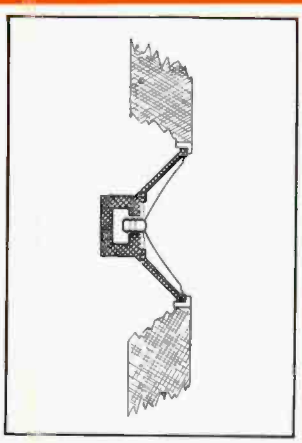
AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

JUNE, 1956

50¢



For the right way to mount a speaker in a wall—and much other useful speaker information—see page 34.

The serious hobbyist who makes his own disc recordings has long envied his professional counterpart in the availability of "hot stylus" equipment—admittedly costly, but most necessary for top-quality results. How one reader made his own is described on page 24.

COMPRESSION AND EQUALIZATION IN SOUND MOVIES

INPUT TRANSFORMER DESIGN

THE DIFFAXIAL SPEAKER

Record Revue —— Audioclinic —— Jazz by Jean

THE STANDARD OF COMPARISON FOR OVER 20 YEARS

HIGH FIDELITY TRANSFORMERS

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

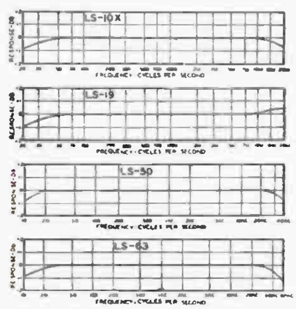
TYPICAL UNITS

LINEAR STANDARD series

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

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

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

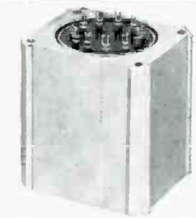


LS-10X Shielded Input
Multiple line (50, 200, 250, 500/600, etc.) to 50,000 ohms . . . multiple shielded.

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

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

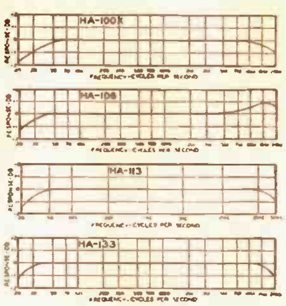
LS-63 P.P. Plates to Voice Coil
Primary 10,000 C.T. and 6,000 C.T. suited to Williamson, MLF, ul.-linear circuits. Secondary 1.2, 2.5, 5, 7.5, 10, 15, 20, 30 ohms. 20 watts.



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

HIPERMALLOY series

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



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

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

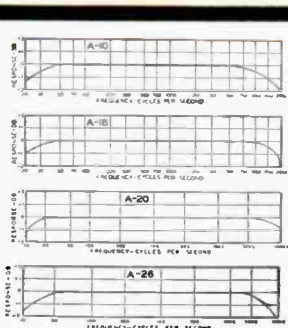
HA-113 Plate to Line
15,000 ohms to multiple line . . . +12 db. level . . . 0 DC in primary.

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

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

ULTRA COMPACT series

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



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

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

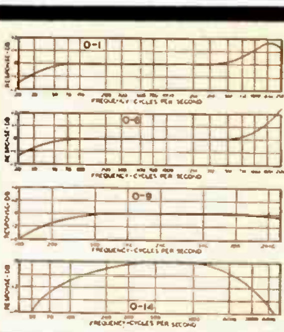
A-20 Mixing Transformer
Multiple line to multiple line for mixing mikes, lines, etc.

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

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

OUNCER series

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



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

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

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

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

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

SPECIAL UNITS TO YOUR NEEDS

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

UNITED TRANSFORMER CO.

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THE BRITISH INDUSTRIES

Sounding Board

Now

5 Garrard Record Players

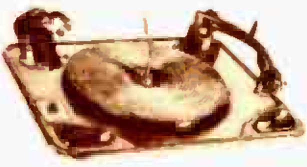
each the world's finest

Why?

The reason is simply that people's needs in record playing equipment vary considerably. Even assuming that all models of a line are made with the same eye to superlative quality, there are still differences in budget, variations in the physical setup of a music system, the user's own attitude toward features vs. price, and his personal ability to hear and appreciate the subtle variations in performance brought out by different record-playing units.
Therefore, Garrard now makes the following 5 models, intended to satisfy the requirements of every high fidelity system.

Model 301 . . . "The Professional" Transcription Turntable:

This is the turntable used by Mr. G. A. Briggs, at Carnegie Hall last October. Readers of Audio Magazine will recall that stock models of this $89.00 turntable, recently tested by an independent laboratory (Audio Instrument Co., Inc.), under the personal direction of Mr. C. J. LeBel, performed even better than most professional disc-recording turntables. Mr. LeBel's full report was given in this magazine (May issue), and we will gladly send you a copy of the report. However, Mr. LeBel is not the only expert who has checked the Model 301 and found it outstanding. Garrard puts this turntable through the most exhaustive performance test procedure ever devised by a phonograph manufacturer . . . and accurate measurements of speed, wow, flutter, rumble, flash and insulation are contained in an individual inspection card, enclosed with each machine, and *referring to that turntable only.* We know of no other turntable which is so supported by documentary evidence of its fineness.



RC98 . . . "Crown II" Super Auto-Manual Record Changer:

New ideas come and go, but basic engineering advancements have a tendency to long life. This $67.50 unit is our highest priced record changer, yet it retains some of the basic features which Garrard pioneered as long as 20 years ago and which have never been surpassed. These include the pusher platform — bent spindle combination, still the only device insuring gentle handling of all records. In addition, the RC98 provides a veritable galaxy of innovations. An exclusive feature . . . rheostat-controlled continuously variable + or — wide range adjustment of each speed, "tunes" the changer to the pitch or key of a musical instrument. If you have "perfect pitch," you may be able to perceive even the slightest variations in the music, and you need

The Sounding Board

— cut along dotted line and save —

The Sounding Board

this special RC98 feature to keep all your records true to the original performance. Another important RC98 feature (now found on all Garrard changers) is a full-manual position which gives this automatic changer the added versatility of a first-line single-play manual turntable.

RC88 . . . "Triumph II" Deluxe Auto-Manual Record Changer:

Most high fidelity enthusiasts regard our previous "Triumph" model, the RC80, as the dean of high fidelity record changers. This machine set the standard of the field for six years. Now the RC80 has been superseded by the new RC88, which nets for $54.50. You can incorporate the RC88 into your system, knowing that it offers you features tested in thousands of homes and literally millions of playing hours. Besides the pusher platform, the RC88 has the all-Garrard-built Induction Surge 4-pole shaded motor — smoothest, quietest, most powerful and up-to-date type available today. This motor will cause no hum, even when used with sensitive pickups. It will run tirelessly and effortlessly year after year. And — the main operating part of the motor, the rotor, is super-finished and individually weighted by exclusive Garrard equipment . . . for quiet, perfect speed. The RC88, RC98 and RC121, are driven by a new-type true-turret drive with all speeds operating directly off the motor on a single turret. This provides excellent results, without belts.

RC121 . . . "Renown" Auto-Manual Mixer Changer:

This fine unit is the first Garrard Record Changer to be made with the straight spindle — overarm arrangement of the style you will find in many record changers. But here any resemblance to ordinary units stops. The RC121 is a mighty little machine and a true-Garrard changer. It is the most compact, most economical automatic changer ever presented by Garrard. It nets for $42.50 and fits into any cabinet area suitable for a record changer. This makes it your ideal replacement unit for old-fashioned changers of other makes which fit into smaller areas than could accommodate previous Garrard models. At the same time, despite its compact size, the RC121 offers almost every important Garrard feature, and some of its own. It has the same full manual position, the same type of motor, the same aluminum, true-tangent tone arm, heavy steel unit plate, and inch-high turntable. It comes fully wired, ready to plug in and play. A special feature . . . Simpli-Mix Operation, permits the RC121 to operate automatically on records of varying diameters, which may be stacked together.

Model T "Crest" Manual Record Player:

If yours is a budget system, and you do not need record changing features, the Model T will give you all the performance of the famed RC80 record changer, at the very low net price of $32.50. It is basically an RC80, with the record-changing mechanism left off. If you have been checking the budget system recommendations of experts during the past few years, you will have noticed how many times this unit has been endorsed.

We cannot go into greater detail here on the relative merits of the various Garrard units. However, we do have a special series of Product Analysis Sheets, covering each Garrard player. Request these sheets for your own comparison. The coupon below will bring them to you, with a copy of the B.I.C. High Fidelity Plan Book, which illustrates all Garrard and other Quality-Endorsed products of the B.I.C. Group.

Sincerely yours,

Leonard Carduner

President

British Industries Corporation   Dept. GF-16
Port Washington, N. Y.

Please send BIC Hi Fi Plan Book, and the following Garrard Product Analysis Sheets:

- ☐ 301
- ☐ RC98
- ☐ RC88
- ☐ RC121
- ☐ Model "T"

Name ____________________

Address ____________________

City ____________ State ________

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AUDIO

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London Letter

RICHARD ARBIB*

Britain's First Audio Show

Hundreds of people queuing in the street in drenching rain in order to enter the hotel, to queue on the stairs to wait, to queue along a corridor to get into one of the many demonstration rooms, was a characteristic which signified that London's first Audio Show was an undoubted success.

Held at the fashionable Washington Hotel in Curzon Street, this was the first of Britain's Audio Shows, patterned upon those only too familiar in U.S.A. The crowds were so great that no accurate figures of attendance were kept. It has been variously estimated that between 15,000 and 25,000 people crammed the hotel during the three days the Show was open. Your correspondent had such difficulty in forcing his way through the crowds that he was only able to hear personally a few of the demonstrations.

A feature of the Show different to the American ones was that the dining room and main lounge of the hotel had been converted into small exhibition halls. Each of the 40-odd exhibitors had a small booth in which his wares were displayed. This was a great advantage because visitors who managed to force their way around these booths were able to see relatively quickly all the new items of Audio equipment which were on show. Each exhibitor had one or more rooms in the three floors of the hotel which were devoted to the sound demonstrations.

The following were probably the most outstanding new items of interest and they are mentioned in alphabetical order.

The Acoustical Manufacturing Company's constant-charge electrostatic loudspeaker had its first public demonstration. Attractively designed, the speaker has the appearance of an open baffle, *Fig.* 1, the size being only 33″ × 25″ × 3″. The polarising supply is incorporated in the base of the unit and it is claimed that the response covers the whole audio range and will produce a level of approximately 95 phons in an average living room. It has a figure-of-eight distribution independent of frequency. Rumour has it that Williamson, of amplifier fame, co-operated with P. J. Walker, Acoustical Manufacturing's Managing Director, in the design of this unit which undoubtedly was one of the big attractions at the Show.

The great E.M.I. organization has en-

* *Multicore Solders Ltd., Hemel Hempstead, Hants, England.*

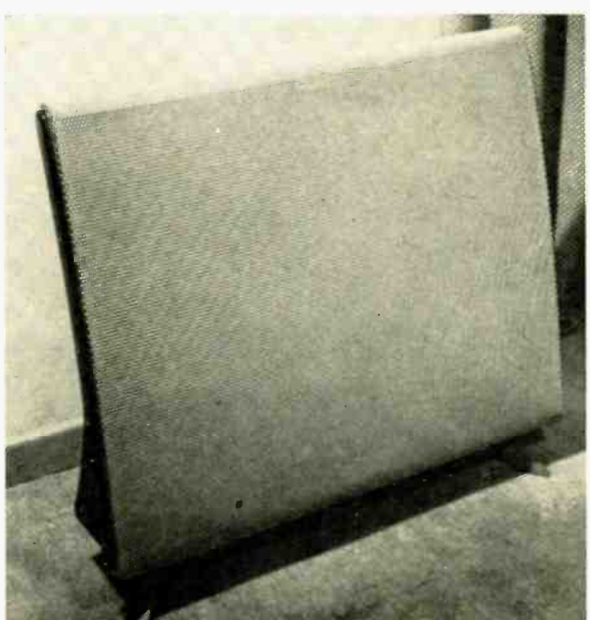
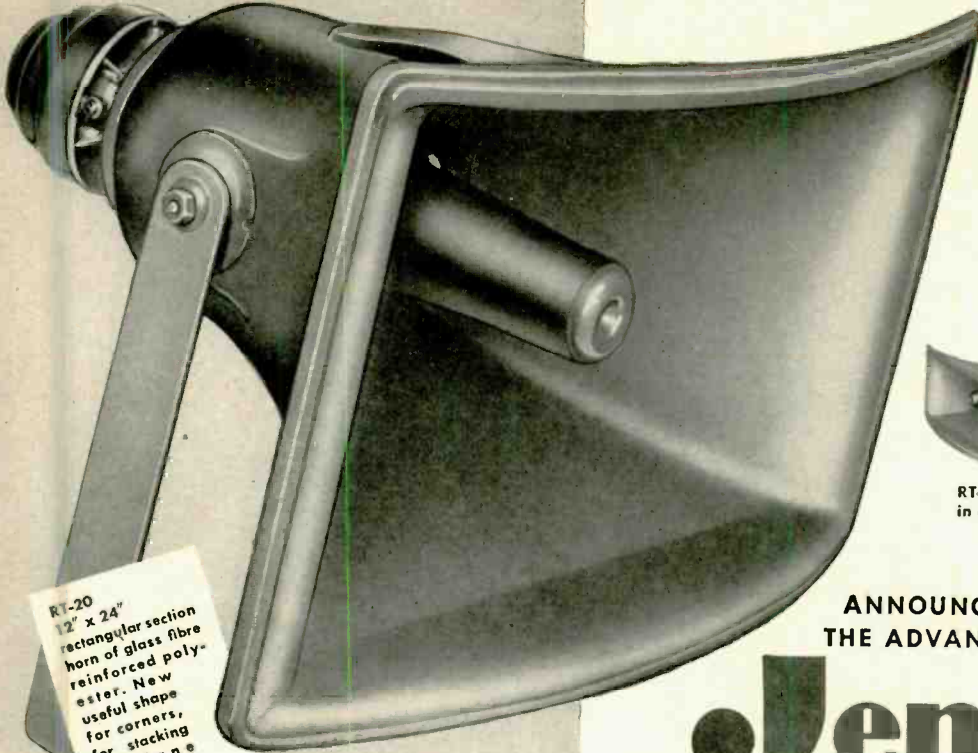


Fig. 1. The Acoustical electrostatic loudspeaker is claimed to cover the audio range provided by the Quad II amplifier.



RT-20's
in plane array

RT-20's
in circular array

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Three years of product design and a background of nearly 30 years of field experience and manufacturing know-how come to you in Jensen Professional Series loudspeakers. We can't begin to illustrate or describe all the items here—nor tell you about all the new features for convenience and performance which we've built into them. Catalog 1070 tells the whole story, including valuable information on sound system design. Send for your free copy today.

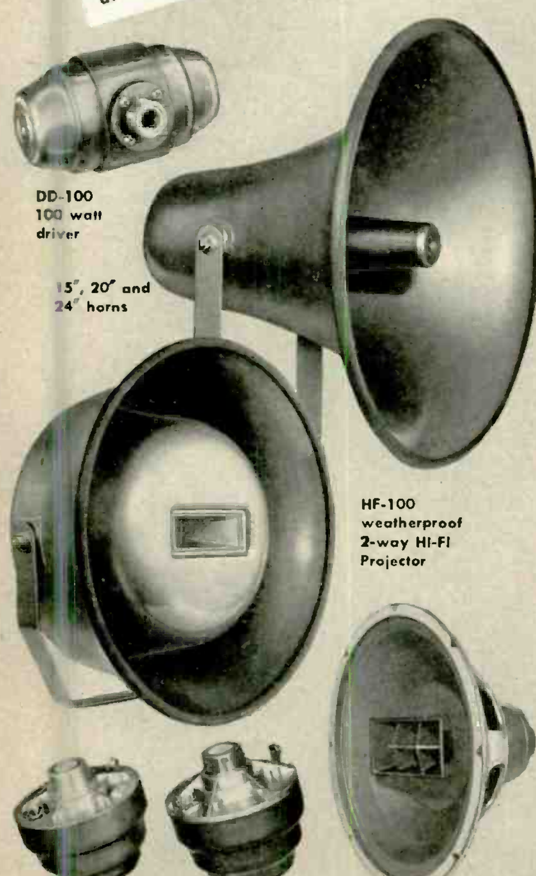

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Fig. 2. The Ionophone D-15 loudspeaker made in England by Plessey. The unit shown contains the r.f. oscillator and the speaker "mechanism" itself which has no moving parts.

tered the high fidelity market with a packaged system including what is called an Emisonic loudspeaker combination embodying six specially designed speaker units, three for the bass and two for the middle register, with an electrostatic ribbon transducer on the front of the cabinet for the extreme top. The loudspeaker cabinet of massive design, incorporates an 18-watt power amplifier and is connected by 25 ft. of cable to what must be one of the largest preamplifiers which high fidelity enthusiasts have ever seen.

A feature of the Goodmans Industries exhibit was their Acoustical Resistance Unit which is a device to enable high-quality reproduction to be obtained with a comparatively small size of cabinet. These units are sold so that they can be incorporated by the user in cabinets of approved design. Goodmans were also demonstrating an experimental full-range electrostatic unit. G.E.C. were reproducing records through their metal cone speaker.

Another loudspeaker attraction which had constant queues of enthusiasts awaiting to enter the room was Harold Leak's demonstration of his latest combination of electrostatic and moving coil units. The treble electrostatic section incorporates its own polarising supply and cross-over network whilst the bass response is provided by an entirely new type of moving-coil loudspeaker designed by Leak and mounted in one of the large B.B.C. type cabinets used by the corporation in all their studios and control rooms.

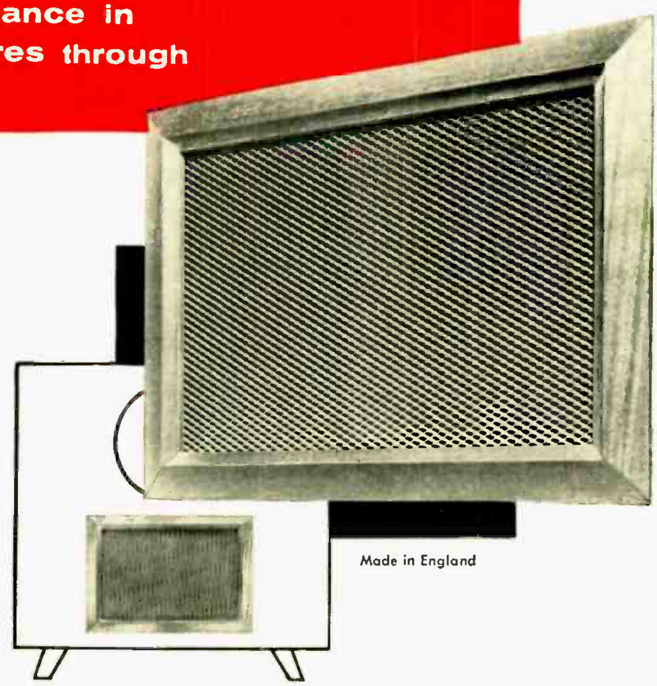
Pamphonic were demonstrating the loudspeakers which are already quite familiar to U.S.A. enthusiasts. I heard from many visitors that they considered that the Tannoy demonstration was one of those of the highest quality. Tannoy were exhibiting the same units which were shown at the Toronto Audio Show. The high-frequency unit incorporates a unique phase matching system, together with a powerful magnet system with a plastic-coated light alloy diaphragm. The low-frequency units employ rigid curvilinear cones with flexible edge terminations.

Another novel reproducer which caused interest, was the Plessey Ionophone, *Fig. 2*,

Fig. 3. Trixonic "800" single-unit 12-watt amplifier employs a novel arrangement of controls—one of which is a loudness control.

a new 3-letter word that spells . . .

Improved Performance in Loudspeaker Enclosures through 'Friction' Loading



The ARU represents a new, improved idea in loudspeaker loading. Now, a speaker enclosure need be only two-thirds the size required for a bass-reflex.

In addition to extending and reinforcing bass response, the ARU effectively smooths out resonant peaks. It does this by introducing a resistive element which lowers the 'Q' of the enclosure as a resonator.

More specifically, an enclosure of the proper volume for a given speaker or speakers — employing the correct ARU will provide performance noticeably superior to that obtained with conventional cabinets.

The ARU will:

- **Provide bass response down to 20 cycles** *with*
- **Negligible resonances above this frequency** *and*
- **Effective loading to zero cycles — with greatly reduced distortion due to excessive cone displacement.**

Installation of the ARU is simple. It is pre-mounted in a wood frame that is easily fitted into a rectangular aperture in the enclosure — and secured by means of ordinary screws.

Four ARU models are available for Goodmans Axiom and Audiom loudspeakers, or other makes of similar characteristics.

For complete details, see your dealer or write to Dept. QF-1

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A Product of Goodmans Industries
Makers of the famous **GOODMANS** High Fidelity **LOUDSPEAKERS**

Fig. 4. The plinth below the Pye "Black Box" record reproducer incorporates an 8-valve pre-set three-station FM tuner controlled by plug-in quartz crystals.

which is used in connection with the bass reproducer with a crossover of 2,000 cps. In operation, a built-in oscillator supplies high voltage at radio frequency and this is applied to a Kanthal electrode contained in a small quartz glass tube. The resultant glow discharge can be varied in intensity by modulating the oscillator at audio frequency. Owing to the crowds, your correspondent did not have the opportunity of personally hearing this combination. (*We have, and we consider it excellent.* Ed.)

Pye were demonstrating their Cantata and Concerto loudspeaker systems which are already enjoying good sales among high fidelity stores in this country.

Rola-Celestion, R.C.A., Tannoy, Vitavox, and Whiteley were all demonstrating speaker combinations which have won favour among enthusiasts. Trix were showing an interesting new type of floor cabinet speaker based on a French invention which enables very wide diffusion to be obtained through a single internal distributor.

Gilbert Briggs of Wharfedale was demonstrating his new loudspeaker combinations specially designed for the distribution of stereophonic sound.

It was unfortunate that many of the rooms in which these demonstrations were given were much too small and the crowds pushing in and out did not make it possible to appreciate fully the undoubted advantages of many of the newer devices.

Amplifiers

So many amplifiers were on show that it is not possible to comment upon all of them because this would merely be a catalogue of amplifiers available on the British market. Among the new ones seen and heard for the first time were those shown by Decca, E.M.I., Thermionic, and Trix.

The design of the Trixonic "800" was particularly interesting because of the unusual method of mounting the control knobs. This design will be appreciated from *Fig.* 3.

FM Tuners

To meet the demand created by the extension of the B.B.C. FM service, several new FM tuners were on show for the first time. Those of unusual design included the Simon, made to match their tape recorder, and the Pye, built in the form of a plinth to be mounted below their "Black Box" reproducer, as shown in *Fig.* 4. This instrument has almost the same appearance as the American Columbia 360, and when mounted on the FM plinth, provides a combination giving reasonably high quality in comparatively small space. It will no doubt be an attraction to many smaller homes.

One of the highest quality FM Tuners available is that made by Dynatron which is now a branch of the well-known Ekco Organization. It provides pre-set tuning to the three B.B.C. programmes and can be mounted in the base of a cabinet and operated by remote control through a flexible drive. A fourth position is provided for the switching of a gramophone pickup.

Some of the leading amplifier manufacturers showed FM Tuners made to match their preamplifiers. These included Quad, Leak, and Rogers.

High quality transcription type pickup arms were shown for

(*Continued on page 50*)

Designed for making Modern High Fidelity Recordings

the New **REK-O-KUT**

Imperial

PORTABLE DISC RECORDER
and PLAYBACK REPRODUCER

Offers These New Premium Features:

- Overhead Recording Lathe (Model M-12S) with Interchangeable Standard and Microgroove Leadscrews. Hand-crank for Run-in and Run-off Spiral Grooves . . . calibrated scale for timing.
- Cutting Head (Model R-56) with Recording Response from 50 to 10,000 cycles.
- Playback Arm (Model 160) for records up to 16" — with dual-sapphire magnetic cartridge.

The new Rek-O-Kut Imperial is equipped with a Model TR-12H Turntable driven by a hysteresis motor. Recording and playback amplifier is built-in. Recordings can be made from tape, live, 'off-the-air' or from other record discs — at 33⅓ and 78 rpm (45 rpm optional).

Imperial

complete with Cutting Head, 120-line Leadscrew and Timing Chart $599.95*

(less microphone)

**slightly higher West of Rockies*

New Model M-12S
Overhead Recording Lathe
fits Rek-O-Kut Challenger Disc Recorders
available separately.

with 120-line Leadscrew
and Timing Chart
(less Cutting Head) $150.00*
Model R-56 Cutting Head 60.00
(Interchangeable Leadscrew Prices — available on request)

See your sound dealer — or write to Dept. VE-1

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CANADA: Atlas Radio Corp., 50 Wingold Ave., Toronto 10, Ontario

LETTERS

Re-direct re: Transformers

SIR:

I was pleased to see that Mr. Crowhurst, in his letter (May issue) concerning my article on "Transformer Design for 'Zero' Impedance Amplifiers" (March, 1956) "does not contest Mr. Grossner's observation in his concluding paragraph." This, incidentally, is the most important paragraph, for it reads: "Tests on stable zero-resistance (attained by controlled positive feedback) amplifiers with output transformers designed in accordance with the procedures outlined in this article confirm the advantages stated herein."

Mr. Crowhurst's argument, therefore, seems to be concerned primarily with my analysis of low-frequency distortion, although it gives the impression of being an attack upon the major thesis of my article. I believe his relevant criticisms can be summarized as follows:

1) That I have "used X_L as a *linear* parameter;"

2) That my low-frequency equivalent circuit is incorrect;

3) That my "assumption that distortion is associated with X_L . . . is definitely not valid." Again, elsewhere in his letter: "the value of X_L is not the determining factor for distortion current;"

4) That "the attainment of precisely zero impedance . . . has no singularly inherent advantage in simplifying or economizing in output transformer design."

I must take issue with each of these contentions.

1) In the article, X_L is explicitly described and treated as a *non-linear* function. For example, after Eq. (*9*): "the inductance, being a non-linear function . . ." Again, in the paragraph following Eq. (*39*): "Flux density and non-linear nature of X_L." Indeed, a considerable portion of my analysis of low-frequency distortion deals with the non-linear nature of X_L, which is shown to depend on the flux density by virtue of the fact that permeability and harmonic distortion vary with flux density.

2) Mr. Crowhurst proposes a different representation of the shunt branch of my equivalent low-frequency circuit (figure 1.) I have been well aware of the other representations for the shunt branch.[1] The configuration I use is quite deliberate for the following reasons:

a) As the circuit most widely used by authorities on transformer circuitry, it lends itself to a comparatively simple mathematical treatment provided we take the precaution[2] of using for the effective value of I_m (the reactive component of the exciting current) the square root of the sum of the squares of the fundamental and harmonic components of the magnetizing current.

b) The equivalent circuit proposed by Mr. Crowhurst yields quantitative results, using a more laborious procedure, that are for all practical purposes equivalent to the results obtained by the distortion analysis in my article.

3) Mr. Crowhurst asserts that it is invalid to associate distortion with X_L. He claims to demonstrate his contention by postulating "a hypothetical transformer with a fairly *large* air gap" in which the inductance is more linear than a core with little or no air gap. If we follow this procedure to its logical limit we would remove all the laminations to obtain an *air* core and *no* distortion due to X_L. Thus Eq. (*9*) in my article would seem to become invalid. Unfortunately, my critic's hypothetical transformer is just that—hypothetical. At least 99 per cent of *real* output transformers have *no* air gap or a very small air gap, otherwise they would become exorbitantly large and impractical.

