held pressed against the cylinder by spring tension, had to be touched by a "sounding body" in order to have vibrations induced in it. The traced line or groove was varied transversely rather than in depth; this is the type of recording known today as *lateral*.

Sound recorders were constructed by several other experimenters, such as Duhamel and Wertheim, during the first half of the 19th century. All of these devices, like the apparatus illustrated in *Fig. 7—2*, required direct connection between the source of sound and the recording stylus. The immediate ancestor of the modern phonograph is therefore considered to be the instrument built in 1856 by Léon Scott de Martinville, whose recorder was the first to receive its energy through acoustical rather than mechanical coupling to the source.

Sound to be recorded on Scott's instrument was directed through a horn

* *Contributing Editor*, AUDIO ENGINEERING.

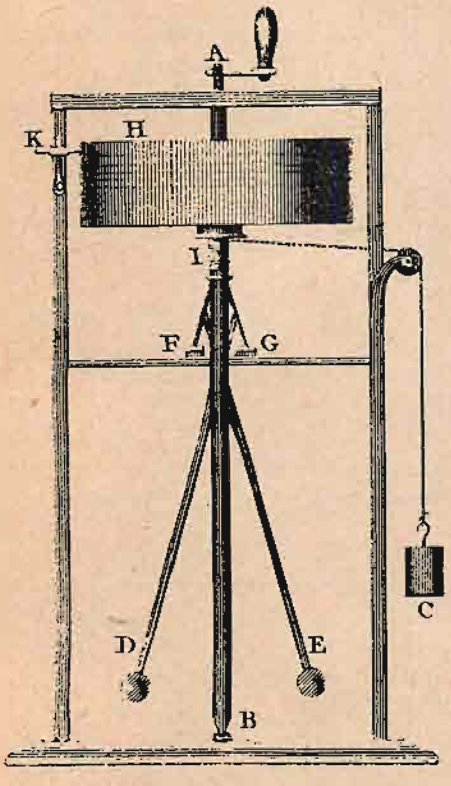

Fig. 7-1. Young's sound recorder and chronometer of 1806 (from a copper engraving of that date). The original caption reads: "The axis AB being turned, either by the handle A or by the weight C, the balls D, E, fly out, and carry the weights, F, G, further from the axis; in consequence of which the increased effect of friction retards the motion when it becomes too rapid. The barrel H is turned in the meantime, with the axis, and is allowed to descend as the thread at I is uncoiled, so that the point K, which is pressed against it by a spring, describes on it a spiral, which is interrupted whenever the pin K, is touched." From: A Course of Lectures on Natural Philosophy and the Mechanical Arts, 1807.

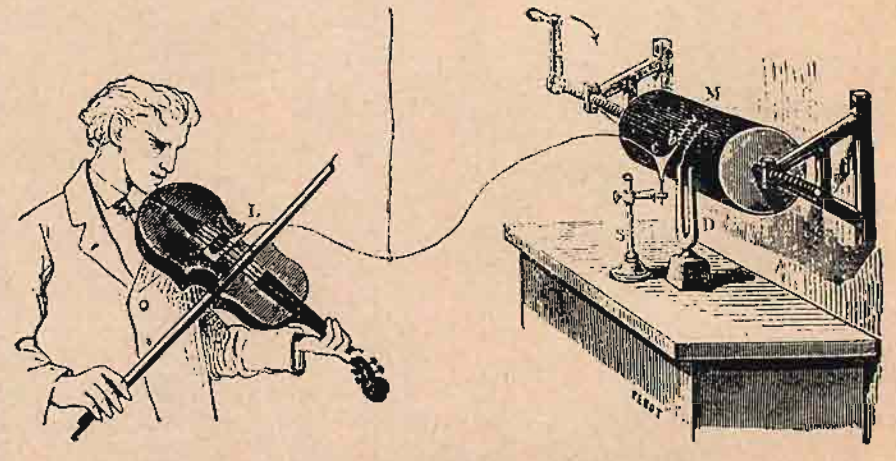

Fig. 7-2. Early experiments in sound recording. No intermediary diaphragm was employed, as in the phonautograph, between the source of sound and the recording stylus. From: Telephones et Phonographes, Alfred Niaudet, 1878.

against a parchment diaphragm and attached hog-bristle stylus. The point of the stylus pressed against a cylindrical surface treated with lampblack, so that the path of displacement produced by stylus vibrations was scratched into the lampblack, revealing the white paper underneath. The traced line was made to travel along the time axis of the graph by continuous rotation of the cylinder past the point of stylus contact, and a feed screw moved the cylinder longitudinally, creating a helical rather than a circular trace.

This device was called, appropriately, the phonautograph, from *phone* (sound), and *autograph* (self-writing). It was manufactured commercially by the Paris firm of Koenig as a laboratory instrument for measuring and recording, a mechanical oscilloscope. (See *Fig. 7*—3). The translation of acoustic vibrations into a frozen engraving of their wave forms thus ceased to be a purely experimental technique. Within its limitations the phonautograph could capture the characteristics of frequency, overtone structure, and dynamic range of any given group of sounds. There remained only the final step of devising a method to recall the sound from its symbolic state.

The process of recall had to reverse the recording sequence exactly, that is, to produce mechanical and then acoustical vibration by dragging a compliant stylus through a rigidly engraved graph of recorded sound. The stylus would then be forced to vibrate in a similar manner to the recording stylus which had received the original sound energy, and imitative acoustic waves could be set up through an attached reproducing diaphragm. Scott predicted that the day would come when recorded sound could be re-created, but it was more than twenty years before an instrument of recall was built. Although the principle was known, the quantitative problem of creating a groove rigid and deep enough to direct the motion of a reproducing stylus had to be solved.

Strange as it may seem, "talking machines" already existed; these were pneumatic devices designed to produce intelligible speech rather than musical tones. The keyboard controlled speech organ (*Fig. 7*—4) constructed by Josef Faber of Vienna was considered the most perfect of the robots. It could be made to speak by means of a complicated and ingenious mechanism, artificial vocal apparatus consisting of bellows, valves, adjustable air cavities, a little fan wheel to roll its r's, and rubber lips and tongue. Such devices, mechanical forerunners of the modern electronic *voder*, were the outcome of a different branch of acoustical research than Scott's, but they probably stimulated thought in terms of sound reproduction.

A machine to perform the reversal of Scott's recording process was suggested by several writers in periodical literature, and in April, 1877, Charles Cros deposited with the French Academy of Sciences a sealed packet containing the description of a complete reproducing system. Cros planned to make metal records of phonautograms by photo-engraving after the lampblack groove had been traced.[1]

The first working model of a sound reproducing machine, however, was made in the laboratory of Thomas Edison later that year. Edison drew up the plans shown in *Fig. 7*—5 and assigned a worker in his laboratory, John Kruesi, to build a "phonograph" within a budget of eighteen dollars. Like Cros, Edison realized that the engraving had to be stiff enough to force the stylus to follow the recorded convolutions. He solved this problem by producing a deep embossing in tinfoil, a medium with a compromise degree of hardness. The embossing stylus was mounted so that it could indent, in varying degree, a sheet of tinfoil wrapped on a pregrooved brass cylinder. The depressions of the cylinder's threads accepted the indented material, and although each playback deformed the shape of the groove, enough of the original form was retained to reproduce speech intelligibly. This retention was made possible by the very poor efficiency of re-

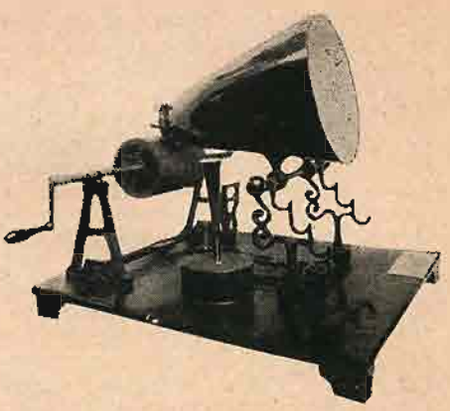

Fig. 7-3. The phonautograph of Leon Scott de Martinville. (Courtesy The Smithsonian Institution).

[1] (Translated excerpt from Cros' paper) "Speaking generally, my process consists in obtaining traces of the movement to and fro of a vibrating membrane, and in using this tracing to reproduce the same movement, with its intrinsic relations of duration and intensity, either on the same membrane, or on one adapted to give out the sounds which result from this series of movements.

"It is therefore necessary that an extremely delicate tracing, such as may be obtained by passing a needle over a surface blackened by fire, should be transformed into a tracing, capable of sufficient resistance to guide an index which will transmit its movements to the membrane of sound.

". . . By a well-known photographic process, a transparent tracing of the modulations of the spiral can be represented by a line of similar dimensions on some resisting substance—tempered steel, for example. . . ."

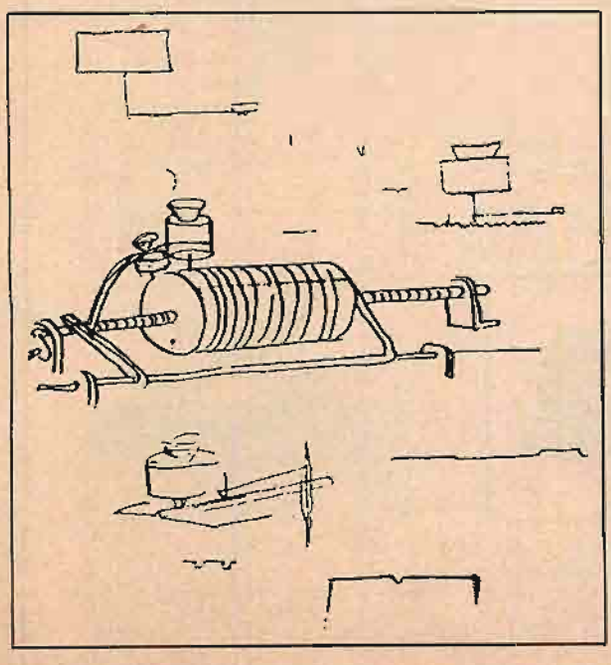

Fig. 7-5. Edison's original working sketches for the phonograph. From: The Life and Inventions of Thomas Alva Edison, by **Dickson, 1894.**

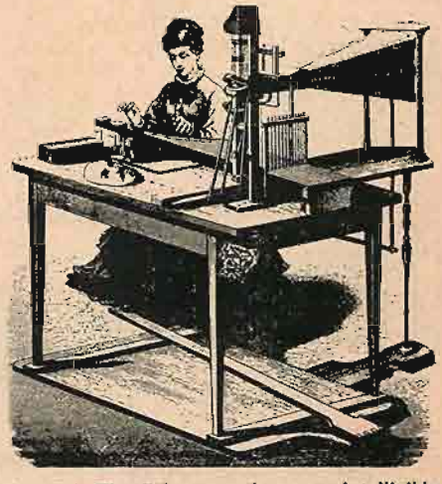

Fig. 7-4. The Faber speech organ. Intelligible speech could be "played" from the rubber lips in front of the bellows. From: Internationale Zeitschrift fur Allgemeine Sprachwissenschaft, **1884.**

production; the resistance presented by the playback stylus was far less than the original recording force.

The phonograph was demonstrated before various scientific groups. When, in 1878, it was presented at the *Académie des Sciences*, it was received by several members with suspicion, and the suggestion was even made that the operator of the machine seemed to be "grimacing" like a ventriloquist. One Academy member who was more realistic remarked that Edison's invention, while valid, consisted of the sheet of tinfoil. In any case the use of a recording medium with an in-between degree of hardness was a successful but inefficient solution to the problem of reproduction. Charles Tainter and Chichester Bell (a cousin of Alexander G.) took out a patent in 1886 which corrected this feature and which went a long way towards making the phonograph practical. Embossing was discarded for cutting (the recording stylus was given a sharp edge), and the record was protected from damage during playback by the rounded shape of the reproducing stylus tip.

Commercial Development of the Phonograph

During the next few years recording was advanced to a point where it could be exploited commercially. At first the reproduction of sound found its main application in office dictating machines. Edison himself listed the reproduction of music only fifth in a tabulation of proposed uses, with the recording of family records and "the last words of dying persons" a close sixth. An 1892 phonograph instruction manual showed various models of industrial cylinder recorders being manufactured, differing mainly in the type of motive power used. They were driven by treadles, water motors that worked through connection to the faucet, or electric motors, both battery and line operated, as pictured in *Fig. 7—7*. All of these systems were later superseded by the governor controlled spring motor, which was adopted almost universally for both office and home machines until the house current motor was revived.

Record players were quite expensive, too costly for the ordinary home. Machines for entertainment were provided in coin-operated public phonographs which would play a selection into one or more stethoscope-type hearing pieces or through a horn. Records had to be changed manually, but the modern record changer was foreshadowed by a repeating mechanism that brought the reproducer back to the start of the record and started the needle in the grooves automatically. A dealer trade magazine, *The Phonogram*, warned that the success of talking machines in the entertainment field was ephemeral, and might be bad for the growth of the phonograph industry. An editorial in this periodical stated, in 1891:

> "There is danger of too much attention being given . . . to the 'coin-in-the-slot' device (*Fig. 7-8*) at the expense of the more legitimate business of the companies, of introducing the phonograph into general use among business men. The exhibition of the phonograph for amusement purposes . . . is calculated to injure the phonograph in the opinion of these seeing it only in that form, as it has the appearance of being nothing more than a mere toy, and no one would comprehend its value or appreciate its utility. . . ."

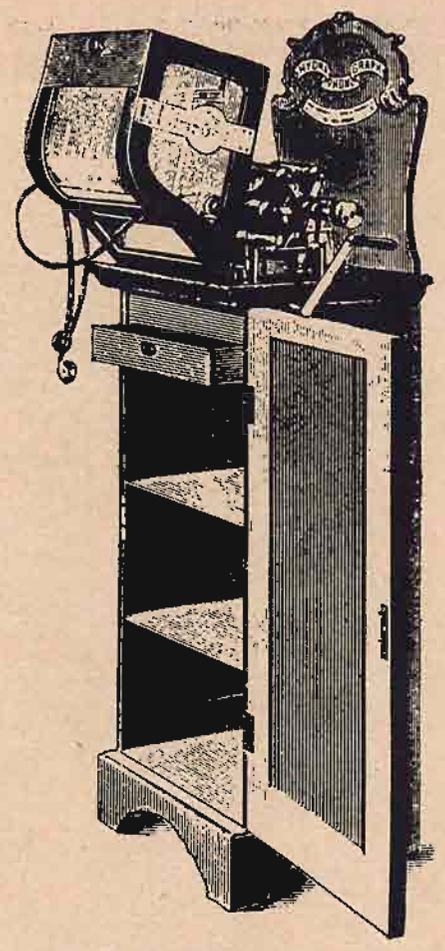

Fig. 7-8. A 1900 juke-box—the Edison "Hydra-Phonograph," a six-cylinder coin-operated player. From: Die Modernen Sprechmaschinen.

But despite the editors of *The Phonogram*, and also despite the recriminations and patent suits and countersuits that raged among manufacturers, the phonograph emerged as a popular instrument whose main function was entertainment in the home.

Techniques for the mass production of records from a single master mold, developed by Emil Berliner (who started his researches by successfully carrying out the proposals of Cros) made records for home entertainment possible, and in addition introduced problems of standardization which had not existed when the same machine did both the recording and the reproduction. Early record buyers had to be advised, for example, to adjust the motor speed during the opening announcement until "the tones of voice seem to be in a natural key, and neither too high and shrill nor too low and heavy."

It did not take long for manufacturers to achieve mechanical excellence and reasonable cost in their record players. An Edison phonograph at the turn of the century was a nickel-plated joy to behold, well designed and rugged.[2] The pickup, then called a speaker, produced only a small fraction of an ounce pressure on the cylinder groove, and had a permanent sapphire needle mounted in it. (See *Fig. 7—9*) The quality of the reproduced sound, however, was very poor. Distortion was high, blasting occurred at those parts of the music which found sympathetic resonance in the reproducing apparatus, and frequency response—besides being very irregular—was so restricted that all fundamental tones represented by the lower half of a piano keyboard were missing, except as they could be detected by their harmonics. The absence of bass, together with the severely limited volume, gave the sound the characteristic tinny quality associated with old players.

In an effort to obtain increased sound output, many unique systems were employed. Among them there was

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[2] Many are still in good playing condition.

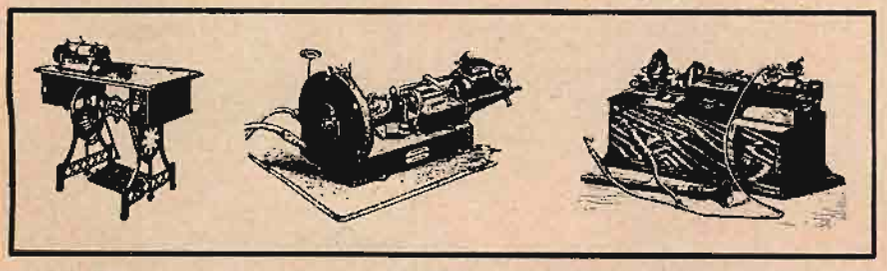

Fig. 7-7. Three commercial products of the 1890's. Left to right, the Tainter treadle Graphophone, the water-motor Edison Phonograph, and the electric Edison Phonograph, available for battery use or "wound for the incandescent current." From: A Short History of the Talking Machine Industry, **Columbia Graphophone Company, 1913;** The Phonograph and How to Use It, **National Phonograph Company, 1900;** and Die Modernen Sprechmaschinen, **1902.**

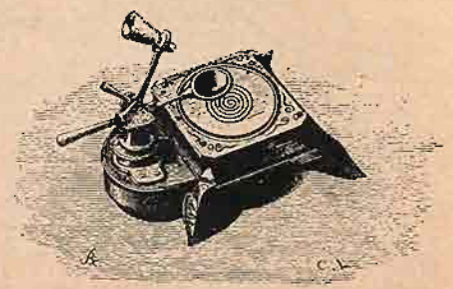

Fig. 7-6. Edison disc phonograph. From: The Telephone, the Microphone, and the Phonograph, **1879.**

Speaker Treatment for Improved Bass

CAMERON BARRITT*

A simple method of lowering the effective low-frequency limit of inexpensive speakers, but not one that is recommended for high-quality woofers.

A DESIRABLE FREQUENCY RESPONSE characteristic for an audio reproducing system requries adequate lows as well as highs. Amplifiers are available which can handle the necessary range, but the loudspeaker is the bottleneck in the drive toward more perfect audio reproduction. The problem of rendering sufficient highs can be met by various means such as the employment of "tweeters"—some of which can go close to the upper limit of human audibility—but the low-frequency speakers or "woofers" usually fall far short of the lower limit. Sound is propagated at frequencies as low as 16 cps, and 20 cps is usually considered as being audible. LP records are capable of going down to 30 cps, by way of further example, but not many speakers go this low.

The lower limit of a properly baffled speaker is determined by the mechanical resonant frequency of the vibrating piston or cone. A certain amount of propagation occurs below this frequency but response falls off rapidly beyond. The resonant frequency of a mechanical vibrating system is determined by the mass and the compliance—the inverse of stiffness. These two are the electro-mechanical analogs of inductance and capacitance. The mechanical resonant frequency formula is $f_r = 1/2\pi\sqrt{mC}$. The mass of a speaker cone is determined for the most part by constructional requirements for rigidity, and is not readily altered. Furthermore, if one were to increase the mass very much in order to lower the resonant frequency, phase response would suffer and poor transient response might result. For best reproduction of transients a low m/C ratio is required. On the other hand, the compliance of the speaker depends on the "give" in the cone suspension or mounting and no undersirable consequences will result from increasing its value.

* *1200 Susquehanna Ave., W. Pittston, Pa.*

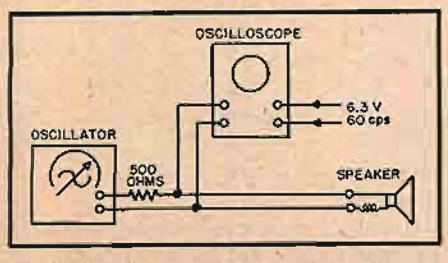

Fig. 3. Circuit arrangement used to determine resonant frequency of loudspeaker.