Partridge, in his excellent analysis of low frequency distortion, derives the following equation for fractional distortion, *D*:

$$D = \left(\frac{I_H}{I_F}\right)\frac{R_P}{X_L}\left(1 - \frac{R_P}{4X_L}\right)$$

where D = ratio of harmonic to fundamental voltage, I_H/I_F = ratio of harmonic to fundamental current, R_P = the parallel combination of source and load resistances, and X_L = shunt reactance. This equation also clearly shows that X_L is a determining factor for distortion content. Furthermore, Partridge's equation reduces to Eq. (*9*) of my article, if we recognize that $4X_L \gg R_P$ and we permit $I_H/I_F = 1$ in order to find an approximate expression for *maximum* distortion.

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[1] For example, four different configurations are shown in M.I.T. Staff "Magnetic Circuits and Transformers," 1943, p. 195. Also, some writers use a harmonic generator in the reactive branch.

[2] Ibid., pp. 187, 188.

(*Continued on page 53*)

If it's worth engineers' time...

...it's worth engineered cable

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TV CAMERA CABLE

Belden quality built to exacting specifications for black-and-white or color cameras. Harmonizing color—lightweight for easier handling.

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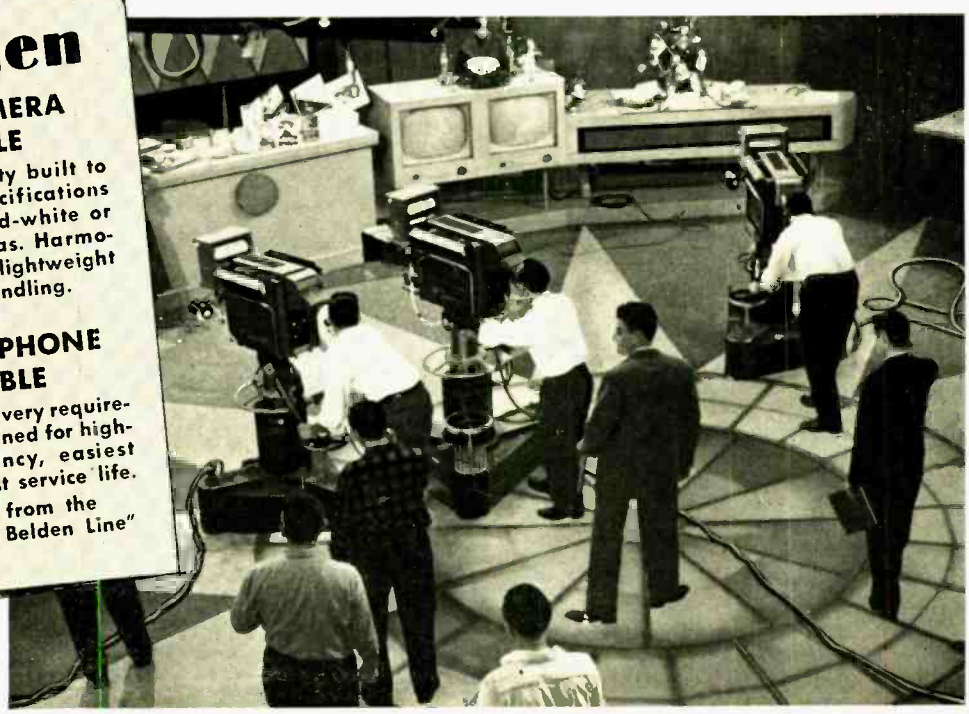

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WIREMAKER FOR INDUSTRY
SINCE 1902
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5-8

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Electrical Household Replacement Cords • Electronic Wires • Automotive Replacement Wire and Cable

ABOUT MUSIC

HAROLD LAWRENCE*

Silence, Please!

In 1949 *The New Yorker*, under the vigorous leadership of the late Harold Ross, declared war on the New York Central Railroad. At that time, Grand Central Terminal echoed with the sound of commercials relayed over a public-address system every two minutes. If a traveler happened to arrive at the hall ahead of schedule, he might be sold anything from beer to flashlight batteries. About the only shelter area in the place was the rest room. Ross came to the aid of the badgered commuter in no uncertain terms: "We wonder how a traveler would make out if he were to carry an amplifier device into Grand Central and shout back at the commercials. 'Aw, shut up!' would be a proper response to make in the great hall these days. Undoubtedly the traveler would be seized and ejected from the terminal, as a disturber of the peace."

Almost as a direct result of *The New Yorker's* editorials, the State Public Service Commission ordered hearings on the matter. Shortly afterward, the commercials were discontinued and plans for introducing them on the city's buses were also dropped.

During this affair, a term invented by radio broadcasters came into its own: "captive audience." An audience becomes captive when it enters or passes through a given place for one purpose, only to find itself face to face (or ear to ear) with commercials. The technique is commonly employed in restaurants where "messages" are inserted between pieces of dinner music on special FM circuits, and in movie houses that include commercial trailers announcing the new sale at a supermarket or the sensational values to be found at the local haberdasher. In such situations, the audience is trapped: It came to eat or to watch a film, and found itself instead the target of pitchmen.

In this age of electronics, there are many other invaders of the privacy of the individual. "In the realm of sound or rather *noise*," wrote Ashley Montagu in a recent article for *The Saturday Review*, "it must be said that the offenses committed this way in the United States are unparalleled for sheer barbarism anywhere else in the world." He goes on to mention the din and discord created by automobile horns, the noises of gear-shifting, the backfiring of trucks and buses, the shriek of police sirens, the blasts of factory whistles and mobile PA units.

The human nervous system, however, can withstand these industrial and mechanical noises to a far greater extent than it can the type of commercials mentioned above. There are more subtle forms of audio torture than the ear-drum-assaulting noises of modern urban life. For example, has it ever occurred to you that we are all members of a captive audience for certain recorded music?

In bars, diners and soda parlors across the nation, some 500,000 juke boxes pour forth bassy and brassy accompaniments to our drinks, sandwiches and banana splits. Salon music oozes from strategically located speakers in restaurants and cocktail lounges. Music of the potted palm variety, of course, has been with us for a long time. But since the advent of tape recording and the microgroove disc, background music has made inroads in entirely new fields.

Some new apartment houses feature such added inducements to prospective tenants as music-filled corridors and elevators. The hush of the funeral parlor is now soothingly broken by tranquil music emanating from cleverly hidden speakers. Banks have lost much of their austerity these days by blending mood music with financial transactions. Dentists' instructions, "Open . . . Rinse . . . Spit . . .", are now heard above the sounds of violins in thirds. The list also includes factories, supermarkets, hospitals, bus and railroad terminals, hotel lobbies, drug stores, theatre lounges, office reception rooms, barber shops, etc. You simply can't get away from it.

With rare exceptions, the type of music heard in these places is cut from the same bolt of velvet; that is, the arrangements are almost uniformly in the Mantovani tradition, with syrupy strings, mooning horns, listless beat and larger-than-life echo-chamber sound. Some enterprising business people, for whom ready-made programming services are unacceptable, select and play their own records and tapes. One French restaurant on Long Island, for instance, maintains a first-class record library of the latest Parisian "chansons," in tasteful versions. But tasteful or not, there are times when (1) you want to be alone with your thoughts, (2) you've heard enough background music for one day, and (3) the volume level is so high it drowns out conversation.

In addition to piped-in background music, the portable radio has made further encroachments upon our musical privacy. TV competition has forced radio broadcasters to emphasize music above other forms of entertainment. This fact, coupled with the phenomenal rise in the sales of portable radios—a result of the development of the transistor—has served to bring music into even more remote areas.

On the beach, one can no longer bask in the sun and listen to the roar of the waves; the blare of the tiny receivers takes care of that. Weekend vacationers armed with their indestructible (so the advertisements claim) portables add to the din of subways and buses.

We won't mention the cab drivers whose tastes don't exactly coincide with yours. In the new "midget" taxis of New York City, where the passenger practically leans over the driver's shoulder, a rock-and-roll number could bring on temporary (? Ed.) insanity.

Let there be no mistake about it: I love music. But, to paraphrase RCA Victor's slogan ("The Music You Want, When You Want It"), I don't want the music I don't want, when I don't want it!

* *26 West Ninth Street, New York 11, N. Y.*

NEW LITERATURE

• **Carter Motor Company,** 2644 Maplewood Ave., Chicago 47, Ill., has available reprints of an article titled "Conversion Simplified," which details the procedure for conversion of 6-volt Carter Genemotors and Dynamotors for operation on 12-volt storage batteries. Written by Carter chief engineer Ray Simon and published in APCO Bulletin, official organ of American Police Communications Officers, the article contains money-saving information which is of great iterest to all operators of raido-equipped taxicabs, police cars, ambulances, fire trucks, and other vehicles carrying mobile radio equipment. Your request for a copy should be directed to Ray Simon at the address shown above. **K-1**

• **Minnesota Mining and Manufacturing Co.,** St. Paul, Minn., covers important physical and magnetic properties of twelve Scotch brand magnetic tapes and films in a new technical data booklet which is available on request. The 12-page publication covers such physical properties as backing thickness, ultimate tensile strength, yield strength, elongation at break, residual elongation, tear and impact strength, and coefficient of expansion. Magnetic properties include coercivity, retentivity, coating thickness, erasure characteristics, bias-current requirements, relative low-frequency output, and relative high- and low-frequency sensitivity. Your request for this booklet should be addressed to Dept. A6-114 **K-2**

• **Cannon Electric Company,** 3208 Humboldt St., Los Angeles 31, Calif., has issued a new engineering bulletin on Type D sub-miniature Cannon connectors coded D-6. The 8-page 2-color booklet contains actual-size photographs, dimensional data, soldering, mounting and shell deviations; standard assemblies and variations, and several application illustrations. Requests for copies should be directed to the Catalog Department. **K-3**

• **Photocircuits Corporation,** Glen Cove, N. Y., translates the results of five years of production experience into a comprehensive set of "Standard Printed Circuit Tolerances" and publishes the information under that title in a 2-page publication designated Technical Bulletin P-9. Included in the standards are such items as diameter tolerances of unplated and plated holes, location tolerances between holes, and tolerances governing hole to pattern, front-to-back alignment, over-all dimensions, line width and spacing, and plating. Copies may be obtained by writing to the Engineering Department. **K-4**

• **Audio Devices, Inc.,** 444 Madison Ave., New York 22, N. Y., has just published a new bulletin on Type EP Audiotape, extra-precision magnetic recording tape for telemetering, electronic computers, and other specialized applications. The folder lists the physical characteristics and magnetic properties of the tape which is available on base materials of either cellulose actate or Mylar. Also included in the publication is a price list of reels of various lengths, widths of tape, and thickness of base material. The EP Bulletin will be mailed free on request. **K-5**

• **General Electric Tube Department,** 1 River Road, Schenectady, N. Y., has available a 20-page booklet containing data on GE's new metal-ceramic receiving tubes. Design and construction innovations of the tube are described along with application data and operating characteristics. Illustrations show the extensive facilities and advanced equipment employed in the manufacture of the tubes at the GE plant in Owensboro, Ky. Requests for copies should specify Booklet ETD-1212-A. **K-6**

Why use ordinary tape...

...now that **FERRO-SHEEN** *costs you no more?*

irish

BRAND

GREEN BAND

is now made by the exclusive

FERRO-SHEEN

process!

FERRO-SHEEN is the exclusive **irish** tape manufacturing process which astounded the audio world when it was introduced 18 months ago and has rendered ordinary tape old-fashioned, if not obsolete. **irish FERRO-SHEEN** process tape has by far the smoothest, most firmly anchored and most homogeneously bonded magnetic oxide coating of any recording tape ever made. It ends your worries about wearing out or gumming up your costly tape recorder heads with the abrasive, easily shed oxide coating of ordinary tape. It gives you unprecedented fidelity because the uniformity of oxide coating minimizes the danger of high-frequency losses in recording and of print-through on the recorded reel during storage. It is simply the best-engineered tape in the world.

irish GREEN BAND
1200 feet
$3.50

The Only Premium Quality Tape at the Standard Price

If not available at your favorite dealer, write directly to:

ORRADIO INDUSTRIES, INC.
World's Largest Exclusive Magnetic Tape Manufacturer
OPELIKA, ALABAMA
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EDITOR'S REPORT

STOP PRESS!

MOST IMPORTANT NEWS of the week comes from the Parts Distributors Show in Chicago where it was announced that the Institute of High Fidelity Manufacturers would conduct audio shows in both Los Angeles and San Francisco during February of next year. The first show to be presented by the Institute on the West Coast is in Los Angeles, February 6 to 9, followed the next weekend by the San Francisco show, February 15 to 18. Negotiations are now progressing between the Institute and the West Coast Electronic Manufacturers Association (WCEMA) with respect to the latter group's participation in the Institute show in Los Angeles.

It was announced officially that the Audio Engineering Society will participate in the Institute's first New York High Fidelity Show, which will be held September 27–30 at the New York Trade Show Building, and will hold its convention coincidental with the show, presenting some 40 papers on audio to AES members and others who wish to attend over the four-day session.

The two shows on the West Coast offer a convenience to exhibitors from East and Central sections of the country in that exhibits can be dismantled at the conclusion of the Los Angeles show and shipped in a truck caravan to San Francisco with the assurance that they would arrive in time for the opening there. With many of the important manufacturers located away from the West Coast, this arrangement is certain to save many headaches usually resulting from a quick move from one set-up to another.

On the assumption that we will be able to get space, AUDIO will be on hand at all of the Institute's shows, and we will look forward to seeing many of our readers at each one.

TV ENCROACHMENT

In this day and age, one often reads the newspapers with mounting indignation at one subject or another, usually brought on by either stupidity or cupidity on the part of those who would have our lives run for us rather than to permit us to have a more or less free hand in controlling our destiny, our activities, and the contents of our pocketbooks. But we really blew our top. so to speak, at a recent item in an esteemed newspaper of the merchandising industry—*Retailing Daily*—and in all fairness we must add that it was no fault of the paper. The item in question related a suggestion made by the Pennsylvania Broadcasting Company of Philadelphia, through its president, Benedict Gimbel, Jr. They proposed the elimination of the 88 to 94 megacycle segment of our present FM band and the reallocation of those frequencies to a new television channel to be known as 6A.

According to the company, "the present FM allocation plan is a pure waste of spectrum space, and even if the 88–94 mc band were taken away from FM, there would still be plenty of space left for FM operation."

Television now occupies a total bandwidth of 72 mc—more than three and a half times the total occupied by both AM and FM radio. And we submit that there is considerably more entertainment on radio than there is on television. We submit further that listener hours on radio exceeds viewer hours on television by three to one, at least, considering the use of automobile radios, semi-commercial mass music reproducing systems, and just ordinary household listening.

We sincerely hope that the FCC gives this suggestion the short shrift it deserves, and recommend that those who agree with us might well make their opinions known by letters to the commission. It just might help.

"MYLAR" IS A REGISTERED TRADEMARK

When a person or the legal quasi-person, a corporation, owns a trademark which is properly registered, he is under compulsion to protect it to the best of his ability by calling attention to a misuse of the name every time it occurs. Unless he does so, he is likely to run the risk of losing the ownership of the trademark, which then falls into public domain.

We made the mistake of referring to Mylar (as a base for magnetic recording tape) with a small M in the tape recorder section of the February issue. We know better, for we know that Mylar is the registered trademark of duPont polyester film, but it happened to slip through anyway.

In due course, we received a superb example of letter writing from Jack Burchenal of duPont's Product Information Service in which we were chided most gently for the error. In fact, we were hardly chided at all, it was so gentle. But no matter how soft the rebuke, our own conscience magnified it to large dimensions, for we know we were wrong and would most certainly not contribute to the loss of property by anyone.

It is a fact that duPont lost the trademark on Cellophane because it was misused so often that the courts finally ruled that it had become a generic term. To protect a trademark of this type, it is legally necessary to notify a misuser every time the misuse occurs. We hope we shall not make the same mistake again.

Readers will remember that the term "bass-reflex" was a registered trademark of Jensen Manufacturing Company for many years, and could only be applied legally to speaker cabinets of their manufacture. If it were applied to others, the manufacturer was liable for damages for trademark infringement. Jensen voluntarily relinquished the rights to this trademark about seven years ago, allowing its use by anyone. However, they now have the term "Triaxial" under registry, and this term may be applied only to Jensen speakers.

Thus endeth the short course in trademark law.

MODEL 580, 1000-CYCLE CROSSOVER / MODEL 581, 400-CYCLE CROSSOVER

THE PICKERING ISOPHASE is a revolutionary new speaker with a single diaphragm that is curved and virtually massless. This diaphragm is moved or driven as a unit by an electrostatic field. It re-introduces an audio signal into the air at a low velocity to closely approximate the unit area energy of the sound at the microphone in a concert hall or studio, thereby creating a "window-on-the-studio" quality that is breathtakingly realistic. Conventional cone or dynamic type loudspeakers reproduce sound by moving only small amounts of air at high velocities. The ISOPHASE, with its large sound-generating surface, is a radical departure from the older concept.

The ISOPHASE is available in two models. Model 581 covers the musical range from 400 cycles per second up to well beyond the limits of human hearing. The response over this range is consistent and absolutely uniform—without the slightest bump, peak, or resonance of any kind. This in itself is an unprecedented characteristic for a loudspeaker.

Model 580 has the same uniform response and clarity starting at 1000 cycles per second and similarly going out to supersonic frequencies.

Using an ISOPHASE SPEAKER with a FLUXVALVE PICKUP, recorded sound is reproduced for the first time *without distortion caused by the frequency characteristics of the transducers* . . . the middle and higher frequencies are recreated with a smoothness, definition, and degree of balance never before achieved with any speaker.

PICKERING & CO., INC. OCEANSIDE, N. Y.

Professional Audio Components *"For those who can hear the difference"*

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Compression and Dialog Equalization in Motion Picture Sound Recording

EDWARD P. ANCONA, JR.*

Intelligibility of dialog recorded for motion pictures is strongly affected by acoustic conditions during recording and reproduction. The usefulness of compression and dialog equalization in assisting intelligibility is shown and typical circuits of compressors and dialog equalizers are discussed.

Sound motion pictures are today an important means of communication, embracing the diverse fields of art, entertainment and education. In most films the spoken word, as recorded on the sound track, is of paramount importance; especially in educational, training and documentary films the effective communication of ideas by the voice of the narrator or actors is a major factor in the success of the film. It is the purpose of this article to describe some of the methods used to improve the transmission of the words and increase the effectiveness of the communication channel between a film producer and his audience.

Motion picture sound recording equipment today can produce recordings whose low distortion, frequency response, and dynamic range are more than adequate for faithful and natural reproduction of dialog and music. Operation of the equipment, and quality control of the recording from stage microphone to theatre loudspeaker involves well established techniques, and with reasonably qualified technicians all along the line high-quality recordings can easily be made.

The basic steps in transmission of narrators' and actors' words to the ears of a motion picture audience can be summarized—and idealized—as follows:

1. Record under controlled acoustic conditions on good equipment maintained in good condition.
2. Edit and rerecord to achieve dramatic continuity and to smooth out previous technical imperfections.
3. Process with care to get best prints with the least distortion.
4. Project on good equipment which is maintained in good condition.
5. Surround the audience with desirable and controlled acoustics.

Steps 1, 2, and 3 are, for the most part, well under the control of the recording technicians. With good equipment and qualified personnel, the recordings will be good mechanically and electrically. To the sad experience of many producers, however, steps 4 and 5 often depart from the ideal, and recording engineers—and directors and producers—must take these departures into account to insure the effective presentation of their film to the audience. The audience have only one chance (the one showing they attend) to abstract a maximum of intelligence from the recorded sounds which are being reproduced in a room whose acoustics profoundly influence these sounds, but acoustics over which they, the audience, have no control. The producer, director, and sound men concerned with the production of a given film, however, practically always hear the recorded sound under optimum acoustic conditions and on well maintained equipment. Therefore, those involved in producing films should take cognizance of the fact that their audience will often be seeing and hearing the film under less than optimum conditions, and during recording and rerecording, the sound should be so modified as to assist that audience in gaining the most intelligibility from the reproduced sounds.

Degradation Factors

What are some of the specific factors which tend to degrade the intelligibility of the sound the audience hears? First, perhaps, is the monaural recording. (The obvious exceptions will not be discussed here.) With recordings made on a single channel and reproduced on a single speaker the audience has lost the power of binaural discrimination against interfering sounds occurring on the stage with the actor. *Good microphone technique* and control of stage acoustics play a large part in helping the audience over this hurdle.

Second, the apparent frequency content of the recorded material is changed by certain physiological and acoustic factors. The well known Fletcher-Munson curves of equal loudness show the variation in sensitivity of the ear to different frequencies as a function of the intensity of the sound. Since motion picture dialog recordings are nearly always played back at a level higher than the actor's normal speaking level (in order to cover a large audience) the result is an apparent increase in the low-frequency content of the recorded material. Also, the voice level employed by an actor on a quiet set is usually lower than normal speech levels, because a person in quiet surroundings will involuntarily lower his voice. Studies of spectral energy content of speaking voices have shown that in these circumstances the voice characteristic shows a relative increase in low-frequency content. Furthermore, because most acoustic materials are less absorbent at low frequencies and increasingly absorbent at higher frequencies, recording stages and auditoriums will have longer reverberation periods at the lower frequencies. The combined result of these factors—the Fletcher Munson effect, the speaking level of the actor, and the reverberation characteristics of stages and auditoriums—is to make recorded dialog sound heavy and boomy when reproduced at a high level. Correction for this effect, called *dialog equalization,* is commonly used in making dialog recordings for motion pictures.[1]

A third factor affecting the recorded dialog is perhaps more subtle, due to its transient nature, although in its cumulative effect it certainly results in as much intelligibility degradation and audience fatigue as the other factors mentioned above. Most speech sounds encompass a volume range which is greater than that which can advantageously be reproduced in the average theatre. When faithful volume range reproduction of such material is attempted, either the loud passages are too loud, or the low-level passages too low, depending on the gain of the reproducing system. In the first case the loud passages seem to be exaggerated in loudness, producing a false staccato effect or "bounciness;" while in the latter case the low-level sounds will be lost, due to being within or below ambient theatre noise level.

Speech sounds are transient in nature,

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* *RCA Film Recording, 411 Fifth Ave, New York 16, N. Y.*

[1] M. Rettinger and K. Singer, "Factors governing the frequency response of a variable-area film recording channel," *JSMPTE*, Vol. 47, No. 4, October 1946, p. 299.

and low-level syllables or consonants can follow quickly after high level syllables or vowels. Thus, in the previous paragraph, the term, "ambient theatre noise level," could be taken to include the reverberation of a high-level syllable or vowel. This reverberation can mask a low-level syllable or consonant which immediately follows it. Particularly in 16-mm motion pictures, which are so often shown under unfavorable conditions—high ambient noise level, little or no sound proofing, highly reverberant rooms, the projector in the same room with the audience, and using a recording medium of inherently low dynamic range—particularly under those conditions are effects of masking of low-level sounds by ambient noise and reverberation most telling in their deterioration of intelligibility of the recorded material and in the production of listening fatigue. This transient deterioration of intelligibility is not easily apparent upon casual listening, especially to those familiar with the recorded script, but it can interfere with the effective communication potential of the film to the same or greater extent than the other factors discussed previously.

It is desirable, therefore, to compress the volume range of dialog recordings to make the high-level sounds relatively less loud, and the low-level sounds relatively louder. The physical limitations of any attempt manually to compress the volume range of speech are obvious, and electronic means have been developed to accomplish this task. Such an electronic device is known as a compressor, and is sometimes also referred to as an "electronic mixer."

At this point, the necessity, or at least, the desirability of certain practices in the recording of motion picture dialog has been shown. These are: good microphone technique, dialog equalization, and compression. The subject of microphone handling on the recording stage is an extensive one and offers material enough for a separate paper (or book) by itself and will not be dealt with here. The remainder of this article will be devoted to a discussion of typical circuits used in compressor amplifiers and dialog equalizers and some of the practical aspects of their use.

The Compressor

The basic components of a typical compressor amplifier are shown in the simplified schematic diagram, *Fig.* 1. The main signal path is from the input through the variable-gain stage and the output stage, to the output. A portion of the output is fed back through the side amplifier to a rectifier where a voltage is developed which is a function of the peak level of the output signal. This voltage is applied as a bias to the grids of the variable mu tubes to control the gain of the amplifier in a predetermined manner. Depending on the polarity and proportions of this control voltage, the amplifier will act as a compressor, a limiter, or an expandor. If the input of the side amplifier is connected to the output of the main amplifier, as shown, the device is said to be "backward acting." If the side amplifier input is connected to the main amplifier input, it is said to be "forward acting." In general, compressors will be "backward acting," and expandors will be "forward acting."

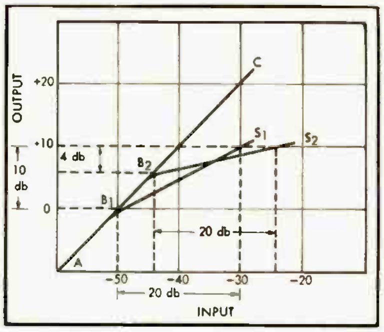


Fig. 2. Input-output characteristic of a compressor. A-C, linear (uncompressed). A-B_1-S_1, compression with 2:1 slope. A-B_2-S_2, limiting with 5:1 slope.

The operating characteristics of an amplifier with automatic gain control are shown in *Fig.* 2. A normal amplifier will have an input-output characteristic represented by the straight line, A-C, of 45 deg. slope; a change of 1 db in input results in a 1-db change in output. When operating as a compressor (Sw_1 in *Fig.* 1 closed), the amplifier will cause its input-output characteristic to depart from the straight line, A-C, at some point, B_1 and assume a new slope, B_1-S_1. The particular point at which the characteristic breaks away from the straight line is known as the "breakaway point" and can be set up by the rectifier bias control, R_2 in *Fig.* 1. The particular slope of the new line can be set with the side amplifier gain control, R_1 in *Fig.* 1. Thus, B_1-S_1 represents a condition of breakaway at 0-dbm output level, with a 2:1 slope; a change of input of 2 db results in a change of output of 1 db. For B_2-S_2 the slope and breakaway controls have been set for a breakaway at +6 dbm, and a 5:1 slope. The slope and breakaway controls are somewhat interacting and several successive adjustments are usually necessary to obtain a desired characteristic.

As a matter of practice in motion picture recording work, the 2:1 slope is most often used when compression is desired, and the recording system is so adjusted that the range from 100 per cent to 10 db below 100 per cent is compressed. Under these conditions the system is said to be using "20 into 10 compression;" that is, the top 20-db range of microphone output is compressed into the top 10 db of the recorded track. Other amounts of compression, such as "30 into 15" or "10 into 5" are often used.[2]

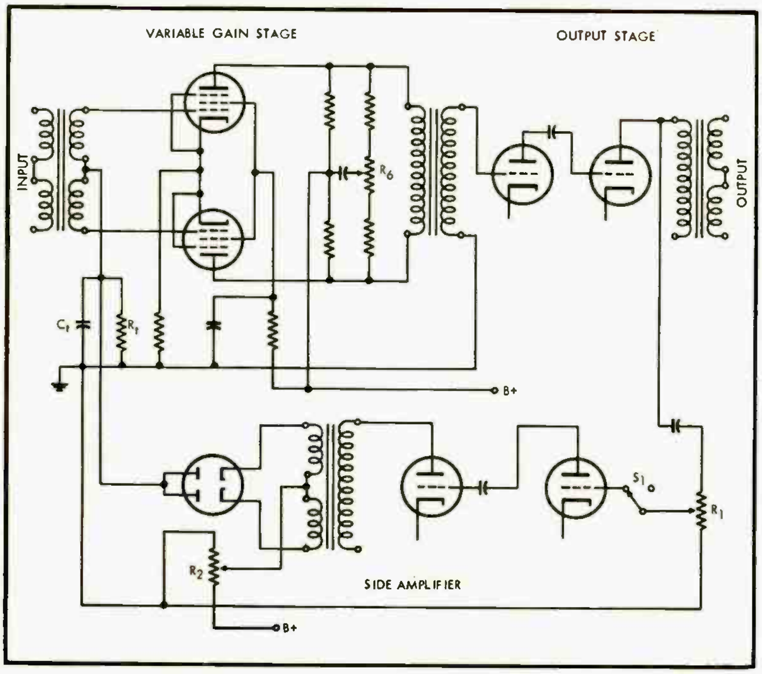
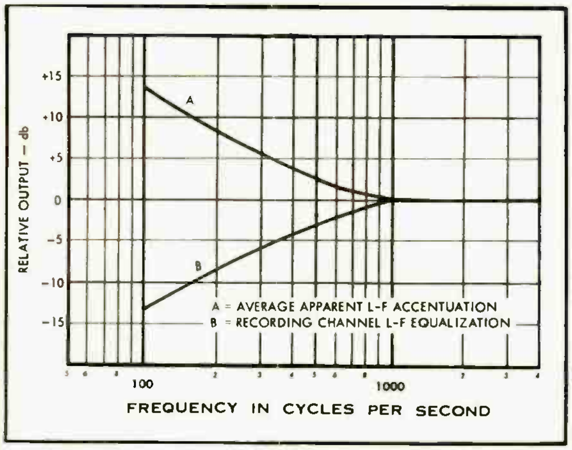


Fig. 1. Simplified schematic of a typical compressor amplifier.

[2] J. G. Frayne and H. Wolfe, *Elements of Sound Recording*, John Wiley & Sons, New York, 1949, Chapter 10, pp. 173–183.



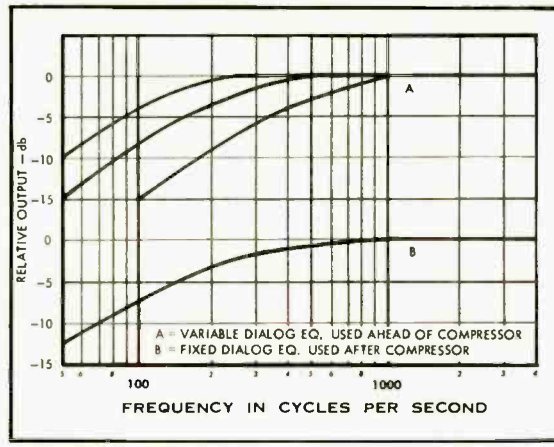


Fig. 4 (left). Characteristic curves of compressors. Fig. 5 (right). Effect of dialog equalizer.

When the amplifier is set for a slope ratio of 5:1 or greater, it is said to be acting as a limiter. The limiting characteristic has different advantages from the compression slope, as will be discussed later. Limiters used in radio broadcast work have ratios as high as 20:1, where the input-output characteristic is practically horizontal.

Two other important operating characteristics of a compressor in addition to its input-output curves are its attack time and release time. The attack time is the length of time required for the amplifier to reduce its gain when a signal suddenly appears at a level above the breakaway point—in other words, the time required to charge the timing capacitor, C_t, through the side amplifier rectifier. Critical listening tests show the desirability of very fast attack time, on the order of a millisecond or less. *Figure* 3 shows a recording of a timing test on the RCA MI-10234 compressor. The test was made by sending a 5000-cps signal into the compressor at a level just below breakaway and then suddenly increasing the level of the signal 20 db. The compressor immediately acted to reduce its gain to limit the change in output level to 10 db. It is apparent from *Fig.* 3 that the attack time was between 0.4 and 0.6 milliseconds.

The release time is the time required for the compressor gain to return to normal when the input signal falls below the breakaway point—in other words, the time required for the timing capacitor to discharge through R_t. The release time for dialog recording is usually set to about 100 milliseconds. (This is equivalent to a release *time constant* of about 25 milliseconds.)

An important consideration in the operation of a compressor is the matter of *balance*. There are very few electronic devices which will change gain without changing their d.c. operating point. This change in d.c. potential must be balanced out or it will appear at the output as an undesirable addition to the program, usually as a low-frequency transient which is termed "compressor thump." In the compressor circuit of *Fig.* 1, it will be noted that the gain change potential from C_t is applied to the 6K7 grids in parallel. As a consequence, the plates will change potential in parallel, resulting in no current flow through the interstage transformer primary. (The program signal, of course, is fed to the 6K7 grids in push-pull, and the amplifier works in the usual manner of any push-pull amplifier for this signal.) In order for the d.c. change to be completely balanced out, however, the two 6K7's must have exactly similar E_g-I_p characteristics and identical plate loads. The first requirement is met by using a matched pair of tubes, and the second by adjustment of the balance potentiometer, R_b.

A number of gain control devices other than the variable mu tube have been used, and with few exceptions all require some sort of arrangement to balance out "thump" generated by the gain change potential. Among these are the variable load tube—one tube acts as a variable plate load resistor for another tube; the "dynastat"—a closely coupled microphone and speaker, with gain control obtained through variation of speaker field current; pulsed triodes, with gain control obtained by variation of pulse width; and pentagrid tubes. Of these, only the variable mu tubes and the variable load circuit are capable of fast acting time, high signal-to-thump ratio,

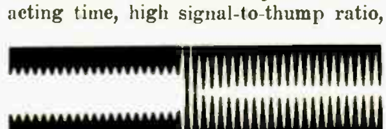


Fig. 3. Attack time oscillogram of RCA MI-10234 compressor.

low distortion, and easily maintained balance.

In a previous section were discussed the various factors contributing to an increase in low frequencies heard during reproduction of motion picture dialog. These were the Fletcher-Munson effect, the actor's voice level, and the reverberation characteristics of sets and auditoriums. If the average amounts of low-frequency accentuation due to these causes are added together and a smoothed out average curve drawn, we have the graph of (A) in *Fig.* 4. It is apparent that for natural reproduction of motion picture dialog, we should insert in the recording channel an equalizer with a characteristic inverse to that of (A). This is shown at (B).

A compressor tends to smooth out any difference in levels in program material which it handles. Thus, if the low-frequency attenuation described above were placed in the channel ahead of the compressor, the compressor would tend to erase some of the effect of the equalizer. This action is not in the manner of a tone control but is a transient action which changes the relative levels between syllables or vowels of different low-frequency content. Because of this effect it has been found desirable to split the total amount of recommended dialog equalization roughly in half, placing part ahead of the compressor and part after. The part after the compressor is fixed while that ahead of the compressor is located in the console and is made adjustable so that the mixer can compensate for such variations as different actors, different speaking levels, and different acoustic conditions. *Figure* 5 shows, at (A), a representative set of dialog equalization curves used in a recording console, and (B) shows the fixed equalizer which completes the total amount of dialog equalization used. The console equalizers can be simple *R-C*

The Diffaxial Speaker

ABRAHAM B. COHEN*

Multispeaker system performance may be obtained from integrated two- and three-way speaker structures by designing their multirange sections around those principles which produce specialized performance for the individual ranges. Division of these operating ranges may be accomplished discretely to produce a desired integrated mechano-acoustical-electrical crossover characteristic.

DURING RECENT YEARS, loudspeaker development has been concerned preeminently both with *unified loudspeakers* of the multiunit types or with loudspeaker *systems* employing separate loudspeakers. In common concept these structures might be called *multirange* loudspeakers in that they are comprised of assemblies of *specifically* limited-range units either directly integrated into one structure, or are alternately comprised of physically independent units of specifically limited range and usually all housed in one enclosure. There are specific differences, of course, between a reproducing system employing three separate types of loudspeakers and a system in which there is but a single integrated loudspeaker, which, however, may be comprised of two or three separately operating elements each performing within a specified range. In general it is easier to dseign a multispeaker system of separate units because of the freedom afforded in choosing whatever size and type of reproducer is necessary to meet any of several widely different specifications that may be laid down for the system. In the case of the integrated speaker wherein all the reproducers are mounted on one frame it requires considerably greater ingenuity in design to encompass a particular specification because of limitations of space. The desired end result of such integrated speaker design is to provide as close to multispeaker performance as is possible in the integrated system. This paper concerns itself with the details and performance of such an integrated multirange loudspeaker in which are integrated as well, those engineering concepts behind separate multispeaker systems.

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Fig. 1. The three-way Diffaxial, an integrated multirange speaker employing a mechanical crossover network between woofer and treble diaphragms, and an electrical crossover network for the tweeter.

The Diffaxial Concept

The multirange speakers to be described stem from these concepts and belong properly to the "Diffaxial" family of speakers. The Diffaxial type of loudspeaker generally and specifically pertains to loudspeaker structures based on the *split-range operation* produced by the patented "Diffusicone"[1,2] structure, which, in conjunction with *through-axially* arranged top-range tweeters, extends the two-way Diffaxial into a three-way Diffaxial. This structure is illustrated in *Figs.* 1 and 2.

Since the introduction of the original Diffusicone, continued development in diaphragm structures and in the techniques of their fabrication have resulted in improvements in the design of such a dual-diaphragm loudspeaker whereby it is now possible to obtain even more precise control of the independent actions of the two diaphragms on the one structure. As a result of these controls of both the frequency range of the individual diaphragms and the manner in which they individually roll off in response, it is possible to control precisely the *mechanical crossover* characteristic between the main diaphragm and the auxiliary sub-diaphragm known as the Diffuser. Since this high-frequency auxiliary diaphragm is mounted on the same axis of motion as the main diaphragm, the assembly as shown in *Fig.* 3 is consequently called the Diffaxial or specifically, a two-way Diffaxial, because it is actually a two-way system in which both vibratory mechanisms are mounted on the same axis and attached to the same voice coil, but in which discretely separate motions occur in the two diaphrams because of the mechanical crossover. The exact method will be shown by which two such diaphragms may perform in completely separate functional manner to produce two-way speaker performance even though driven by the same voice coil.

We may expand this Diffaxial family by placing a tweeter projector on the same axis of propagation, in this case with the projector passing through the woofer magnet structure. The advantages of this thru-axial placement of the tweeter projector as they pertain to efficiency of transduction and to uniform wide angle response will be shown. For the present we will recognize this structure (as in *Figs.* 1 and 2) to be a three-way diffaxial in which there is mechani-

[1] U. S. Patent #2,641,329 Levy and Cohen.
[2] A. B. Cohen, "Hi-Fi loudspeaker design," *Radio-Television News*, Dec. 1952.

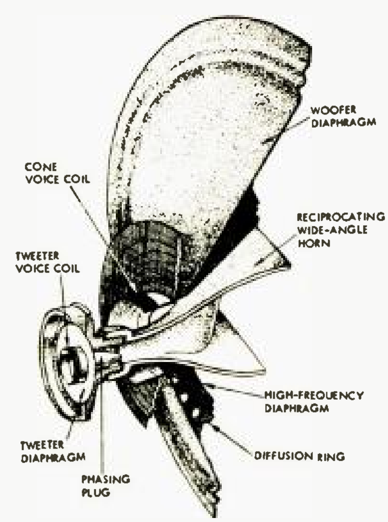

Fig. 2. An exploded view of the three-way Diffaxial speaker showing the joint structure of the woofer diaphragm and the treble diffuser radiator with the tweeter located through the axis of the main driving mechanism.

Fig. 3. The basic two-way Diffaxial speaker. A mechanical network couples the treble diffuser with the main diaphragm to produce differential motion of the two.

cal crossover between the woofer section of the diaphragm and the auxiliary Diffuser diaphragm, and an electrical crossover between the complete dual-diaphragm assembly and the tweeter unit projector itself. The methods and areas of these crossovers depend upon the individual diaphragm structure, design, and size, and will be discussed in detail.

Advantages of Multirange Transduction

Even though the benefits of multispeaker systems may have been discussed frequently, there are always new aspects to these discussions which may add light to the art. Another reason for discussing briefly the advantages of multispeaker systems is that by pointing out the benefits that accrue from such a system we may then easily bridge over to the specific reasons for the design of the various parts of the integrated multirange loudspeakers. Once we have developed these areas wherein the multispeaker systems excel we may then extrapolate these factors of design into the integrated type to obtain as much of the benefit of the multirange system as possible.

The main objective behind the design of multispeaker systems is, of course, the possibility of designing separate speakers to be most efficient and to operate to optimum desired levels of performance *within given frequency bands for which they are specifically required*. Thus we find the woofer is a structure designed to operate most efficiently in the low-frequency band of the acoustic spectrum. A midrange speaker is designed to produce the highest efficiency of performance within the midrange, and likewise a tweeter is designed to produce the most desirable performance in the treble range. We must realize that while these particular items—the woofer, the midrange speaker, and the tweeter—*together* make a high-fidelity speaker system, individually no *one* of these speakers can perform as a high-fidelity transducer by itself. This is quite apparent in any multispeaker system in which it is possible to cut out individual speakers. Listening to any one of these components will soon make it apparent that these component speakers are individually *not* wide-range reproducers. Even though this seems almost axiomatic, it is often lost sight of in terms of speaker design of either the multispeaker system or the multirange loudspeaker.

Component Speakers are Specialized

A simple example will illustrate the thinking behind the statement that the high-fidelity component speaker is by itself altogether different in concept than a single wide-range loudspeaker. For example, in the case of a *single loudspeaker* intended to reproduce the *entire audible source* by means of a single moving diaphragm, it is apparent that the diaphragm of the speaker and the moving system as a whole must be designed as compromise between low-frequency performance and high-frequency performance, for while large sturdy diaphragms are required for good lows, light delicate diaphragms are necessary for good highs. Because of this dual demand upon the single diaphragm of a simple wide-range speaker, the high-frequency performance of a loudspeaker is dependent upon the degree to which it is possible for a small apex area of the diaphragm to disassociate itself from the rest of the diaphragm, so that the high-frequency signals that come into the voice coil be called upon to vibrate but a small portion of the main piston. It is possible to design the diaphragm as a whole so that its apex area "uncouples" itself from the main diaphragm when subject to vibratory forces exerted by the voice coil. These apex uncoupling methods are accomplished by diaphragm shape, pulp composition, and built-in compliances, as will be described.

There are, however, practical limits to the means by which such diaphragm compromises may be made. For example, if the diaphragm were to be made very light in order to provide better high-frequency efficiency, we might alternately find that the loudspeaker may be susceptible to low-frequency instability as far as its piston motion is concerned. Thus, in the wide-range single-diaphragm speaker, the diaphragm design is a good compromise, as far as its piston motion is concerned, between low-frequency stability and high-frequency efficiency. However, if this same loudspeaker were to be limited only to low-frequency reproduction, then the diaphragm may be redesigned with maximum concern for its low-frequency combined with maximum piston stability. Thus it is seen that once we begin to *specialize* in the design of a loudspeaker *for a particular range* we are able to accomplish the design for that restricted range in a much more efficient manner than would be possible for a loudspeaker of the same size using a single diaphragm to reproduce the entire spectrum. This shows where those designs that are the keystones of multispeaker systems have much to offer towards the design of the multirange type of integrated loudspeaker.

With the basic concept in mind, therefore, that the multirange loudspeaker should be, as far as possible, an embodiment of all major design precepts of the multispeaker systems, let us then proceed to a transition of those actual designs into one integrated reproducer as they are accomplished in the Diffaxial loudspeaker family.

A Laboratory Demonstration

The basic Diffaxial assembly is shown in *Fig.* 3. This is a system comprised of a woofer diaphragm at the apex of which is affixed the auxiliary multisectional high-frequency radiator and diffraction ring, known as the Diffusicone section. These elements work in conjunction with one another through *mechanically differentiating circuits* to provide functional two-way speaker system performance. Although the physics of this mechanical crossover network may be theoretically quite involved, yet once it has been accomplished in a working model, it is rather easy to demonstrate, on a laboratory basis, the discrete quality of the system. Such a laboratory demonstration was made by the writer before a technical session of the AES Convention in November, 1955. For those readers who were present at the session, it will be recalled that the demonstration consisted of actually running a frequency response curve of a completely assembled 15-inch loudspeaker of the two-way Diffaxial type. After the curve

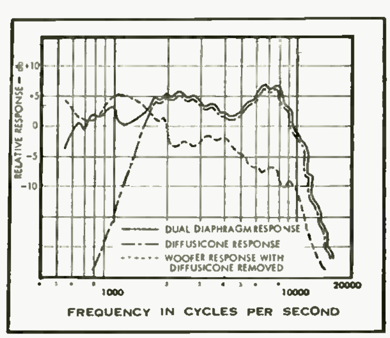

Fig. 4. Two-way Diffaxial response showing differential performance between woofer and high-frequency diaphragms.

of this completed speaker was obtained the Diffusicone section was removed from the speaker and the response curve was then run again. The results obtained at this demonstration are illustrated in *Fig.* 4. In this figure, the solid curve represents the performance of the speaker before the removal of the Diffusicone section, and the dotted curve represents the performance of main or lower-frequency diaphragm after the removal of the Diffusicone. These curves actually illustrate the fact that in this structure the addition of an auxiliary radiating diaphragm designed specifically for upper band radiation, and furthermore, designed specifically to work in conjunction with the woofer structure, ***substantially adds a second band of frequencies to that of the woofer.*** The success of this design lies in the mechanical coordination between the woofer diaphragm and the auxiliary diaphragm. On a large diaphragm not designed for this operation the addition of the auxiliary radiator may very well result in deleterious consequences.

Crossover Considerations

This dual band performance is accomplished successfully only when the two radiators are designed to be compatible to each other both in their individual band coverage, and in the degree of overlapping areas of these individual bands, in addition to the mechanism itself which provides the crossover function. Referring again to *Fig.* 4 it will be observed that there is an area of overlapping performance of the low-frequency diaphragm and the auxiliary high-frequency Diffusicone section as indicated by the shaded area. Such overlapping is essential in multispeaker design to avoid areas of depressed response where neither of the transducers is operating, as indicated at (A) in *Fig.* 5.

Another factor which determines where the crossover shall be made is the spatial distribution of the high frequencies from the lower-frequency diaphragm. It is commonly recognized that cone type reproducers tighten up their radiated field pattern as the frequency of reproduction increases. This is illustrated at (B) in *Fig.* 5, which shows how the high-frequency performance of the main diaphragm at 45 deg off-axis may be 5 db down from its on-axis level. It might therefore be desirable to transfer the radiation field away from the main diaphragm at 5000 cps to the more efficient auxiliary high-frequency diaphragm by which extra spatial dispersion may be obtained in addition to greater high-frequency transduction efficiency.

These two factors (a) compatible overlapping areas of response, and (b), compatible transfer of polar response—need minute considerations, in multispeaker systems *and* in multirange integrated speakers. In the former, suitable performance is obtained by separate speakers, each individually designed for its specific band, with electrical circuits providing the necessary frequency separation. In the latter, the required performance is obtained by separate diaphragms, each individually designed for its specific band, with mechanical circuits providing the necessary frequency separation.

Physics of Mechanical Crossover

No one part of our acoustic art is by itself irrevocably isolated from any other part. Perhaps in no other technical field is there such a fine interplay of electrical, mechanical and acoustical phenomena. Simply told, an electrical *signal* causes mechanical *motion* which sets up an acoustical *radiation field.* To borrow from the deeper realms of physics there is a "unified field" theory that welds together all the aspects of loudspeaker

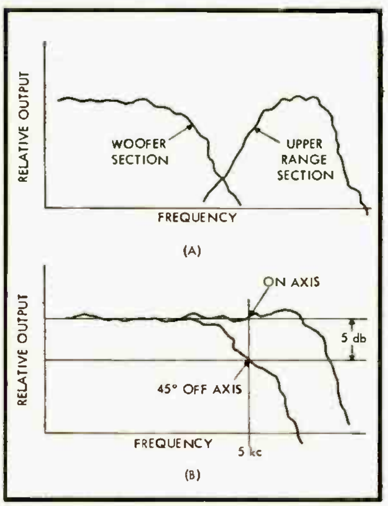

Fig. 5 (A) Improper frequency overlap resulting from irregular response in multispeaker design. (B) When off-axis response begins to fall off, operation should be transferred to more dispersive radiator.

performance. In no less a degree there exist mechanical circuits analogous to electrical circuits.

The same formulas for electrical crossover may be put to use for mechanical crossovers. It is erroneous to think of a crossover of an acoustic system—specifically that of a loudspeaker system—to be governed only by the electrical network that may be in use. The *total crossover* characteristic which governs an acoustic *system* is comprised not only of the characteristics of the *electrical* network, but is also dependent upon the *mechanical* crossover characteristics of the diaphragms themselves, plus the *acoustical* characteristics of the enclosures in which these loudspeakers find themselves. The over-all crossover characteristic is a combination of these three, and must be considered as one integrated crossover network.[3]

How then, is mechanical crossover achieved between two diaphragms driven by the same moving voice coil? This mechanical separation of motion may be illustrated by referring to the action of an automobile traveling over a road in which there are several types of irregularities such as the slow roll, or heave, of the road as well as a rough "washboard" type of road. With our modern shock absorbers, there is no question how the car reacts over these various types of roads. When we travel over a slowly rolling hill, the road pushes up on the wheels, the wheels push up on the shock absorbers, and the shock absorbers in turn push up on the body of the car and the body of the car follows along the slow motion of the rolling hill. However, if somewhere along this road there are a lot of small washboard areas, these irregularities will again push up on the wheels of the car, the wheels of the car will push up against the shock absorbers but the shock absorbers, which are really low-pass *networks,* will not transmit the highly recurrent washboard action of the road to the body of the car. We find actually that various sections of the car are vibrating independently of one another, even though they are both driven by the same force—the wheels moving up and down with the road. The wheels and the shock absorber appendages are moving both at the slow swell of the road and also along with the washboard action, but the body of the car is traveling more with the slow swell of the road and being affected but little by the washboard action. Here then, is what we might call mechanical crossover of a vibrating system. That part of a system which is closest to the vibrating source is vibrating in full compliance with the force applied to it, whereas the body of the car which is uncoupled from the driving force by the shock absorbers differentiates against the high-frequency motion in preference for the low-frequency motion. In fact, this is almost exactly how mechanical crossover is accomplished in a dual-diaphragm type of loudspeaker.

We might consider a dual-diaphragm loudspeaker voice coil to represent the wheels of the car. It is being driven by the voice coil currents to conform with signals which are of both high and low frequencies. Obviously, for low-frequency signals the voice coil will travel slowly, and for high-frequency signals it will vibrate rapidly. When both high

[3] A. B. Cohen, *Hi-Fi Loudspeakers and Enclosures* (Chapters 6, 7, 13) John F. Rider Publisher.

and low frequencies are imparted to the voice coil it will travel with a resultant motion made up of the low frequencies and the high frequencies together in a complex form. The motions of the voice coil will, of course, be imparted to the both diaphragms which are attached to it. Now, off hand it might seem that both diaphragms should move in identical fashion because they are both driven by the same voice coil. This would be true if both diaphragms were of infinitely rigid substance. If there were no compliances—the "shock absorbers"—anywhere in the system, then the two diaphragms would move simultaneously according to the bidding of the voice coil and there would be no dual-diaphragm action as far as separation of frequencies is concerned. Yet there would still be a very distinct radiation difference between the two diaphragms. The smaller auxiliary diaphragm will not reproduce nearly the same lows that the larger diaphragm will.

From experience, we know that a small diaphragm will not reproduce low frequencies the same as a large diaphragm. In a more technical consideration, we may say that the two diaphragms exhibit different radiation-impedance characteristics. More specifically, the radiation from any piston is a function of its diameter and its frequency. For a particular frequency, a given piston will have a given radiation impedance which will determine the efficiency with which a moving system will reproduce a frequency imparted to it. In general, the larger the diaphragm the higher the radiation impedance for a given frequency; conversely, for a given size of diaphragm the lower the frequency the lower the radiation impedance. It is thus apparent that for maximum low-frequency reproduction we want to make the diaphragm as large as possible (as in woofers). On the other hand, if the diaphragm is small, then it will have poor low-frequency radiation impedance with consequent severely attenuated low-frequency performance. Immediately we visualize that even where the two diaphragms are driven by the same voice coil their respective low-frequency response will be determined by their sizes, and the *mechanics* of the system have introduced an acoustical rolloff in response of one diaphragm in comparison with its mechanically cooperating partner.

Up to this point we have discussed the different radiation fields that ensue from diaphragms of different sizes, but of infinitely rigid material. However, it will readily be recognized that no material is infinitely rigid, especially paper, which is a very fortuitous circumstance. The fact that the diaphragm material is not infinitely rigid means that we can mold it and design it to do our bidding. Thus, because of its compliance we are enabled to put parameters around its performance other than that of size. This then will be the basis of examining those designs that go into the mechanical vibrating systems which will determine their frequency discriminating characteristics—which will be not apart from size considerations, but in addition to them, for together they form the mechanical crossover function.

Our objective in the illustrated dual-diaphragm assembly is for the large diaphragm to reproduce the low frequencies and to play a minimum part in reproducing the highs, and for the auxiliary Diffusicone to reproduce the high frequencies with minimum low-frequency performance.

Being made from compliant material, diaphragms are quite susceptible to deformation which may be governed by the combined effect of the diaphragm material and the diaphragm shape. For example, a *flat* piece of paper supported around its periphery exhibits very little resistance to mechanical deformation for pressure exerted at its center. However, were this same piece of paper to be rolled into the shape of a cone and placed upon a table with its base down, it would exhibit considerable resistance to deformation if pressure were applied to its apex. This matter of shape determining the stability of a diaphragm is readily recognized in practice where woofer diaphragms are usually built deeply conical so that they retain maximum piston stability. Now, returning to the sheet of paper, we find two limits to its stability—minimum stability when flat, maximum stability when conical. Between these limits there will be varying degrees of mechanical stability depending upon the contour variations of the diaphragm.

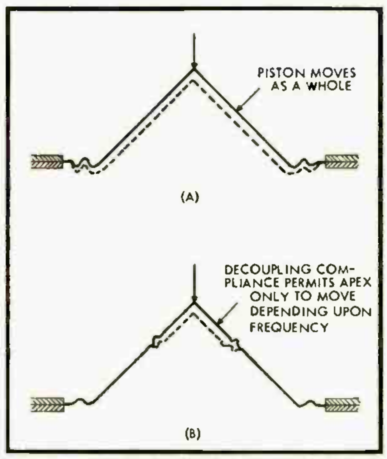

Fig. 6. Differential motion of parts of the diaphragm is obtained through the use of decoupling compliances.

The very simplest contour variation that we may consider is the built-in compliance or decoupling element (shock absorber) somewhere along a zonal plane near the apex area of the diaphragm, as illustrated at (B) *Fig.* 6. Obviously, when pressure is applied to the apex of the cone this apex will move, but the motion will not be transferred as readily to the main body of the cone because of the "shock absorbing" properties of the decoupling compliance. Frequency discrimination will, of course, be involved in this motional transfer. As in the case of the car going over the bumpy road, the high-frequency vibrations will energize only that portion of the moving system between the driving force and the decoupler—in this case the apex area. The main body of the cone will be isolated relatively from these high-frequency impulses by the decoupling compliance. Thus the high frequency signals will be called upon to drive only a relatively small light diaphragm (the apex area) because of this compliance rather than the large heavy diaphragm. The end result is more efficient transduction of high-frequency energy.

As far as low frequencies are concerned, the decoupling compliance will naturally pass them on to the entire diaphragm and relatively full piston action will occur.