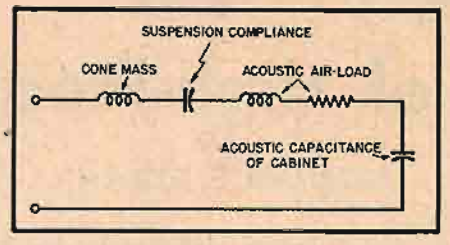

Fig. 1. Equivalent electrical circuit of a loudspeaker mounted in a baffle.

The total compliance or capacitance of the speaker system also depends on the acoustic capacitance of the air volume in the baffle if it is the totally enclosed type. The equivalent electrical circuit[1] of a loudspeaker mounted in an enclosed baffle is shown in *Fig.* 1. Notice that the two analogical capacitances are in series. If the baffle is made as large as possible, it will be so much larger a capacitance than the cone compliance that the limiting value will be in the suspension. The remaining reactance — the inductance representing the quadrature component of the speaker's air load—is usually small enough to be ignored (except in the case of the R-J speaker enclosure where it is exalted to make possible a smaller speaker enclosure). Consequently that leaves just the cone suspension compliance on which to work in improving the bass range of a speaker.

[1] Harry F. Olson, *"Elements of Acoustical Engineering."* McGraw-Hill.

Since the baffle is of no concern, one can use the "free-space resonant frequency" of the speaker as the working criterion. Although the mass of a speaker cone can not be controlled enough to vary this frequency very much, the cone suspension can be treated to make it more compliant and this would lower the resonant frequency the same as would increasing the capacitor in an electrical "tank" circuit. There are two methods of doing this, and by utilization of both it is possible to lower the frequency response limit 30 per cent or more. A relatively inexpensive 8-inch speaker treated by this system can be made equal in bass-range capability to a good quality 12-inch speaker.

Methods of Increasing Compliance

The first method is called "slotting" by the makers of Permoflux loudspeakers. As shown in *Fig.* 2, the speaker is made less stiff by radial incisions in the suspension. The improvement derived from this treatment depends on the merit of the suspension design beforehand. The suspension area of some good modern speakers is extremely thin, as can be

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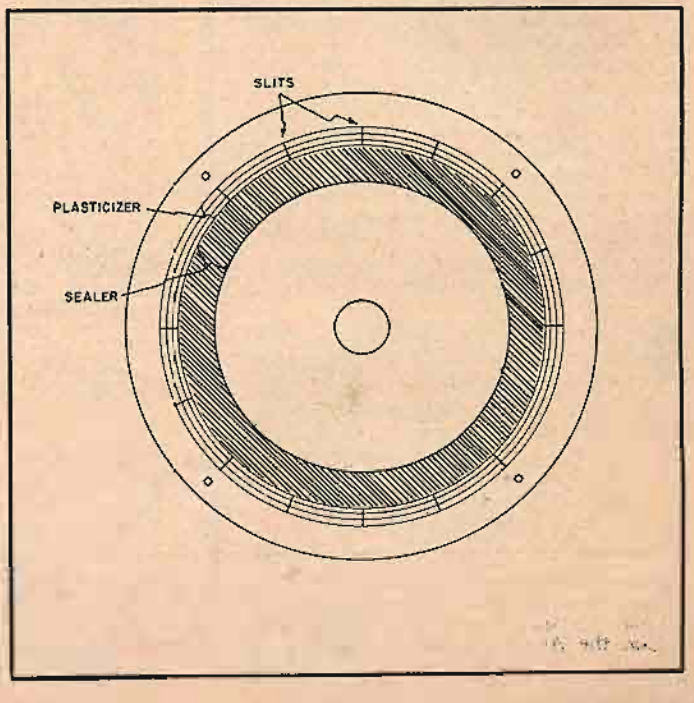

Fig. 2. Method of slitting cone, as described by the author, and location of shellac sealing ring.

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Wide-Angle Dispersion of High-Frequency Sound

ABRAHAM B. COHEN*

A description of the design of a series of high-frequency horns with improved performance in the horizontal plane and a minimum of diffraction in the vertical plane.

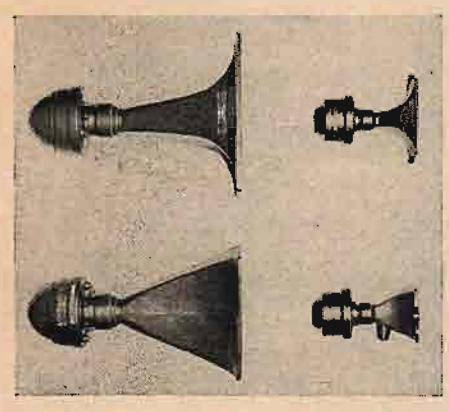


Fig. 1. Two commercial horns which employ the reverse-flare principle described.

Summary:

A high degree of wide-angle dispersion in one plane may be achieved by means of a compound horn in which the primary section allows wave expansion only into the undesired plane. This creates a pressure gradient along the horn walls defining the desired plane. The built up pressure is subsequently allowed to expand into the desired plane by reversal of the direction of flares of the horn walls. This reverse-flare device in conjunction with a square horn mouth provides wide-angle radiation free from phase cancellation and mouth diffraction effects.

AN ESSENTIAL REQUISITE of a tweeter radiator is that the high-frequency energy be distributed over a wide horizontal angle. Failure to attain such a characteristic results in off-axis loss of level of the high frequencies. However, wide-angle dispersion by itself is not the optimum solution to high-frequency radiation. The following three attributes must prevail simultaneously.

a. Maintenance of the sound pressure of the entire frequency range of the tweeter over the entire angular coverage desired.
b. The over-all efficiency of the horn must not be sacrificed in making the horn a wide-angle radiator.
c. The angular response shall be free of irregular energy lobes as the frequency changes.

Figure 2A compares graphically these characteristics of merit for the three types of tweeter horns commonly known as the multicellular type, the pie-wedge type, and the recent University "Reverse Flare" type. The multicellular characteristic shows regions of extreme energy fluctuation. Such fluctuation dependent upon frequency and angle, is

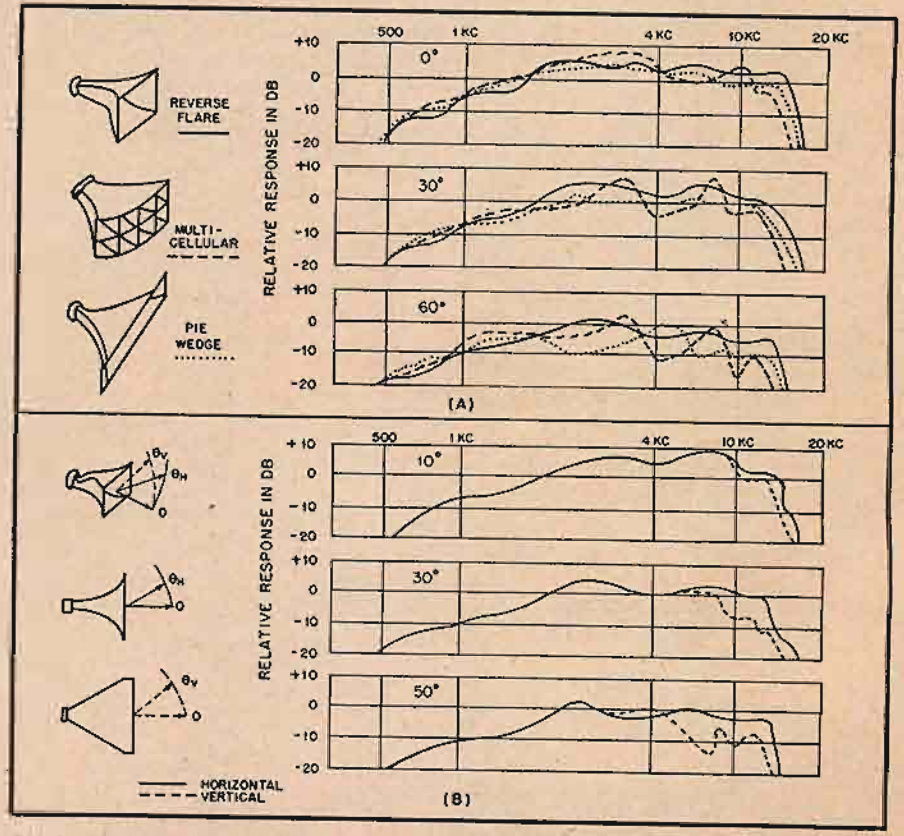


Fig. 2. (A) Comparison of performance of reverse flare, multicellular, and pie-wedge horns. (B) Relative angular response in horizontal (solid lines) vs. vertical (dotted lines) radiation in reverse-flare horn.

* *University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N. Y.*

due to the phase cancellation of energy from the several individual sources of radiation from the multicellular mouths. Where multicellular sources are absent, as in the pie-wedge type of horn and in the reverse flare horn, there is no evidence of these phase discriminatory cancellations. However, it will be noted that the pie wedge exhibits considerable energy loss in the mid-band-pass region for increasing angle. The conventional narrow vertical dimension of the mouth of this type of horn gives rise to excess diffraction of energy into the vertical plane which is tantamount to energy loss in the horizontal plane.

Where neither multicellular nor wedge-mouth devices are used, as in the reverse flare horn, high horizontal efficiency performance is obtained, and there are no phase cancellation regions, as *Fig.* 2A indicates. The favorable ratio of horizontal to vertical radiation for this type of horn is illustrated in *Fig.* 2B.

The reverse flare horns illustrated in *Fig.* 1 show that this type of horn first expands rapidly in the vertical direction, and as the mouth of the horn is approached it begins to expand also in the horizontal direction. Hence the name "Reverse Flare" horn. The second feature of this horn is its square mouth configuration (in contrast to the narrow slit type). This *combination* of reverse flare and square mouth shape prove especially effective in giving the horn its desirable performance.

It is often stated that high frequencies project in a narrow beam, while low frequencies spread out in a wide beam. The truth of the matter is that all sound spreads out in ever widening circles regardless of frequency, *provided* there is no restriction or obstruction in the way. For instance, a pulsating sphere will give rise to a perfectly spherical wave front regardless of the frequency of pulsation. On the other hand, a twelve-inch cone type speaker beams the higher frequencies because of the radiation characteristics of the diaphragm shape and construction. It is the combination of *radiator size, radiator configuration, and frequency* which determines how loosely or how tightly a particular high-frequency sound will be dispersed. Following the same laws of physical acoustics, the *horn size and shape* will play an important part in the dispersion of the high-frequency energy radiated from the mouth of the horn.

Horn Pressures

All horns, including the reverse flare type, are pressure controlling devices. At the throat of the horn (the narrow end), the sound pressure is the greatest, while at the mouth of the horn (the wide open end), the sound pressure is the least. At any point along the axis of the horn between the mouth and the throat, the sound pressure is of some intermediate value. The actual manner in which the sound pressure throughout the horn varies depends upon the rate of growth of the area of cross-section of the horn. This cross-sectional growth is determined by the law under which the particular horn expands.

One of the most efficient of horn expansions is the exponential type. This horn is remarkably efficient as an impedance matching device between the source of sound at the throat of the horn and the atmosphere into which the mouth of the horn radiates. Its cross-sectional area expands according to the "natural law of growth," expressed by

$$\frac{A_2}{A_1} = \epsilon^{.000366 f_{co} x}$$

where f_{co} = the designated cut-off frequency of the horn in cycles per second

x = the distance in centimeters between two points within the horn and along the horn axis

A_2, A_1 = the areas of cross-section of the horn at the two designated points along the axis

ϵ = base of natural logarithms, 2.71828.

By choosing the cut-off frequency f_{co} desired, the physical expansion of the horn may be laid out. From this equation it is seen that for a given distance x between two points, and for low values of cut-off f_{co}, the exponential factor ϵf_{co} is smaller than for large values of cut-off frequencies. Consequently, the ratios of areas at these points along the axis are smaller for low-cut-off horns than for high-cut-off horns. This means that the horn designed for low cut-off expands slowly, while the horn designed for high cut-off expands rapidly.

This provides a means of determining in what geometric manner the sound pressures within the horn are distributed. For instance, in a horn with a high cut-off frequency which will necessarily expand and flare out quickly, the fast flaring walls of the horn allow the wave front to spread out rapidly in a direction transverse to the axis. Consequently, the total pressure of the wave front will be distributed quickly over the enlarged area between the fast flaring walls. This will result in a rapidly diminishing pressure per square unit of the wave front surface. On the other hand, in a horn with a low cut-off frequency where the walls expand slowly, the wave front development in a direction transverse to the axis will be restricted. Accordingly, the per unit area pressure distribution on the wave-front surface will diminish slowly. Thus a knowledge of the cut-off frequency of the horn will determine the fashion in which the sound pressures in the horn are geometrically controlled.

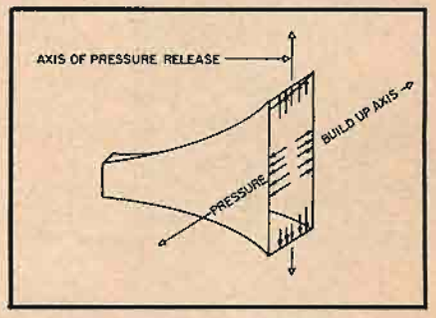


Fig. 4. Internal horn pressure configuration. The flaring upper and lower walls allow wave-front expansion which reduces the pressure on these walls. The non-flaring vertical walls restrict wave expansion causing build up of pressure against these walls.

Sound Radiation

To perform useful acoustic work, these internal sound pressures must eventually emerge from the horn into space. In making this transition, the sound pressures cross the mouth of the horn, which is its threshold into space. The mouth of the horn then becomes in essence the *sound radiator* for the energy reaching it with a particular pressure variation dependent upon the horn flare. Thus the size and configuration of the horn mouth, the horn flare, and the frequency involved will determine the degree of wave-front dispersion. Standard functional analysis of exponential horns shows that in this combination of factors, fast flare means wide-angle dispersion for highs, and large mouth means narrow-angle dispersion for lows (provided the mouth diameter is at least one third the wave length of the sound being radiated).

In the practical application of these guiding factors of horn design, the reverse-flare horn finds it possible to strike a unique balance between horn flare and mouth size. In brief, this is accomplished as follows. By first restricting wave expansion in one plane

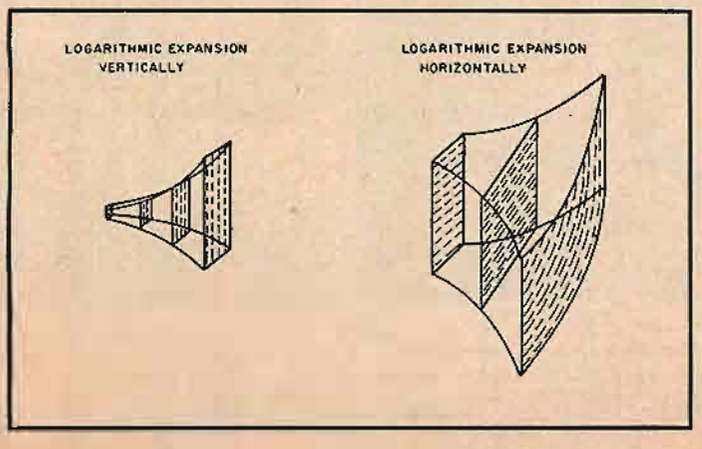
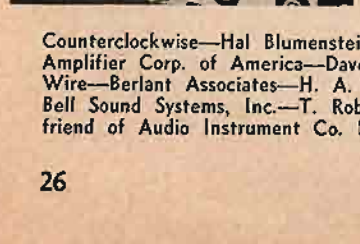


Fig. 3. Cross-sectional area development of reverse-flare horn. One area progresses from the preceding area according to the exponential expansion for a given cut-off frequency.

The 1952 Audio Fair in Review

A return in retrospect to the greatest audio show of all. Until next year, that is.

HARRIE K. RICHARDSON



IF YOURS WAS NOT the good fortune to attend the 1952 Audio Fair, you missed witnessing the culmination of the maturing process which has transformed the audio industry from a loosely-bound package of diverse interests into a monolithic mass which welds together in common objective many of the basic arts and sciences.

Of course, this is but another way of saying that audio has grown up—a thought we have been hearing for years on end. And we don't question the correctness of its expression in the past. On the other hand, we feel that the time has come to broaden its meaning—to give it the absolute quantity which prevails when an industry achieves the stability that comes with self-sufficiency.

Impressive proof that the audio industry has reached this stage was displayed in abundance at the 1952 Fair. Even the most casual analysis of visitors verified the belief that today's audio fan is far removed from the puttering individual whose chief satisfaction—whether in audio or anything else—lies in putting things together and taking them apart again. In the space of but a single year the character of the audio fan has undergone the transformation which the industry itself is now reflecting. Simply speaking, audio manufacturers today are serving individuals who are interested in audio chiefly because of its ability to add to the richness of their existence, and who care little, if at all, about audio because of its technical enchantment.

It is for these reasons that we believe audio has at last achieved maturity in the fullest meaning of the word.

Among the 13,000 visitors who attended the 1952 function were hundreds of prominent persons, including the distinguished Dr. E. H. Armstrong, inventor of FM broadcasting, whose presence lent both dignity and authority to the Fair as the accepted meeting place of the audio industry.

Following is this reporter's annual effort to convince you that, until you've thrilled to an Audio Fair, you just ain't been around.

Success on a national scale was clearly evident in the impressive display of Philadelphia's Acro Products Company. In addition to the now-famous Acrosound output transformers which were first introduced at the 1951 Fair, there were shown many new devices with which the company is making its bid as a leading manufacturer of audio components.

Packaged sound systems in highly original cabinetry, together with an excellent switching system for A-B testing, made the exhibit of **Allied Sound Corporation**, New York, both inviting and satisfying. In both respects it reflected the firm's lavish new sound studios in midtown Manhattan. Newest of the country's major distributors of fine audio equipment, Allied Sound has gone all out in providing music lovers and audio fans with the industry's most pretentious demonstration facilities.

As in previous years, **Alpha Wire Corporation** graced the Fair with an informative showing of wire and cable for practically every conceivable audio application. The importance audio is assuming in the general field of electronics is well exemplified by the annual participation of Alpha—major supplier to the entire electronics industry—in the Fair.

The title of **Altec Lansing Corporation's** exhibit might well have been "The Three Sixes", judging from the tremendous

Counterclockwise—Hal Blumenstein with Mrs. and Dave Hafler of Acro—Allied Sound Corp.—Altec Lansing Corp.—Ampex Electric Corp.—Amplifier Corp. of America—Dave Sarser and sister Sebe for Audak Company—Audio Center of Arrow Electronics—Audio Devices—Alpha Wire—Berlant Associates—H. A. Hartley with H-T speaker—Cook Labs and Bozak Speakers—Bohn Music Systems—David Bogen Company—Bell Sound Systems, Inc.—T. Robinson-Cox of Beam Instruments—Audio-Video Products' Instrumentation Exhibit—C. J. LeBel and L. S. Goodfriend of Audio Instrument Co. Inc.—Audio Exchange teamed with Jeff Markell Associates with touch of humor, and the much needed aspirin.

interest shown in the company's new 601A, 602A, and 604C coaxial speakers. Still another six might enter the picture if we afforded due attention to the 606A corner speaker enclosure. Although other Altec products — including the famous 21B microphone and Peerless transformers — were displayed, The Three Sixes won the battle for attention hands down. This was the first public showing of the new Altec speakers in the East.

The growing interest of music lovers in professional tape recorders for home use was evidenced in the **Ampex Electric Company** display of the famous Ampex Type 400 recorder housed in a handsomely finished mahogany cabinet. Also shown were the latest Ampex models for broadcast stations and recording studios, including the new stereophonic portable.