However, there are other means of accomplishing this decoupling action that are not quite so apparent. The pulp from which the diaphragm is fabricated also determines how sections of the diaphragm will disassociate themselves for specialized frequency ranges. The diaphragm material is made up of a lot of interwoven fibres, effectively behaving as a mass of small intertwined springs made up of individual pulp fibres. The transmission of the force from the apex to other sections of the diaphragm is accomplished by one minute fibrous spring exerting its force against the next minute fibrous spring. These built-in segments, in toto, constitute the compliance of the material itself. The nature of the pulp material from which the fibres are obtained, the length of the fibres involved, and the manner in which these pulp materials are bound together determine to a great degree the transmission of the force from the apex of the diaphragm to the body of the diaphragm as a whole.

We have thus explored the three methods by which frequency differential *motion* of parts of the diaphragm may be obtained—diaphragm shape, decoupling compliances, and integral pulp formulation. In their combined form they effectively control the mechanical crossover characteristic of the system, with the end effect that these built in three-way

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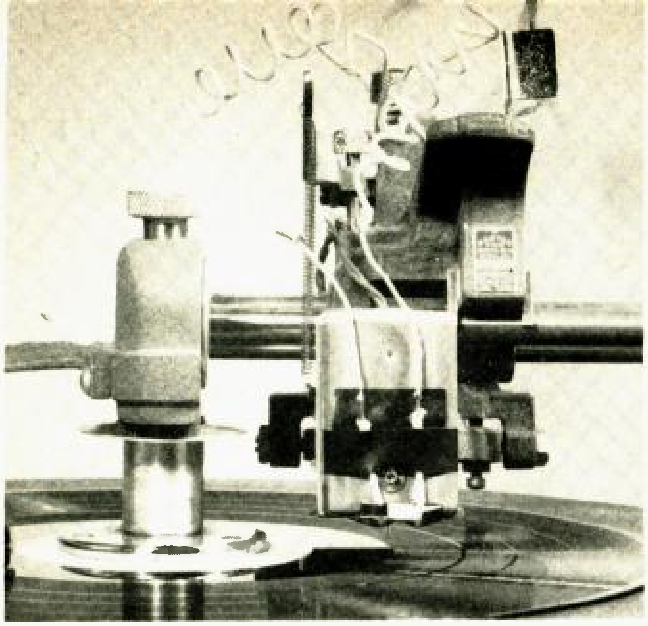


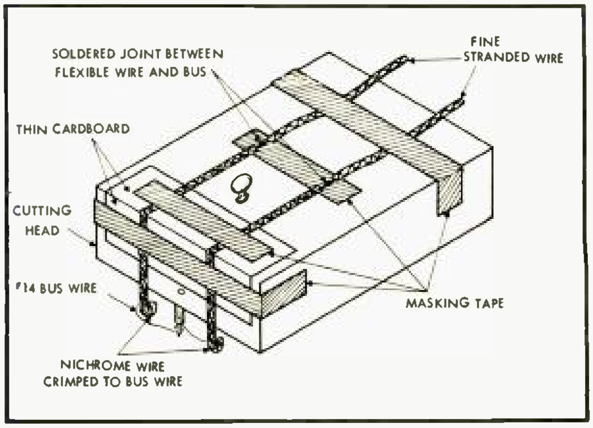


Fig. 1 (left). Presto recording head with home-mode stylus heater hookup, for home LP recordings. Fig. 2 (above). Unit is detachable at "floating" connection between conductor and bus to allow insertion of cold stylus for cutting 78s.

at home with AUDIO

LEWIS C. STONE

Hot Stylus in a Hi-Fi Groove

Hi-fi experimenter applies coil of nichrome wire to heat sapphire cutting stylus for successful home LP recordings.

This month's essay on do-it-yourselfing has to do with a hot tip. The tip-off is that this "deal" was consumated by our reader Borini a year or so ago. Which is about enough time to judge the product, and we are told that it has worked out fine. In fact, as you will see further along, we verified this claim. This project is therefore suitable for the hi-fi experimenter and novice, as promised in our agenda back in 1954.

The cost of a commercial hot-stylus rig runs, as you may know, to around a hundred dollars. The home-made job, our reader assures us, cost him a total of less than two. See, in *Fig.* 1 a closeup of the way the heater rig is attached to the cutting head, and in *Fig.* 2 a self-explanatory isometric projection of its construction.

Provided it is a lacquer disc you are cutting, the hot-stylus process will produce microgrooves with mirror-smooth sidewalls with a minimum of background noise. Furthermore, it will provide a wider frequency response far deeper into the diameter of the disc. To achieve this result you may wonder (as we did) just how hot does the stylus have to be?

According to an article by William S. Bachman, "The Columbia Hot-Stylus Recording Technique," (Audio Engineering, June 1950), the actual temperature attained by the stylus [was] not measured. But with a power of one watt and 0.4 to 0.5 amperes there is heat enough to work the grooves into the surface of the disc with lowest surface noise and minimum frequency deviation. On playback, the high-frequency response shows minimum loss at the inner diameter of the disc. In fact, without softening up by the hot stylus, another authority avers that losses at the inner microgrooves can be as much as 10 db at 10,000 cps.

Apparently the temperature *setting* is not critical, and satisfactory recording results can be had with various types

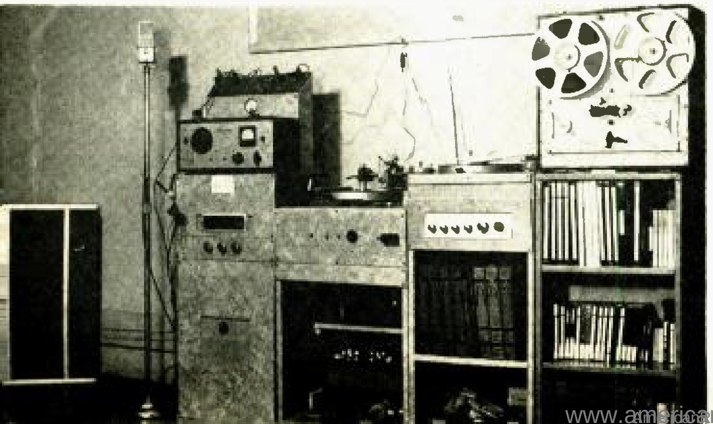
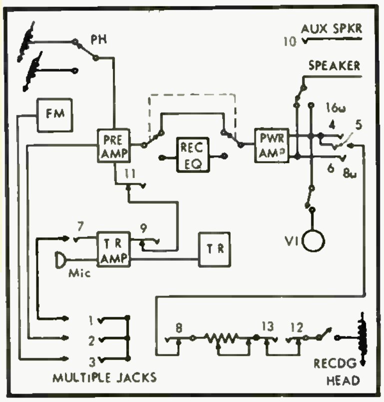


Fig. 3. System is planned for forthright operation, all parts in view, from jack-panel atop left cabinet to tape recorder at right. Second from left is record-cutting deck with playback table alongside. Back space between units and wall allows easy access for servicing.



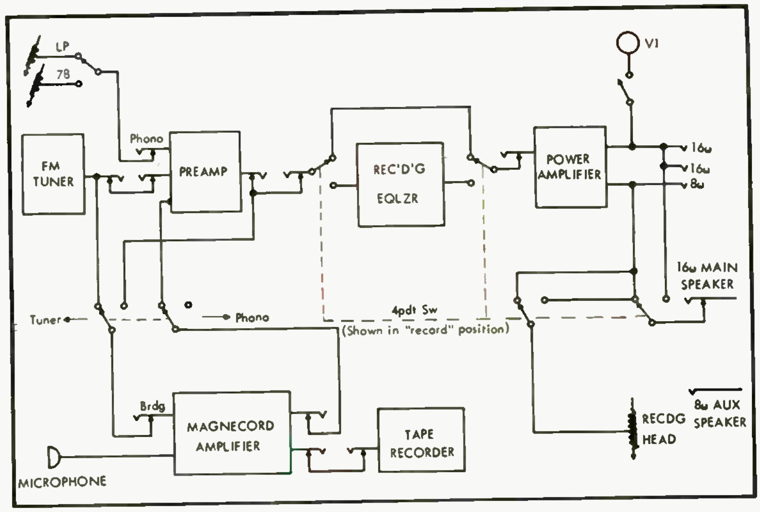


Fig. 4. Schematic showing "as is" arrangement of components as used in this system. Fig. 5 (right). Suggested re-array, more in line with accepted audio practice, more convenient operation.

of lacquer discs. We did determine that temperatures at the stylus tip might vary from 400 to 600° F. While commercial rigs are fitted with a temperature control and an indicating meter (one make is calibrated in color: red for standard, green for fine-pitch recording) our experimenter does a cutting job with his home-made unit applying heat gradually to the stylus by means of a potentiometer. In this man's experience the setting for the desired heat (determined in his earlier and rasher days by a split-second finger touch) is at about the middle of the dial, i.e., with about 25 ohms in the heater circuit.

Unencumbered Hi-Fi

The scene of this recording set-up is ranged over four converted bookshelves. The ones at each end (see *Fig.* 3) are 38 in. high, 18 in. wide and 12 in. deep; the second from the left holds the recording turntable and is 34 in. high, 22 in. wide and 19 in. deep; and the one next to it with the playback table is 38 in. high, 18 in. wide and 17 in. deep. The illustration shows the array lined up along a wall, with about a foot of clearance behind for servicing.

Our photograph leaves little doubt that the supporting cabinetry is homemade, using unpainted bookshelves of ⅞-inch white pine as a basis. The mottled surface effect is a covering of a plastic material, gray in tone to match the hammertone finish of the Magnecord panels. Ventilating grille cloth insets are seen at the tuner, power amplifier, and over the preamplifier, all of which are mounted in removable panels.

The entire hi-fi system follows the block schematic of *Fig.* 4. Alongside, *Fig.* 5 represents a format suggested as a better operating hook-up, more in line with established and accepted audio practice. Nonetheless, it is in terms of the former that the system is presently used, and the "as-is" schematic is referred to in the following brief notes on the home made jack-panel as a device for making the interconnections to cut discs from live FM performances originally recorded on tape.

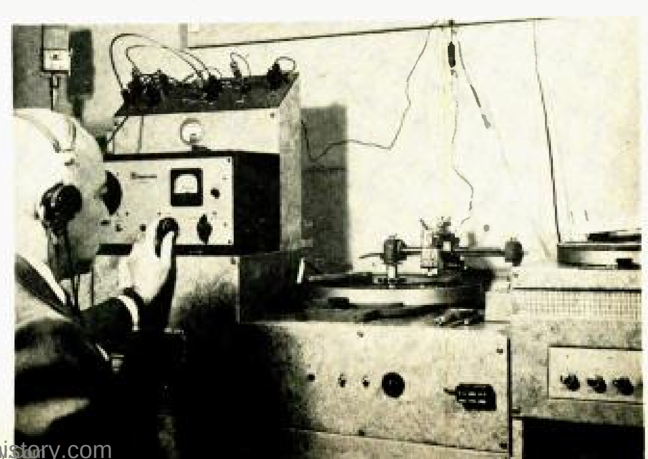
With that system as it is now used you would connect jacks 8 and 13 to a 6-ohm potentiometer which is said to represent a simple compensator network for frequencies below 500 cps—the crossover frequency of the Presto 1-D recording head used here. And you might be inserting a 2-db drop in response by increasing the resistance. You could, by using the patchcords, connect 9 to 11, 4 to 8, and 12 to 13 (all of these seen in *Fig.* 4); and into jack 5 would go a set of high-impedance headphones for monitoring (*Fig.* 6). Naturally the VI would be switched on, then the equalizer. The output-impedance switch is set at 16 ohms to match that of the recording head, while the potentiometer knob is turned to preset the desired resistance, from one to six ohms. (Cords are stored in spring clips, *Fig.* 7).

In another procedure suggested for recording simultaneously on tape and disc you would plug the output of the FM tuner—which is on a cord with a plug—into jack 1. The input to preamplifier (also with plug) is connected into jack 2, while jack 3 and jack 7 are connected with a patch cord. In this fashion, the FM signal is fed into two amplifiers. The tape amplifier has a VU meter and a volume control. Independent of it is the recording amplifier with VI meter, volume control, and an array of patch cord connections, for cutting discs. Needless to say, the "proposed" system hookup, as in *Fig.* 5 above, lends itself to the same operation with less waste motion, since "jumpering about" would be eliminated.

Stylus Heating

The subject hi-fier's chief interest has been recording on discs, from the very beginning. A voice teacher, he tape records his pupils' "outputs" then dubs them to discs for home study and review. Recording from tape to disc frees the former for repeated use, and thus holds down expense. The discs, on the other hand, become important voice-training tools. And since nothing is more revealing than a private session with one's own voice, the discs must hold undistorted performances that in themselves often suffered from the

Fig. 6. Hi-fi experimenter at one of the many controls monitors cutting of LP disc from tape of live FM program. Note patch cords in record-playback jacks of jack-panel at top left.



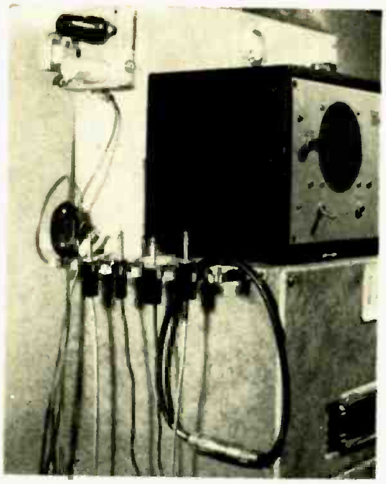


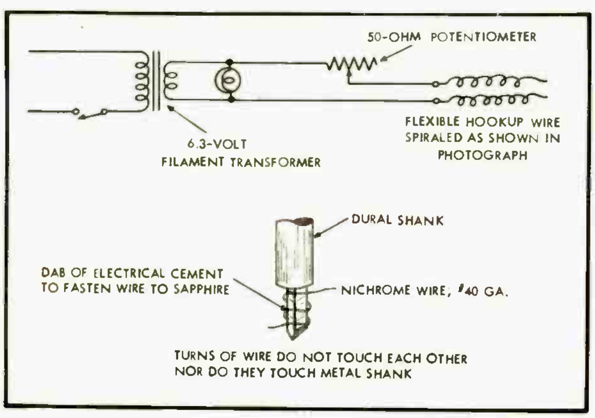
Fig. 7 (above left). Between "jumps" patch cords are held in spring clips attached to off-side of cabinet housing tuner, main amplifier, tape recorder amplifier. Fig 8 (above right). Camera gets hi-fi worker's eye view of cutting stylus as nichrome heating wire is coiled around sapphire tip.

imperfections natural to voice trainees. Frequently, to illustrate a point, tape recordings of operas and solos picked up from live FM programs are played to give students an idea of how it is done by professionals.

It could be that our reader would probably have traded present "good" for presumably newer "better" with the regularity and persistence of other seasoned hi-fiers (see AT HOME WITH AUDIO, April 1956) were it not for the fact that he is obliged to produce discs as a part of his voice teaching programs. Where means ran out, ingenuity drifted in. He got together the materials to make discs the hot way. In Mr. Bachman's article was the key, and we quote: ". . . The first method tried, in early 1948, consisting of winding a small coil of copper wire directly on the sapphire jewel and heating it with a direct current, worked so well that it is still in use. . . ." Also that it was the best way so far discovered for increasing dynamic range and reducing surface noise, plus the economy of improved recording closer to the center of the disc.

The physical process of collaring the stylus with a heating coil calls for steady hands. See, in *Fig.* 8, for example, and through a (magnifying) glass *clearly*, how both combine to get that 40-gauge wire (nichrome, in this case) around the tip of the sapphire cutting stylus. Proceed as follows: (1) Hold the stylus upright in a small vise to free both hands for winding. (2) Use a magnifying glass mounted on an adjustable stand (as shown) and wind three or four turns of the nichrome wire around the sapphire tip, keeping clear of its metal shank to avoid shorting. (3) Make sure that each loop is free of the other (*Fig.* 9) then secure the coil to the sapphire tip with an electrical heat-resistant cement.

Fig. 9. Wrap of wire around stylus is shown in gross at bottom, with circuitry of heating transformer above.



Our reader heats his stylus with a.c. (although d.c. is used by Mr. Bachman) by means of a 6.3 volt filament transformer. He sharpens the sapphire tip no more than once during its usable life of about six or eight hours of cutting. Sharpening more often reduces the length of the sapphire and makes it difficult to wrap heater wire around with space enough to be effective. When used cold, the stylus can be sharpened three or four times, which is to be expected. This is best done at the factory, either by sending the stylus direct or through your audio parts dealer. In fact, our reader uses a cold stylus for 78s, which explains the temporary look of the mounting of the heating array on the recording head, as it must be easily put on and taken off.

The Sampling

Before betraying a hi-degree of credulity (hi-fiers *sound* plausible, and we have to pass up many systems proposed to us for discussion in these pages) we had a session of A-B-ing our reader's production with some of our own by comparing a playback of our own tape, recorded on an Ampex 350, of a live concert by the N. Y. Philharmonic Symphony, and the identical selection (it happened to be the Violin Concerto in D minor by Sibelius) on a disc dubbed from a Magnecord tape by the subject reader, the disc being played back on our Garrard 301 turntable with Leak diamond pickup at the same time. The passages were synchronized, the channel selector turned from tape to disc player and back.

The home-made disc dubbing was nicely balanced as to highs and lows, but compressed somewhat when compared with the Ampex tape sound. The disc was played with an RIAA characteristic, bass at flat and treble attenuated quite a bit, probably because the violin came through with a particularly brilliant tone.

Ostensibly finalized, there is as yet no absolute hi-finality in our reader's hi-fi system. Its present shape-up was developed over some years, beginning with a disc recorder, a

(*Continued on page 40*)

Input Transformer Design

The choice of an input transformer depends greatly on the use to which it is to be put. The author tells how to determine if a transformer can be made to work satisfactorily under given conditions and how to complete the design to obtain the desired results.

NORMAN H. CROWHURST*

TRANSFORMERS are things we like to do without in audio, but there are some positions in the circuit and some applications in which they seem to be unavoidable. For example, it is not practical to connect the low impedance of a 50-ohm microphone or pickup directly to the input grid of an amplifier, because the output of the device is not sufficiently above the inherent noise levels of the circuit to give a satisfactory signal-to-noise ratio. For this reason it is highly desirable to use a good transformer to step-up the signal without giving a corresponding step-up in background noise.

So we need to design an input transformer that will give the best possible compromise between maximum step-up to achieve good discrimination of signal against noise and the maintenance of a frequency response that is as good as possible. In general, the bigger the step-up the more difficult it is to maintain a good wide-band frequency response.

Where do we start in designing such a component? The first and most important thing to realize is that one cannot design such a transformer without adequate reference with the circuits with which it is going to be used.

With this fact in mind it is well, for both the designer and the prospective user of such a transformer, to first of all explore the situation on the basis of using a hypothetically perfect transformer. Find out what is the maximum performance a transformer could be expected to achieve, assuming that a perfect one might be available somewhere. Having explored the situation from this aspect, it is evident that a practical transformer will achieve a performance somewhat short of this.

A procedure like this may seem to appear like a waste of time, but in practice it is found to save time because it dictates quite simply a reasonable performance specification to lay down. Without this preliminary exploration one might be striving to achieve a performance that is quite impossible even if the transformer were perfect.

Dynamic Transducers

The commonest application of this type consists of an electro-dynamic transducer, either a microphone or pickup, which requires to be fed through a transformer into the input stage grid of a tube. The dynamic transducer has a source impedance consisting basically of a resistance in series with an inductance as shown at *Fig.* 1, while the grid has an input impedance which is basically capacitive, although there may be a slight resistive element.

If we apply an ideal transformer between these two, the simplest way of visualizing the situation is by consider-

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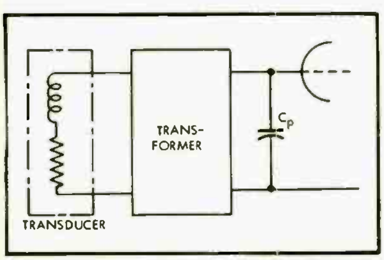


Fig. 1. The commonest function of an input transformer is to couple a low impedance transducer, whose impedance consists of resistance and inductance, to the high impedance grid input circuit of an amplifier. Here C_p stands for the effective grid input capacitance, including that due to wiring strays.

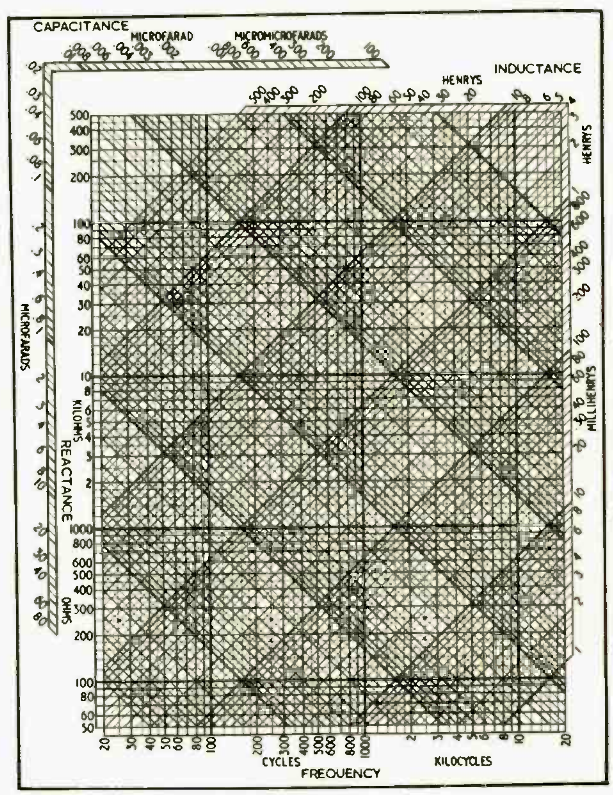


Fig. 2. A reactance chart covering the range most useful in the design of input transformers.

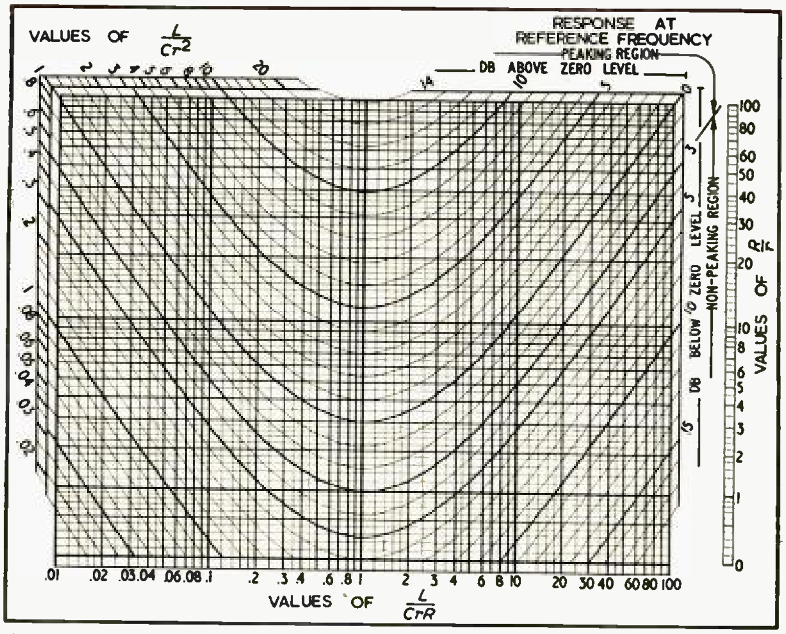


Fig. 4. Chart for determining the response shaping produced by various circuit element combinations. The values of L/Cr^2 at the top and left are for cases where the secondary is unloaded, the db at reference frequency being obtained by following the curves to the top or right side of the chart. Where the secondary is loaded, the equivalent circuit, given at Fig. 7 uses reference values along the bottom and right hand side to locate a position in the body of the chart, the result being read off at the same place.

ing the transformer to multiply the effective grid input capacitance by the square of the step-up ratio of the transformer. Supposing the effective grid input capacitance is calculated to be 30 μμf and the step-up ratio is 100:1; then the capacitance will be multiplied by 10,000, giving an effective shunt capacitance, referred to the primary, of 0.3 μf. This has a reactance of 50 ohms, as shown on the reactance chart of *Fig.* 2, at just over 10 kc.

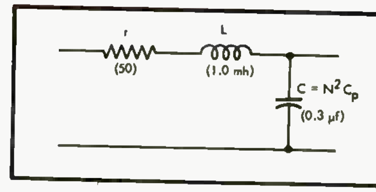


Fig. 3. Equivalent circuit of arrangement discussed in the text. The values in brackets are for the particular case considered.

So a 100:1 step-up from a pure resistance of 50 ohms to a grid with an input capacitance of 30 μμf would produce a response with a rolloff of 3 db at about 10 or 11 kc. This is assuming that the transformer was perfect and did not add any components to the circuit except a straightforward step-up.

But we should also take into account the effect of the inductance component of the transducer. Assume this is 1 millihenry. The basic circuit then consists of 50 ohms, 1 mh and 0.3 μf in the arrangement of *Fig.* 3. From these values we evaluate $\frac{L}{Cr^2}$ as $\frac{10^{-3}}{3 \times 10^{-7} \times 2.5 \times 10^{3}} = 1.33$, and $LC = 3 \times 10^{-10}$. From *Fig.* 4 the first value gives +1 db at reference frequency, while the second value with *Fig.* 5 gives the reference frequency as 9 kc. Next, from *Fig.* 6, we see that a curve with +1 at reference frequency gives a peak of +2 db at a relative frequency of 0.78. In this case this represents a response with a peak of 2 db at about 7 kc, 1 db up at 9 kc and about 12.5 db down at 20 kc.

This is what a perfect transformer will do. If a response not as good as this can be considered acceptable, then design may be proceeded with for a 100:1 step-up transformer for the operating condition. Otherwise, the best plan is to find suitable step-up ratio that is basically capable of producing a response that will be acceptable. Let's assume that we have set ourselves the target of producing a response to better than ±1 db up to 20 kc.

Halving the step-up will reduce the referred capacitance from 0.3 microfarad to 0.75 microfarad. This changes the values to $\frac{L}{Cr^2} = 5.33$ and $LC = 7.5 \times 10^{-11}$ which indicates a response of +7 db at a reference frequency of 18 kc. This arrangement will thus give a response with a peak of a little more than 7 db at a frequency somewhat below 18 kc, but the use of secondary loading will readily pull this peak down.