Interest in the **Amplifier Corporation of America** exhibit was easily captured by the new Electro-Magnemite tape recorder. Weighing only 12 lbs. and moderately priced, the Magnemite offers every feature of the most expensive disc-type office dictating machine. Available also are such useful accessories as remote-control microphone, typewriter control box, and voice-actuated starting mechanism. From where this observer sits, it appears that the Electro-Magnemite may well pace the field in the switch from disc to tape for office dictation.

Eloquent proof that audio fans are susceptible to life's more earthy aspects was found in the exhibit of New York's **Arrow Electronics' Audio Center.** Surrounded by a representative display of equipment was a large jig-saw puzzle with one piece missing. Several hundred odd pieces were placed in a box immediately below the puzzle, and visitors were permitted to select a piece at random in the hope that it would fit the open space. Those who succeeded were given a trade certificate good for merchandise in the Arrow sound room. Thousands of participants proved the success of the puzzle gimmick in bringing the name Arrow to their attention.

If we had to name a single most popular display at the Fair, it is a certainty that **The Audak Company** exhibit would be the probable choice for top honors. Maximilian Weil, Audak president, long known for his virtuosity in the field of pickup design, gave graphic evidence that his reputation as a capable showman is equally well deserved. Two noted musicians—David Sarser, violinist with the NBC Symphony and co-designer of the famous Musicians Amplifier, together with his lovely sister Sebe, cellist with the City Center Opera Company—gave half-hourly performances in the Audak exhibit, demonstrating the fidelity of the new Audak Chromatic reproducer. Prior to the Fair, Dave and Sebe made a series of recordings; the demonstration consisted of playing these recordings, with the live performers taking over at unannounced intervals. So excellent was the reproduction that any distinction between the two was largely a matter of guesswork. Adding to the demonstration's dramatic proportions was the fact that both musical instruments employed were Stradivari, valued at well over a hundred thousand dollars. Strictly big time.

As might be expected, **Audio Devices, Inc.,** provided one of the Fair's more interesting showings of recording materials. Bryce Haynes, ad manager, and Bob Browne, who handles the A-D account for **Rickard & Company,** advertising agency, were on hand to receive their annual congratulations from prominent industry figures for publication of another fine directory of tape recorders in "The Audio Record." Herewith we tender our own thoughts of approbation for a job well done —one which is of distinct value to the audio industry.

Living evidence that audio fans are not without a sense of humor was offered by The Audio Exchange, Jamaica, N. Y., with a prominently displayed sign bearing the message, "Another Audio Exchange Service—FREE ASPIRIN." Sharing this suite with The Audio Exchange was Jeff Markell Associates, New York, who presented an unusual showing of custom cabinetry. There was no exhibit more satisfying to the true music lover—the person who thinks of audio as an adjunct to his living room which is both functional and decorative.

Precision audio equipment for specialized professional usage was the keynote of the **Audio Instrument Company** exhibit. Design and development engineers landed here as a sort of unofficial headquarters. On hand to explain and demonstrate the phenomenal instruments shown was the "dean" of the audio industry, C. J. LeBel, company president, founder and secretary of the AES, and vice-president of Audio Devices, Inc.

Entry of Ampex into the field of multidimensional sound reproduction held the spotlight in the exhibit of **Audio & Video Products Corporation,** New York. Superb program material and excellent switching facilities permitted listeners to A-B high-quality single-track recordings with Ampex's new "Stereophonic Sound." Interesting to note, incidentally, the tremendous growth of **Audio & Video Products** since last year's Audio Fair. In addition to operating one of the country's most complete recording studios, recording and distributing pre-recorded tape through its subsidiary **A-V Tape Libraries, Inc.,** Audio and Video has formed an Instrumentation Division and a Commercial Products Division, both of which are among the nation's leading purveyors of audio equipment to industry.

This was the second appearance at the Audio Fair of two British products — Acoustical Q.U.A.D. amplifiers and Tannoy dual-con-

Counterclockwise—Æ featured by British Industries Corp.—The Carduners of British Industries, Leonard and Gene—Æ's Sandy Cahn with Vic Brociner—Brook Electronics—Browning Laboratories—Cook Laboratories' binaural disc played with special Livingston arm—Cinema Engineering Co.—Collins Audio Products' kits and tuner—Lucite enclosure shown by Jensen—Kelton speaker—C. G. Barker of Magnecord with new synching device—General Electric Co. with diamond styli—Mrs. and Mr. E. J. Gately, Jr. with new corner speaker—Jim Parks of Fisher Radio Corp.—over-size Fairchild dynamic pickup—Electronic Workshop's small new speaker enclosure—Electro-Voice's display well populated, Willard Wilson of Wilmington (Del.) Electrical Specialty Co. in foreground—Daven prexy Louis Newman—Danby Radio Corp. speaker enclosures.

centric loudspeakers. Shown under the auspices of **Beam Instruments Corporation**, New York, both units were demonstrated in conjunction with the very American Weathers capacitance pickup. An altogether impressive example of really fine audio quality.

Excellently portrayed in the exhibit of **Bell Sound Systems, Inc.**, were the many forward steps the company is taking to make high-quality audio equipment available to homes of modest income. More than average attention was accorded the new Bell amplifier Model 2200—a truly remarkable combination of superb performance and moderate price. Also the target of great approval was the improved Bell tape recorder.

Represented by its able and gracious president Emanuel (Bert) Berlant, **Berlant Associates, Inc.**, repeated its success of former years with one of the Fair's more interesting and complete displays of Concertone tape recorders for both home and industry. The rapid growth of interest in the tape recorder as an integral component in home music systems was clearly reflected in the enthusiasm of many company executives, Mr. Berlant being no exception.

The Fair offered no better example of aggressiveness and expansion in the audio field than that shown by **David Bogen Company, Inc.** Within the past year Bogen has added a new FM-AM tuner, several new high-quality amplifiers, and a remarkable wireless intercom system to the line of equipment it manufactures. All of these items helped to make the Bogen exhibit completely satisfying.

Custom-built music systems with a capital C were shown in the display of **Bohn Music Systems Company, N. Y.** Taking part in the Fair this year for the first time, Bohn, on the strength of its striking display, may well be expected to achieve a position of leadership in the field of custom building.

Combined in bringing binaural disc recording to the audio public for the first time were **Cook Laboratories** and **R. T. Bozak & Company.** Surprising indeed was the fact that the records and equipment shown were commercial entities in every respect—not laboratory models as might have been expected—and are already available as stock items from a number of progressive jobbers. The recordings were made by Cook and are designated as binaural editions of the firm's Sounds-of-Our-Times series. In the Bozak-Cook exhibit reproducing equipment included two Bozak multi-unit speakers, and a dual-pickup tone arm made by Livingston.

Commendation is due **British Industries Corporation** for the excellent taste which prevailed in an effective showing of Garrard record changers, Leak high-quality amplifiers, Wharfedale speakers, and R-J speaker enclosures. This was an exhibit strictly for the music lover, with demonstration records carefully chosen for their esthetic value as well as for their technical characteristics. Although strictly an American company, B. I. C. until recently confined its activity to the distribution of English-made products. Not long ago, however, through a subsidiary it began distributing the American-manufactured R-J speaker enclosure.

High fidelity without compromise was demonstrated by **Brociner Electronics Laboratory.** Introduced was the new Brociner Model 4 corner horn and the A100 preamplifier-equalizer. It is the contention of Victor Brociner, company president, that a loudness control *per se* is not the answer to the need for complete compensation in an amplifier—that the control itself must be adjustable if complete compensation is to be achieved. It naturally follows that the preamp made under the Brociner name includes such a feature.

If, by any chance, you've been wondering just how many equalizing positions a preamplifier should have in order to compensate for all of today's commercial recordings, you may find the answer in the new Brook Model 4. Shown for the first time publicly in the exhibit of **Brook Electronics, Inc.**, this handsome-appearing unit came in for a far higher-than-average percentage of oohs and ahs from Fair visitors. The presence of charming Ann Hall, Brook sales executive, lent an air of urban gentility to the Brook display which was well in keeping with the superior quality of the equipment shown.

Tuners, tuners, and tuners—including the new Model RV-31—provided the principal interest in the display of **Browning Laboratories, Inc.** This newest Browning model offers an exceedingly high standard of performance, yet is designed for installation in cabinets where limited space is available. Present and accounted for was the Browning high-quality audio amplifier, but without question the tuners captured the show.

Recording engineers whose only criterion is perfection found a rewarding experience in their visit to the exhibit of **Frank L. Capps & Co.** In addition to the precision recording equipment for which the Capps organization is renowned, there was introduced a new condenser microphone which may well blaze a trail toward general improvement in commercial recording.

Strictly professional audio equipment—ranging from complete amplifiers to wire-wound precision resistors—was shown by **Cinema Engineering Company.** Clearly shown was the fact that Cinema has attained a position of enviable leadership in the supply of precision devices to recording studios, broadcast networks, and manufacturers.

Counterclockwise—Gray Research's pickup arms—Edward Gray of Grayline with Phono-Gard—Harrison Radio Corp.—Harvey Radio Co. Inc.—Hudson Radio & Electronics Corp.—Karlson speakers—Klipsch with large photo of typical living-room installation—Lafayette Radio, of New York—new McIntosh corner speaker—Pilot, new hit with tuners—Revere tape recorder—Peerless transformer display—Newcomb amplifiers—Music Masters' displaying record making facilities—Mark Simpson Mfg. Co.'s G. Leonard Werner with latest product—peace at last, in Measurement Corp.'s exhibit—Leonard Radio, of N. Y.—Jim Lansing speakers—happy Langevin Mfg. Corp. salesmen.

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FEATURES:

- Intermixes 10 and 12 inch Records at All Speeds.
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Base Dimensions: 14¾" x 12¼"
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Audio engineers and audio enthusiasts all agree that the quality of any sound reproducing system is the sum total of all of its components units. One weak link in the chain dooms the entire system to mediocrity.

In a record reproducing system, the record changer is the first consideration. If high fidelity is to be attained, the record changer should be the finest obtainable.

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Complete service and replacement facilities maintained for your convenience.

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Tuner kits which afford remarkable performance, yet are priced surprisingly low, were featured in the display of **Collins Audio Products Company.** Formerly a manufacturer of high-priced tuners, Collins has been a leader in bringing custom quality within range of the modest budget.

Philadelphia's **Danby Radio Corporation** diversified its display to include custom-built components as well as complete music systems. Emphasized was the company's ability to perform with equal agility in the design of high-quality amplifiers and fine cabinetry.

The Daven Company presented an impressive display of precision devices ranging from audio attenuators to wire-wound resistors. Clearly evident was the fact that Daven is maintaining without blemish its leadership in the field of precision equipment.

If the Fair offered an award to the exhibitor displaying the greatest number of individual products, **Electro-Voice, Inc.,** would win hands down. A single quotation from the official Fair directory, in which is listed the products shown by various manufacturers, indicates the completeness with which E-V is blanketing those phases of the audio industry in which it competes—"low, mid, high, and super-high frequency drivers." Evidence of the company's stature in the loudspeaker field may be found in the fact that E-V speakers were chosen for reproducing the binaural program from WQXR and reproduced at the Society's annual banquet. Items seen in the E-V display ranged from tiny pickups to the massive Patrician four-way speaker system.

Completely packaged sound systems comprised the display of **Electronic Workshop Sales Corporation,** New York. Center of attention was the unique assembly first described in the article titled "On a Budget" in the May, 1952 issue of Æ. Striking cabinet design made the E-W exhibit one of the Fair's more intriguing.

Even a casual description of the equipment shown by **Fairchild Recording Equipment Corporation** would occupy far more space than this review affords. Principal interest of music lovers was concentrated in the new 215 Series high-compliance pickup cartridge. Bordering on the fantastic was the Fairchild-developed device for lip-synching magnetic tape with silent film for TV broadcasts. A bit more realistic was the standard Fairchild tape recorder which sells for somewhere around twenty-seven hundred dollars. Realistic?—did we say. Yikes!

Avery Fisher, president, **Fisher Radio Corporation,** took a well-deserved bow for the new Fisher 40-watt all-triode amplifier and preamp-control unit. Shown in conjunction with the Concertone tape recorder, for which Fisher is exclusive Eastern distributor, the new amplifier assembly was deeply impressive.

The Super Horn, a new patented corner speaker enclosure, was the center of interest in the exhibit of **Gately Development Laboratory,** Clifton Heights, Penn. Many and favorable were the comments regarding its performance.

First of the major manufacturers to enter the high-fidelity field, **General Electric Company** gave monolithic evidence of its intention to retain a position of leadership. Introduced as a companion item to the well-known GE variable-reluctance pickup was a new phono equalizer. Tom Nicholson, GE sales executive, assured this observer that the company will make an announcement of major importance to audio enthusiasts ere the passing of many moons.

You can always count on **Gray Research and Development Company** for equipment displays which are both entertaining and informative. Although Gray is highly involved these days in the production of various gadgets for use in TV broadcasting, evidence that the company's first love is not forgotten was shown by an impressive exhibit of tone arms and equalizers.

Making its initial Audio Fair appearance, **Grayline Engineering Company,** Chicago, introduced a record demonstrator which is certain to capture the attention of music dealers everywhere. Surprisingly compact (it's about the size of a portable phonograph), the Phono-Gard record player is virtually automatic in that it does not require manual placement of the tone arm on the record to be demonstrated. This, together with other automatic features, practically removes the element of damage to records.

Any doubt prevailing in the minds of Fair visitors concerning the truthfulness of the slogan "Harrison Has It", was dispelled beyond question by the display of the slogan's originator, **Harrison Radio Corporation,** New York. An interesting display of the equipment of practically all leading manufacturers.

In his second Audio Fair appearance, H. A. Hartley, president, **H. A. Hartley Co., Ltd.,** London, England, duplicated the success with which he first greeted his American friends last year. In his own words, Mr. Hartley's display contained "speakers, speaker housings, amplifiers, pickups, motors, record-changers, and all kinds of cabinet components, of a quality beyond criticism, to please and permanently satisfy every man who is beginning to think that the quest for realism in reproduction is a will-o-the-wisp forever leading him into extravagances of price and bulk."

Harvey Radio Company, Inc., New York, introduced for the first time publicly two recording instruments which, unquestionably, will blaze a trail of success in

Counterclockwise—Pentron recorders draw interest—Permoflux binaural exhibit always crowded—new Pickering turnover cartridge—Grommes amplifier of Precision Electronics—Presto Recording Corp.—Jules Bressler beaming over Radio Craftsmen preamp—Rangertone studio recorder—Reeves Soundcraft tape in handy 5-drawer boxes—Stromberg-Carlson shows exquisite cabinetry—W. L. Brooks, tapeMaster chief Engineer, with lab model of new hi-fi recorder—Sonocraft covers the field—Sun Radio stresses balanced systems—Stephens Mfg. Corp. shows speaker cabinets, with Stephens speakers installed—G & H Wood Products teamed with Electronic Workshop to create Sound Workshop—Soundcrafters, Manhattan dealer—H. H. Scott—Collaro record changer being shown by Jack Willson—River Edge Industries cabinets—Rek-O-Kut line of disc equipment.

"This new 'Scotch' Brand 7-inch professional reel cuts machine maintenance costs!"

Extra-large hub gives new "Scotch" Brand reel exclusive advantages

✓ **LOWER ROTATIONAL SPEED** produced by new larger hub means less vibration, decreased machine wear. Recording equipment stays on the job longer with fewer stops for repairs and adjustments. The new 2¾" hub gives this 7" reel approximately the same ratio of outside diameter to hub diameter as the standard NARTB 10½" metal reel. Rewind speed is actually 10% faster than the ordinary 7" reel despite the slower rotating speed.

✓ **CUTS TIMING ERRORS 50%!** By reducing tension changes as tape is spooled off, this new reel reduces timing errors to a minimum.

✓ **REDUCES PITCH CHANGES!** Using this new reel, you can splice recordings of long musical programs with far greater stability of pitch.

SEE YOUR DISTRIBUTOR FOR A SUPPLY OF "SCOTCH" BRAND 7" PROFESSIONAL REELS AND NEW DRY LUBRICATED TAPE!

Tape on new reel is improved 4 ways!

1 **"DRY LUBRICATING"** process gives you a tape that practically eliminates sticking, squealing and cupping . . . a completely dependable tape that turns in a flawless performance in extremes of heat and humidity.

2 **100% SPLICE-FREE!** Tape supplied on the new "Scotch" Brand 7" professional reel is guaranteed to be completely free of splices.

3 **THINNER CONSTRUCTION** allows a full 1200 feet of tape to be wound on the new reel despite its larger hub. Magnetic properties of this new tape are identical with "Scotch" Brand #111-A, the industry's standard of quality.

4 **GUARANTEED UNIFORMITY!** Output variation of tape wound on the new reel is guaranteed to be less than plus or minus ¼ db at 1000 cps within the reel, and less than plus or minus ½ db from reel to reel.

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SCOTCH BRAND MAGNETIC TAPE

their respective fields. One, a miniature wire recorder known as the Minifon, is no larger than an average novel, is battery-operated, and permits up to 2½ hours of uninterrupted recording. The other, a portable tape recorder known as the Cub-Corder, also is battery-operated, resembles a small brief case in appearance, and opens an entirely new field of informal interview to broadcast reporters thanks to its portability. Widespread publicity accorded both of these instruments by the daily press made the Harvey exhibit one of the Fair's focal points.

The Fair offered no better display of the equipment of all leading manufacturers than that afforded by **Hudson Radio & Television Corporation**, New York. Only one year ago Hudson was battling to overcome the handicap of a change of company name. So thoroughly has the battle been won that it's a safe bet that you can't recall the firm's former monicker.

Magnificent is the only word which will describe with adequacy the performance of the new Jensen Triplex speaker system, shown to a Fair audience for the first time by **Jensen Manufacturing Company**. Naturally, other Jensen speakers were on display, but it must be admitted that the Triplex stole the show.

Three speaker enclosures, lined up side-by-side, and set up for A-B testing, permitted visitors to see for themselves that the new Karlson cabinet is not critical as to the driver with which it is used. Containing an Altec 601A, an Altec 602A, and a Jensen G-610, the three enclosures shown by **Karlson Associates**, Brooklyn, are the first to strike the market with a mar-proof Formica finish.

Good performance from a speaker enclosure of small dimensions was demonstrated by **The Kelton Company**, Cambridge, Mass. Internal constructional features gave the impression that the Kelton enclosure was built in keeping with the so-called M. I. T. speaker, designed by professors Baruch and Lang, although it did not require corner installation for optimum performance.

Sharing honors with the fabulous Klipsch speaker system was its inventor, Paul Klipsch, in the exhibit of **Klipsch Eastern, Inc.** In one of his infrequent visits to the East, Klipsch, who prefers Hope, Arkansas, to the big city, satisfied many visitors with a truly authentic explanation of how and why the Klipsch system through the years remains the standard of comparison with thousands of audio connoisseurs.

Lafayette Radio, Inc., demonstrated graphically the reasons for its longevity as one of the industry's oldest mail-order houses. Displayed was the equipment of practically all leading manufacturers. Attendants were quick and able to explain why Lafayette offers ready delivery to mail order buyers, as well as to customers who visit any one of the company's three stores in Newark, Boston, or New York.

Long known in the audio industry, the name Langevin once more is achieving the eminence which it relinquished several years ago. Evidence to this effect was graphically afforded by the impressive exhibit of **Langevin Manufacturing Company**. Devoted largely to plug-in preamplifiers, power amplifiers, power supplies, and transformers for a wide variety of professional applications, the display clearly brought home the company's great accomplishments under its competent president, Donald Morgan.

James B. Lansing Sound, Inc., introduced a new runner in the perpetual race for the title of "best" of loudspeaker systems. It is the new Model D-31050, a massive corner system which is truly remarkable in its ability to deliver superb audio performance. Shown also were the various Lansing driver units—from the 15-in. D-130A woofer to the 175-DLH tweeter-lens assembly—which have secured for Jim Lansing a position of leadership in the speaker field.