A value of resistance referred to the input circuit at 125 ohms gives values of

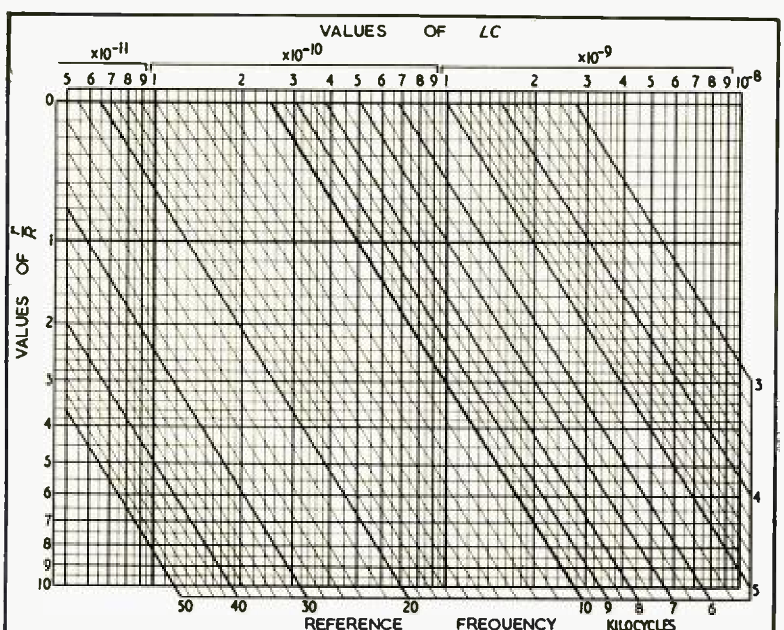
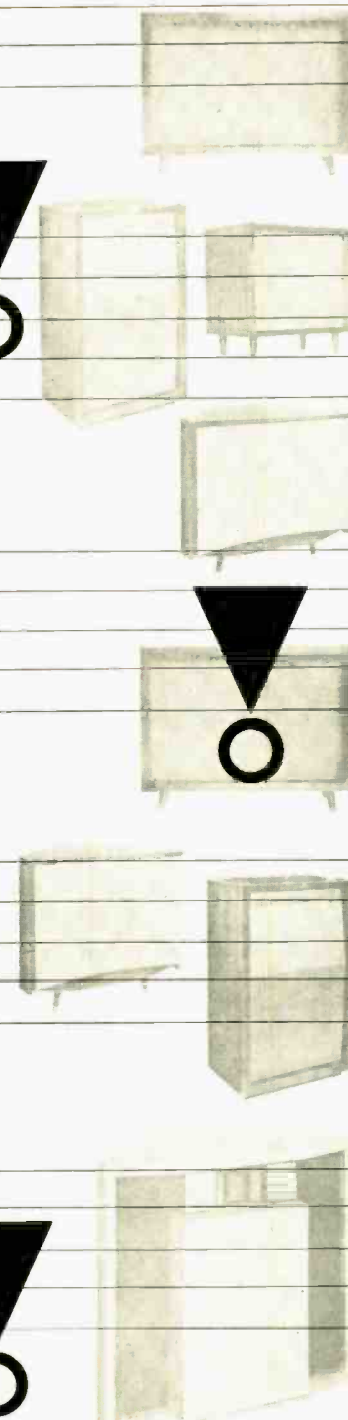


Fig. 5. Chart for determining the reference frequency for the response shaping shown by Fig. 4. If values of L/Cr^2 are used, the line for $r/R = 0$ is used, at the top. Where values of L/CrR are used, the appropriate value for r/R is used, noting that this is the reciprocal of the value of R/r used on Fig. 4.



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$\frac{L}{CrR}$ (see *Fig.* 7) as $\frac{10^{-3}}{7.5 \times 10^{-8} \times 6.25 \times 10^{3}} = 2.13$; $\frac{R}{r} = 2.5$ and $LC = 7.5 \times 10^{-11}$. This indicates a response of −1 db at a reference frequency of 22 kc. So this value of referred resistance on the secondary will load this peak down so that the response is −1 db at 22 kc and has a peak of about 0.6 db at 13 kc. On the secondary side this would require an actual resistance of about 0.312 meg. This arrangement is based on the assumption that we use a 50:1 step-up ideal transformer.

In practice, as we have to apply losses to pull the peak down, it may be possible to use the transformer core losses to serve at least part of this function. But there is another factor that has to be considered in designing a practical transformer. This will introduce additional shunt capacitance in the grid circuit, and also increase the effective source inductance by the addition of leakage inductance. So the values of L and C used to compute the response with an ideal transformer will both have to be increased somewhat, and in all probability this will bring the response below the one just computed for an ideal case. This means that some margin should be allowed, if the over-all response is still required to be within the original limits set.

For some applications, for example the ribbon mike, the source impedance is practically a pure resistance throughout the audio band, in which case the design of the transformer can be considered without needing to take into account the inductance component of the input source. This means that the design of the transformer will only need to consider the inductance component contributed by the transformer itself in the form of leakage inductance for the high-frequency response.

Crystal or Electrostatic Transducer

Another application that could be considered for input transformer is to couple a capacitive source such as a crystal microphone or pickup or maybe even some kind of electrostatic transducer. Here, assuming an ideal or perfect transformer, it might be possible to achieve some gain by using a step-up.

For example, if the grid input capacitance is 30 μμf and the capacitance of the crystal is 500 μμf, it should be possible to employ an impedance step-up of 16:1, or a voltage ratio step-up of 4:1 to achieve optimum matching.

But for this kind of application practical transformers completely fall down on the job. It is quite impossible to design a physical component that will achieve this kind of step-up for working between capacitive source and load impedances. The use of reactive terminating impedances means we have to completely reorient our conception of what different components contribute to the performance of the circuit.

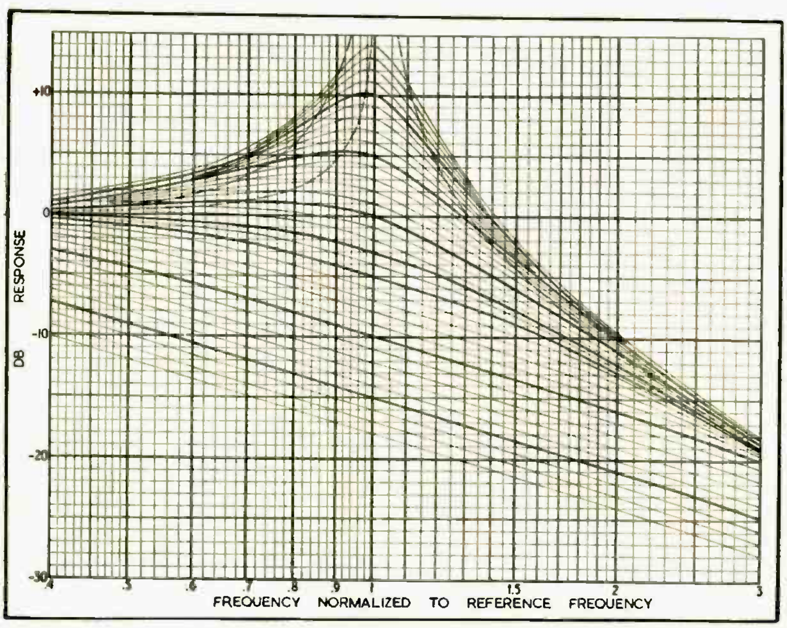

Fig. 6. Response shapings selected by the chart of Fig. 4. Actual frequencies can be calculated from the reference frequency given by Fig. 5. The dotted lines indicate the points of maximum slope on the curves (the outside ones) while the middle one indicates the point of the peak, which is useful in response computation when the peak is not very high.

With resistance termination, core losses, appearing as a shunt resistance, merely present insertion loss throughout the entire spectrum—except where they may be useful in damping peaks as just mentioned. Winding resistances also contribute to insertion loss. But between reactive source and load impedances, any resistance has frequency discriminating effect.

A shunt resistance, such as a core loss represents, will produce a low-frequency rolloff which will have its 3-db point where the resistance is equal to the referred reactance of the source and load combined in parallel. Series resistance, such as will be contributed by winding resistances, produces a high-frequency rolloff, the 3-db point of which will be at a frequency where the total referred resistance is equal to the combined reactance of the source and load referred in series.

Assuming for the moment that primary inductance can remain infinite, leakage inductance zero, and winding capacitances zero, it appears that the losses in the transformer will result in a frequency response with a rolloff at each end, without taking into account its essential reactances.

Assume the transformer is 80 per cent efficient, which is a reasonably good power transfer efficiency for an input transformer because of its small size—and it would have to be physically small to achieve even an approximation to zero leakage inductance and winding capacitance. Then the core loss, referred to any given winding, will not be more than 100 times the total winding resistance referred to the same winding which means that the spacing between the 3-db points on the low-frequency and high-frequency rolloffs, as contributed by losses alone, will be not more than about a ratio of 400:1. To get a wider frequency response it will be necessary to have a transformer of higher nominal efficiency.

(*To be continued*)

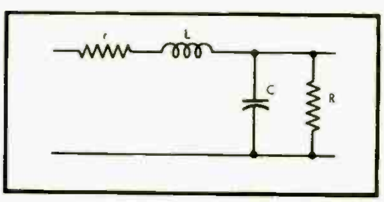

Fig. 7. Basic circuit for the high frequency response of an input transformer: r is the source resistance, and L the source inductance (if any) plus the transformer leakage inductance referred to the primary; C is the total secondary shunt capacitance referred to the primary (i.e. multiplied by the square of the step-up ratio), while R is the secondary load resistance (if any) referred to the primary (i.e. divided by the square of the step-up ratio).

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AUDIOCLINIC ? ?

JOSEPH GIOVANELLI*

We are pleased to have helped as many readers as we have with the problems confronting them concerning audio. Your cards and letters have been most encouraging, and so we are expanding our service to you. If your question does not appear in the column, either because it is not of sufficiently general interest or because of space limitations, it will be answered by mail. This will enable more people to benefit from this column. Questions sent directly to me at the address given will reach me directly and so can be answered more promptly than those sent to AUDIO's office. Please enclose a STAMPED, SELF-ADDRESSED ENVELOPE with your question.

Tuner Connections

Q. Can the tuner described in Audioclinic, Dec., 1955, be fed into a magnetic pickup channel, as there is no microphone input provided on my preamplifier? H. Snyder, Philadelphia, Pa.

A. If the input has a flat response, or uncompensated position, the tuner may be fed into it. If it has not, the tuner must not be so connected if quality performance is to be had. A magnetic input is normally not flat, having a treble rolloff and a bass boost. Thus, the tuner would, when fed into such an equalized circuit, lack highs and have an exaggerated bass response. Assuming that there is a flat response position on your equalizer selector switch, there is still one more problem: this type of input is often terminated in a 47,000-ohm grid resistor whereas, because of the size of the coupling capacitor, C_6, (in the December figure) in its output, the tuner should be terminated in a minimum of 0.5 megohms for adequate low-frequency response. To compensate for the low resistance of the preamplifier grid circuit, change the coupling capacitor, C_6, from a .02-μf to a 0.1-μf, 200-volt d.c. rating.

Many magnetic pickup channels are not provided with a flat response position, making them, as has been previously noted, unsuitable for use with this tuner. The schematic in *Fig.* 1 is a preamplifier especially designed for use with this tuner. It may be fed into one of the high-level inputs on your amplifier, such as that used for a tuner or a crystal phonograph pickup. The first stage of this preamplifier is a 6SJ7 feeding a 6J5 cathode follower output. We have incorporated the circuit for the 10,000 cps whistle filter described in AUDIOCLINIC, Dec., 1955, in the grid circuit of the cathode-follower stage. The power supply needed in conjunction with this unit must be capable of supplying 6.3 volts a.c. at 2 amperes and 250 volts d.c. at 30 milliamperes, well filtered. Power for the preamplifier may be obtained either from your basic amplifier or from its own power supply. If the tuner has not yet been constructed, it would be practical to house it in the same cabinet with its preamplifier, making for an extremely compact unit.

Amplitude Modulation

Q. What is meant by amplitude modulation? L. Hilliard, Reno, Nevada.

A. The sine waves shown in *Fig.* 2 represent a transmitter sending out a signal with no program material impressed on it. The process of impressing such information on the transmitted wave (carrier) is modulation, be it amplitude, frequency, phase, pulse, or what have you. In amplitude modulation (AM), the vertical distance between crests and troughs changes, and at a rate dependent upon the frequency of the program source at the time. If the change in the size (amplitude) of the wave is small, the volume output will be low. If there is a large change in amplitude, high volumes will be heard by the listener. Remember that when two signals combine in non-linear fashion they beat or heterodyne. After this beating process, we have the original frequencies and also the sum of the two and their difference. (Let us assume our carrier frequency to be 1000 kilocycles per second; let us impress upon that carrier a 1000-cps tone. This tone will beat with our carrier, forming at least two other frequencies: 1001 kc and 999 kc, the sum and the difference of 1000 kc and 1 kc. The two beat tones thus produced are known as side-bands.) We are concerned with the sum, the difference, and the carrier, as the audio frequency impressed on the carrier is not radiated because the antenna is not designed to radiate frequencies in the audio spectrum. These three signals are passed through the various amplifier stages in the receiver, finally reaching the detector. All of these three frequencies are considerably above the audio spectrum. It is the purpose of the detector to reconvert these three into the 1000-cps tone originally transmitted. This is done by using the sum and difference produced by the beating that now takes place in the receiver, just as it did in the transmitter. The three frequencies are rectified and filtered so that they cannot enter the audio stages of the receiver but the beat between 999 kc and 1000 kc (1000 cps) is allowed to enter these audio stages and eventually be heard.

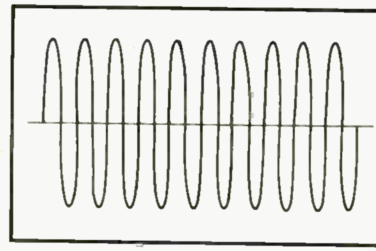

Fig. 2. Unmodulated carrier wave.

Electrostatic Loudspeakers

Q. What is the principle of an electrostatic speaker? H. F. Robbins, N. Y. C.

A. Such a speaker is very similar in operation to a condenser microphone. It consists of a movable plate and a fixed one. A fairly high d.c. voltage is applied across the two. The attracting force thus created causes the movable plate to come closer to the fixed one. This becomes the center, or rest position, of the speaker. Effectively, an a.c. voltage is connected in series with the d.c. previously mentioned. During one-half of the a.c. cycle, its voltage is such as to be added to the d.c. voltage, causing the attracting force to increase and hence, the movable plate to come even closer to the fixed one. During the other half of the cycle, the polarity of the voltage is in such a direction as to cancel some of the d.c., causing the attraction between the two plates to be lessened with respect to the static or rest position, which, in turn, causes the moving plate to increase its distance from the fixed plate. Actually, the movable plate is not so free to move as it might appear from this explanation. If it were, a certain amount of non-linear operation would result, and if the motion could be sufficiently great, it would touch the fixed plate, shorting the power supply and probably damaging it and the speaker.

In practical electrostatic loudspeakers there are two fixed plates and one movable diaphragm, thus providing a push-pull action which minimizes distortion. The circuit must be so arranged that the low and middle frequencies are prevented from entering the speaker or, again, distortion and possible damage to the speaker and the d.c. power supply are likely.

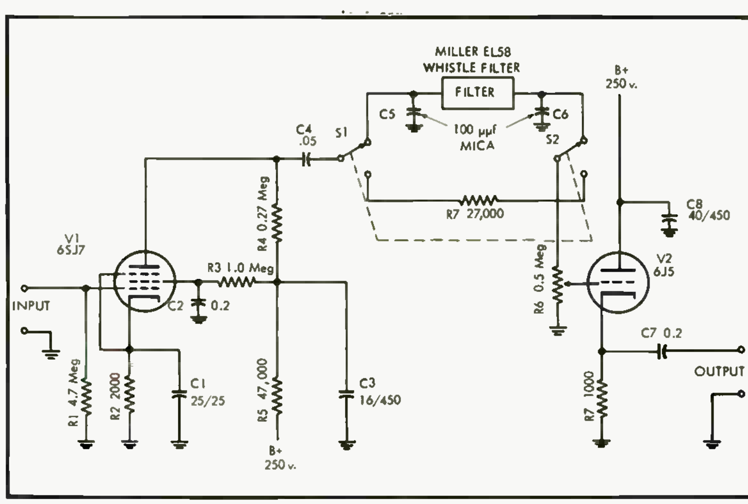

Fig. 1. Preamplifier used for high impedance or crystal tuner and designed to feed a high-level input in the usual control unit.

* 3240 Newkirk Ave., Brooklyn, N. Y.

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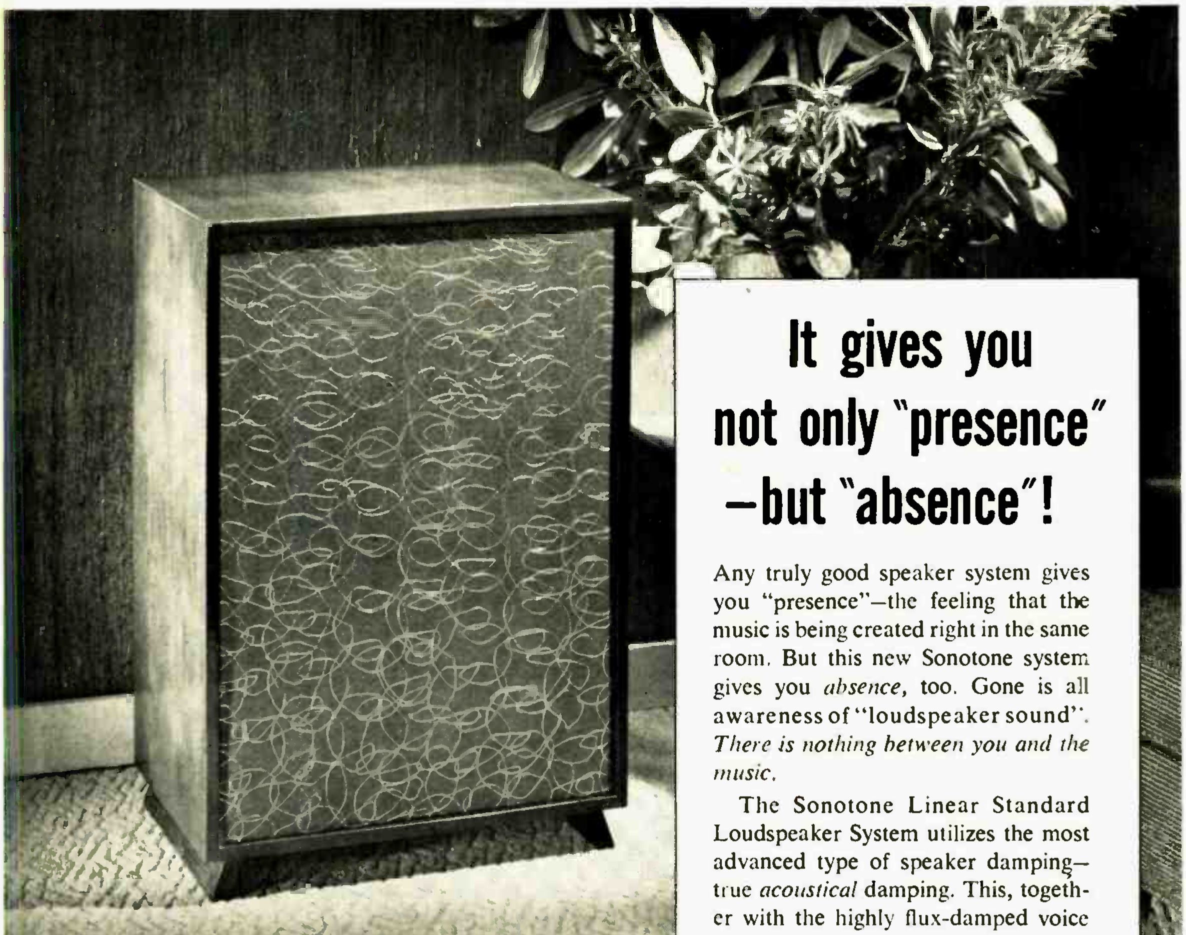

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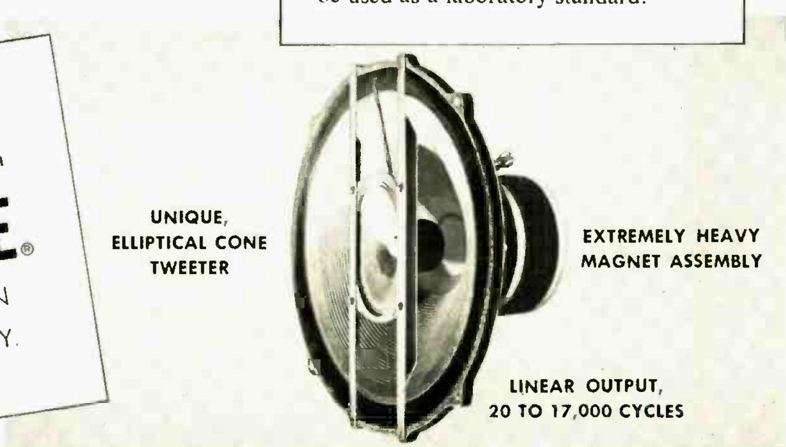

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Speaker Enclosures

EDGAR M. VILLCHUR*

Sound–Chapter 10, Part I

To operate properly, a loudspeaker must be housed so that the sound waves from the front are not cancelled by those from the rear of the cone. The author discusses various types in simple terms.

THE FUNCTION of the loudspeaker "motor" is to produce mechanical vibrations in the voice coil, corresponding to the acoustical vibrations of the original voice or music. When this has been done, however, the task of recreating the sound is far from completed. We must couple or communicate the mechanical vibrations to the air, and the way in which we do this has a profound effect on the workings of the motor itself.

The voice coil, vibrating alone, can accomplish little in the way of radiating sound. It has no bite of the air, and even though it were to move back and forth vigorously it could do almost no useful acoustical work. It would be as ineffective as the shaft of an electric fan with the blades removed. And so we attach a diaphragm to the voice coil, to give it some air to work against.

But this does not wholly solve the problem, as anyone knows who has ever listened to an unmounted speaker sitting on a table. Even with its diaphragm, an unmounted loudspeaker reproduces very little bass. The cone becomes decoupled from the air of the room at lower frequencies, for reasons that we will examine in a moment. It is at these lower frequencies that the speaker mounting device or enclosure becomes indispensable; the primary function of the enclosure is to keep the diaphragm coupled to the air at the lower part of its frequency range.

A casual perusal of a sound equipment catalog, or of the advertisements in a magazine devoted to sound reproduction, would apparently indicate the fact that there is a very large number of speaker enclosure designs, each with its unique properties. But there are only three basic types of mounting device, each, of course, with variations on the basic theme. These three types may be categorized as the direct-radiator baffle, the resonant enclosure, and the horn.

* *Acoustic Research, Inc., 25 Thorndike Street, Cambridge 41, Mass.*

The Direct-Radiator Baffle

When a speaker cone moves forward it simultaneously compresses the air in front of it and rarefies the air behind it. At high frequencies the wavelengths are short, and the cone itself acts to "baffle" or separate the front wave from the back wave. But at low frequencies the areas of compressed air in front of the cone are in direct contact with the areas of rarefied air at the back: the molecules of air hasten around the edges of the speaker to equalize things.

Thus the vibrating cone sets up a vibratory low-frequency wind around its edges, as illustrated in (A) of *Fig.* 10—1, but radiates little bass energy. The pressures and rarefactions in front of the cone are sapped by the opposite rarefactions and pressures behind it, and never get to work on the air of the room. This type of energy source is called a *doublet*—it has two parts, each radiating out of phase with the other, and cancelling the effects of its mate.

The solution to the doublet problem is quite simple—it is to insert an external baffle between the air in front of the speaker and the air behind it. In practical terms we saw a hole in a piece of rigid material, and mount the loudspeaker against the hole in such a way that it faces its audience through the opening. In this way the circulatory currents of air around the speaker edges are stopped, as illustrated in (B) of *Fig.* 10—1, and the pressures and rarefactions produced in front of the speaker can only move outward.

That is really all there is to it: the theoretical problem of preventing the speaker from losing its bite at lower frequencies is completely solved. The solution has its drawbacks from the practical point of view, but if the cone vibrates in an accurate replica of the input signal, simple baffling probably introduces the least amount of change in the conversion from mechanical to acoustical energy.

The practical problems involved relate to size, and to the fact that in a direct-radiator system the greatest burden is placed on the fidelity of the speaker mechanism: for a given sound output the cone has to move the farthest. There are three approaches to meeting these practical problems: wall mounting, use of a large, totally enclosed cabinet (a variation of which is the Hartley "boffle"), and employment of the "acoustic suspension" system.

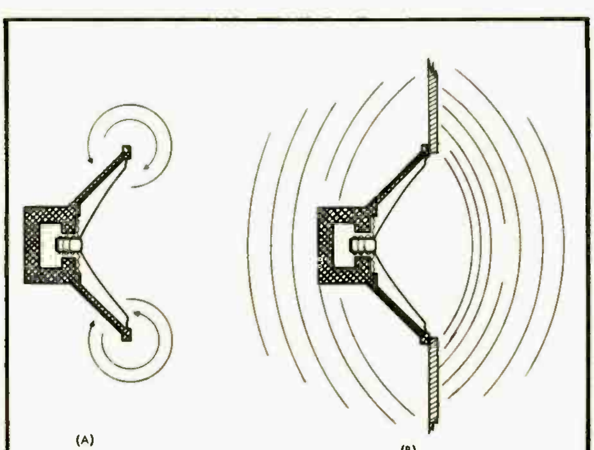

Fig. 10—1. (A) Interaction between front and back of unmounted speaker. (B) Baffle prevents front and back waves from cancelling.

Wall Mounting

If we are to prevent interaction between the front and back of the cone successfully, the diameter of the baffle must be equal to at least half a wavelength at the lowest frequency that we are concerned with. This means that, for baffling a direct-radiator system down to 40 cps or so without losses, a baffle 14

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Model K-11, complete with hysteresis motor	$445.00
Recorder mechanism only, with hysteresis motor	259.50

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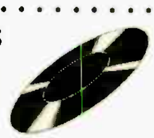

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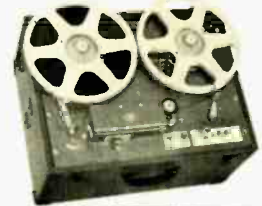

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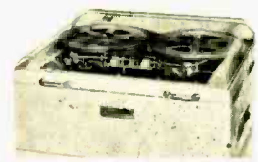

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feet across is required. The impracticality of such a piece of furniture is obvious.

However, such baffles are effectively built into every house, in the walls between rooms, or those covering a stairwell or closet (provided the landlord is willing that they be considered as such). Wall mounting provides about as excellent and trouble-free a method of speaker "enclosure" as can be had. The rules that must be followed are relatively simple, compared to those for the more complicated enclosures. These rules are:

1. The speaker must not face into a tunnel-shaped opening, either forward or backward. Such an opening will tend to act like a resonant organ pipe, and will itself "speak" its own tones in the upper bass.
2. The speaker must be securely anchored.
3. The rear of the speaker must not be enclosed by a volume of limited dimensions (see the discussion following on totally enclosed cabinets).

One method of mounting a loudspeaker in a wall is illustrated in *Fig.* 10—2. When all of the conditions referred to are satisfied this type of mount is called an "infinite" baffle.

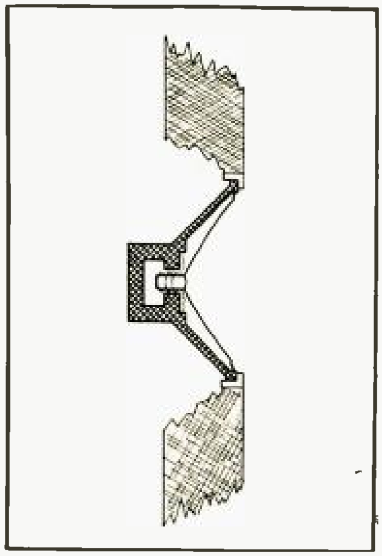


Fig. 10—2. Speaker mounted in a wall, avoiding pipe-shaped space formed by thickness of wall.

Totally Enclosed Cabinets

The characteristics of the infinite baffle may be closely imitated by the use of a totally enclosed cabinet. Here, as in the case of wall mounting, all interaction between the front and back of the speaker is prevented, but new problems are also introduced.

The most important of these new problems is the effect of the volume of air enclosed by the cabinet, which the rear of the cone must compress and expand when it moves in and out. This volume of air constitutes a pneumatic spring, and it increases the spring tension of the speaker's mechanical system.

Now there is nothing wrong with spring tension in the mechanical system of the speaker. Such spring tension has, as a matter of fact, been built into the speaker, in the elastic suspensions used to hold the cone and voice coil centered. These suspensions, as we have seen, partly determine the bass resonant frequency of the speaker's moving system.

But the proper amount of spring tension has been built into the speaker, and the resonant frequency is already as high as has been intended. (Although we would like the bass resonant frequency to be as low as possible there is a lower limit for a given speaker: too low an elastic restoring force in the suspensions permits the voice coil to travel beyond the range of uniform magnetic flux, and introduces distortion in the low bass.)

When the pneumatic spring of the cabinet's enclosed air is added to the mechanical springs of the speaker suspensions, the resonant frequency is raised. If the volume of air in the cabinet is very large[1] the pneumatic spring is weak and the effect is negligible: if the cabinet volume is too small the pneumatic spring is stiff, and the resonant frequency may be raised as much as an octave. We already know that we must expect bass attenuation, at 12 db/octave, below the resonant frequency: we thus stand to lose heavily in the bass unless our cabinet is of very large dimensions.

Other precautions that must be observed in using totally enclosed cabinets are:

1. The cabinet must be very rigid and vibration-proof. Three-quarter inch plywood, held together by screws and glue, and having ribs spaced about a foot apart, is one way of achieving this rigidity. Another method, that has been suggested by G. A. Briggs, is to use sand-filled panels.

2. The interior of the cabinet must be lined with sound absorbent material (such as Fiberglas in 4-inch thicknesses) to prevent standing waves and air-column resonances from forming within the cabinet. The enclosure must not act like a closed pipe.

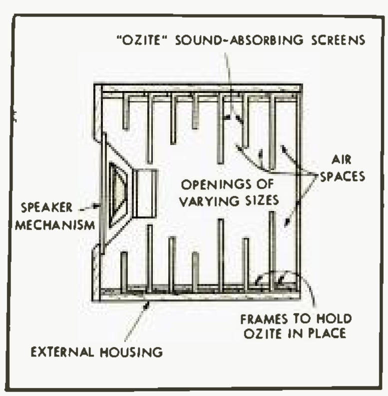
It is interesting to note that the sound-absorbent material does not decrease the effective interior volume of the enclosure from the point of view of its pneumatic stiffness, but actually increases it. When the cabinet is filled with such material the effective elastic compliance or "give," and hence the effective cubic volume, may increase as much as 1.4 times.

3. Sound is refracted from the edges of the speaker cabinet: it is therefore a good idea to mount the speaker somewhat off-center, to avoid cancellation from edge refractions.

A variation of the direct-radiator speaker cabinet is provided by the Hartley "boffle." In this unit a system of successive layers of sound-absorbent material is employed in the enclosure to absorb most of the rear wave, but the

(*Continued on page 61*)

[1] Conservative dimensions for totally enclosed cabinets are: 15-in. speaker, 15 cu. ft.; 12-in. speaker, 9 cu. ft.; 8-in. speaker, 4½ cu. ft. Reduction of these figures by 25 per cent or so does not usually involve much of a sacrifice.



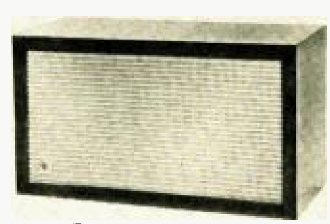


Fig. 10—3 Types of direct-radiator systems in commercial practice:
(left) Totally enclosed cabinet
(Courtesy R. T. Bozak Sales Co.)
(center) Hartley "boffle"
(Courtesy Hartley Products Co., Inc.)
(above) Acoustic suspension system
(Courtesy Acoustic Research, Inc.)

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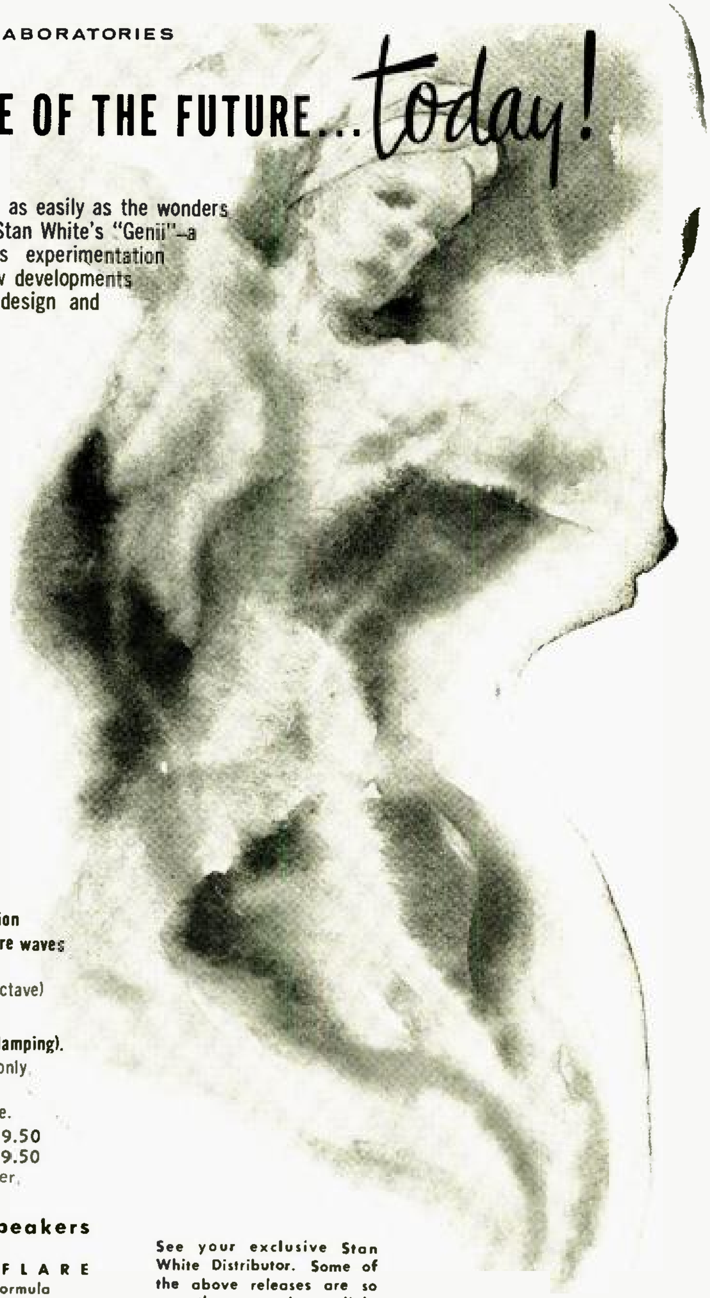

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"Friction-Loaded" Cabinet - - Preliminary Report

A detailed description of an improvement on the basic bass-reflex principle which is claimed to have certain advantages. Tried experimentally, the design lives up to its promise, and offers a simple and effective method of eliminating the "boom" from the "boom box."

C. G. McPROUD

SOME MONTHS AGO, we received a manuscript (which will appear in full in the August issue) in which the author, Edward James Jordan of Goodmans Industries, proposes an interesting theory relating to bass-reflex cabinets. This type of acoustic phase inverter is perhaps one of the most maligned elements of hi-fi equipment, and not always rightly so. It is a fact that there are some cabinets of this type which are somewhat less than perfect, but it is equally certain that for the space involved and the simplicity of the construction, a bass-reflex cabinet can give a very good account of itself. Several years ago, Drisko[1] presented a method which is still referred to as one of the serious and effective treatments of the alignment of a bass-reflex enclosure. The basic premise in Mr. Drisko's article was that the port should be "loaded" with some acoustic resistance to damp the resonance of speaker and cabinet, and many readers have followed this method with excellent results. Basically the object was to cover the port with more or less thickness of burlap or some other fairly heavy material until the resonance disappeared. Mr. Jordan, however, goes somewhat further.

As is fairly well known, the presence of a port on a cabinet eliminates the resonant peak of the loudspeaker mechanism and substitutes two smaller peaks—usually with one on each side of the speaker resonance —both of which are of much smaller magnitude than the single peak was. If the port area is exactly right for the combination of speaker and cabinet, both peaks are of the same magnitude. If the port is too small, the lower peak has the greater amplitude; conversely, if the port is too large, the upper peak is the greater.

Mr. Jordan proposes, in the friction-loaded enclosure, that the *total* port area be adjusted to the correct value, but that part of the total area shall be an unobstructed opening and part of it shall be an opening with a high acoustic resistance. His solution, in practical form, was to make a small port of the usual type with no obstruction in front of it and to finish out the total amount of port area with a series of thin slots which could best be made by cutting a series of saw slots. Thus, in effect, the small unobstructed port would tend to boost the amplitude of the lower-frequency peak, yet the total area would be correct for the balancing of the two peaks. The effect of the thin slots—that of adding acoustic resistance across the resonant circuit comprised of the air mass and stiffness—was to damp out the upper peak; the lower peak was essentially allowed to build up to its normal value, and since it was in the frequency range where the speaker itself falls off in response, the over-all tendency would be to have a flat response throughout the low-frequency ranges.

Suiting the Action

The whole proposal sounded like such a good idea that we assembled some equipment to try it out. Inasmuch as Mr. Jordan is with Goodmans Industries, it seemed only logical to choose a Goodmans Axiom 22 speaker mechanism for the test. This writer has long favored the back-loaded corner cabinet with direct radiation from the front of the cone and with horn-loaded reflex ports coming out between the walls and the sides of the cabinet—a design similar to one presented by the writer as long ago as 1949[2]. A simple cabinet of this type is the Klipsch Rebel series, with the medium-sized model fitting in with the requirements of a 12-inch speaker as well as with the needs of the smaller living-room for practical size. For the experiments we persuaded Cabinart to part with a Rebel IV enclosure.

Specifications

According to Mr. Jordan, the optimum volume of the cabinet for a 12-inch speaker should be 7800 cu. in., with a tolerance of ± 10 per cent. The Rebel IV is approximately 6800 cu. in., slightly smaller than recommended, but we tried it out anyway. The open port is recommended to have an area of 16 sq. in., with the same tolerance, and the total slit area is recommended for 18 sq. in. Each slit should be not less than 1/32 in. wide and not more than 1/10 in., and the length should not be less than 200 times the width. It was also specified that the distance through the slit should be not less than ¾ in. and not more than 1¼ in.

In other words, we took some liberties with the original specifications, so we made the unit somewhat adjustable. The Rebel IV cabinet has a "port" along the back, its dimensions being 28 in. long by ⅜ in. wide. This particular "side" of the cabinet is only about 4 in. wide, so we cut an opening of some 20 sq. in. at the bottom of this panel, and arranged a slide which could be moved to vary the opening at will.

Construction

None of this was difficult to do, but during the experimentation the back of the cabinet was taken off and put back on so many times that it was finally necessary to increase the length of the screws to make them hold tightly. The port opening could be varied from outside, and was adjusted by means of a series of impedance measurements. Then we would cut two slits, reassemble the cabinet, and make more measurements. This continued for some time, as can well be imagined, but in the doing of this step-by-step operation, much information was gained. Mounting curiosity caused us to experiment with different cabinet linings after the measurements began to shape up to our satisfaction, and we obtained more information about the effect with no lining, and with linings of different types—Kimsul, Ozite, and tightly cemented felt recommended by Ingalls Electronics Co.,[3] distributor of a felt suited to this purpose.

Results

The results will appear next month, together with sufficient information to show the direction anyone could go in the same sort of experimentation.

[1] Benjamin B. Drisko, "Getting the most out of a reflex-type speaker," AUDIO ENGINEERING, July, 1948.

[2] C. G. McProud, "A new corner speaker design." AUDIO ENGINEERING, January-February, 1949.

[3] 30 Putnam Ave., Greenwich, Conn.

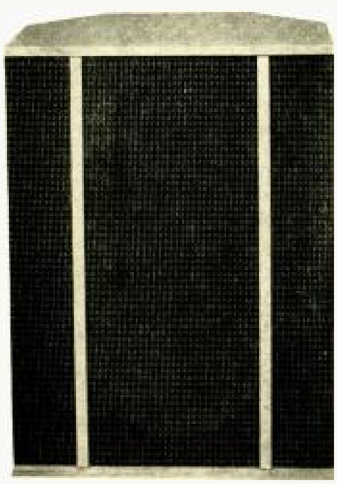


Fig. 1. Cabinart "Rebel IV" corner speaker cabinet chosen for the experimentation.

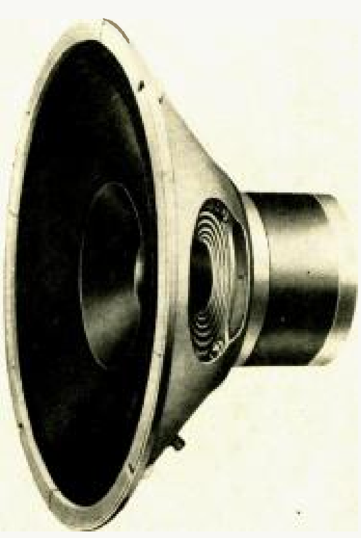
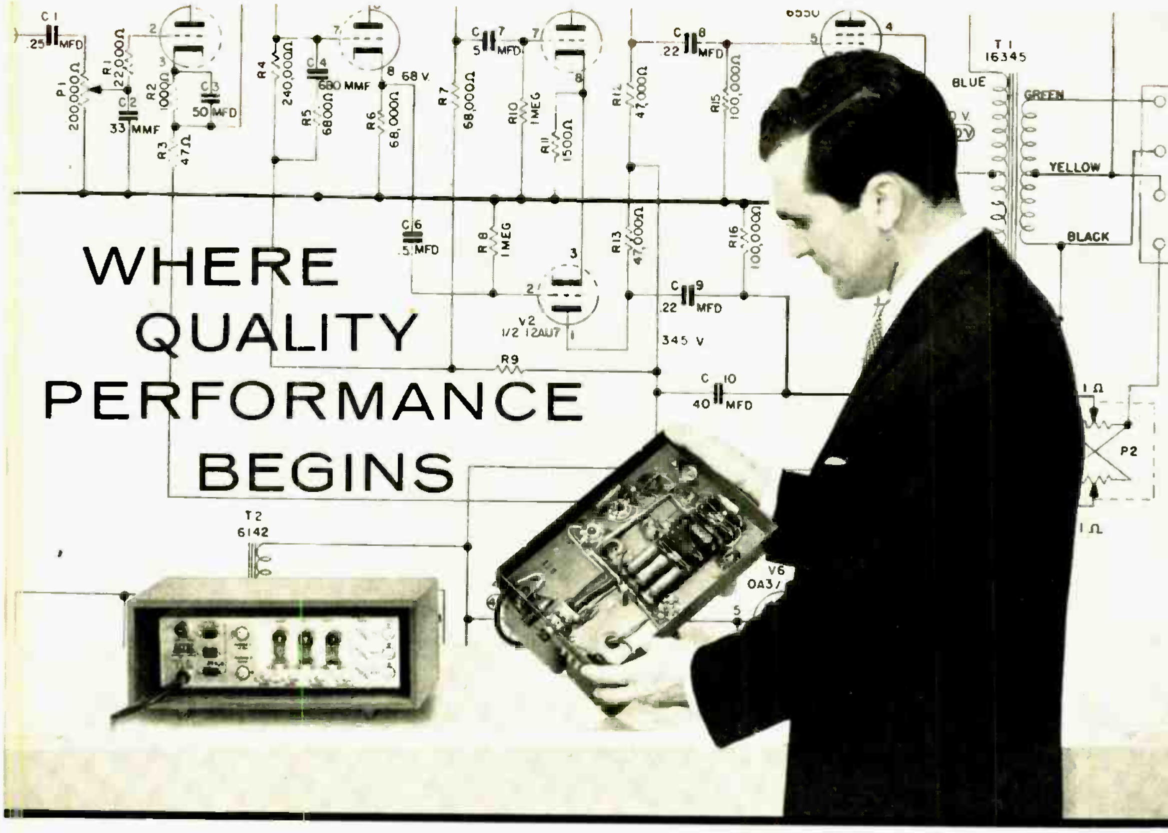


Fig. 2. Goodmans "Axiom 22"—a 12-inch cone with an auxilliary high-frequency radiator.



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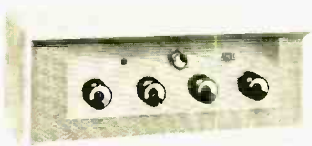

339B MELODIST AMPLIFIER
10 watts of power at less than 2% thd · frequency response 20-22,000 cps · system gain 132 db maximum · three inputs; one low level, two high level · maximum control with four compensation curves, separate treble and bass controls · mahogany or blond hardwood cabinets*...$129.00

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highest power: 35 watts at less than ½% thd · frequency response ± 1 db, 5 to 100,000 cps · noise level −40 dbm: 85 db below rated output · heavy duty tube complement: 1-12AY7, 1-12AU7, 2-6550, 1-5U4GB, 1-0A3/VR75 · simplified circuitry for exceptional stability and long life...$159.00

*ALL ALTEC LANSING FURNITURE CABINETS BEAR THE SEAL OF THE FINE HARDWOODS ASSOCIATION

Be Your Own Record Critic

Match your skill with other readers and get paid off in records of your own choice—as these three have.

FIRST, this month, goes to William Page of Galveston, Texas, for his brief but concise summary of the value of the "Kid Ory" Contest record. Second prize goes to another type of review, George W. Windolph's detailed descriptive account from Natick, Mass. And third honor must go to Fred H. Schwartz, Jr., of Columbus, Ohio, who also came through last month; Mr. Schwartz's critical comment plus his personal recollections add up to a good account.

Odd, isn't it, that we got less than 50 per cent as many reviews of this Dixieland jazz as we did of Stravinsky's "Fire Bird". Who says nobody listens to the classics?

—*E.T.C.*

Mr. Canby's Review:
Kid Ory's Creole Jazz Band
Good Time Jazz 1-12008

I'm no proper authority on jazz like this – I just like it. We chose this for the contest record as a good example of one very active side of present-day recording, and we hoped, naturally, to dig out some interesting ideas and talent from our readers who also like this kind of music—and this kind of fi.

This is old fashioned jazz, not at all progressive and, surely, none the worse for that. If you are a semi-outsider, you won't be one of those who gets hot under the collar over the difference between traditional jazz and the modern or progressive, since both have things to offer. Actually, I find I have more to say about the modern jazz, because it is fast involving itself with all sorts of aspects of the "classical" world of music. But I thoroughly enjoy listening to the old stuff.

For one thing, as here illustrated, it has fully achieved its style and manner: it is perfected, settled, and so highly effective. No muddling around, no experimenting, no fishing for new things. That makes for good listening, for musical efficiency.

For another, it strikes me that the emotional tempo of this old-style jazz is remarkably leisurely, relaxed, comfortable, compared to the more frenzied music of much later-style jazz. Why not? This is an echo of other, less atomic times.

I won't try ot vouch for Kid Ory's present performance as compared with other music of the same school, though I know he is one of the real old timers. It sounds good to me, and the recording is ultra hi-fi, close-up but full-bodied. There's a remarkably big bass sound, too, the result of some fairly calculated mike placing, I'd guess. Real big thump.

And Mr. Page's:

Although the situation is rapidly improving, a good microgroove jazz record is still a rarity, since most of them are lacking either in talent or in quality or both. Here then is an exceptional record for not only is it high fidelity but it features Kid Ory, the famous New Orleans jazz trombonist, with a small group of talented musicians. Kid Ory, long on fame, has been unfortunately short on recordings since the 1920's, but here he shows that he has lost none of his skill over the years. He plays a type of New Orleans Jazz that is quieter than most, but which is marked by his amazing originality and versatility.

There are nine numbers on the record, and for lagniappe Kid Ory's own recipe for crawfish bisque creole appears on the back of the jacket.

Mr. Windolph, second prize winner, takes a different approach with considerably more detail about the music itself:

Like most records, this is two-sided, but in this case it is a shame to call either of them Side 2. From the beginning with the Ory-composed "Savoy Blues" to the final "Indiana" it is a sterling example of the creole style pioneered by Ory. Throughout the record there is a fine lead trumpting by Alvin Alcorn, and calm but effective rhythm support from Ed Garland on bass and Minor Hall on drums. In "A Closer Walk with Thee" a beautifully religious effect is achieved in the opening clarinet solo. This is quietly supported by bass, guitar, piano, and drums. "Shake That Thing" provides a quick change of pace and features a "toothless" vocal by Minor Hall. "Tin Roof Blues" features fine playing in takeouts by clarinet, trumpet, trombone, and piano, then winds up with excellent growl trombone by Ory. He then continues with the opening lead in "Indiana" which goes on to an ensemble finish as do all the others.

So much for the results of the second contest—will you be in the winners column next month?

Prize Choices

As first prize winner, Mr. Page receives a choice of three records reviewed by Mr. Canby in the April issue, and he selected:
Clementi: Piano Sonatas Westminster WN 18091
Mozart: Early Quartets Westminster WN 18092
Sweelinck: Music for Harpsichord Vox PL 9270

Mr. Windolph, noting "From Kid Ory to this," chose Sweelinck: Music for Harpsichord Vox PL 9270
Vivaldi: Concertos for Two Trumpets, Concertos for Oboe Concert Hall CHS 1242

Mr. Schwartz requested:
Mozart: Litaniae Lauretanae, K. 195. L'Oiseau-Lyre OL 50085

BE YOUR OWN RECORD CRITIC

Choice of LP records for three best reviews sent in each month.

Simple as that! Just write your own review on the record selected by Mr. Canby for the "Problem of the Month," send it in, and perhaps yours will be one of the fortunate three chosen by the judges. If your review is first, you may select any three records reviewed in this issue; if yours is second, you may select two; the third choice may select any one record. Your selections will be shipped to you postpaid at no cost to you.

Each month, Mr. Canby will name one record as the "Problem of the Month." Listen to it, study it both as to music and as to recording quality. Then write a brief review on a postcard—no other entries will be considered—and send it to AUDIO, Dept. RR, P. O. Box 629, Mineola, N. Y. so that it arrives on or before July 5, 1956. Winners will be announced in the August issue, and the review chosen as first will be published, along with Mr. Canby's own review, in the same issue.

For this month's problem, Mr. Canby has selected:

Tschaikowsky: Symphony #4. Boston Symphony, Munch.
RCA Victor LM 1953

Buy it, borrow it, or just listen to it somewhere—then tell us what you think about it.

RULES

1. Decisions of the judges are final and no correspondence will be entered into regarding entries or choices of the judges.
2. Reviews of the selected record must be submitted on a government postcard. No others will be considered.
3. Only one entry will be considered from each contestant.
4. All entries are to become the property of Radio Magazines, Inc., and the one chosen as first will be published.
5. From the list of records reviewed by Mr. Canby in the issue in which the "problem record" is announced, the writer of the review chosen as first will be given three records of his choice; the writer of the review chosen as second will be given two records of his choice; the writer of the review chosen as third will be given one record of his choice.
6. Entries will be judged on the basis of both musical and technical accuracy. Neatness and form will not count, but the reviews must, in the opinion of the judges, be sufficiently legible to be read easily.

AT HOME WITH AUDIO

(from page 26)

tuner, record playback, and of course a preamplifier. Later came the basic tape recorder with 7-inch reel deck, followed by a spooling unit holding 10½-inch reels. As to future additions or modifications, he is planning to build a 50/60-watt amplifier with separate power supply; buying another tape recorder with half-track heads and 7-inch reels for dubbing tape to tape.

Past and present, the system boasts the following well known units, which we list in abc order:

1. Browning FM tuner, RV-31
2. Electro-Voice microphone, V-3, Vari-Z
3. General Electric RPX-041A cartridge
4. Heathkit Preamp-Equalizer WA-P2
5. Heathkit Williamson amplifier WA-1, 20 watts.
6. Livingston Universal 16-inch pickup arm
7. Magnecorder tape recorder, PT6-AH
8. Magnecorder amplifier, PT6-J
9. Magnecorder auxiliary spooling mechanism, PT6-M
10. Presto recording head, 1-D
11. Rek-O-Kut 12-inch playback turntable, LP743
12. Rek-O-Kut 16-inch turntable for recording
13. Rek-O-Kut 16-inch overhead lathe, Master Pro M-5
14. Goodmans 12-inch Axiom 22, Mark II, coaxial speaker
15. Jensen 8-inch wide-range speaker
16. Cabinart Rebel 4 speaker enclosure
17. Audio Disc chip chaser.

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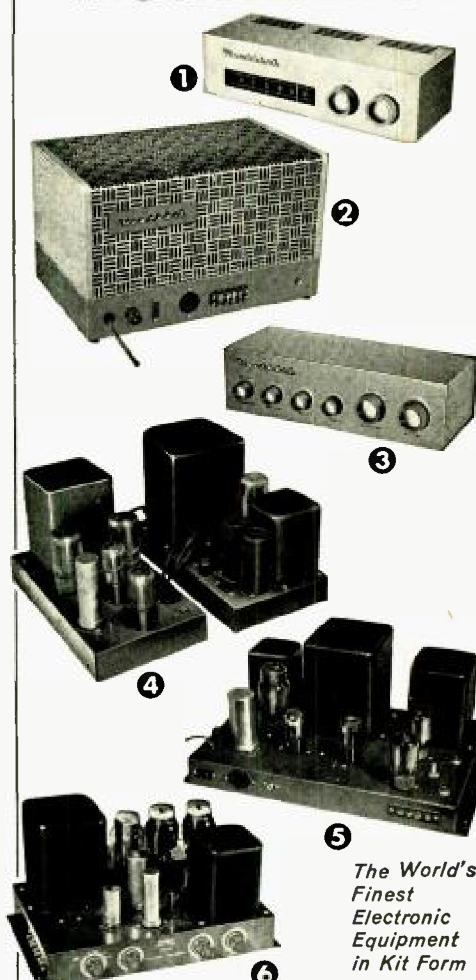


❶ Heathkit FM TUNER KIT

Features brand new circuit and physical design. Matches WA-P2 Preamplifier. Modern tube line-up provides better than 10 uv. sensitivity for 20 db of quieting. Built-in power supply.

Incorporates automatic gain control—highly stabilized oscillator—illuminated tuning dial—pre-aligned IF and ratio transformers and front end tuning unit. Uses 6BQ7A Cascode RF stage, 6U8 oscillator—mixer, two 6CB6 IF amplifiers, 6AL5 ratio detector, 6C4 audio amplifier, and 6X4 rectifier. Shpg. Wt. 7 Lbs.

MODEL FM-3 **$24.50**

❷ Heathkit 25-Watt HIGH FIDELITY AMPLIFIER KIT

Features a new-design Peerless output transformer and KT66 output tubes. Frequency response within ±1 db from 5 cps to 160 Kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20-20,000 cps. IM distortion only 1% at 20 watts. 4, 8, or 16 ohms output. Hum and noise, 99 db below rated output. Uses 2-12AU7's, 2-KT66's and 5R4GY. Attractive physical appearance harmonizes with WA-P2 Preamplifier. Kit combinations:

W-5M AMPLIFIER KIT: Consists of main amplifier and power supply, all on one chassis. Shpg. Wt. 31 Lbs. Express only. **$59.75**

W-5 COMBINATION AMPLIFIER KIT: Consists of W-5M amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. wt. 38 Lbs. Express only. **$79.50**

❸ Heathkit HIGH FIDELITY PREAMPLIFIER KIT

Designed specifically for use with the Williamson Type Amplifiers, the WA-P2 features 5 separate switch-selected input channels, each with its own input control—full record equalization with turnover and rolloff controls—separate bass and treble tone controls—and many other desirable features. Frequency response is within ±1 db from 25 to 30,000 cps. Beautiful satin-gold finish. Power requirements from the Heathkit Williamson Type Amplifier. Shpg. Wt. 7 Lbs.