The Fair offered no more complete display of the audio equipment of all leading manufacturers than that afforded by New York's **Leonard Radio, Inc.** Featured was a showing of the new Tape-Sonic tape recorder, which Leonard first announced publicly through its advertisements in Æ.

Newsworthy indeed was the exhibit of **Magnecord, Inc.**, not alone for its showing of fine tape recording equipment, but for the public introduction of MaVoTape, a new full-range pre-recorded tape library. Tape recordings under the trade name "Magnecordings by Vox," are now available in both single- and dual-track at 7½ ins./sec. recording speed. MaVoTape, Inc., producer and distributor of the new tape library, is owned jointly by Magnecord and Vox productions.

Something new was added to this year's showing of **McIntosh Engineering Laboratory**. In addition to the world-renowned McIntosh amplifier there was displayed for the first time the new McIntosh speaker. A corner enclosure, the new McIntosh development may well be expected to diversify the leadership which is maintained by the name McIntosh in the audio industry.

Under a colorful sign which bore the intriguing invitation, "Rest Your Ears—Silence is Golden", **Measurements Corporation, Inc.**, built a display of test equipment which gave liberal attestation to the company's world-wide reputation. Presided over by genial Jerry Minter, Measurement Corp's chief engineer, this exhibit was one of the Fair's high spots for designers of precision audio equipment.

Emphasized in the exhibit of **Mark Simpson Manufacturing Company** was the new Masco Concert Master 20-watt remote-control amplifier. First described publicly in last month's issue of Æ, the Concert Master, although moderate in price, is superb in the quality of its performance. Sharing honors with the new amplifier were improved models in the Masco line of moderately-priced tape recorders.

No exhibitor showed greater signs of company expansion since last year's Fair than did **Music Masters, Inc.**, New York. In 1951—a modest display centered largely around LP recordings; in 1952—one of the Fair's more interesting displays of everything from pickups to amplifiers. More than normal attention was accorded the firm's dubbing service—an economical means of preserving rare recordings on acetate discs.

Thankful to the West were Fair visitors for giving them the fascinating display of fine audio equipment shown by Hollywood's **Newcomb Audio Products Company**. A broadened line of high-quality amplifiers and portable public address equipment, plus improved distribution among leading dealers, has established Newcomb as one of the nation's leading manufacturers engaged in producing top-flight audio equipment.

An accessory stole the show in the exhibit of **Pentron Corporation**. Many prospective buyers of tape recorders for home use were heard to decide that the recorder to buy was the one which permitted the use of 10-in. professional reels, just in case they might enter the advanced stages of their hobby. And, it goes without saying, that the standard Pentron tape recorder, when fitted with the Model X-302 Adapter Kit, is the only unit in its price range which will handle the big spools.

Despite the excellence of Permoflux speakers and enclosures, the **Permoflux Corporation** exhibit was dominated this year as it was last year by the magnificent tonal reproduction of the company's high-fidelity dynamic headphones. A solid testimonial to the high quality of these phones lay in the fact that, with one exception, wherever binaural equipment was demonstrated, they were chosen to provide listeners with the full dynamic impact afforded by multi-dimensional sound. Speaking informally and personally, those phones are really something.

No question about **Pickering and Company** presenting one of the Fair's high spots—introduction of the new Model 260 turnover-type diamond-styli cartridge. High-fidelity enthusiasts have long awaited a cartridge of this type from Pickering, and are certain to welcome it with thousands of encouraging orders. Heartening also to his many friends who visited the Pickering exhibit was the presence of gentle and competent Norman Pickering, company founder and prominent audio pioneer.

[*Continued on page 60*]

Down and across—Fred Cunow with Telefunken microphone—two-motored Thorens changer, plays top and bottom—Tung-Sol tubes make new friends—V-P Sam Baraf of United Transformer Co.—attractive display of V-M record changers—Waveforms, Inc. display always crowded—Webster-Chicago with disassembled Web-Cor changer—Terminal Radio Corp. spotlighted Tapak portable tape recorder—University Loudspeakers Inc. in new cabinet—Ultrasonics' 2½ cu. ft. corner speaker—Paul Weathers with his capacitance pickup.

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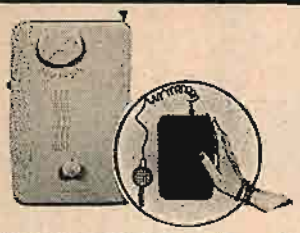

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Complete with microphone, stethoscope type earphones, 1 hour spool of wire, tubes, batteries, and instructions. **$250**

Morocco Leather Zipper Case $7.50

Transformer-rectifier Unit for operation of motor from 117 v. AC line $20.00

RECORDING WIRE On spools, in dust-proof plastic containers, suitable for mailing.

¼ hour ..... $5.00 — 1 hour $9.00
½ hour ..... 7.00 — 2 hour 17.00
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The NEW CUB CORDER
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Weighs only 12 lbs. 14 ozs., and no larger than a portable typewriter. Completely battery-powered, and performs all functions of a professional unit. Dynamic microphone "doubles' as earphone for playback. Has output for external amplifier. Two 2-speed models available: 3¾" and 7½"/sec. or 1⅞" and 3¾"/sec., in either single or dual track.

Complete with microphone/earphone, 5" reel of tape, rechargeable wet cell, 67½ v. B battery, take-up reel, tubes, and instructions. **$295**

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Model F100 (blond finish) **$374.50**
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PHONO PREAMPLIFIER and EQUALIZER

An extremely flexible, quality unit. Has 5 inputs and selector switch for magnetic pickups, crystal pickup, FM-AM tuner, low level microphone, as well as a 3-position selector switch for correct compensation to match recording characteristics. Features bass and treble boost and attenuation. Power is obtained from main amplifier. Furnished complete with tubes and connectors.

C104A—In Mahogany-finish Cabinet **$57.50**
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Less Cartridges **$35.00**

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12 inch Microgroove . . . 12 min. Playing Time per Side

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EDWARD TATNALL CANBY*

Music Hath Complications

HOW MUCH is music worth, per minute? How much will the public pay—for what? An elusive business this, yet every single move that is taken in the record field now—musical or technical—is a new thrust towards the ultimate answer, in cash returns. Record making, we sometimes forget, is a business.

The developments are now coming along thick and fast. We have left behind the post-record-war area and are moving into new situations. The musical market, flooded with incredible masses of recorded stuff these last years, is still far from glutted, but things are tightening up. Competition for that carefully priced musical minute is becoming really tough; ingenuity, shrewdness, calculating technology and musicology are more and more necessary.

The record industry moves simultaneously on the technical and the musical fronts. The two are intimately related to a fascinating degree. On the one hand, new types of records can be launched, newly priced versions of the old types; on the other hand, the musical offerings can be juggled about, tied into new technical combinations, combined, separated re-recorded in new versions. The possible combinations of price, record type, and music are infinite.

Since last month's mention of the RCA extended play 45, Columbia has quickly followed with its own extended play 45. Both big companies now have launched low priced labels, Blue Bird for RCA and Entre (the most unpronounceable title I've yet run into) for Columbia; all this in addition to the experimenting in "short" semi-pops LP lines that was an early move in the present shifting.

It's not easy to separate technical from musical factors in all this—but, for this month, I'll look mostly in the technical direction. Let's put aside the touchy question of music itself. What music (at what price, on what sort of record)? That needs separate discussion. Here's what's been going on, as I see it, since the Record War ended in 1949.

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Flash Back

Stage One, as I see it, in the post-record-war history (i.e., after RCA began making LP's and Columbia began making 45's) was the settling into place of the two speeds. LP won hands down in the classical department. No one could now question that, though 45 continued to hold a place in the semi-popular classics. The 45, however, had it all over LP in most other areas, where short compositions, tied to the billions of 78's and their three-minute formats, were the rule. Popular, juke box, show tune, hill-billy and the rest.

Stage Two, at least in the classical end of things (and that's my biz) came when the discovery that European music could be had cheaply and easily for efficient LP processing in this country led to the extraordinary expansion of small LP record companies, by-passing the 78 altogether as the big companies could not yet do. A big advantage, and the results were really sensational. Thanks to LP-only, a microscopic record company, taping in Europe, could put out music to compete with the big outfits who could neither desert their expensive U.S. musical contracts nor their two-speed and three-speed duplication.

Stage Three was an offshoot of all this. If small business on LP could succeed in the face of the big companies, how about a big operation using similar material—conveniently simple tape operations among the European musicians? Inevitable, in our business-opportunity world, and Remington was merely the first to try, while the big companies were still tied up in their multiple speeds. And so the first radically lower priced LP records appeared, other companies soon following along, using every means of cost cutting, good and questionable, to get out a maximum of music on LP at a minimum price.

And simultaneously there came the now familiar 30-per-cent-off development on standard LP record sales—another one of those inevitable business-opportunity matters, bound to work—even though, from some points of view, also questionable. Mass LP selling, no listening booths (which mean crawling sales), a liberal return policy. Clever, and so far pretty much foolproof. Here was another pressure on the large companies.

Small LP-only concerns, larger cut-rate LP makers, discount sales, all working towards lowering the cost-per-minute of music on records. Stage Three, without a doubt, involves some of the most questionable maneuvering in record history. Many a shady deal was involved, such as the blatant pirating that for awhile caused sensational news, the deliberately faked labels on some releases, the trumped-up orchestras and performing groups. Still goes on, though perhaps the worst is over. Nevertheless, right or wrong in detail, this Stage Three, the pressured lowering of record prices, could not have been stopped and in the end, I feel, will have benefited music lovers and the trade as a whole in the old competitive way.

Stage Four? Here we are, up to date. Stage Four is the Big Company Reaction. So far the list prices for records have held. Instead, the answer from these leaders has been indirect, in the new lines of records now appearing and in the dropping of the 78—a fabulous weight removed and a great new freedom gained.

Big Company

How does the big company bring out competitive music? The moves originate now with one, now the other, but since there are no restrictions placed on the competing types of records (in 1901 the various companies almost killed themselves off in a patent war that tied up the entire record field) the other big companies follow along as they please. Look at the current offerings:

1. The "short" LP, low priced. Large numbers of popular overtures, ballet works, etc. verging on the light semi-popular.

2. With the 78 eliminated—full-length operas and other colossal works, to compete at last with the LP-only offerings of the small companies. Until 78 duplication went out the big companies were helpless in this vital area. Now they can offer their fancier artists, bigger names. (But the small companies have good stuff here; the competition is really stiff.)

3. With the 78 eliminated—the extended

Musical Milestone

Wall Street Journal News Story (FRONT PAGE, Oct. 30th, 52)

WEIL's Milestone:

Record vs. Live Music

NEW YORK—How close has the modern phonograph come to perfection?

Inventor Maximilian Weil, maker of the first commercial electronic phonograph pickup in 1926 and holder of some 260 patents in the field, provides an answer at the Audio Fair in New York this week.

The Audak Co., of which he is president, has on hand one of Toscanini's NBC Symphony violinists and a cellist from the New York City Opera, both playing instruments made by the renowned Stradivari. Intermittently they put down their bows—and the music is carried on by a phonograph recording made by the same musicians. *The switch, to most listeners, is not discernible.*

"This is the type of sound reproduction we've dreamed of almost since the inception of the phonograph," says Mr. Weil. "It's a major milestone."

Thousands of music lovers waited in long lines for a chance to hear, for the first time in their lives, this daring side-by-side comparison with the actual artists.

The audience heard, at first hand, the reasons for the universal acclaim of the Audax Chromatic pickup. The superb performance of the Audax CHROMATIC reproducer (magnetic) gave the listeners irrefutable proof that, in music, listening quality is everything. And the Audax CHROMATIC Diamond reproducer alone, has just that quality.

Listen to the Audax CHROMATIC and discover, for yourself, how close the modern phonograph has come to perfection.

✓ CONVERT your (L-6) POLYPHASE with a replaceable Audax Chromatic Diamond stylus, now available at your dealer.

✓ One single magnetic pickup plays all home records—replaceable Sapphire or Diamond styli.

✓ Available to fit the new compass-pivoted AUDAX arms and record changers.

✓ Be sure to get your 1953 ELECTRONIC PHONO FACTS from your dealer, today.

AUDAK COMPANY

500 Fifth Avenue **New York 36**

Creators of Fine Audio-Electronic apparatus for over 25 years.

The Standard by Which Others Are Judged and Valued.

play 45, as of this month, looks as though it would fit neatly between the straight three-minute juke-box-popular area and the light classic stuff now appearing on the "short" 10-inch LP. The new 45 will take anything that runs 6 to 8 minutes comfortably; whereas the "short" LP can run from there up to the full 15 minutes, according to need. Definitely a useful advance.

4. Tackling from another angle, the big companies now launch their low-priced lines—Blue Bird, Entre, and others no doubt to come. This is the old accepted method of meeting a price-lowering pressure; we had it back in the 1930's as well. The new and intriguing twist to it is (a) the scope of the second-line offering is now vastly increased and (b) the competitive situation, what with the fighting array of small companies and the wide-open tape opportunities still existing in Europe, is far more complex.

It's a delight to me, for instance, to find the old Harty verision of Handel's Water Music suite, the original and still the best performance, now on LP. (It was one of the early "X" sets—remember? X-13.) So much the better that it is at lower-than-standard price, in the Entre line. Much excellent 78 material will be, so to speak, forced back on the market in improved form through this development. Good! Wider fields will be covered in newer recordings, too; RCA's early Blue Birds evidently exploit the British HMV connection for a new range of British-made performances.

5. One final slant to big-company operations today—the Limited Edition, which Decca is now testing out. The complete Beethoven violin sonatas, limited to 2500 sets. Limited editions have been successful in the past in many forms, notably the old 78 "society" recordings, launched through big companies. Perhaps there's a new place for them in today's complex picture.

* * * * *

Complicated? Bewilderingly so. Did we once have but two new types of record, the LP and the 45? We still have the two systems, now reconciled to an unforeseen degree thanks to the universal three-speed players (and the new separate spindles for 45, originated by Garrard and now spreading to other brands of machine). But the two speeds proved to be merely the beginning of the subtle and spreading developments now going on. What next? When the present juggling of prices, music, and record types reaches its full tide, we'll get some new and radical technical development. I've heard rumors—but all this will be for later.

BEETHOVEN SYMPHONIES

Beethoven, the man of extreme contrast—terrific tension and utterly sweet relaxation—is seldom performed to the full in both these aspects. Few of the well known conductors can approach the whole picture, portraying the extraordinary tension in the music and "letting down" at the crucial moments of relaxation, at the same time holding the whole structure together in the perfection of detail that is the greatest Beethoven characteristic of all. An almost impossible job and, for my money, only one man now can come near the perfect, Bruno Walter. In his performances the inner structure is limpidly clear, each detail treated to perfection; he realizes the majestic tensions of the big moments and there is no one who can bring forth the sweetness in contrast as expressively, as deeply, as he.

Beethoven, Symphonies #2, #4. N. Y. Philharmonic, Bruno Walter. **Columbia ML 4596**
Beethoven, Symphony #2. Vienna Philharmonic, Schuricht. **London LL 629**

Schuricht's Beethoven is good. He is able to relax, allow Beethoven to sing, without letting down too much on the tensions which must be there. This version of the 2nd is most enjoyable, well recorded and sympathetically played. But the Walter Beethoven, on direct comparison, is better still. Greater tension, greater relaxation; a higher lyricism, a more pure, more perfectly shaped line with details more accurately chiseled, melodies shaped for more expression. The comparison shows a certain informal softness in Schuricht, a minute inaccuracy, an informality of detail that would scarcely be noticeable without the Walter example.

Walters 2nd is on a single side, gets somewhat fuzzy near the end. But there's room for the 4th symphony on the other side, a typically fine reading of a work that is remarkably hard to perform intelligibly and so is not too often heard. The wider spacing on the London disc allows higher level—too high in some parts; the pre-emphasis seems sharp and the quality is that brilliant, close-to sound, in a big liveness, that characterizes ffrr.

Beethoven, Symphonies #1, #9. NBC Symphony, Robert Shaw Chorale, soloists, Toscanini. **RCA Victor LM 6009 (2 LP's)**
Beethoven, Symphony #9. Vienna Philharmonic, Gesell. der Musikfreunde, soloists, Kleiber.
Beethoven, Symphony #1. Vienna Philharmonic, Schuricht. **London LS 631**

A three-way comparison that's worth a day's work in itself. The Schuricht First, companion to the Second above, is similarly excellent, a jovial, genial, solidly filled out performance bringing out the meat in this symphony; my ony criticism, again, is a slight unevenness in the detail work. (The Bruno Walter competition on Columbia is an early LP, though a good one.) Toscanini's First is done as Toscanini does his Italian overtures—the violence with which the louder parts are played, the tautness of the lyric portions are to the best of my judgment wholly inappropriate to the spirit of the music, even if impressive in the listening. The Schuricht is a mile ahead.

The ever-insurmountable Ninth? I would not take either of these hi-fi versions on to my desert isle (equipped, of course, with a convenient a.c. outlet). The Kleiber Ninth is a strange one and unaccountable; the details are all there, the playing accurate, but the music plods. All the parts but no Whole. No drama. The climaxes seem absent-minded, somehow, though there is nothing immediately wrong, in the notes.

Part of it might be in the recording—a large amount of close-to work, individual instruments standing out in places not usually heard, a distracting kind of busy-ness that emphasizes slight inaccuracies, detracts from the grand over-all conception. Part, too, is plain lack of shape in the strong detail, as in the famous two-note opening idea which here is soggy and characterless, affecting the entire first movement. There is a pounding march quality which comes of imperfect rhythmic phrasing. Not a good performance.

Toscanini's Ninth is utterly different. I find it far less endurable still—but in no weak way; it is, as one can imagine, a tower of strength, if misguided strength. There is no Beethoven in which the extremes of tension and lyricism are more directly contrasted than here. Toscanini's tension beats anyone else's—it is unbearable because it is utterly relentless, savage; there is no lyric contrast. The softer parts are almost hastened through, the great climaxes thunder with the roar of a hundred demons. A great experience any way you look at it, but by no stretch of my imagination, at least, the music that Beethoven conceived. It is hard, cold music, harsh, incredibly powerful. Try it for yourself if you don't believe me. And compare with the Walter Ninth on Columbia or the ancient Weingartner, now reissued also on Columbia, if you want the best.

BEETHOVEN PIANO SONATAS

A more specialized interest for audio fans, these sonatas have been so extensively recorded these last months that a brief mention is in order—beginning with the renewed observation that piano recording via tape and LP is now fabulously improved over the first wavering, flutter-ridden peaky piano LP's that so shocked the record collectors. Most of the Beethoven sonatas, though varying in sound, are remarkably fine in the technical rendering of piano tone.

The Complete Beethoven Piano Sonatas. Wilhelm Kempff.
Decca (14 LP's, separately available)

The rules of the Beethoven symphony apply to these works too—and few pianists can build the precise and multitudinous details of these works into the proper imposing musical Whole, preserving again the lyric and the dramatic intensity as well. Kempff is not as outwardly dramatic as most players of Beethoven—you'll be disappointed on first hearing at what seems a lack of "staginess," of the big effect. He is quiet and mousy. But the musical details are so superbly realized here, the structure grows so inevitably from them into inevitable and impressive wholeness that these are the records you can listen to again and again with growing pleasure, where other pianists seem flashy and false.

Piano tone is a bit wooden and hard (Kempff has an uncompromisingly hard touch at best, it would seem), with some bad surface noise here and there; a few sonatas flutter, though not painfully. Not tops in recording.

Beethoven, Piano Works. (Lighter sonatas, rondos, etc.) Hugo Steurer. **Urania LP's.**

Steurer is a genial, pleasing player who goes in for no histrionics, plays most (so far) the lighter Beethoven. His piano has a bassy, big, full sound (mike under piano?), his records nicely fill out the in-between areas. Some of the music is seldom heard.