MODEL WA-P2 **$19.75**

❹ Heathkit Williamson Type HIGH FIDELITY AMPLIFIER KIT

This amplifier employs the famous Acrosound TO-300 "Ultra Linear" output transformer, and has a frequency response within ±1 db from 6 cps to 150 Kc at 1 watt. Harmonic distortion only 1% at 21 watts. IM distortion at 20 watts only 1.3%. Power output 20 watts. 4, 8, or 16 ohms output. Hum and noise, 88 db below 20 watts. Uses 2-6SN7's, 2-5881's and 5V4G. Kit combinations:

W-3M AMPLIFIER KIT: Consists of main amplifier and power supply for separate chassis construction. Shpg. Wt. 29 lbs. Express only. **$49.75**

W-3 COMBINATION AMPLIFIER KIT: Consists of W-3M amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. Wt. 37 lbs. Express only. **$69.50**

❺ Heathkit Williamson Type HIGH FIDELITY AMPLIFIER KIT

This is the lowest price Williamson type amplifier ever offered in kit form, and yet it retains all the usual Williamson features. Employs Chicago output transformer. Frequency response, within ±1 db from 10 cps to 100 Kc at 1 watt. Harmonic distortion only 1.5% at 20 watts. IM distortion at rated output 2.7%. Power output 20 watts. 4, 8, or 16 ohms output. Hum and noise, 95 db below 20 watts, uses 2-6SN7's, 2-5881's, and 5V4G. An exceptional dollar value by any standard. Kit combinations:

W-4AM AMPLIFIER KIT: Consists of main amplifier and power supply for single chassis construction. Shpg. Wt. 28 lbs. Express only. **$39.75**

W-4A COMBINATION AMPLIFIER KIT: Consists of W-4AM amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. Wt. 35 lbs. Express only. **$59.50**

❻ Heathkit 20-Watt HIGH FIDELITY AMPLIFIER KIT

This model represents the least expensive route to high fidelity performance. Frequency response is ±1 db from 20-20,000 cps. Features full 20 watt output using push-pull 6L6's and has separate bass and treble tone controls. Preamplifier and main amplifier on same chassis. Four switch-selected inputs, and separate bass and treble tone controls provided. Employs miniature tube types for low hum and noise. Excellent for home or PA applications. Shpg. Wt. 23 Lbs.

MODEL A-9B **$35.50**

The World's Finest Electronic Equipment in Kit Form

New Heathkits are easy to build..

Heathkit construction manuals are full of big, clear pictorial diagrams that show the placement of each lead and part in the circuit. In addition, the step-by-step procedure describes each phase of the construction very carefully, and supplies all the information you need to assemble the kit properly. Includes information on resistor color-codes, tips on soldering, and information on the tools you need. Even a beginner can build high quality Heathkits and enjoy their wonderful performance.

HEATH COMPANY

A Subsidiary of Daystrom Inc.

BENTON HARBOR 25, MICHIGAN . . . .

JAZZ By... JEAN

JEAN SHEPHERD*

TODAY I GOT A BATCH of LP's in the mail and a short while later after listening to the lot of them, I began to have the seedy sensation usually referred to in radio commercials as "nagging backache." My back aches a good part of the time but it usually doesn't nag or argue with me. It simply lives its own miserable life while I stew out mine. But now it nagged. I asked my friendly neighborhood druggist for a quick-acting, but gentle, remedy guaranteed to make me again a "regular fellow," but it was no go. My ache went further than that of the singing commercial and needed more than something that tasted like the finest chocolate to cure. Mental pip brought on by a surfeit of mediocrity, exhibitionism, plug-gism, magenta-album-liner-prosism, and general creeping ennui. A few quick laps around the track, a couple of dozen push-ups, some knee-bends, a finger of Johnny Walker, and once again my good eye sparkled with its old abandon and my back subsided to the normal dull throb. But the whole nasty experience gave me pause to consider. This sort of thing does that to a man. Kind of brings one up short or even shorter than one is usually brought up.

I am convinced that when the archeologists of a thousand years hence are digging around in the ruins of 20th Century Man, the thing they will unearth most frequently next to Chevvy hub-caps, plastic Donald Ducks, and yo-yo's will be millions of round flat objects pierced for earlobe decorations, but most probably connected with some long forgotten tribal ritualistic orgy. But we know better, don't we? They will be placed in museum cases and will probably be sold to the *avant garde* of the time to be used as wall decor much as African masks are used today. And I am afraid that a goodly percentage of the stuff being cut currently belongs on walls and underfoot right *now*, not a thousand years from now. Certainly it seems to have no place on any self respecting reasonably selective record turntable. For the life of me I can't understand what goes on in the cloudy minds of many record company execs that compels them to issue some of the stuff that is being expensively packaged and distributed today. Of course, the first answer is the inevitable buck, but a lot of these turkeys don't even fill the somewhat simple role of dollar-bait. Why then? Who knows.

There is a common superstition among record buyers that the only field that is crowded with mediocre banal commercial releases is the much, and justly so, maligned "pop" record market. However, it is the sad duty for me to report that "Creeping Nothingness," my own term, is becoming a major pox in *all* the areas of recorded music. This includes the "serious" as well as jazz releases. Since jazz is the specific province of the present essay I'll stick to that area, but I would like to point out in passing that the problem of too many issues per month and the inevitable decline of quality and selectivity is not a jazz issue alone but is very much in evidence in the "serious" or classical catalogs as well. Perhaps even more so, but

(*Continued on page 54*)

* *283B Reichelt Road, New Milford, N. J.*

Captured again, and to stay with us for a long time, we hope, is our (and WOR's) J. Shepherd, shown here listening attentively to record cut by 19-year old "boy wonder" trumpet player using $29.95 horn. The selection being played is the unforgettable "Frim Fram Sauce." Kindly note absence of dark glasses and other paraphernalia often affected by jazz commentators.

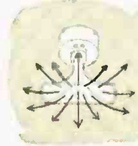
NOW! FUNCTIONAL DESIGN IN LOUDSPEAKERS

Functional Design is the most wonderful achievement of modern day living. We see it everywhere...in jet aircraft, industry, even the kitchen. Functional Design combines efficiency and practical application to make living a more comfortable and pleasurable experience.

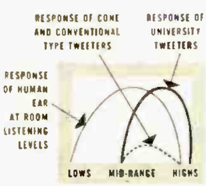
DIFFAXIAL SPEAKERS HAVE FUNCTIONAL DESIGN

The most advanced principles of audio and acoustic engineering have been combined to produce a speaker of exceptional quality...*the Diffaxial*...principles which *also* embrace the modern concept of Functional Design. Here are the features that make University Diffaxials ***different:***

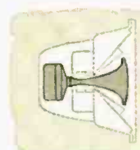
The *genuine* "Diffusicone" principle with true mechanical crossover is so unique that *it's patented.* Coaxial dual horn loading at the apex of the cone extends the mid and high frequencies with remarkable efficiency. A radial projector with aperture diffraction gives uniform, wide-angle dispersion. Thus, you enjoy *full fidelity*, no matter where off speaker axis you may be listening.



The compression driver is coupled to the *exclusive* and *patented* "reciprocating flare" horn...the greatest advance in wide-angle horn development. This specially designed exponential horn *positively* provides maximum uniformity of wide-angle dispersion in the horizontal plane with optimum vertical coverage.



Only *bona fide* compression driver tweeters are employed for highest conversion efficiency...in the order of 50% as compared to the low 5% of "ordinary tweeter variations" using less effective designs. University drivers use advanced super-sensitive magnet assemblies, are hermetically sealed and precision built. Note from graph how University tweeters fully compensate for deficiencies of the ear at high frequencies.



True thru-the-axis design. The tweeter driver unit is fitted to the "reciprocating flare" horn thru the center of the woofer magnet assembly. Only with this *thru-the-axis* design is it possible to project high frequencies thru a horn of scientific *formula-correct* length and configuration. Only thus can highest efficiency, lowest distortion and uniform wide-angle treble reproduction be achieved.

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University LOUDSPEAKERS, INC., 80 So. Kensico Ave., White Plains, N.Y.

Diffusicone -15

A 15" 2-way Diffaxial speaker. Employs the deluxe multi-sectional "Diffusicone" element and heavy 24 oz all-Alnico 5 Magnet. 30 watt* power handling capacity. 8-16 ohms. **$45.00 User net.**

Diffusicone -12

A 12" 2-way Diffaxial speaker. Employs deluxe multi-sectional "Diffusicone" element and extra heavy 24 oz. all-Alnico 5 magnet. Unusual 30 watt* power handling capacity. 8-16 ohms. **$33.00 User net.**

Model UXC-122

A 12" 2-way Diffaxial speaker. Standard uni-sectional "Diffusicone" element. Super-sensitive Alnico 5 magnet of shallow design for application flexibility. 25 watt* capacity, takes those heavy transients with ease. 8-16 ohms. **$29.75 User net.**

Diffusicone -8

An 8" 2-way Diffaxial speaker. Employs deluxe multi-sectional "Diffusicone" element. Exceptional sensitivity and 25 watt* power capacity makes this an outstanding performer for its size. 8-16 ohms. **$23.50 User net.**

AUDIO ETC.

Edward Tatnall Canby

The Sound-Man Artist

Little do most professionals in the audio world think of the possibility that their jobs are a vital part of a major cultural force in today's society—that they are as much a part of the "art" of our time as were the great Renaissance painters and their hordes of technical assistants and working apprentices.

The above somewhat vaporous statement is occasioned by my recent realization that taste for recorded sound is changing rather rapidly—and that this is obedience to the dictates of the professionals in the recording business who determine what that sound shall be. My ear is at their mercy, if you wish. But I am also inspired and stimulated and pleased by their work, as are millions of other listeners. They are, in a big way, cultural leaders, because they pioneer in an art that is of a big sort now, the presenting of musical sound via the loudspeaker, in the home. It's as big and as influential an art as any that has ever been part of an active society.

You'll find that the changes in any dynamic art—whether it be painting or microphoning or auto designing or concerto writing—follow a rather familiar social pattern. Who *starts* them? Who thinks up the new ideas, the innovations? Does society itself mold the progress of this, its own expression—do the designers simply follow the desires of the people? Or do the leaders tell the people what they must like—and will like? It's hard to say. These questions seem always to come up, one way or another. Does the Gothic cathedral style express its age? Or was it put over on the people by those who thought it up? Who was it that thought up those fish-like tail fins on the 1956 autos? Did he—or they—add the fins to the cars' rears in order to meet the people's wishes or was it pure fantasy? Does auto design reflect our age, our society, our needs, our feelings?

Arts and Crafts

Well, I think it does, and I think it rates as art. I don't, frankly, see any great difference in practicality, as things now stand, between the "fine" arts and just plain art, commonly known as craft. For a long time I've felt that things are now in such a state of flux with us that today's menial craft may easily become tomorrow's great art and no holds barred. I see no particular reason why autos shouldn't represent the artistic thinking of our time, as Gothic cathedrals (and other things) represent that of the Middle Ages. I am much too well aware that what we think of as the art of the past was extremely often merely craft, at the time, that what to us seems priceless and pure and above mere everyday life—Art with a capital A—was for the people of its own day very much a part of life. And often enough it wasn't even prized.

Styles in cultural values change dizzily. Who knows what will be elevated to the highest realms, come tomorrow. Who would have thought that the low-down music of New Orleans would ever rate as art. Who would have imagined the Sears Roebuck catalog as of cultural value. It has just been deposited on microfilm in the Library of Congress as an important social document.

Frankly, I thing we should look for art beneath every stone, so to speak, and expect to find it in the most unusual places, in this dynamic age of rapid change. And so I rate, among other things, the art of microphoning as the equal of many another interpretive art—stage designing, film producing, piano playing, and so on.

I think, as mentioned in one of my record reviews, that the time is almost here when the microphone artists, the men responsible for the acoustics of the recorded sound, should be billed on our record covers along with the composer, the conductor, the performer. Good publicity for the hi-fi department, of course; but it seems to me legitimate publicity, surely as legitimate as some of the fancy hi-fi terminology now applied abstractly to mike technique—the Enhanced This and the Full-Frequency That. I would rather see names of sound men out in front than mere titles for the sound itself. Let the men themselves be praised for the good sound—and let them be responsible, too, as are the artists and the conductors.

And so I note that styles in recorded sound are changing, and changing as rapidly as styles in auto design. I don't care a fig whether autos are "designed to sell," whether the intention is strictly commercial or strictly arty. Because I honestly don't think there is properly any ultimate difference. I feel that in any active society, commercial trends, elevated high-art trends, pleasing-the-people and pleasing the whims of the artists—all these things average out and add up and cancel down to a common denominator of progress which is the true reflection of that society, for good or for bad, for what it is worth. Call it art, if you wish.

Seven or eight years ago, I was both amazed and shocked by the new-type sound of London's 78 rpm "ffrr," first of the trade-name hi-fi recording techniques. I found the relatively close-up, ultra-live technique confusing to my then ear—as though, say, the fiddles were at arm's length and at the same time at a vast distance in a huge space. It was a novel, odd, new and essentially unfamiliar effect.

It was fascinating and it sold well, too.

Since then, I suspect, the "ffrr" technique hasn't changed very radically in later "ffrr" records, as far as miking and acoustics go. London's sound (English Decca) has been about as consistently reliable in effect as any I can think of. Almost any London recording can be pulled out of the shelves and used as a typical illustration of the "ffrr" sound. But, for my ears and for many other people's what was once strange and new and remarkable is now familiar, accepted—it has already become the norm for our changing styles and tastes in this new musical medium.

We have become accustomed to the once-novel effects and we like them—for good reason. We now understand, with our ears even more than with our minds, that recorded sound has laws unto itself, that no "concert hall sound" is ever literally possible on records, that we must therefore re-interpret music—all music—in terms of the new and revolutionary sound-medium through which it is now to be presented.

I mention "ffrr" because, I think most readers will grant, London was, if not the first to use intelligent recording techniques, the first (in our country at least) to codify and exploit the technique itself, with a name to pin it down. The "ffrr" sound would seem to have more recognizable characteristics and continuity from one record to the next than some other named sounds I might suggest, too.

A Social Art

No matter that public relations people still trumpet about concert hall reproduction, that listeners still feel they want to be sitting in an imaginary concert seat. Fine—let them use their good imaginations, and let publicity play with the concert hall as long as it sees fit. Have your cake and eat it. But the plain fact is that microphoning already is an art unto itself, with its own laws, its own principles, and its own special culture. The fact is, moreover, that the art of microphoning is a tricky and profound one because it must take into account not only the entire subtlety of recording acoustics but, also, the whole cultural history of music itself! Is stage designing, theatre production, film making, any more demanding of wide know-how and background? Not to my way of thinking.

Microphoning is, of course, a social art —that is, it is an art which can only be practiced cooperatively. There is seldom any one man who is wholly responsible for the quality and characteristics of the sound in a given recording. So it is, as well, with many of today's arts and crafts. We have an overweening desire, today, to pin the glory (and the responsibility) on one exalted leader. It takes a lot of people to design a new car, to put on a new musical show, produce a movie, play a symphony. We glorify the musical conductor, as though the orchestral musicians were so many inhuman pawns in his hands. We glorify some of the film producers, rating the team with which they work at a lower value. In jazz and pops we are still undecided; sometimes it's the man who swings the baton (Kostelanetz, Waring), sometimes the chief solo player and organizer, sometimes the singer. But in almost every form of pops music (to use the term broadly) we are at least conscious of the team work. We know that there is seldom any one composer as such—except the guy who wrote the tune. Though we seldom give him any credit, we are aware that the popular arranger has more to do with a musical number of this sort than the composer of the tune. Teamwork, one way or

(*Continued on page 60*)

EDWARD TATNALL CANBY*

1. GENIUS, MACRO AND MICRO

Beethoven: Symphonies #9, #8. Schwarzkopf, Hoffgen, Hafliger, Edelmann; Gesellschaft der Musikfreunde, Philharmonia Orch., von Karajan.
Angel 3544B (2)

For my ear this is the finest Ninth Symphony to appear on records since the advent of LP and modern recording.

This is no sensational whirlwind performance. It does not overwhelm with sound, nor is it supercharged with unbearable emotion—not, at least, on the surface. The aura of big-time publicity, that goes along with most Ninths, is pleasantly lacking. The "maestro" here, who no doubt is as desirous as any conductor for his own personal glory, nevertheless manages a conductorial miracle in that he effaces himself virtually completely in favor of the music and Beethoven. So, too, with the singers and players. It is a dedicated performance—dedicated to Beethoven.

There is not an eccentricity detectable in the entire piece, where most conductors can't resist doing something odd or unusual, to leave their special signature behind them. There are no radically fast tempi, nor any that are abnormally slow—the speeds are natural and "right." There is enormous musical tension, but no hysteria, no shrine-worshipping, nor for that matter, any plodding. The whole is at a maximum of sheer *musical* efficiency and if it is a towering performance, you'll feel simply that it is because Beethoven is a towering composer. The music is all his, the performers, for once, are all *performers* in the most basic sense.

All of which goes for the engineers as well—for they are also performers in this sort of enterprise. No self-conscious "hi-fi" here, no abnormal or stunty tricks; but a maximum use of modern close-up-with-big-liveness technique to get over the sense and clarity of Beethoven in terms of today's home listening.

Undoubtedly the last movement, with its "impossible" chorus and solo parts, is the tour de force of this recording. The musicians, instrumental and vocal alike, manage to prove that this famous movement *is* singable, after all! There's scarcely a shriek or a squawk in it; the singers are effective, instead of simply inspired, the solosits hit their high top notes with ease, and so do the chorus members. And the engineers have for once managed to get the entire enormous sound of this movement within the dynamic range of the recording, right up to the end. Clarity is optimum, even those last noisy measures that so often expire in a grandly fuzzy blur.

You'll note some generously wide groove spacing here, at correspondingly higher cost for the buyer. Good! If ever wide grooving was desirable and indeed necessary, it is here. Extra cash is nothing in the face of an assurance of good tracking right through the noisy finales on side 1 and side 3, plus good wearing qualities for the many repeat performances.

(The Eighth Symphony, thrown in on the extra side, merits its own discussion but is inevitably overwhelmed by the Ninth. Von Karajan's Eighth is challenging—he gives this usually placid and "cute" symphony a new dynamic treatment, high-tension like the Fifth or Seventh, for a useful revaluation. The first movement benefits wonderfully; it's a ball of fire under the high-tension treatment. But the second and final movements seem pretty fast and not too convincing. The Minuet movement is lovely.)

Bach: Fifteen Two-Part Inventions; Concerto in D Minor. Wanda Landowska, harpsichord; Orch. cond. Eugene Bigot.
RCA Victor LM 1974

Only one side of this record is newly recorded, and that side includes a section of the Bach keyboard Inventions, those in two parts, the three-part Inventions evidently having been put aside for later treatment at leisure. (The Concerto, on the other LP side, is a reissue of a pre-war French recording.) But on this one new side, as in so many of Landowska's recent recordings, you'll find a life-time's experience distilled into the superbly shaped performances of these very small, very meaningful little pieces. Two lifetimes, if we also include the vast experience of composition boiled down by old Bach himself into these small products of genius.

Almost anybody will enjoy the quick, strong clarity of each of the Inventions, but those who have actually studied them on the keyboard (they are intended as musical study-pieces) will find an endless wealth of interest in a thousand and one details of elegant and interesting phrasing, rhythm, ornamentation, dynamics. There was much *ad lib* elaboration of such music in Bach's day and there is much of it in Landowska's playing; we can learn the more from her while maintaining our own right to do the music as we feel it ourselves.

Recording is the usual somewhat dry, wiry Landowska sort, free of distortion and crystal clear, without massiveness. It is best played at a low level, that of the original instrument, as in most harpsichord recordings. (Many listeners play them too loud.)

The Concerto reissue on the second side is a fine performance but sadly dated in sound quality. The record, frankly, is issued for the Inventions. The fact that Landowska is not willing to rush things to the point of filling out two new LP sides at once is all to her credit, as a great artist who takes her time to do a good job in this day of too much music.

Rameau: Premier Livre de Pièces de Clavecin, 1706; Pièces de Clavecin (Suites #1 and #2), 1724. Marcelle Charbonnier, harpsichord.
Epic LC 3185
Rameau: Complete Harpsichord Works. Robert Veyron-Lacroix, harpsichord.
Westminster WM 3303 (3)

The Westminster album, as the title would indicate, includes the music on the Epic record, as well as much more, on its six LP sides. It is the sort of album that a few years ago would have had us gasping—Rameau, *complete!* Not these days.

Both these harpsichordists are well worth listening to, and both project the formerly inaccessible music of this great old Frenchman in a way that makes for remarkably easy listening. Both, of course, have studied the elaborate art of ornamentation that is a prime requirement in this French music—no usual pianist even begins to understand it—and in both recordings the ornaments, the trills and turns and dips and fancy elaborations of the written notes, are fluent and entirely natural, therefore intelligible and musically interesting to any ear. The ornaments virtually make this music—without them (and without the harpsichord's bright sound and trigger-quick action) the music is mostly meaningless, as many a pianist has discovered.

Westminster's Veyron-Lacroix has the smoother, more polished technique and the smoother recorded sound, recorded "absolute," that is, without audible liveness. It plays back beautifully at low level, that of the actual harpsichord itself. Charbonnier is a more forthright, somewhat more uneven player and the Epic (Philips) sound is a shade more boisterous too. Yet of the pair of harpsichordists, I feel that hers is the more potent performance by a bit; Charbonnier's range of phrasing, registration, contrast, is somewhat greater than Veyron-Lacroix's; she does more interesting things with the music at her best.

Veyron-Lacroix includes much novel and new Rameau along with the more familiar music of the 1724 Suites and their amusing and imaginative descriptive titles. His album is highly recommended if you will enjoy a leisurely six-sided exploration of a whole world of French grace and symmetry.

The Siena Pianoforte—Mozart: Piano Sonatas in E Flat, K. 282; A, K. 331; Vars. on a Theme of Gluck, K. 455. Kathryn Déguire.
Esoteric ESP 3004

Esoteric's remarkable piano, reputedly built in the early 1800's, presented to an Italian King, heard by such greats as Liszt, rediscovered, zanily, in the middle of the North African desert encased in thick plaster, then again after the war lying overturned in an Israel street—this wonderfully carved and ornamented instrument has been somewhat of a musical problem. What to do with it, on records? Esoteric's first Siena album, Mozart and Scarlatti, was an anticlimax; for not even a Siena piano can make good music out of a so-so player's performance.

I missed the intervening numbers in the special Siena series (which has even its own set of numbers), though I heard the Bach recording at an audio show and found it well played. This one, album #4, is at last an excellent one, for the pianist has a warm and knowing feeling for the music of Mozart, and this old-style upright has a tone quality

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

and coloration that is highly suited to Mozart's music.

You won't find the Siena piano as sensational as the publicity might suggest, but don't underestimate it. In the hands of a capable musician. It has a modest, retiring, gentle sound, subtle, very musical, seldom loud and flamboyant. If you've ever heard an old square piano, or if you've heard a Mozart-period piano on records, you'll have an idea of its tone quality.

Next: let's have Chopin on the Siena. For a long time it's been becoming clear that Chopin's music was far more gentle, as he played it, than we generally hear it now, in the powerhouse virtuoso manner. He should be particularly beautiful on this piano of his own day.

BRIEFS ON WHAT'S NEW AND INTERESTING

Beethoven: Symphony #2; Coriolan Overture. Philharmonia, von Karajan.
Angel 35196

Beethoven: Symphony #4; "Ah, Perfido!". Schwarzkopf; Philharmonia, von Karajan. **Angel 35203**

To supplement the Ninth and Eighth of Beethoven, reviewed above, these two I particularly recommend as unusually fine performances. The Second and Fourth are from the even-numbered symphonies, traditionally felt to be less important by our 19th Century predecessors; in the light of today's much wider interest and curiosity about "lesser" music they respond wonderfully to a more serious approach and show themselves as great as they always were.

Note the coupling of an extra shorter work in each of these recordings. Good idea. "Coriolanus" is superbly dealt with, "Ah, Perfidio!," a concert (unattached) aria for soprano and orchestra, is wonderfully sung.

Beethoven: Piano Concerto in D, Opus 61. Artur Balsam, Winterthur Symphony, Dahinden. **Concert Hall CHS 1239**

Here's a remarkable oddity for those who are up on Big Beethoven, and a fine parlor-game record to boot. The Piano Concerto turns out to be a piano arrangement by Beethoven himself of his familiar Violin Concerto. It is remarkably effective, if not exactly preferable to the fiddle version. Nicely played by Balsam and competently done by the Winterthur Orchestra.

Schubert: Piano Sonata in B Flat; Laendler, Op. 171. Leon Fleisher, piano.
Columbia ML 5061

Schumann (I think it was) called Schubert's great C Major Symphony the Symphony of Heavenly Lengths; this superbly long piano sonata is its counterpart on the keyboard, a late Schubert opus full of the most unforgettable flashes of breathtaking genius, of vast emotional depths uncovered in a few telling notes, of marvelous melodies and rhythms.

And here let us hail the LP record! The only real trouble with this work is that it is so long. Very few listeners can sit through it for the first time at a concert without getting hopelessly lost and so it rarely appears on concert programs. It throws them all out of balance, anyhow. What's more, it is both difficult to project and to play, and un-showy in its exterior, so relatively unrewarding for the virtuoso. But on records it can find its own place, and here it does.

Let it play—and don't mind the length. After a few hearings it will begin to sink in and it will become memorable. And this recording is memorable, too, in that Fleisher has the musical knowledge, the technique and the modesty to play the great piece for itself and out of itself, intelligently and beautifully.

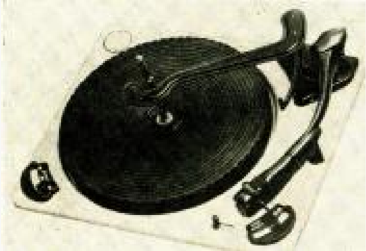
The endearing little dance movements, filling out the disc, are a wholesome refresher.