Beethoven, Piano Sonatas. (Projected complete cycle). Kurt Appelbaum.
Westminster LP's

A nervous, high strung sound, with too many eccentricities of rhythm to suit most Beethoven listeners. A strong pianistic personality—which gets in the way of Beethoven's even stronger one. Good piano, a bit thin and hard in tone. (Recorded by Columbia.)

Beethoven, Piano Sonatas. Wilhelm Backhaus. **London LP's**

A fiery, old fashioned Romantic in his Beethoven, playing in an almost Paderewski style. If you like Beethoven played as of the Liszt-Wagner school, this is it, and good too, if slightly anachronistic! Excellent piano quality, at least in the recent LPs.

BROWSING FARE

Scarlatti-Tommasini, The Good Humored Ladies. Poulenc, Les Biches. Paris Conservatory Orch., Desormière. **London LL 624**

Two lightly related ballet suites. The Ladies derive from several Scarlatti harpsichord sonatas, ingeniously (and too cutely) orchestrated. Nice variant to Handel's Water Music and the like. Les Biches are just what you think, though we in our slightly less direct English might better speak of "The Hens" in the hen-party sense. A nose-and-thumb, jazzy bit of music from 1924—like most music of the '20's it makes wonderful hi-fi stuff! The best of ffrr.

Shaw, Don Juan in Hell. The First Drama Quartet. (Boyer, Laughton, Hardwicke, Moorehead.) **Columbia SL166 (2LP's)**

Not music but words—the complete show as it has been given the country over. Excellent, except that the audience laughs are strangely—if you've been to it—missing. I'm inclined to think they should have had a studio audience; a radical experiment on records I'll admit, but it might work as well as it does in radio and TV on comedy shows. This is a comedy, to put it mildly. Better get up your own audience of at least a half dozen before you play it through. That'll fill in the laughs. Super hi-fi speech recording, natch.

Bizet, Jeux D'Enfants. Chabrier, Suite Pastorale. Royal Opera House Orch., Braithwaite. **M-G-M E3000 (12")**

M-G-M's publicity does its best to scare away the classical listener—one might think that nothing but film-style popular classics would ever hit the yellow label, if and when. Yet this is an excellent item for any good collection, the two best French Romantic composers in really first rate lyric music, very sympathetically played and beautifully recorded. And—M-G-M be praised—the notes on the back of this LP by Edward Cole are among the best I've read lately. Really thought-out ideas, not just carbon copy stuff. Do it again, M-G-M!

Mozart, 21 German Dances. Frankenland State Symphony, Kloss. **Lyrichord LL 31**
Beethoven, 12 German Dances; Schubert, 6 German Dances, Mozart, 6 German Dances. (Paris Radio Orch.), Paris Philharmonic, Leibowitz. **Esoteric ES 512**

It's not often we are reminded that an orchestra is a group of disparate individuals, each blowing his own horn; M. Leibowitz' Schubert with the Paris Philharmonic is a painful example —here is a group of players apparently sight reading, their noses buried in their music, oblivious of all else! A fine illustration of bad ensemble—poor team work—under a conductor whose hand must be as precise and as mechanical. Soulless playing.

The Frankenland version of the Mozart, by contrast, is very musical; its only trouble (aside from lack of highs) is lack of a sense of humor —some of Mozart's dances are delightfully droll —this group plays them all dead serious.

Casals Festival at Perpignan, vol. 1: Mozart. (Kleine Nachtmusik, Sinfonia Concertante K. 354, Violin Concerto #5, Divertimento #11, Oboe Quartet K. 370.) Perpignan Festival Orch., Casals; soloists. **Columbia SL 167 (5 LP's)**

I distrust festivals. Especially when centered about some world-famed figure such as the quite worthy Pablo Casals, master cellist. There is a built-up hysteria, a hero worship, connected with these events that is fine for those present—but doesn't come over at all well on records. What does come over, too often, is a kind of distraught, tense playing, a host of petty mistakes, roughnesses, that are unimportant at the scene but noticeable in recorded form, evidence of poor mike placement under duress and blatant evidence of poor (recording) acoustics—above all, the evidence that the composers, at the moment, were far less in the forefront than the performers. That is not good on records.

All of which is illustrated again in vol. 1 of this second Casals Festival. (The first was the Prades Festival.) There's good playing here, but not tops; hardly an item in the set but can be topped by another and clearly better performance on records. But the worst drag is the dead pall of room sound, enough to kill any music and quite uncharacteristic of Columbia's usual work. Add to this a 5-LP set in which two discs have half-filled sides with gaping blank areas, and the last disc—believe it or not —one entire side devoted to an "inscription" by Casals, a few words of wisdom scratched into an acetate, the other side taken up by all of 7/8 of an inch of Casals cello, the rest being blank . . . you can't miss the Festival atmosphere! Does one pay for this sort of thing?

SOUND HANDBOOK

[*from page 22*]

the mechanical friction amplifier, *Fig. 7*—10 which involved a mechanical means of increasing diaphragm movement, and compressed-air amplifiers, *Fig. 7*—11 which employed a pneumatic relay arrangement for the same porpose.

But standards of fidelity may involve subjective factors. The early commercial records and home machines were received by an audience as yet unsophisticated in the matter of comparing musical tones with their mechanical

facsimiles. One does not critically feel the texture of miraculous cloth, and the phonograph (various commercial models of which were also called the graphophone, the gramophone, the talking machine, and the phonet) was judged by blunted senses. Below is another estimate of the Edison phonograph, written in 1900 by the manufacturer:

> "Mr. Edison has perfected the Phonograph. Beginning with the early tinfoil machine, Mr. Edison has developed the Phonograph step by step, until to-day the Phonograph stands on the pinnacle of perfection. It perfectly reproduces human voice; just as loud—just as clear—just as sweet. It duplicates instrumental music with pure toned brilliancy and satisfying intensity. Used with Edison Concert Records, its reproductions are free from all mechanical noises; only the music or voice is heard. It is strong and vibrant enough to fill the largest concert hall. It is smooth and broad enough for the parlor."

Advertising copy writers in the phonograph industry soon recognized the dramatic possibilities in the concept of musical reproduction indistinguishable from the original. A series of talking machine ads of 1908, one of which

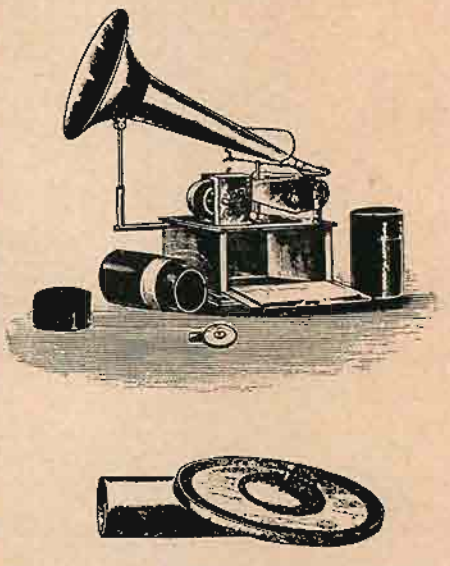


Fig. 7-9. Parzer-Muhlbacher "Sprechmaschine," Berlin, about 1900. The ball stylus and diaphragm are shown below. From. Die Modernen Sprechmaschinen.

is reproduced in *Fig.* 7—12, boasted that one couldn't tell the difference between hearing opera stars sing and hearing their records played. This optimism was caught up by the copy writers of competing companies, and it seems to have remained to this day.

Standardization of the Reproducing System

The phonograph industry had not reached agreement on basic design features. The woes of the modern purchaser of records, who may complain about the three types of records in use, are more than matched by the troubles of record fanciers of the Nineteen Hundreds, who had to choose between three types of cylinder records (5 in. Concert diameter, 2¼ in. standard diameter,

and standard diameter with fine-line grooves) and two types of disc records (lateral cut and vertical cut), each of which required its own special player or adapting attachment. It was many years before standardization of basic features was adopted.

The main issues to be settled were: whether to use cylinder or disc records, vertical or lateral recording, and standard or fine-line grooves.

Use of the disc record simplified the problem of casting many copies from a master. Cylinder records had at first to be laboriously re-recorded from the master one at a time, by a special pick-up-recorder unit with a playback stylus

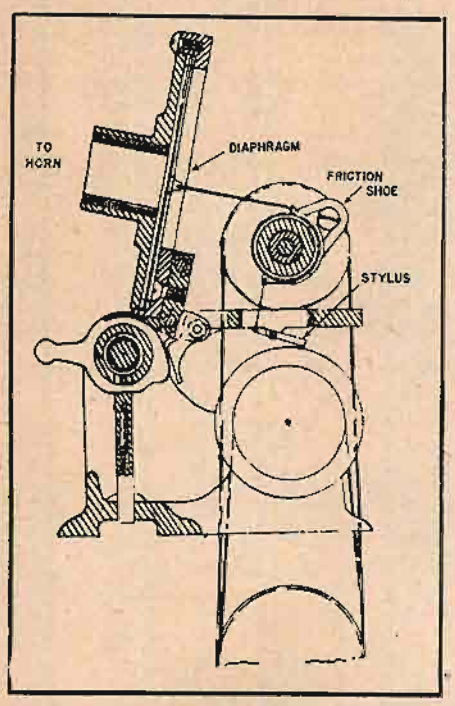


Fig. 7-10. Columbia cylinder Graphaphone with mechanical friction amplifier. From: The Reproduction of Sound, **H. Seymour, 1918.**

on one side and a cutting stylus on the other. On the other hand cylinder records do have a certain advantage over the disc, in that the longitudinal velocity of the stylus relative to the groove remains the same throughout the record, while the groove-stylus velocity in a disc record is constantly reduced with the smaller radius of each successive groove. The difficulties of mass production of cylinder records were finally overcome by a process which made pressings from a master cylinder possible—a record material was chosen which shrank after hardening so that it could be slipped out of the mold. But the simplicity of the disc system won out, and the disc came to be used universally except in dictating machines.

It was more or less natural for cylinder records to employ the vertical cutting system and disc records the lateral, although this pairing did not always occur. Edison referred to lateral recording in his 1877 patent, but credit for developing the system in practice goes to Berliner. *Figure* 7-13 illustrates the different way in which the groove is shaped for the two types of recording.

The Edison company continued to use vertical cutting in their heavy disc records for many years, but lateral cut records, the type made by the old phonautograph, finally became the standard for all home discs.

Grooves in the first records were slightly wider than the modern standard groove, cut 100 to the inch. Playing time for a cylinder was about two minutes. This time was increased by the introduction of "microgroove" technique, which used a groove of approximately the same width as the modern LP groove and increased the number of grooves per inch to 200, not much less than the pitch of contemporary microgroove records. "Long-playing" records of the first decade of the twentieth century were accompanied by the same advertising acclaim as those of the sixth. Ads for Edison fine-line cylinder records give one the feeling of a visitor to an ancient site who finds things strangely familiar. But the microgroove record lost out until many years later.

There was not too much room for improvement in the acoustic phonograph. The reproducer head was made as sensitive as possible, and the "morning glory" horn, so named because of its

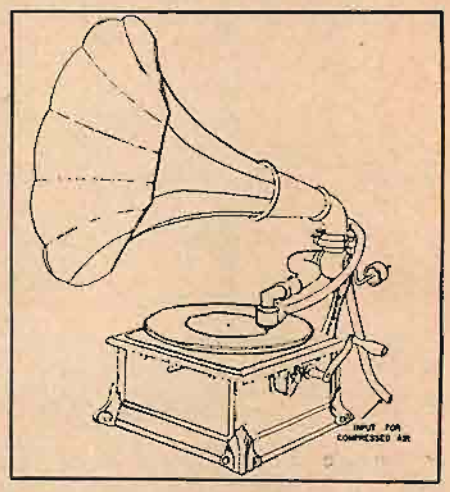


Fig. 7-11. French Phonograph (Pathé, about 1905) with compressed air amplifier. From: Le Génie Civil, 1906.

exponential flare, was substituted for the conical one. Then the outside horn was replaced by a folded horn in the cabinet, rigid with respect to the cabinet but connected by a flexible joint to the hollow tone arm, which itself formed part of the flare. Larger horns housed in console cabinets made the coupling between the diaphragm and the air of the room more efficient, particularly in the bass, producing more volume, fuller tone, and a decrease in distortion.

The Phonograph Amplifier

Direct recording and reproduction has severe limitations. It is difficult if not impossibe, with this technique, to radiate enough energy into the room to create an adequate intensity of sound. Even if the reproducing styus were so well loaded acoustically that the vibrations produced by the record groove did produce the desired instensity level, the

Fig. 7-12. "High Fidelity" in 1908.

groove walls would be so strained that they would probably crumble. In addition the natural resonances of the system are very prominent. Suppression of the violence of resonant behavior by damping, and by the design which places the resonant frequencies out of the audible range, reduces the efficiency further. The use of very light loading on the stylus has a similar effect. Such measures as these are made feasible, however, by amplification. The reduced power shaped by the record groove instead of being used for direct acoustical radiation, is employed to control an independent source of greater energy.

Edison had developed a pneumatic amplifying or "relay" system which he called the *aerophone,* but it was designed as a public address system for speech rather than for records. A successful phonograph amplifier was employed in the British auxetophone, the idea for which was first patented by Short in 1898 and developed further by Parsons soon after. This device contained a pneumatic system like that of the aerophone; the vibrations induced in the reproducing system were used to throttle periodically a steady flow of filtered air furnished by a motor-driven compressor. The reproducer head contained a stylus-actuated pneumatic valve which released bursts of air in the proper form and sequence to imitate the recorded sound. Short directed the air bursts against a reproducing diaphragm, but Parsons found that the modulated air stream could be released directly into the room. A contemporary critic of the auxetophone wrote that it was suited only to public halls, because of a constant hissing produced by the air flow and because the volume was too great. (!)

Another type of amplifier used commercially was purely mechanical in nature. The stylus was coupled to the

reproducing diaphragm via a string and friction shoe which passed over a rotating wheel, and extra energy was picked up through friction with the surface of the wheel. The principle was the same as that of the ship's capstan. When motion of the stylus caused it to tighten up on the string, frictional coupling to the wheel was increased, and diaphragm displacement was augmented by wheel motion. When the stylus loosened tension on the string the diaphragm returned to its normal position due to elasticity.

The most revolutionary advance in phonograph technique after the introduction of the Bell-Tainter system was the marriage of recording and elec-

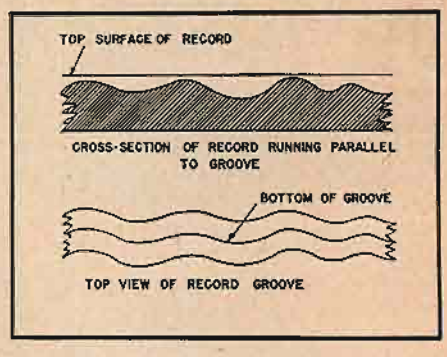


Fig. 7-13. (A) Vertical or hill-and-dale recording, originally known as the "phonograph cut." (B) Lateral recording, originally called the "gramophone cut."

tronics. Electrical recording and reproduction had been experimented with since the earliest days of the phonograph, and was mentioned in Edison's original patent application, but the development of amplifying tubes and superior electro-mechanical equipment was necessary for realization of its advantages. In electrical recording, sound was no longer impressed directly onto the record cutting head, but was first converted to an electrical signal through a microphone and amplifier. This signal, whose electrical wave form corresponded to the acoustic wave form of the sound, was fed to an electric cutting head. The cutting stylus was displaced by the electrical power applied to it rather than by acoustic power.

An electrical cutter is basically a motor. Playback had to involve a reverse electro-mechanical process, using a pickup head which acted as an electrical generator. Playback stylus displacement induced voltages in the pickup of the same wave form as that of the groove, and these voltages were amplified and converted into sound by a loudspeaker.

Electronic amplifiers can now be built whose degree of fidelity to the input signal compares favorably with the degree of accuracy with which the human ear can judge distortion. This is not true of electro-mechanical and electro-acoustic apparatus; the greatest obstruction in the path towards fidelity is still the pivoted or suspended mechanical device. We have not yet learned how to control the machine with the same precision with which we can control the electronic circuit. The problems of the contemporary audio engi-

neer are thus not as far removed from those of phonograph designers of the Nineteen Hundreds as one might think.

PATENTS

[from page 2]

V_3, the key to the system, is a high-mu triode biased by R_{10}–R_{11} across the B-supply, with the cathode bypassed by C_7. The grid is also bypassed for audio by C_6. C_5 is the conventional screen bypass for V_1. The triode normally has a high plate resistance and draws little current through R_3 and K_6. It also has little shunting effect on the signal for this reason; the same is true for resistor string R_6–R_7–R_8–R_9. V_3 causes no degeneration of signal because its grid and cathode are bypassed.

The voltage on the plate of V_3 is essentially that on the plate of V_1. When the V_1 plate voltage rises more than, say, 20 volts above its resting value (the result of a sudden negative control-bias rise on its grid) the heightened voltage on the plate of V_3 brings it into the low-resistance, high-plate-current region. The current of V_3 is drawn through R_3, opposing the rise in voltage across R_3 (which is, of course, the output voltage of V_1) and keeping the undue rise down to negligible proportions. The effect is to clip the sudden transient and prevent unpleasant noises. As an illustration, an unchecked transient may cause a 100-volt peak; the clipper keeps it down to about 20 volts, well within the normal level. Negative V_1 plate swings tend to be slower and do not cause audible transients, so no negative clipping is required.

Screen compensation works this way: When a negative control voltage rises on the grid of V_1, screen current through the screen dropping resistors R_6 and R_7 decreases and screen voltage becomes more positive. This rise appears on the grid of V_2. The plate current of V_2 increases; since it is drawn through R_4, it causes a greater drop across R_4 which tends to counteract the change in screen voltage.

Values of components and tube types are not given in the patent specification but, as usual, a little thought would indicate them.

A copy of any patent specification may be obtained for 25¢ from The Commissioner of Patents, Washington 25, D. C.

MAGNECORD and VOX Join With New Tape Library

"Magnecordings by Vox," first full-range recorded tapes for commercial sales featuring major orchestras with noted conductors and soloists, are rapidly being made available throughout the country.

These "Magnecordings" are offered as both full and half-track recordings on standard recording tape at 7½ in./sec., thus providing either hour or half-hour programs on a single 7-in. reel, depending on the type of recording desired. Special equalization in recording will give reproduction to 15,000 cps. Price for 7-in. half-track reel —one hour—is pegged at $9.95.

Recordings will be made by Magnecord for MaVoTape, Inc. from the "master" tapes of Vox Productions, Inc., and will be distributed initially through Magnecord outlets. Plans call for six releases per month.

NEW PRODUCTS

• **Portable Tape Recorder.** Performance based on NARTB specifications is afforded by the new Magnemite Model 610-SD battery-powered tape recorder with spring-wound motor recently introduced by Amplifier Corp. of America, 398-4 Broadway, New York 13, N. Y. Constant tape speed, with flutter content within ± 0.1 per cent over the full winding cycle of six minutes, is achieved by means of a patented centrifugal flyball governor on the spring motor. The motor may be rewound during operation without any perceptible effect on recording or playback. A triple-purpose indicator lamp signals 30 seconds before rewinding is necessary, shows if the power switch is accidentally left on, and indi-

cates any undue variation in tape speed. The 610-SD operates at a tape speed of 7½ ins./sec., furnishing 15 minutes of continuous playing time on a standard 5-in. tape reel. Recordings may be played back on any standard studio equipment. Measuring only 11¾ × 10 × 7½ ins., the Magnemite weighs only 15 lbs. complete with self-contained batteries which afford 100 operating hours without replacement. Technical specifications and prices will be supplied on request.

• **Sound Analyzer.** A new instrument which, in addition to measuring intensity, separates sound signals into their component frequency bands, has recently been added to the extensive line of noise-measuring devices manufactured by Hermon Hosmer Scott, Inc., 385 Putnam

Ave., Cambridge 39, Mass. Designated Type 420-A Sound Analyzer, the unit contains high- and low-pass filters which can be independently adjusted in steps of one-half octave. A simple interlock permits the pass-band width to be fixed in any multiple of one-half octave. The position of the pass-band can then be adjusted throughout the audible range by means of a single control. The 420-A exceeds all proposed specifications of the ASA for filter-type sound analyzers. The instrument is housed in a saddle-leather carrying case and may be used while the operator is walking about. Weight is 20 lbs. and dimensions are 10 × 10 × 6 in. Bulletin will be mailed on request.

• **Multi-impedance Dynamic Microphone.** There is little to be required of a microphone, both in performance and flexibility, that is not present in the new Astatic unidirectional Model DR-11. Frequency

response is 40 to 10,000 cps and available impedances, achieved by means of a built-in transformer and selector switch, are 50, 200, 500 ohms and high. Output level is −54 db. The unit employs Astatic's sintered-metal method of acoustic phase shifting. Front-to-back pickup differential is approximately 15 db. Dynamic element is floated in rubber for structural stability and reduction of mechanical pickup. The DR-11 is finished in satin chrome with maroon trim, and is supplied with Amphenol connector and 18-ft. shielded cable. Astatic Corporation, Conneaut, Ohio.

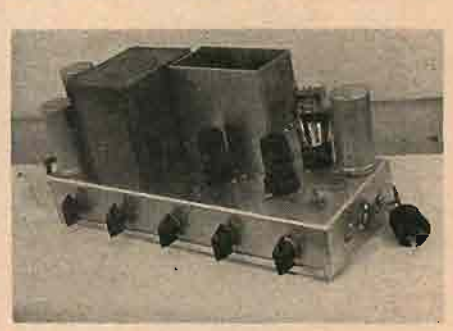
• **Magnetic Tape Recorder.** Five piano-type pushbuttons permit selection of all operating functions, including fast forward, playback, stop, record, and fast reverse, in a new low-priced Knight tape recorder recently announced by Allied Radio Corporation, 833 W. Jackson Blvd., Chicago 7, Ill. Panel-mounted control affords choice of 7½ or 3¾ ins./sec. recording speed. Frequency response at the higher speed is 70 to 8500 cps. Playback is by means of a built-in power-amplifier and speaker, with additional provision for feeding external equipment. Extremely compact, the new Knight re-

corder measures only 14 × 12 × 7 ins. It is housed in a sturdy, luggage-type carrying case. Carrying weight is less than 22 lbs. Supplied complete with crystal microphone, 600-ft. roll of tape, and 5-in. take-up spool.

• **Magnetic Tape Recorder.** Many improvements over earlier models are included in the new Eicor Model 230 tape recorder. Major design emphasis has been placed on functional styling, an example of which is the new "Finger-Flip" control arrangement which affords simultaneous switching of mechanical and amplifying systems. Built-in dual-speed capstan permits instant choice of 7½- or 3¾-in. recording speed. Normally furnished for dual-track operation, the 230 features a plug-in recording head which can easily be replaced with a single-track head for applications which require editing and splicing. An automatically engaged pressure roller keeps tape in close contact with capstan for elimination of slippage

and consequent reduction of wow and flutter. Frequency response at 7½ ins./sec. recording speed is 70 to 8000 cps within ± 3 db. Cover for portable case carries microphone, break-away power cord, and extra reels. Eicor, Inc., 1501 W. Congress St., Chicago 7, Ill.

• **High-Quality Amplifier.** Although extremely compact, the new Deco Type PTL-8 amplifier affords a calibre of performance normally expected of units considerably larger. Combining an equalizing preamplifier and a power amplifier on a single chassis, the unit has a rated power output of 9 watts with less than 1 per cent harmonic distortion. Intermodulation is said to be correspondingly low. Frequency response is 20 to 20,000 cps within ± 1 db. Hum level is 90 db below rated output. Panel controls include separate bass and treble controls, loudness control, and a combined input selector and phono-equalization switch which ac-



commodates all types of records when played with a variable-reluctance pickup. Dynamics Engineering Co., 234 W. Elm St., Oxnard, Calif.

• **Magnetic Tape For Instrumentation.** In view of the rapidly increasing usage of tape recording equipment for instrumentation and data analysis, Minnesota Mining and Manufacturing Co., St. Paul, Minn., is now producing Scotch tape preselected for telemetering and other instrumentation uses. The new tape is relatively free of nodules, or surface imperfections, and represents considerable improvement over standard tape for instrumentation applications, although it offers no superiority over regular Scotch tape for the recording of musical programs.

ORGAN INSTALLATION

[*from page 16*]

driver unit and associated horn. Similarly, above 4000 cps the dividing network again diverts the input to a unique horn-type unit designed especially for this very high frequency range.

It is apparent that such a system does not require the use of large and heavy multicellular horns and low crossover frequency thus substantially simplifying the system. As the frequency increases, progressively smaller sources are employed which can therefore have high efficiency in their limited band width (approximately three octaves) as well as improved polar characteristics. The resulting reproducer was found to have very low distortion at the maximum power levels encountered from the lowest notes of 64 cps to well beyond the 12,000-cps value specified. This low-frequency limit with wavelength of about 18 feet obviously simplified the problem, and the horn mouth size of 33 by 36 in. was entirely adequate. Overall dimensions of the reproducer are approximately 38 wide × 62 high × 24 in. deep.

Pedal-Channel Reproducers

The two pedal-channel reproducers each consisted of a large exponential horn driven by two 15-inch Jensen P15-LL special low-frequency direct-radiator type driver units. These horns had continuous exponentially flaring walls with design cutoff of approximately 30 cps. Mouth size was 57 × 89 in. yielding an area of about 35.2 square feet. The throat area was approximately 354 sq. in., giving excellent loading characteristics for the two 15-inch loudspeakers. Tests verified that no enclosing chamber was necessary over the back of the driver units. *Figure* 5 is a diagram of the pedal channel reproducers.

The wavelength at 32 cycles is about 36 feet, and there was no floor or similar reflecting surface adjacent to the horn mouth to increase its apparent size. However, with this excellent horn loading the electrical power handling capacity of the 15-inch drivers was easily in excess of the 30 watts specified. Reproduction of all pedal tones down to 32 cps met the requirements of high output and low distortion at the highest power levels encountered.

The Loudspeaker Array

Because of the necessity for suspending the entire loudspeaker array, it was imperative to obtain the maximum in efficiency and power handling capacity so that the number of reproducers could be kept at a minimum. The further requirements for low distortion and wide frequency range clearly indicated the necessity for high-quality loudspeakers.

The entire array of reproducers was supported on a platform and hoisted by power winch to a centrally located po-

sition near the roof. *Figure* 6 shows the complete array before hoisting. The individual reproducers were arranged on the periphery of the platform leaving sufficient working space in the center for all required operations. The platform was accessible from a catwalk just under the roof. All cable connections were completed after the array was raised into position. Each manual-channel reproducer horn was hinged to the platform at its back edge and could be tipped back to lie flat for access to the Triaxial loudspeaker driver unit. These reproducers were locked in normal position by latching to the next adjacent reproducers. The driver units for the pedal channel reproducers were directly accessible from the back.

As indicated in the block diagram separate cables were used for each manual reproducer and for each driver unit in the pedal reproducers. These cables extended from the amplifiers, located adjacent to the console near one end of the auditorium, to the loudspeaker array. These 14-ga. cables with a length of approximately 300 feet were satisfactory for use with the 16-ohm load impedances, thus eliminating the need of additional transformers. Plug connectors at the loudspeaker array simplified installation.

All of the individual reproducers were oriented so that the "axes of radiation" all would lie in a horizontal plane directing the sound into the slanting (domed) roof. The sound was thus reflected downward into the audience adding a feeling of "expansiveness". This procedure, while quite satisfactory for the reproduction of organ type music, is entirely contrary to the required procedure for public address systems where the sound must be directed to the audience and all reflection must be eliminated so far as possible. The deep balconies—usually the downfall of the PA system—proved no particular problem due to the high percentage of reflected sound energy in the auditorium. The reproduction was entirely satisfactory in all parts of the hall even for the high-frequency range.

With such an application as this there is no opportunity to test performance before the actual final operation because the system performance is dependent on the audience size and the ambient noise. Many doubts existed as to the adequacy of the system despite the favorable performance with an empty auditorium. However, the performance during the two conventions justified the careful planning of the system, and unsolicited praise from many of the official personnel verified the acceptability and adequacy of the system.

TABLE 1

SPECIFICATIONS FOR MODEL 2C2 CONNSONATA

Swell Manual: 61 Keys
Great Manual: 61 keys
Pedalboard (standard AGO): 32 notes

Stop list:

Great
- Open Diapason
- Melodia
- Gross Flute
- Dulciana
- Gamba
- Trumpet
- Great Union Off (8′)
- Great 4′
- Swell to Great 16′
- Swell to Great 8′
- Swell to Great 4′
- Swell to Great 2′
- Great Tremolo Off

Echo

Echo and Main

General
- Tremolo—Light
- Tremolo—Medium
- Tremolo—Heavy

Pedal
- Major Bass
- Gedeckt
- Bourdon
- Dulciana
- Great to Pedal 8′
- Swell to Pedal 8′

Swell
- Geigen Diapason
- Harmonic Flute
- Gedeckt
- Echo Salicional
- Viola da Gamba
- Vox Humana
- Oboe
- Swell 16′
- Swell Unison Off (8′)
- Swell 4′
- Swell 2 2/3′
- Swell 2′
- Swell 1 3/5′
- Swell Tremolo Off

Balanced expression pedal controlling over-all volume of entire instrument

Off/On power switch with pilot light

Note: Tremolo is activated on entire organ by depressing any of the tremolo switches. Is cancelled on individual manuals by using Tremolo Off switches.

NETWORKS

[*from page 17*]

ing, the source impedance seen by each speaker should be as low as possible.

It is evident that conditions (1) and (2) will be implicitly satisfied if requirements (3) and (4) are met.

Two networks that will fulfill requirements (1) through (4) are shown in *Fig.* 1, where R is the impedance of the speaker, and f_c (the "crossover" frequency) is the frequency at which the radiated power is equally divided between the two speakers. The input impedance of either of these two networks is equal to R, and is independent of frequency, if the following conditions are met: (a) the impedances of the speakers must be equal, and (b) the impedance of each speaker must be a pure resistance.

Circuit A of *Fig.* 1 provides a considerably sharper frequency division of the signal than does circuit B; the power radiated by each speaker of circuit A falls off at a rate of 12 db per octave in the cut-off band, whereas the slope for circuit B is 6 db per octave. Which of these circuits is the more desirable depends on several factors. Use of the sharper slope, for instance, reduces the range of frequency over which any one speaker has to handle an appreciable amount of power. However, unless great care is exercised in locating the speakers, this same sharpness of crossover may destroy the illusion that the sound is being radiated from a single source, since the fact that the sound is being produced in two frequency bands is more obvious under these conditions.

Relative Advantages

From the point of view of the hobbyist, circuit B offers certain advantages over the more complicated circuit A. It is true that a saving in complexity of the circuit is probably of negligible importance, *per se;* and certainly any reduction in size and weight of the circuit will be a small percentage of the volume and weight inherent in the speakers themselves. However, there is a material saving in the cost of the components required—circuit B requires only about 36 per cent of the inductance, and some 70 per cent of the capacitance required by circuit A for a system having the same crossover frequency and the same speaker impedance. Since the capacitors used in a high-fidelity system must be of the high-quality, oil-filled variety, and since the values of capacitance required in a practical system are quite large, a reduction by 30 per cent in capacitance represents a very real reduction in cost. Moreover, use of a smaller inductance will result in a lower resistance in the inductors, with a slight resultant gain in efficiency, and with a concomitant improvement in damping.

In circuit B, any resistance in the inductor winding can be written off as part of the speaker resistance, and can easily be balanced by addition of a padding resistance in the other half of the circuit. However, a reasonable amount of resistance unbalance can be tolerated, except when feedback is used from the voice-coil windings. In the latter case, phase shift may become excessive if balance is not maintained.

Similarly, inductance in the speaker winding can be regarded as part of the inductor in one branch of circuit B. Unfortunately, however, since this speaker is carrying the low-frequency components of the signal, the inductance in this speaker is of less importance than it is in the other speaker, which is not compensated by the circuit configuration. By application of Thévenin's theorem, one may see that it is possible to regard shunt capacitance around the high-frequency speaker as included in the series capacitor, although this capacitance should be negligible, even at the highest audio frequencies.

So far, nothing has been said about requirement (5) above, i.e., that the speakers should see a low-impedance source. Unfortunately, both of the above circuits are weak in this respect, circuit B perhaps having a slight advantage over circuit A. Moreover, the source impedance—and hence the speaker damping—will be a function of frequency. If speaker resonance occurs at a frequency at which the damping

is ineffective, "muddy" performance is inevitable.

However, a low source impedance can be provided by applying the voltage across the voice coils as an inverse feedback signal. Feedback voltage may be developed by the circuit shown in *Fig.* 2. For "flat" output, R_1 and R_2 should be equal. A certain amount of tone control can be exercised by varying the ratio of R_1 to R_2, thereby varying the relative outputs of the two speakers.

It is assumed that inductors will be wound especially for the circuit, since it is highly unlikely that the non-standard values of inductance required will be available commercially. The fact that L and C will resonate at the crossover frequency can be used to determine the required inductance. However, this method does not insure the relationship $L=R^2C$ (or $L=2R^2C$), due to tolerances in R and C, and the voltage relationships in the circuit may deviate seriously from those predicted on a basis of the nominal values. A more satisfactory procedure would be to adjust the inductance to the actual resistance and capacitance values, absorbing the tolerances in these quantities in a slight shift of the crossover frequency. The proper inductance may easily be determined by use of the circuit shown in *Fig.* 2; if R_1 and R_2 are equal, the correct amount of inductance will provide a constant voltage gain from a to b, independent of frequency. Values of L and C, normalized with respect to R, are plotted against crossover frequency in *Fig.* 3.

If circuit A of *Fig.* 1 is used, care must be taken to maintain equal resistance, inductance, and capacitance in both branches of the circuit. R and C can be trimmed with the help of a simple bridge, but cut-and-try seems to be the only feasible way to insure balance of the inductances, at the same time satisfying the condition, $L=2R^2C$. In this respect, the simplicity of circuit B proves to be a strong argument in favor of the latter circuit.

Either of the two circuits shown in *Fig.* 1 is readily adaptable to systems of three or more speakers. For a three-speaker system, a complete dividing network and its associated speakers may be substituted for one of the speakers indicated in *Fig.* 1—since the network with its speakers presents a constant resistive impedance, the original network will operate exactly as if working directly into a speaker.

E-V PURCHASES RME

Albert R. Kahn, president of Electro-Voice, Inc., announced recently that Radio Mfg. Engineers, Inc. (RME) has been purchased by E-V in keeping with an over-all program of meeting the needs of a great and expanding market in the audio-video field.

RME, a 19-year-old firm which manufactures communications receivers and accessories, will remain under the present management of E. G. Shalkhauser and Russ Planck, and all RME business will be conducted from its present offices at Peoria, Illinois.

EQUALIZER

[*from page 19*]

value equal to R_s minus the coil resistance.

As a general observation, r.f. chokes can be used in applications requiring inductances of less than 15 mh. While a high Q is desirable, it can nevertheless be discounted to the extent that it is possible to attain the necessary objective. For extremely "sharp" curves, best results can be obtained by the use of toroids, but for most applications it will be found that r.f. chokes can be used, and at considerably less expense.

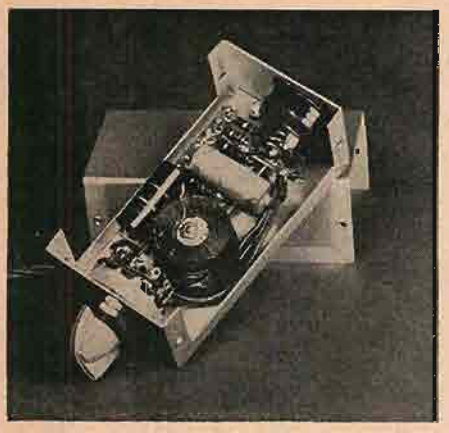


Fig. 5. Internal construction of the equalizer shown at the right in Fig. 4.

AES NEWS

[*from page 12*]

the Society, and as a consequence have been elected Sustaining Members for the coming year, in accordance with the Constitution. These organizations are:

Altec Lansing Corporation
Audak Company
Audio & Video Products Corp.
Audio Development Company
Audio Devices, Inc.
Bell Sound Systems, Inc.
British Industries Corporation
Cinema Engineering Company
Columbia Records, Inc.
The Daven Company
Electro-Voice, Inc.
Fisher Radio Corporation
Harvey Radio Company, Inc.
Magnecord, Inc.
McIntosh Laboratory, Inc.
Pickering & Company, Inc.
Presto Recording Corporation
Reeves Sound Studios, Inc.
Reeves Soundcraft Corporation
Rek-O-Kut Company
Terminal Radio Corporation

Election Results

The results of the annual election were also announced at the Society's business meeting, October 29. The new officers, for the year ending October 31, 1953, are:

F. SUMNER HALL ..... *President*
JERRY B. MINTER .. *Executive Vice-Pres.*
W. S. PRITCHARD .... *Central Vice-Pres.*
R. L. BURGESS ..... *Western Vice-Pres.*
C. J. LEBEL ..... *Secretary*
RALPH A. SCHLEGEL ..... *Treasurer*

Three new governors were elected to fill expiring terms: C. R. Sawyer, Price E. Fish, and Jay H. Quinn. Albert A. Pulley was appointed by the Board of Governors to fill the unexpired term of Jerry Minter, who became executive vice-president. The remaining governors, with one year yet to serve, are W. Oliver Summerlin and John D. Colvin. C. G. McProud, retiring president, becomes a governor for one year in accordance with a provision of the Constitution which was adopted by vote of the membership, along with a number of other amendments to both Constitution and By-Laws. All of the changes submitted to the membership for vote were adopted, with no more than three dissenting votes on any particular section.

Copies of the Constitution and By-Laws as amended will be sent to all members as soon as they can be printed. For the first time in the Society's history, all 29 of the papers given at this year's convention will be assembled in a single volume, complete with illustrations, and furnished to members shortly after the first of the year. These collected papers will be available to non-members for a nominal charge.

LETTERS

[*from page 6*]

extraordinarily handy when picking up the amplifier. . . .

EDWARD H. BENNETT, JR., A.I.A.,
80 East Jackson Blvd.,
Chicago 4, Ill.

SIR:

. . . As for the chassis, it is quite agreed that absolute solidity is necessary but this was achieved much more easily than by hollowing out a solid block of aluminum, as suggested by Frudd. The parts were assembled, placed in a mould and molten aluminum poured around them.

Since the writer did not happen to have in his garage (he has no garage, as a matter of fact) an old turret lathe on which to wind the hyper-toroidal, sextifilar transformers (quadrifilar not being sufficiently absorptive of ergs) he was forced to have cores made in the shape of an old turret lathe, winding the coils on these. This was difficult, as might be suspected, but was deemed advisable.

The speaker system presented no problem, especially after reading Frudd's lucid account. It was, however, found necessary to connect at least one of the speakers electrically, a total of nineteen speakers being used.

FRANK S. LEVY,
Levy-Tathwell Company,
P. O. Box 1955,
Charlotte 1, N. C.

(Obviously, you can't please all of the people all the time. We appreciate the many comments on the Frudd System and the many constructive suggestions received, particularly since this was Æ's first studied attempt at humor. But we can't understand why no one *noticed Mr. Drenner's article in the same issue.* ED.)

A MONTHLY SUMMARY of product developments and price changes of radio electronic-television parts and equipment, supplied by United Catalog Publishers, Inc. 110 Lafayette Street, New York City, publishers of Radio's Master.

These REPORTS will keep you up-to-date in this ever-changing industry. They will also help you to buy and specify to best advantage. A complete description of most products will be found in the Official Buying Guide, Radio's Master—available through local radio parts wholesalers.

Miscellaneous Radio, TV, and Electronic Parts

ARCO ELECTRONICS—Introduced ceramic disc capacitor series CCD, CCDN, used primarily for coupling and by-pass in r.f. and higher-frequency circuits . . . are wax impregnated with low-loss phenolic coating . . . voltage rating 1500 v.d.c.t., 500 v.d.c.w. Also feed-though capacitor series CCF designed for high-frequency coupling with a minimum of inductive reactance through elimination of wire leads.

CHEST LABS.—Added series MT, SMT, MMT transistor transformers.

GUARDIAN ELECTRIC MFG.—Discontinued the 25-cps a.c. coils in their relays No. 200-6A, 200-12A, 200-24A, 200-115A. Added No. 200-5 to their contact switch assembly series at $3.35 net.

LITTELFUSE—Added No. 30307.5, 7½-amp fuse in their 7AG fuse series and No. 312.187 to their 3AG fuse series.

MILLER CO., J. W.—Introduced No. 522, phono-oscillator coil at $1.98 net . . . No. 112-H6, air-core midget transformer at $1.59 net, and 4 other air-core transformers.

SOLA ELECTRIC—Discontinued 5 constant-voltage transformers, superseded by 5 new models.

Recording Equipment, Speakers, Amplifiers, Needles, Tape, Etc.

AMERICAN MICROPHONE—Introduced crystal lapel microphone No. CL-3 at $28.45 list . . . frequency response 50-5,000 cps, output level −55 db (0 db = 1 volt/dyne/cm²), diameter 2¼", depth ⅝", weight 6¼ ozs. Decreased price to $3.60 net on No. CR-5, crystal cartridge, 1 volt output, 50-6,000-cps frequency range, weight 5 grams, supplied with one-mil-radius Osmium tip needle.

ARGOS PRODUCTS—Discontinued No. PC-1, record changer carrying case.

ATLAS SOUND—Discontinued speaker support stand No. HM-2 and marine midget projector No. WX-5.

PERMOFLUX—Introduced No. CH-16B (blond) at $86.10 net and No. CH-16M (mahogany) at $74.70 net. Both are dual corner horn baffles with multiple arrangement of 8" speakers or an alternate mounting board for one 12" speaker.

RADIO MUSIC CORP.—Introduced Model TP 12E, turntable chassis with 12" platter, synchronous motor, at $100.50 net.

TURNER CO.—Introduced Model C-3, microphone desk stand, 5½" high, 4¾" diameter, 14 oz. weight, satin chrome finish. Model B-3 (same as C-3) with brown metalustre finish. Model G-3 (same as C-3) with gunmetal lustre finish, all 3 models at $2.01 net each. Also added Model TR2 at $9.00 net, matching transformer, matches 30-50, 200-250, and 500-ohm lines to grid, wide frequency response: ±1 db from 40-10,000 cps, one hole mounting, equipped with 3-contact locking connector and 7 ft. two-conductor shielded balanced line cable.

Test Equipment

G.E.—Discontinued Model YNA-4, industrial oscilloscope for reengineering purposes. Increased price on Model YTW-3, industrial tube analyzer to $528.97 net.

HICKOK ELECTRICAL INSTR. CO.—Increased price on Model 465, double-range d.c. kilovoltmeter. The leads and carrying case for this model are discontinued.

JACKSON ELECTRICAL INSTR. CO.—Added Model 707, cathode ray tube analyzer at $419.50 net.

RADIO CITY PRODUCTS—Discontinued No. 322AK, tube tester kit . . . No. 322PK, portable tube tester kit . . . No. 323M, tube merchandiser . . . No. 450A, hi-megohm multitester and No. 450AP, portable multitester. Increased price on No. 453, Master Multitester to $49.50 net.

SCALA RADIO—Added Model BZ-123, a combination of Models BZ-1, BZ-2, BZ-3, containing a signal-tracing probe, a low-capacitance probe, and a 100 : 1 voltage-divider probe, at $27.45 net. Also introduced Model BZ-C, a spare or replacement low-capacitance calibrated coaxial cable for any of the above probes.

SPEAKER TREATMENT

[from page 23]

seen when it is held up to a light, and the small amount of improvement possible is effected with a relatively small number of slits. In older speakers with stiff suspensions it appears that more slits are better. A wise approach is to make a small number of slits at first—about sixteen for example—then if the improvement is not what was anticipated, to try more between the first set. A pair of drafting dividers are used to space the slits evenly. They are set by trial so that when "walked" around the edge of the first corrugation they return to the same spot with integral spacing. Then they are walked around again allowing the points to prick the cone and thus mark the correct location for each incision. A sharp razor blade is used to slit carefully as close along a radial as possible, from the middle of the first corrugation (which is the cone edge) across the rim to the area where it is cemented to the "basket." The rim should not be torn and the cuts should go all the way to the bottom of the following corrugations. If the suspension at the apex of the cone, the so-called "spider," is also of the corrugated type, slitting here will afford an additional lowering of the resonant frequency. Often this is difficult or impossible to do, however, and might affect the high-frequency response.

The second means of improvement is called "plasticizing." Plasticizing is accomplished by applying a suitable chemical agent to the suspension to make the fibers more pliable and yielding. The plasticizing described herein was accomplished with Dibutyl Phthalate which can be obtained from large chemical supply houses.[2] Dibutyl Phthalate appears to be a good plasticizer in not drying out over a period of time; but it does have the marked disadvantage of "creeping," that is, spreading through the cone by capillary action. This would be disastrous if allowed as the whole cone instead of just the suspension would thus be made pliable and piston action would suffer, resulting in low efficiency and weakening of high frequencies. To prevent this condition the edge is first made impervious to capillary travel by sealing the pores with an application of shellac, varnish, or cement. This means the addition of a small amount of mass to the cone, and a further lowering of the resonance point is sometimes noticeable but rather negligible. A small soft brush is used to paint the cone in a swath about ¾-inch wide (for large speakers) just inside the curvature of the first corrugation—on *both* sides of the cone. Clear shellac was used in most of the treatments attempted, and with a fair amount of success, but it tends to break down under reaction from the Phthalate if the cone is very well

[2] Eimer & Amend, New York City, for example.

feked. Recent but rather inadequate experience with so-called "radio" cement would seem to recommend it because it does not appear to be affected by the plasticizer. It is important that a good job be done in blocking the creep of the Pthtalate, because if it once gets started through, it is difficult to stop it. One should apply several costs of the sealer if inspection deems it advisable. When this operation is finished and the sealer is dry, the plasticizer may be applied with a cotton swab. Distributing it in even amounts around the periphery of the suspension is desirable, but there is no worry about spreading it laterally as the Phthalate spreads itself. If it should begin to work past the barrier after ageing, another swath of sealer may be applied to stop it.

Results Obtained

By utilizing one or both of these two methods of suspension treatment, the results shown in the chart may be obtained. The improvement in low-frequency capability is evident. We have thus far stressed only the advantages in bass, but no really deleterious effects to the higher ranges have been noted. It would seem that the slitting operation could conceivably cause edge effects resulting in irregularities in the middle frequency range. One of the most pronounced peaks of a speaker's middle frequency response

TABLE I

Results of Speaker Treatment

Speaker	Resonant Frequency Before Treatment	Resonant Frequency After Treatment	Treatment
3" Cinaudagraph P2A1	230	205	Eight slits
		190	Sixteen slits
4" × 6" RCA 446S2	195	155	Sixteen slits
		147	Thirty-two slits
		140	Same, plus cement sealer
		130	Same, plus three applications of plasticizer, ageing after each
5" × 7" RCA 257S1	110	80	Thirty-two slits
		75	Same, plus shellac sealer
		58	Same, plus five applications of plasticizer, ageing after each
6" × 9" RCA 269S1	100	80	Thirty-six slits
		72	Same, plus sealer and plasticizer
		70	Same, plus ageing
		63	Same, plus second application of shellac sealer and ageing
		55	Same, plus four slits in spider and more ageing
8" R&A (British) 880P	108	90	Twenty-five slits
		80	Fifty slits
		72	Same, plus plasticizer
		62	Same, plus second application
		58	Same, plus two more applications of plasticizer, and slitting spider
10" PM 10-12	75	63	Thirty-six slits
		48	Same, plus three applications of plasticizer and ageing
12" GE S-1201D	73*	70	Sixteen slits
		68	Same, plus plasticizer
		50	Same, plus four slits in spider, three more applications of plasticizer, and ageing. (Capillary travel is very marked in this cone.)

* Some speakers of this type come with a resonant frequency as low as 63 cps.

is due to the resonance of the edge.[3] The mechanical alteration of the edge might aggravate the peak somewhat on the less expensive speakers. A small change in frequency of some of the peaks in a loudspeaker's curve has at times been observed, but the extent of the variations has not been quantitatively ascertained because of the apparent inconsequence. The plasticizer, however, would have no pernicious effect as long as it is kept within its prescribed area. If one were treating a speaker intended only as a woofer, there is nothing to lose in the complete treatment and much to gain. If both methods are applied, the slitting operation must be done first because slitting a plasticized rim is quite difficult.

In checking progress the circuit shown in *Fig.* 3 has advantages. The 60-cps 'scope input is used to calibrate the audio oscillator, an operation which should be performed at frequent intervals, particularly with a beat-frequency oscillator When working with low frequencies and such small increments, accuracy of calibration is important. By setting the oscillator to 60 cps and varying the calibration adjustment until a stationary one-to-one Lissajous figure is obtained (circle, ellipse, or inclined line, depending on phase), the oscillator can be set readily without much trouble. To find the resonant frequency of the speaker turn the 60-cps input gain to zero and hold the speaker up in the air. Vary the frequency of the oscillator until the maximum deflection is noted on the 'scope. The frequency indicated by the dial is the resonant frequency. In most cases it can also be detected audibly by noticing when the cone tends to chatter, which is caused by its greater displacement at resonance. The 'scope method, which depends on the rise in speaker impedance at its resonant frequency, is reliable and can also be used for a speaker mounted in a baffle thus serving to indicate the reduction in bass range that the enclosure might cause.

As a before-and-after test of this treatment, LP records with low organ notes[4] are very useful. Often the improved speaker will bring out notes in the lower register which were not even noticed before treatment.

[3] Corrington and Kidd—"Measurements on loudspeaker cones," *Proc. I.R.E.* Sept. 1951, p. 1021.

[4] Columbia ML 4120: Saint Saëns, Symphony No. 3; Columbia ML 4329: Poulenc, Concerto in G Minor are good examples.

ERRATA

October issue, page 92

We are advised by Edward J. Gately, Jr. that the dimension along the top of the cabinet of *Fig.* 2 should be $y/\sqrt{2}$ instead of $\frac{1}{2}y$ as shown.

November issue, page 23

We are advised by George Ellis Jones, Jr. that the screen-to-ground resistor, R_{23}, associated with V_3 should be 10,000 ohms instead of 1000 ohms as shown in *Fig.* 5. The correct value is shown in the parts list on page 79.

WIDE-ANGLE DISPERSION

[*from page 25*]

and then suddenly releasing the wave front in that very same plane, it becomes possible to flare the horn more suddenly near its mouth, which will result in wider dispersion. Second, by choosing the point at which wave front restriction changes *direction*, it is possible to arrive at a vertical mouth opening of sufficient size to control the vertical directivity as desired.

Since the angular dispersion is a partial function of the geometric distribution of pressure within the horn, the reverse-flare horn must be examined geometrically. *Figure* 3 indicates the cross-sectional area distribution of the reverse-flare horn. The horn is, at all times, exponential. Regardless of the shape of the cross-section, one area progresses from the preceding area in a logarithmic fashion with distance x, bounded strictly by the cut-off frequency for which the horn is designed. Since these areas are the product of the vertical and the horizontal dimensions, the horizontal dimension may be chosen to have any desired value. This will permit primary restriction of the wave expansion to be made as severe as desired. If the horizontal dimension is to be kept unchanged from the smallest value as found at the throat of the horn, it will simply mean that the vertical height will do all the expanding. Or if it is desired to let the horizontal dimension expand slightly, then the vertical height need not expand as rapidly. The cross-sectional area may be proportioned in any way best suited to the desired result.

The purpose for the present is actually to *restrict* early horizontal spread of the wave front *within* the horn, but to allow the wave front to expand freely in the vertical direction, within the horn. Restriction of the wave front expansion from the horizontal plane gives rise to an area of high wave-front pressures against the restraining vertical walls. Conversely, freedom of the wave to expand in the vertical direction will result in minimum wave-front pressures against the fast flaring upper and lower walls. As an analogy, picture a cylindrical tube in which two inserted pistons confine a gas under pressure. When these pistons are stationary, the confined gas pressure is equally distributed over the walls of the tube and the piston faces. If the pistons are now suddenly pulled apart, the confined gas pressure will tend to expand toward the piston faces. If the pistons retreat fast enough, the expanding gas may never catch up to them. Consequently, these retreating pistons, which allow the gas to expand in their direction, will have minimum pressure exerted upon them, whereas the restraining walls of the tube will experience the greater gas pressure.

Returning to the horn walls, the difference in wave front pressures against the vertical walls and the top and bottom walls may be represented graphically, as shown in *Fig.* 4. This pressure configuration represents the state of affairs concerning the internal pressures against the horn walls extending from the throat of the horn down to the point at which it may be desired arbitrarily to reserve the pressure distribution. For the moment, let any such point be chosen along the horn axis at which to introduce this pressure reversal.

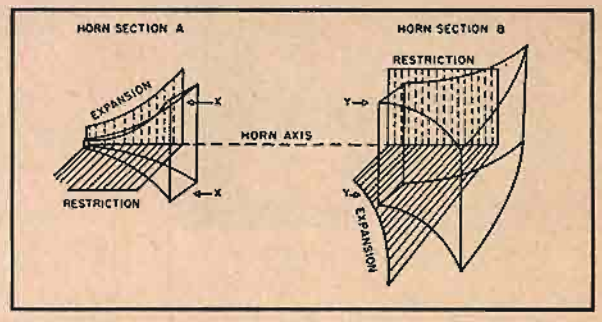


Fig. 5. Flare reversal of the horn walls turns the direction of the wave-front expansion from vertical to horizontal.

Such a desired pressure reversal may be accomplished by restricting the flare of the upper and lower walls which have been expanding, simultaneously flaring

out the vertical walls which up to now have not been flared. This will permit the side thrust pressures which have been built up against these vertical walls, to suddenly burst out of their restraining shell, so to speak, and to be impelled actively along the direction of the new flare. This action is illustrated in *Fig.* 5. In Section *A* of the horn all the wave expansion is in the vertical direction, with wave restriction in the horizontal direction. At these restraining walls there is a resultant boundary of increased pressure. After section X-X, Y-Y, the portion of the horn indicated as *B* now flares rapidly in the horizontal direction, while in the vertical direction there is practically no flare. Because the wave front can no longer expand vertically, pressure will be built up against these upper and lower walls. On the other hand, since the wave is allowed to expand horizontally, the pressure will dissipate itself over the horizontal angle. Thus, the pressure reversal has been accomplished.

Because of this pressure reversal, the dispersion gain in the horizontal direction is two-fold. The first element of gain obtains from the manner that the *B* section of the horn is energized. It is quite permissible to consider section Y-Y as being the throat for a new horn *B*, and that the sound source which feeds this horn to be the mouth X-X of horn *A*. This new sound source X-X is one in which the driving pressure is greatest in the direction of ultimate dispersion, that is, in the horizontal direction. Thus the sound source is "matched" on a pressure configuration basis to the shape of the horn which is to disperse that pressure. Increased pressure dispersion is thus obtained as compared with the case where the throat of the horn is fed from a source of symmetrical pressure distribution.

The second element of gain stems from the much greater flare possible near the mouth of the horn, where it counts most. By allowing but little horizontal expansion prior to the point of pressure reversal, and suddenly limiting the vertical expansion severely after the point of expansion, it becomes possible

thereafter to throw all the desired exponential expansion into the horizontal direction near the mouth end of the horn. As a result of this terminal expansion, the horn will expand much faster in the horizontal direction than would be the case if the horizontal expansion were to have started back at the original horn throat. The end effect of this faster physical flare for the new short horn section is an increased dispersion angle for the high frequencies.

Having thus accomplished wide-angle dispersion of the radiated sound into the horizontal direction by means of flare control, one additional step may be taken to prevent undue dispersion or diffraction effects into the vertical direction. Such control may be obtained in two ways. Just as low flare will produce relatively narrow dispersion, so a large mouth will reduce diffraction. We already have a slow flare in the vertical direction because of the vertical flare restriction near the mouth of the horn. Consequently, half the problem of restricting the vertical dispersion is already taken care of. The second controlling factor, that of mouth size in the vertical direction, may be obtained if that dimension is permitted to become at least one-third of the wavelength of the lowest frequency to be radiated.

Such a condition is accomplished in these reverse-flare horns by locating the point of flare reversal where the vertical dimension is close to the desired vertical mouth height, and from this point on providing but slight vertical expansion. By such dimensional manipulation it is possible to terminate the horn in a square horn mouth, the vertical height of which is sufficiently large to reduce diffraction in the vertical plane to a minimum.

The end result of this flare reversal may be summed up as follows: The mouth end of the horn is transformed into a much faster flare in the horizontal direction; the pressure configuration within the horn is altered to match the flare distribution; the vertical mouth size is proportioned to provide minimum diffraction and dispersion. This three-way attack on the problem of high-frequency distribution produces a family of horns which exhibit a high degree of dispersion efficiency.

Book Review

HANDBOOK OF ENGINEERING FUNDAMENTALS, Second Edition, edited by Ovid W. Eshbach. 1270 + x + 52 pages, $10.00. New York: John Wiley & Sons, 1952.

Æ readers may well wonder why a review of this 1332-page mine of information should find its way into the columns of their magazine. Little may they realize that nine of the 14 sections into which this book is divided have direct application upon their work.

Commencing with a formulary of mathematical and physical data, the treatment proceeds with a section on mathematics, followed by one on physical units and standards wherein are capably covered the dimensional system as it applies to electrical and physical units and mensuration systems. Then follow sections on the mechanics of rigid and deformable bodies, fluids, aerodynamics, and thermodynamics, electricity, radiation (covering light and acoustics), chemistry, metallic and nonmetallic materials, and finally a most excellently presented discourse on engineering law completes the book, which is made easy to use by the 52-page index.

Much of the material has appeared in print before, both in the first edition of this book and in some other engineering texts, but the staff of experts under Mr. Eshbach's able guidance has done an outstanding job of revising it and making the data current. The mathematical treatment will be of great use to those who have forgotten some of the finer points learned in their school days, and to the engineer called upon to do some work in fields apart from his daily activities this text will lend a welcome helping hand. Coverage of such subjects as the radiation theories of light and sound, acoustic absorption and reflection, will come in handily in studio design as will those pages dealing with air conditioning, heating, and ventilation.

This is not a complete text, but it is certainly an adequate handbook—as such it well fulfills its mission. I would have preferred to see the use of continuous pagination rather than that used—namely, each section receiving its own series of numbers, but this is a minor criticism. To those who wish to augment their present libraries with a single volume embracing the broad aspect of engineering fundamentals for reference and daily use, this Handbook is well worth the cost and space it occupies.

—*L. B. Keim*

AUDIO FAIR

(*from page 32*)

Entering the Fair for the first time, **Pilot Radio Corporation** gave graphic evidence of the reasons for its ascension to a position of leadership in the audio industry within the space of one short year. Obvious to the high-fidelity hobbyist and audio engineer were the excellent design and performance features of the new Pilotuner and Pilot amplifiers—just as obvious to contemporaries and competitors was the adroit sales management of **Adolph Gross**, long known as one of the country's more astute merchandisers of electronic equipment.

From out Chicago way came **Precision Electronics, Inc.**, with a thoroughly interesting display of the company's well-known Grommes amplifiers. The Grommes Model 50PG, incidentally, is probably the country's top seller in its price bracket. Although remarkably performing were the Grommes amplifiers, equally impressive to this observer was the youthfulness of Precision's president, personable Bill Grommes. He, along with another Bill—Shrader of Washington—and Norman Pickering of Pickering and Company, are great morale builders because they make the rest of us old-timers in the audio industry feel that—perhaps, after all—we do have an oat or two left.

Presto Recording Corporation, not too long ago known alone for its disc recording equipment, gave solid evidence that today its eminence in the tape recording field is just as pronounced. A thoroughly satisfying exhibit of fine recording equipment—both disc and tape—which meets highest professional standards.

The long-awaited Model 300 equalizer-preamplifier was the highlight of **The Radio Craftsmen, Inc.**, exhibit. Sharing honors was the new Model C-800 AM-FM tuner. John Cashman, president of Radio Craftsmen, Inc., is doing the audio industry a great service with a national advertising campaign designed to show the many advantages of high fidelity for the average home. The first of these ads, a two-page spread in the December issue of "House and Garden," features a statement by Deems Taylor, noted composer and critic. Would that more manufacturers emulated this gesture, by stressing the advantages of high fidelity in general, along with advertising the merits of their own products.

The pride of Col. R. H. Ranger was more than justified as he demonstrated the newest models of Rangertone tape recorders. As president of **Rangertone, Inc.**, his is the guidance which has brought to the audio world a line of tape recording equipment which is unexcelled in the precision of its construction and the perfection of its performance. Strictly professional items, the Rangertone recorders are supreme examples of quality without compromise.

Diversity and expansion have been the year's keynote for **Reeves Soundcraft Corporation**—diversity in the sense that Magnastripe, the Reeves-developed motion picture film on which is placed an oxide strip for magnetic recording, is receiving increased sales effort, and expansion in the sense that sales of all Reeves products are on the upgrade. This exhibit tastefully displayed Magnastripe, as well as Soundcraft recording discs and tape—the overall emphasis being on the care and precision with which Reeves products are manufactured.

Even in an impersonal evaluation of exhibits, such as this is supposed to be, perspective demands that tribute be paid certain personalities who have done their share and more toward creating national consciousness of high fidelity and the wealth of enjoyment it affords the American home. And so it is that we mention here the name of George Silber, president, **The Rek-O-Kut Company**, who as host in his firm's exhibit, never let up on the fight he pioneered to make the nation high-quality-audio conscious. It goes without saying that the showing of Rek-O-Kut turntables, disc recorders, and portable record players, was in keeping with the enviable reputation the company commands throughout the audio world.

Making its initial bow before an Audio Fair audience, **Revere Camera Company** created great interest with a complete showing of tape recorders suited essentially for adding sound to home movies. Special attention was accorded the new Model T-10, a moderate-priced unit which closely approximates the performance of many professional recorders. Among unique features of the T-10 is a built-in index counter which affords quick location of any desired portion of a recorded reel.

Another Fair newcomer was **River Edge Industries**, River Edge, N. J. In every respect the River Edge display reflected the firm's advertising theme—"Audio's Finest Cabinetry." Formerly devoted entirely to the manufacture of TV cabinets, River Edge today is one of the country's major suppliers of fine enclosures for home music systems.

An introductory showing of the British-made Collaro record changer was featured in the display of **Rockbar Corporation**, Collaro's American distributor. Various models were arranged over mirrors, thus permitting visitors to inspect each changer through a complete playing cycle, and see for themselves the manner in which the Collaro operates.

Both professional and home equipment came in for just share of attention in the exhibit of **Hermon Hosmer Scott, Inc.** Audio and acoustical engineers gathered around the famous Scott Sound Level Meters and the new Type 140-A Decade amplifier, while music lovers found substantial interest in the various Scott amplifiers for home music systems. At the risk of being repetitious we are going to quote from last year's Audio Fair Review in which was expressed the thought that "the new Scott amplifiers are exceptional in the scope of equalization they provide for all types of recordings."

Probably the Fair's most varied display of tape recording equipment was that offered by **Sonocraft Corporation**, New York. Justified was the company's reputation as one of the country's leading distributors of tape recorders to home and industry, with particular emphasis on its representation among schools, colleges, and institutions. Sonocraft made many new friends through the graciousness of its competent and likeable president Herbert H. Borchardt.

"Packaged High Fidelity" was the theme around which was built the exhibit of **The Sound Workshop**, a new company recently formed by Electronic Workshop Sales Corporation, New York, and G & H Wood Products Company, Brooklyn. Introduced were completely-assembled high-fidelity home music systems which compete in price with conventional radio-phonographs.

Excellent loudspeakers in tastefully designed enclosures—in a nutshell that's how we can summarize the exhibit of **Stephens Manufacturing Company**. At least that's the story from the music lover's viewpoint. For the audio pros there was the Stephens "wireless microphone"—the little gadget which permits TV and stage performers complete freedom of movement, and the studio-model Stephens coudenser microphone for high-quality recording.

Among the more newsworthy of the Fair's exhibits was that of the **Stromberg-Carlson Company**. Here was shown the complete line of amplifiers, speakers and tuners introduced by a major manufacturer as a mark of recognition to the growing importance of the market for high-quality audio equipment. No stranger to the high-fidelity field, Stromberg years ago held a position of unquestioned leadership. Until recently, however, the company's sound division has concentrated its production in public-address and industrial sound equipment. The superb performance of the new Stromberg units, developed under the able direction of chief engineer Frank Slaymaker, proves once more the truth in the adage "old masters never lose their touch."

Striking custom-built cabinetry shared attention with a lavish showing of equipment in the suite occupied by **Sun Radio & Electronics Company**, New York. As if that weren't enough to assure a constantly-filled exhibit, Sun took no chances and provided its own crowd as well—the official program listing eighteen of the company's personnel as being in attendance. Thanks to an impressive display, the precaution proved unnecessary—the SRO sign being in constant evidence.

Visitors to the **tapeMaster, inc.**, suite were treated to a preview of a newly developed wide-range tape recorder which will make its appearance in dealers' showrooms as quickly as production can be established. It was this reporter's good fortune to hear the new tapeMaster model in competitive tests with recorders covering all price ranges—and herewith is presented the consensus of one opinion that tapeMaster is coming up with a sure-fire winner.

In its initial Fair participation, Germany's **Telefunken Company** made news with an inclusive display of radio receivers, amplifiers, speakers, and, of course, the noted Telefunken condenser microphone. Long known as a world pioneer in the science of sound, Telefunken exhibited equipment well in keeping with the company's brilliant reputation.

As a result of visiting the **Terminal Radio Corporation** suite shortly prior to the Fair's official opening, this observer finds himself in possession of the first distributed copy of what is by all odds the largest and most complete catalog ever devoted solely to audio equipment. Whether you be amateur or pro, music lover or recording engineer,—no matter if you need an intercom system or an intermodulation meter—you are certain to find it in this new Terminal catalog. Messers. Filler, Miller, Simon et al are to be thoroughly congratulated on an unusual accomplishment. Terminal's equipment display gave feature billing to the new Travis Tapak portable tape recorder.

The record changer to end all record changers was observed in the exhibit of Switzerland's **Thorens Company**. Along with standard models which play records in the usually prescribed manner, there was demonstrated a two-motored unit which, in addition to intermixing, will follow almost any desired sequence. Thorens, you may recall, manufactured the changer which was used in the RCA Westminster series of radio-phonographs which were marketed several years ago.

Lone tube manufacturer to exhibit at the Fair was **Tung-Sol Electric, Inc.**, whose Type 5881 is just about the hottest thing you can get in output tubes. Many visitors (present company not excepted) left the Tung-Sol suite considerably better informed on the subject of tube design as a result of discussion with the firm's engineers.

Ultrasonic Corporation, manufacturers of the small corner-speaker assembly designed by Drs. Baruch and Lang of M. I. T., offered demonstrations designed to verify for listeners the remarkable measurements of the unit made in the M. I. T. lab. According to an interview with the inventors which appeared in the New York Times, M. I. T. measurements of the speaker are claimed to prove its ability to reproduce fundamentals as low as 40 cps, although it occupies a space of only 2½ cu. ft.

A new 20-watt version of the famous Williamson amplifier was featured in the exhibit of **United Transformer Company**. Quite naturally, it contained UTC transformers as did the 10-watt Williamson with which it was compared. In addition to completed amplifiers, there was displayed an impressive selection of UTC transformers for most every conceivable audio application.

Along with the hi-fi speakers for which the company is justly noted, **University Loudspeakers, Inc.**, introduced a new line of speaker enclosures designed to complement both period and modern furnishings. With the introduction of the new cabinets, University becomes one of the country's leading suppliers of complete speaker assemblies as well as individual components.

Visitors to the suite occupied by **V-M Corporation** were rewarded by a display of record changers of most every size and type. Popular in exhibit, as it is in sales, was the V-M changer with the "Siesta Switch"—an automatic means of turning off an entire music system at the conclusion of the final record on the changer.

There's no better example of recent growth in the audio industry than that afforded by **Waveforms, Inc.**, whose display included the high-quality amplifier and miniature audio oscillator for which the company originally became noted, as well as a number of new test instruments which have been developed within the past year.

New impetus was given sales of the Weathers FM pickup with a dramatic demonstration which emphasized the virtual absence of record wear due to the unit's 1-gram playing pressure. Conducted by company president Paul Weathers, the **Weathers Industries** exhibit was both effective and authoritative.

Webster-Chicago Corporation, in its initial Fair participation, displayed the firm's entire line of Webcor tape recorders, wire recorders, portable phonographs, and record changers. Pioneer in the science of wire recording, Webcor retains a position of industry leadership—well evidenced by the sales records being racked up by the Model 235 office dictation machine.

Industry Notes--

AUDIO FAIR AFTERMATH . . . Amazing, the large number of Chicagoans, both observers and exhibitors who were seen parading up and down New Yorker corridors—to wit, . . . **Chet Wharfield,** director, Allied Radio Corporation sound department, who came to the Big City a couple of days before the Fair opened in order to visit jobber-friends . . . **John Margolin,** sales manager, tapeMaster, inc., who also made advance appearance to acquaint distributors with new wide-range tape recorder for home music systems . . . **Bill Grommes,** president, Precision Electronics, Inc., who surprised New York correspondents with his youthfulness . . . **Maurice Meshboum,** prominent Windy City artist and true dyed-in-the-wool audio hobbyist, who came to town to listen, listened, and left with binaural bees buzzing in his bonnet.

John Boyers, Spec Barker, and Dick McQueen, all Magnecord, Inc., officials who were just about the busiest boys in town while arranging the binaural broadcasts on WQXR and associated FM Network . . . **Karl Kramer** of Jensen Manufacturing Company, who did his usual excellent job of selling the assembled multitude on the many virtues of Triaxial and Triplex. . . . In other words, you could have called a meeting of the Windy City's audio leaders at any time, with little fear of not having a quorum.

N. Y. C. FAIR HIGHLIGHTS . . . Larry Epstein, president, University Loudspeakers, Inc., beaming with full justification over impressive appearance of company's new speaker enclosures—enthusiasm shared by **Walter Godfrey** whose River Edge Industries organization is handling the production chores . . . **Fred L. Cunow,** sales manager for Telefunken products in the U. S., reports greatly stimulated interest in the firm's condenser microphone as result of showing at The Fair . . . **Dave Ruark,** new ad manager for Audio & Video Products Corporation, reverted to type (he's an ex-announcer) and narrated the demonstration tape for Ampex stereophonic sound—so far has been recognized by only 98 per cent of his friends . . . **Lew Goodfriend,** one of the nation's more brilliant audio engineers, kept hopping by multi-duties—holding down a job, manning a Fair exhibit, and delivering technical paper before AES Conventions. . . . **Ken Boothe,** director of Audio-Video's Instrumentation Division elated at new business originating at the Fair.

FAIR HIGHLIGHTS FROM CITIES HERE AND YON . . . A. A. Ward, executive vice-president, Altec Lansing Corporation, Hollywood, gave what was probably the Fair's most informal interview to **Gene Smith,** feature writer for the New York Herald Tribune—standing squarely between the sixth-floor elevators and the registration desks; others who participated in the same article—although under less trying circumstances—were **Tony Schifino** of Stromberg-Carlson, **Tom Nicholson** of General Electric, and **Leonard Carduner** of British Industries Corporation . . . **Frank McIntosh** and friend-competitor **Lincoln Walsh,** designers and manufacturers of the McIntosh and Brook amplifiers, respectively, surprised Fair visitors (and each other) when each introduced a new corner speaker. . . . **Larry LeKashman** of Electro-Voice, Inc., Buchanan, Mich., used most effective means of introducing firm's new Lavalier microphone—wore one throughout the show.

MISCELLANY . . . Genial **Ed Cornfield** has joined sales staff of Adolph L. Gross Associates, Inc., New York factory reps—a nicer guy never lived . . . **Edward H. Gillette,** executive veepee of Allied Control Company, Inc., announces appointment of **H. A. Yates** as head of newly-formed new products division . . . **Major General Edmond H. Leavey,** U.S.A. (Retired), is newest veepee of I. T. and T. . . . **Edward A. Malling** has been appointed manager of marketing for Components Department of General Electric Company . . . **William W. Dean** at one time contributor to columns of Æ, has been appointed director of engineering of the Langevin Manufacturing Corporation . . . **Dr. Martin L. Klein,** former member of University of Pennsylvania and Stanford University faculties, is new addition to the engineering staff of Stancil-Hoffman Corporation . . . **George I. Long,** general manager of Ampex Electric Corporation, Redwood City, Calif., announces promotion of **Harrison Johnston** to general sales manager . . . **Dr. David B. Parkinson** is new production engineering head of Brush Development Company . . . **John Jacks** has joined sales staff in sound department of Chicago's Newark Electric Company—will assist **Carl James,** who heads up Newark's audio activities.

Audio Engineering—1952

SUBJECT INDEX

OVER 90% of the TRANSMISSION MEASURING SETS Used Today Are Made by DAVEN

Not only is the Daven Company the largest supplier of transmission measuring sets, but it is also a source for every needed type of instrument for the measurement of the transmission characteristics of communication systems. It furnishes units to check all types of broadcast equipment and audio devices for commercial and industrial use as well as for organizations such as utilities, telephone and power companies. Therefore, whatever your requirements are in this field, write to Daven for complete catalog material, and outline your own particular problems for specific assistance from our engineering staff.

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The Type 12A Transmission Measuring or Gain Set is an AC operated rack mounted instrument designed for the measurement of voice transmission systems.

The oscillator consists of a 1000 cycle low distortion feed back type R-C oscillator and buffer and associated power amplifier. The output impedance is 600 ohms resistive. The output level is +10 to −35 Db.

The Receive Section consists of a high gain, wide range amplifier with two balanced inputs. The range of the amplifier is variable from +20 to −80 Db by utilizing the meter scale.

DAVEN TRANSMISSION MEASURING SET 11A

A moderately priced instrument for broadcast equipment. A simplified, accurate, direct reading instrument, designed to make measurements in accordance with FCC regulations.

FREQUENCY RANGE: 20 CY to 20 Kc.
ACCURACY: ±0.1 db, 20 CY to 20 Kc.
RANGE OF LEVEL:
+ 4 to −110 db
−10 to −124 db
in steps of 0.1 db.

APPLICATIONS:
(a) Audio gain and loss measurements.
(b) Measurements of matching and bridging devices.
(c) Complex circuit measurements.
(d) Measuring mismatch loss.
(e) Frequency response measurements.

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UTC Linear Standard Audio Transformers represent the closest approach to the ideal component from the standpoint of uniform frequency response, low wave form distortion, high efficiency, thorough shielding and utmost dependability.

UTC Linear Standard Transformers feature . . .

- **True Hum Balancing Coil Structure** . . . maximum neutralization of stray fields.
- **Balanced Variable Impedance Line** . . permits highest fidelity on every tap of a universal unit . . . no line reflections or transverse coupling.
- **Reversible Mounting** . . . permits above chassis or sub-chassis wiring.
- **Alloy Shields** . . . maximum shielding from inductive pickup.
- **Hiperm-Alloy** . . . a stable, high permeability nickel-iron core material.
- **Semi-Toroidal Multiple Coil Structure** . . . minimum distributed capacity and leakage reactance.
- **Precision Winding** . . . accuracy of winding .1%, perfect balance of inductance and capacity; exact impedance reflection.
- **High Fidelity** . . UTC Linear Standard Transformers are the *only* audio units with a *guaranteed* uniform response of ± 1 DB from 20-20,000 cycles.

TYPICAL LS LOW LEVEL TRANSFORMERS

Type No.	Application	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	Relative hum-pickup reduction	Max. Unbalanced DC in prim'y	List Price
LS-10	Low impedance mike, pickup, or multiple line to grid	50, 125, 200, 250, 333, 500/600 ohms	60,000 ohms in two sections	20-20,000	+15 DB	—74 DB	5 MA	$25.00
LS-10X	As Above	As above	50,000 ohms	20-20,000	+14 DB	—92 DB	5 MA	35.00
LS-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125, 200, 250, 333, 500/600 ohms	120,000 ohms overall, in two sections	20-20,000	+15 DB	—74 DB	5 MA	28.00
LS-12X	As above	As above	80,000 ohms overall, in two sections	20-20,000	+14 DB	—92 DB	5 MA	35.00
LS-26	Bridging line to single or push pull grids	5,000 ohms	60,000 ohms in two sections	15-20,000	+20 DB	—74 DB	0 MA	30.00
LS-19	Single plate to push pull grids like 2A3, 6L6, 300A. Split secondary	15,000 ohms	95,000 ohms; 1.25:1 each side	20-20,000	+17 DB	—50 DB	0 MA	26.00
LS-21	Single plate to push pull grids. Split primary and secondary	15,000 ohms	135,000 ohms; turn ratio 3:1 overall	20-20,000	+14 DB	—74 DB	0 MA	26.00
LS-22	Push pull plates to push pull grids. Split primary and secondary	30,000 ohms plate to plate	80,000 ohms; turn ratio 1.6:1 overall	20-20,000	+26 DB	—50 DB	.25 MA	32.00
LS-30	Mixing, low impedance mike, pickup, or multiple line to multiple line	50, 125, 200, 250, 333, 500/600 ohms	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+17 DB	—74 DB	5 MA	26.00
LS-30X	As above	As above	As above	20-20,000	+15 DB	—92 DB	3 MA	32.00
LS-27	Single plate to multiple line	15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	30-12,000 cycles	+20 DB	—74 DB	8 MA	26.00
LS-50	Single plate to multiple line	15,000 ohms	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+17 DB	—74 DB	0 MA	26.00
LS-51	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125, 200, 250, 333, 500/600 ohms	20-20,000	+20 DB	—74 DB	1 MA	28.00
LS-141	Three sets of balanced windings for hybrid service, centertapped	500/600 ohms	500/600 ohms	30-12,000	+10 DB	—74 DB	0 MA	30.00

TYPICAL LS OUTPUT TRANSFORMERS

Type No.	Primary will match following typical tubes	Primary Impedance	Secondary Impedance	±1 db from	Max. Level	List Price
LS-52	Push pull 845, 250, 6V6, 42 or 2A5 A prime	8,000 ohms	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	15 watts	$35.00
LS-55	Push pull 2A3's, 6A5G's, 300A's, 275A's, 6A3's, 6L6's	5,000 ohms plate to plate and 3,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	35.00
LS-57	Same as above	5,000 ohms plate to plate and 3,000 ohms plate to plate	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	20 watts	25.00
LS-58	Push pull parallel 2A3's, 6A5G's, 300A's, 6A3's	2,500 ohms plate to plate and 1,500 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	40 watts	50.00
LS-6L1	Push pull 6L6's self bias	9,000 ohms plate to plate	500, 333, 250, 200, 125, 50, 30, 20, 15, 10, 7.5, 5, 2.5, 1.2	25-20,000	30 watts	50.00

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