(*Continued on page 58*)

NEW PRODUCTS

• New Garrard Record Changers. Hi-fi enthusiasts who have long admired the Garrard Models RC80 and RC90 record changers will find interest in the announcement that both units have been superseded by two new changers, Models RC88 and RC98, respectively. Garrard is also introducing a new changer never before marketed in this country, the RC121, smaller in size and more economical in price than the RC80 and RC90. The RC88 is called the "Triumph II." It retains all of the outstanding features of the RC80 plus a number of innovations which make it distinctly superior to the earlier model. It includes a manual operating position, a new "true-turret" drive which eliminates drive belts, and a new shaded 4-pole motor with dynamically-balanced, weighted rotor. Stylus pressure and pickup height adjustments are easily accessible on the non-resonant aluminum tone arm. Model RC98, the "Crown II," is similar to the RC88 in most respects, however it is equipped with continuously variable control at all three standard recording speeds. Model RC121, the "Renown," marks Garrard's first offering of a straight-spindle-type changer. Remarkably compact, the RC121 is exceptionally well-suited as a deluxe replacement unit in conventional radio-phonographs. Like the other Garrard changers, the RC121 has a full manual operating position and true-turret drive. A shielded RC network eliminates shutoff noise. Minimum cabinet dimensions are 14½" left to right, 13" front to rear, 4¾" clearance above and 3⅛" below top of motor board. For information and literature on all three new Garrard Models write Dept. G-36, Garrard Sales Corporation, Port Washington, N. Y. **K-1**

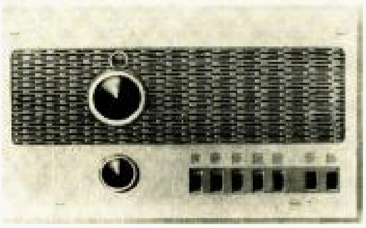
Garrard RC88



Garrard RC121

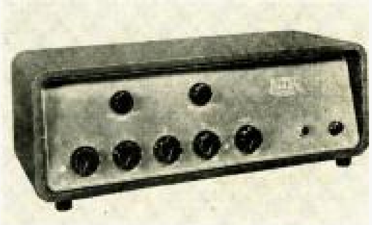
• Heathkit Electronic Crossover. Consisting of two independent electronic filters, one high-pass and one low-pass, the Model XO-1 crossover system is built to operate ahead of the power amplifiers instead of between amplifier and speaker as with conventional crossover networks. Each of the filters is equipped with a rotary switch for selecting the desired cutoff frequency. In operation a single input is divided so that high- and low-frequency portions of the program material are available at the outputs for feeding to separate amplifiers. Because high and low frequencies are amplified separately, intermodulation distortion is considerably reduced. Each channel incorporates a level control for frequency balance. Crossover frequencies are 100, 200, 400, 700, 1200, 2000 and 3500 cps. Heath Company, Benton Harbor 25, Mich. **K-2**

• Harman-Kardon Radio-Intercom System. A new departure in intercom equipment is the system recently introduced by Harman-Kardon, Inc., Westbury, N. Y. Known as the "Control" Model RC-5, the system includes a master control unit, four remote speakers and all material necessary for installation. It performs the following functions: (1) distributes radio programs to any or all remote points, (2) provides intercommunication between the master position and any or all remotes, (3) monitors any or all stations from any or all other stations. The built-in AM radio is an all-printed-circuit superheterodyne. Its output can be distributed to any or all rooms served by the system. A monitoring feature permits checking several children's bedrooms from any other room or rooms. Weatherproof remotes are available for front or rear door installations. A privacy switch is provided on each standard remote speaker. The entire system mounts flush in either plaster or plasterboard walls. Further information will be mailed on request. **K-3**

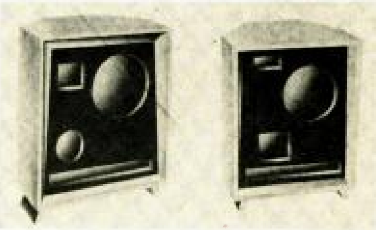


• Rek-O-Kut Disc Recorder. The new Imperial portable disc recorder is a deluxe version of the current Rek-O-Kut Challenger, featuring a newly-designed overhead cutting lathe with interchangeable lead screws, and with provision for making run-in and run-off grooves. It is also calibrated for timing. Built-in playback facilities include the new Rek-O-Kut Type 160 tone arm equipped with a dual-sapphire GE cartridge. Featured in the Imperial is the new Model R-56 cutting head with frequency range of 50 to 10,000 cps. The platen itself is the familiar Model TR-12H rim-weighted aluminum turntable, driven by a constant-speed hysteresis motor. Recordings can be made on discs up to 13¼-ins. in diameter at 33 1/3 and 78 rpm, with optional provision for 45 rpm. The amplifier serves for both recording and playback. Both high- and low-level inputs are provided. A recording level meter is mounted on the control panel which also includes volume, level, and mixing controls. The entire unit is contained in a single carrying case measuring 25" × 22" × 12". Weight is 80 lbs. The cover is detachable and acts as a baffle for a 10-in. PM speaker. Further information is available from Rek-O-Kut Company, 38-01 Queens Blvd., Long Island City 1, N. Y. **K-4**

• Altec Lansing P. A. Amplifier. Four inputs can be mixed simultaneously with the new Model 342A 20-watt amplifier now available from Altec Lansing Corporation, 9356 Santa Monica Blvd., Beverly Hills, Calif. Incorporated in the unit is the Altec "input-matcher" for unusual flexibility. Any combination of four sources can be plugged in, and the 342A can be matched exactly to the specific needs of each source. Thus the amplifier can be quickly "input-matched" to any high- or low-impedance microphone, crystal or magnetic phono cartridge, tuner or tape recorder. Input-tube heaters are d.c. operated to insure hum-free performance. The 342 is equipped with individual volume control for each input, a master volume control, and separate bass and treble tone controls, all mounted on a slanted panel for easy operation and visibility. Requests for descriptive brochure should be addressed to Dept. AE-4. **K-5**



• University "KwiKit" Speaker Enclosures. Where economy must be observed without sacrifice of performance, the new University do-it-yourself enclosure kits provide an excellent answer. The KEN series "KwiKits" are easily-assembled "cornerless-corner" enclosures which embrace the most advanced features of rear horn loading, phase inversion and direct radiation. They are so designed that they function independently of walls and floor. Cut from the finest grade of ¾-in. birch cabinet plywood, KwiKits are precisely machined, pre-shaped and pre-drilled for fitting together with a household screwdriver as the only necessary tool. Designed for PSE (progressive speaker expansion), the speaker mounting boards are constructed to permit the incorporation of additional drivers quickly and simply. Complete information on the KwiKit series is contained in Brochure 78A8 which may be obtained by writing to Desk PA-8, University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N. Y. **K-6**



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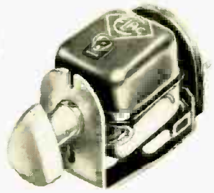
Magnetic Turnover Cartridge



A variable-reluctance magnetic cartridge for both microgroove and standard-groove records, consisting of two completely independent and non-reacting units mounted back to back in a turnover mount. High output voltage, coupled with an absolute minimum of hum pickup, results in a greatly improved signal-to-noise ratio. Output for a stylus velocity of 10 cm/sec is 55 mv for microgroove records and 45 mv for standard groove. There is virtually no magnetic pull, and tests show that the cartridge will not even attract iron filings. Frequency response is flat within ±2 db from 20 to 18,500 cps on vinylite on the microgroove unit and within ±4 db on the standard-groove unit. Stylus force for proper tracking is 6 to 8 grams. High compliance and low effective mass of the styli ensures a maximum of sound quality and a minimum of record wear.

Model MST-2D, with individually replaceable 3-mil sapphire and 1-mil diamond styli $45.00

Model MST-2A, with individually replaceable 3-mil and 1-mil sapphire styli 22.50

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A precision high-fidelity changer, built and tested by Swiss craftsmen. Famous E53 direct-drive, governor-controlled motor, with continuous speed adjustment at each of three speed positions (33⅓, 45 and 78 rpm). Noise level 48 db below average recording level. Automatic intermixing of 10" and 12" records. Special selector for 7" discs. Reject, repeat and adjustable pause controls. Automatic last-record shut-off. Muting switch. Tone arm tracking force adjustment screw. Balanced, heavy 12" turntable.

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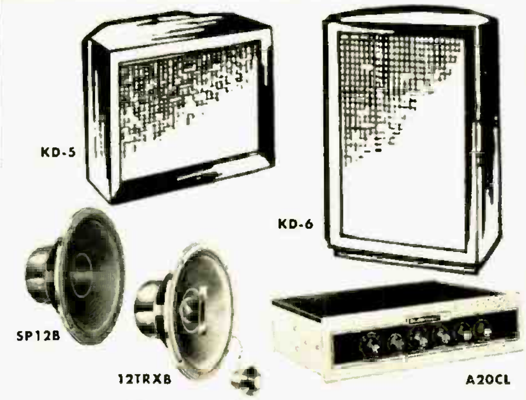
Consists of VIKING FF75SU dual-speed tape deck, two VIKING PB60 preamplifiers and a VIKING D390 portable case. The VIKING 75 Series tape decks, equipped with Dynamu half-track heads having unprecedentedly short flux gaps, provide a frequency response of 40 to 14,000 cps, ±3 db, at a tape speed of 7½ ips. 3¾ ips speed also provided. Full-floated motor mount and compliant belt drive with heavy capstan flywheel eliminate noise and vibration, filter out flutter and wow. The FF75SU version includes the basic tape transport mechanism, head bracket, "in-line" head assembly, standard record/playback head, tape-lifter and pressure pads. The PB60 preamplifiers incorporate the standard NARTB compensation, a volume level control and a variable equalization control. Equalization is variable 5 db above or below the NARTB curve at 10 kc. The tape deck, preamps and carrying case together constitute a complete, portable, universal tape playback system, capable of playing monaural half-track or full-track tapes as well as stereophonic tapes of either the "staggered" or the "in-line" type, and ready to plug into a "flat" power amplifier (or amplifiers).

Complete $166.60



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LONDON LETTER

(*from page 6*)

the first time by Garrard, Goldring, and R.C.A.

R.C.A. provide a matching pickup of 8 pole electro magnetic variable reluctance design. It has a particularly simple method of changing the styli from one speed to the other.

A new Garrard pick-up, *Fig.* 5, embodying dual moving coil units seemed to give extremely good quality reproduction and the Goldring 500 SD which is already well known in the United States, was shown in an improved mounting. Cosmocord exhibited what was probably the widest range of pick-ups.

The only radically new motor combination appeared to be the Garrard battery operated one for 45-rpm records. This novel little unit runs off 6-volt flashlight cells and includes a pickup and automatic start and stop. It will no doubt form the heart of many transistorized portable phonograph reproducers.

Fig. 5. The Garrard PA-10 transcription pickup arm is arranged so that the angle of the pickup head can be set to give the minimum tracking error and the vertical movement can be oil damped if required.

Of interest to tape recording enthusiasts was the new Truvox recorder fitted with a neat built-in counter; the Collaro tape deck incorporating four heads and three speeds; and the new Ferrograph 66 which has been specially styled for the U.S.A. market. It has switched inputs and can be mounted into existing furniture. The fine exterior finish of the Simon recorder and their attractive library-type tape-spool containers showed that some British manufacturers are now paying more attention to styling. No opportunity was available to hear the M.S.S. new professional tape recorder but its specification appearance seemed impressive.

E.M.I. were demonstrating their stereosonic tape-reproducing equipment and the Ferrograph people now also have one of their models available to play stereosonic tapes.

Among the accessories exhibited was an ingenious new Garrard stylus pressure gauge incorporating a spirit level. It was noted with interest that many of the tape recorders were fitted with "Bib" Splicers and that the Garrard and Collaro transcription motors were the models used practically exclusively by amplifier and loudspeaker manufacturers to demonstrate their wares.

The success of the Show must present a problem for the future because obviously a larger venue is required and there are no "convention type" hotels available in London. The building of demonstration rooms in Olympia or Earls Court, which are London's main exhibition halls, would be a most expensive matter.

COMPRESSION AND EQUALIZATION

(*from page 19*)

equalizers using series capacitors; the fixed equalizer is usually of the constant resistance type.

Operation

Figure 6 is a block schematic showing the basic components of a typical motion picture recording channel. The input section of the system has been split into two parts to permit compression of dialog independently of other sound tracks. This system is quite flexible and can be "patched" for use in several ways to obtain maximum benefits from use of the compressor:

1. For narration or stage dialog recording the microphone signal is fed to mixer pot #1 as shown and the compressor is in use. Mixer pots 2, 3, and 4 remain idle.
2. For use in a "direct mix," where a live narration is mixed with music and sound effects tracks, the microphone signal is fed to pot #1 and up to three film phonographs or other sources are fed to pots 2, 3, and 4. The narration is compressed, and the combined music and effects bypass the compressor.
3. For rerecording up to 4 tracks, including a dialog track which has been previously compressed, pots 2, 3, and 4 are used. (The output of pot #1 can be patched into the unused COMBINING NETWORK IN if needed.) The output of the master pot bypasses the compressor.
4. For use in rerecording, when limiting is desired on the combined mix, the inputs can be patched as in paragraph 3 above, and the compressor can be patched to replace linear booster #2. The compressor slope and breakaway controls would be readjusted to produce a limiting characteristic, for example, "20 into 4."

Note that dialog equalizers equivalent to those shown in *Fig.* 5 have been used in this channel in the console and after the compressor, respectively. Quite often more elaborate equalizers are used in all four mixing positions, but those in positions handling dialog will always include the characteristics of (A) in *Fig.* 5.

What are the advantages of the channel configurations described above, and what exactly are the audible effects obtained by use of the compressor?

Paragraph 1, of course, is the basic circuit—a single microphone and a single gain control, with dialog equalization and compression. Probably the first effect noticed by the mixer is that the dialog sounds louder when using compression, even though the volume indicator peaks to the same level. Furthermore, an increased intelligibility and smoothness becomes apparent, due not simply to the sound being "louder," but due to the transient rearrangement of levels within words and syllables effected by the compressor action. Loud or explosive vowel sounds which would produce a disagreeable and distracting blasting effect are reduced in intensity, and lower level consonant sounds which contribute so much to individual word meaning are raised in level. These effects of increased intelligibility and smoothness are most apparent when the dialog material is reproduced in an auditorium (or 16-mm classroom) and in combination with other sounds, either from the sound track (music, sound effects) or ambient in the theatre (audience noise, outside traffic, reverberation). The amount of dialog equalization used is a matter of judgement on the part of the mixer, based on his experience in the sound of his recordings when reproduced in the

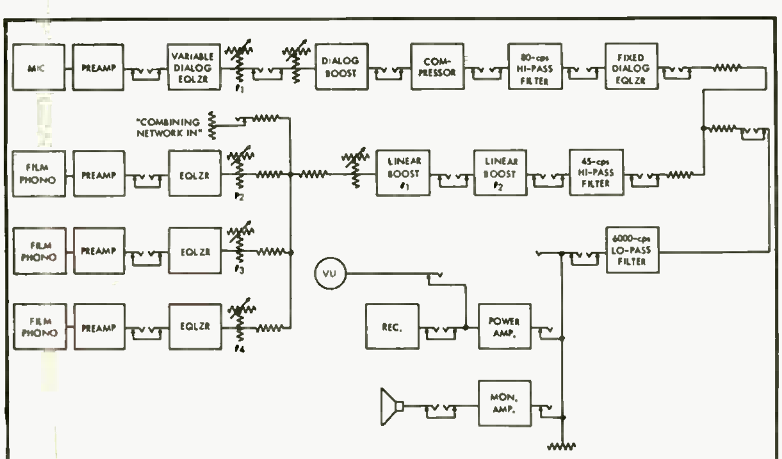

Fig. 6. Simplified block schematic of a typical motion picture recording and re-recording system using a compressor.

average theatre and his knowledge of the characteristics of his own monitor system. The amount used will vary with different voices and acoustics.

The circuit of paragraph 1 is also used when transferring original location recordings to film for editing. Since portable recording equipment usually will not include a compressor, compression can be added during transfer dialog. Additional dialog equalization can also be added at this time, if necessary.

In the circuit of paragraph 2 the use of compression on the voice will make the narration less liable to be covered up by high level sound effects or music. The smoothness and more consistent level of the compressed voice will give greater freedom to the mixer in his handling of the music and effects tracks, since the voice will maintain its intelligibility over a greater range and variety of background sounds. The circuit of paragraph 3 would, of course, be identical to that of paragraph 2 in its results if one of the tracks being mixed was a narration track which had been compressed previously.[3]

The circuit of paragraph 4, in which the compressor amplifier is set up as a limiter, is often used to protect the recording device from serious overmodulation. It is similar to the usual broadcast audio circuit in which a limiter (of more severe slope) is used to prevent overmodulation of the transmitter. The general effect of the limiter is to permit the mixer to mix his program "louder" without fear of overmodulation. The results are not the same as those when compression is used, since in *limiting* the automatic gain control feature of the amplifier is only occasionally used, whereas in *compression* the automatic gain control action is almost continuous.

Disadvantages in Use of Compressor

It might be expected that all the benefits described above are not without a certain penalty and extra effort on the part of the recording crew. This is quite true, and in addition to the obviously increased complexity of adjustment and maintenance of a channel which uses a compressor, there arise certain difficulties through its use in stage recording. With a compressor set for "20 into 10" compression, the channel has 10 db more gain for low-level signals than it has for 100 per cent level signals. This means that all background set noises—air conditioning, outside traffic, noisy lights, etc.—are 10 db louder than they would be without compression. This can present real problems, and it sometimes falls to the judgement of the mixer to decide whether the advantages of compression are outweighted by the distraction of the increased background noises brought about by its use. However, the advantages are considerable enough that it is worth the attempt to avoid or silence the interfering sounds on the set before abandoning compression. Because of the greater freedom in choice of acoustics and microphone position in narration recording, the use of compression here seldom introduces problems of the type described above.

Conclusion

Dialog equalization and compression have been described in this article in relation to their use in motion pictures. However, insofar as they are used to overcome fundamental difficulties arising from inherent characteristics of the human ear and auditorium acoustic conditions, their use would be advantageous regardless of the recording medium, be it tape, film, or disc; or even a live program.

This would indicate that their advantages could apply in recording film strip narration or in public address system work. Conversely, motion pictures made for television use will be reproduced at lower levels in small rooms, and many of the arguments would not apply. However, compression gives commercial announcements more apparent volume and carrying power—a sound preferred by all leading advertising agencies—and the "woompy' quality of many radio consoles and the characteristically close microphone technique of radio announcers often makes some dialog equalization desirable.

It might be well to make a few remarks about the relationship of these techniques to "hi-fi." Offhand it would appear that absolutely faithful reproduction of speech in terms of frequency response and dynamic range would be preferable to the attenuated frequency characteristic and restricted dynamic range recommended here. Unfortunately, "hi-fi" is a loosely defined term; it does not specify the acoustic conditions surrounding the recording microphone or the reproducing loudspeaker, nor does it specify the volume level at which recorded material is to be reproduced. It it just these conditions, of course, which have made dialog equalization and compression desirable. The recording engineer has a large fund of techniques at his disposal, but when making a recording, he must place these techniques in their proper perspective depending on their relative utility to the particular audience for which the recording is intended and depending on the recording medium (35- or 16-mm film, disc, tape, etc.) to be used. When making recordings for motion pictures, slide films, or radio or television commercials, the engineer might re-define "high fidelity" to mean "fidelity in transmission of ideas."

[3] J. O. Aalberg and J. G. Stewart, "Application of non-linear volume characteristics to dialog recording; *JSMPTE*, Vol. 31, p 248, Sept., 1938.

In these applications the *meaning* of the recorded words is the important thing. The extremes of frequency and dynamic range actually contribute little or nothing to intelligibility, and the recording engineer must use his techniques to emphasize the useful speech components and to uncover those that would be lost under adverse listening conditions.

REFERENCE

In addition to the citations in footnotes, the following reference contains interesting information on intelligibility factors, together with methods for determining the degree of intelligibility in certain specific acoustic situations ("calculation of articulation index"):

L. L. Beranek, *Acoustics*, McGraw-Hill, New York, 1954, pp 406-417.

LETTERS

(*from page 8*)

quation (9) is also entirely consistent with the equation used by MacFadyen[3] for distortion due to X_L His equation is also very simple: $D \propto R_K/Z_P$, where R_K is the source resistance and Z_P is the parallel combination of the load resistance and X_L. He of course shows the dependence o D on the flux density.

4) I do not claim in my article that a "magical" effect occurs at *precisely* zero impedance, or that the transformer design is simplified when the source impedance is zero. I explicitly point out the necessity for "the elaborate winding schedule and the same high-quality core material used in the traditionally large transformer." But what I *have* demonstrated (in the table of "Typical Weight Reduction Data") is the significant weight (and cost) saving made feasible by "zero" impedance circuitry *without* sacrificing amplifier quality or performance.

5) Furthermore, in his discussion of the feedback aspect, Mr. Crowhurst demonstrates with precision that he does not know how we are obtaining a zero source impedance. I must take exception to his arguments by explaining our technique briefly.

The gain of one of the voltage-amplifier stages preceding the output stage is made to have a value approximating infinity by the use of a local positive feedback loop. In other words $A\beta$ is given a value of +1. Negative voltage feedback is then applied around the entire amplifier. The gain and phase relationships are controlled to yield an exceptionally stable amplifier that exhibits a source impedance of zero ohms throughout the significant portion of the passband.

The inference in Mr. Crowhurst's arguments is that the source impedance is a variable function of the amount of overall feedback. This is not true. The source impedance is zero whether 1db or 100db of negative feedback is used. The only criterion is that *some* negative feedback is active. By the same token, the nonlinear plate resistance of the output stage does not even enter into the matter.

N. R. GROSSNER,
David Bogen Co., Inc.
New York City

[3] K. A. MacFadyen, "The calculation of Wave-form distortion in iron-cored A. F. transformers" Proc. I.E.E., vol. 98, Pt. III, p. 153, March, 1951

JAZZ BY JEAN

(*from page 42*)

I'll leave that note to other reviewers.

Most people who buy records regularly have a tendency to dismiss such carping statements as mine with the pat answer that runs something like, "So what, I don't have to buy the junk. Let 'em go broke, but I'll still only buy what I want." That's fine as far as it goes, but the problem is much more complicated than that and is one that every buyer gets caught up in sooner or later. The dear dead simple days of going down to the record shop twice a month—or when there were a couple of extra bucks handy to squander on music—in order to hear *all* the latest stuff in the booth, have gone the way of Pick and Pat. It would be necessary to give up job, home, children, self-respect, and ping-pong in order to hear even a reasonable fraction of the current releases all the way through. A room in a cheap hotel near the record shop would be handy, too, in order to cut down travel time and expenses between the hi-fi set at home and the listening booth. At that, there are obviously more than several fanatics who apparently do just that. I would recommend that any of you who doubt me on this score spend a half hour in the Colony Record Shop just observing the actions of *Homo Boobus Jazzicus* on any average night. They never go home. If, indeed, they have any to go to. But for the rest of us poor unbearded undark-glassed mortals, such peregrinations are impossible as well as somewhat distasteful. And damned irritating too. Today it is really a tough job to find good recorded material among all the dross one must wade through. By "good" I simply mean stuff that deserved to be recorded and packaged regardless of classification. And there you have the nub of the whole thing.

Record and Release Everything

There seems to be a current belief as well as practice among record entrepreneurs that anything a jazz musician plays is worthy of passing along to posterity as well as the record shop counters. So hence we have endless inanities such as (quoting from a typical record liner) "this didn't start out as a record session at all, but the boys were blowing one night at Hermie's Bar when in came Max and his tape recorder. Without saying a word he set the mike up next to the Coke machine and two hours later we were really gassed when we heard the playback after the last set." The only thing one wonders about is what kind of gas was used. To the untrained ear in this sort of thing, the first thought that occurs is perhaps a mild variety of nerve gas was blowing through the ventilators in Hermie's place that "historic night." I might add that most such recordings are designated by the notes which always accompany them as "permanent additions to the small list of really *great* jazz performances," end of typical quote. Most of this sort of guff is the purest eyewash and the people who write it know it but they also know it sells records as well as future lucrative assignments in the growing field of liner-note-writing. By the way, this school of writing is becoming closely allied to that of the Madison Avenue singing soap ditties and bears no known relationship to the serious criticism which it pretends to be. So it goes. Don't get the idea that I am trying to say that there is no decent stuff being recorded these days. Far from it. There is, in fact, more first class material available today than ever before, but there is also far more pap than ever before and it is getting more and more difficult to separate the sheep from the goats simply because there are such enormous herds of goats around. And the liner notes all cleverly refer to the goats as being the finest and most worthy of all sheep. A few recording companies have tried to hold the line as best they can, but the trend is against them. The same psychology that is operative in the pop field is more and more taking hold in all areas of the recording business. This briefly stated is one in which the outfit searching for a good seller does so not on the basis of quality of performance and pressing but purely through sheer numbers of releases. "If I turn out fifty new discs a month, I have a better chance to clean up on one of them than if I release only five per month." This is obviously questionable logic since it does not take into account the ephemeral element of quality and only relies upon quantity. But there it is and we have to live with it. All we can do is offer a small tear for those worthy musicians who are being buried under the deluge and hope they get their rewards in Heaven if they can't make it in royalties.

The Sunny Side

Let us now don our dark glasses and finger our imaginary beard as we browse a bit among the newer releases. There are a *few* good ones.

LENNIE TRISTANO..........ATLANTIC 1224

Tristano is a sort of demigod among modern musicians and rightly so. He is, like Bach, much more talked about and referred to than listened to. This was mainly because he is one of the least recorded major jazz figures of the past ten years. For some unexplained reason, many relatively unimportant musicians are able to flood the market with records while a man of the stature of Tristano remains largely unknown to the vast bulk of record buyers. He is here heard in company with Lee Konitz, his long-time associate, in a session recorded on the stand. I'll venture to say that there is hardly a serious jazz musician around who hasn't already put in his order for a copy of this one. And for good reason. Listen to it.

JAZZ COMPOSERS WORKSHOP
SAVOY MG 12059

A very interesting if somewhat pretentious effort by the Charlie Mingus Workshop. Mingus is the highly vocal critic of modern jazz musicians and a talented bass player. The personnel, in addition to Mingus, is in itself imposing. John La Porta, alto, Teo Macero, baritone sax, Geo. Barrow, tenor, Mal Waldron, piano, with Wally Cirillo occasionally appearing on piano, and the impeccable Kenny Clark alternating with Rudy Nichols on drums. The most interesting part of this offering is the writing, which varies from the self-consciously "modern" of the item entitled "Gregorian Chant" to the highly amusing and literate treatment of "Tea For Two." This recording obviously won't appeal to a large segment of the jazz public but I found it consistently attention holding. You might like it also. Exceptionally well recorded.

THE EMINENT JAY JAY JOHNSON
BLUE NOTE 1505

More of the work of one of the outstanding trombonists of the last ten years. Here is a situation that is roughly the reverse of that of Tristano. Johnson is well represented on recording, and in fact, sometimes too much so. His work is always good, if not always inspired, and he should watch the tendency to allow pointless things to be released merely in order to fill out another LP. Happily this disc has some high points that make it a good buy since he appears with a variety of people as these cuts were captured on tape over the last three years. I still say however that too many recordings on the market can be in some ways worse than not enough.

DIFFAXIAL SPEAKER

(*from page 23*)

"shock absorbers" cause the diaphragm to lose its motion as a piston at a frequency for which these compliances become isolating or decoupling agents between the driving force and the diaphragm itself. Thus, it is possible to have the voice coil move at a particular frequency while parts of the diaphragm itself do not move because of the decoupling actions. Thus we might call it a low-pass filter which has isolated the high-frequency motion of the apex area of the diaphragm so it is not imparted to the low-frequency portions of the diaphragm. In essence then we have accomplished half of our objective; namely, we have been able to cause the woofer diaphragm to perform over the area desired and to stop performing above a certain frequency at which it is desired that no motion take place.

Dual-Diaphragm Advantages

Our discussion to this point has been concerned mainly with how mechanical attenuation characteristics are obtained from structures incorporated in a single diaphragm. We must now expand our discussion to apply these principles to the illustrated dual-diaphragm structure of the Diffaxial, for some specific improvements to the crossover characteristic ensue by such construction.

It will be observed from the figures that the auxiliary diaphragm or Diffusicone section, which is mounted directly at the apex area, is of much sharper angle than the main cone, which immediately indicates that this particular auxiliary diaphragm structure will present greater resistance to deformation than if it were to coincide with the more shallow contour of the main diaphragm. Thus we may expect, if only from its steeper shape, that this *small* diaphragm will move more evenly at high frequencies with less zonal decoupling than would the shallower diaphragm. However, there is more involved in this auxiliary diaphragm than merely its shape, although that is of vital importance. The second factor which determines how well this auxiliary diaphragm will move for high frequencies is again its pulp content. Physical inspection of this auxiliary diaphragm will show that its structure, appearance, and texture are entirely different from those of the woofer diaphragm itself. The pulp material from which the Diffuser element is made is chosen to provide maximum transverse stiffness in the diaphragm to cause the diaphragm itself to move as a *whole* with a minimum of decoupling between the driving force and the diaphragm itself, while in the woofer just the opposite is true; it is designed to uncouple itself quickly from the high frequencies so that most of the high frequencies may be imparted to the Diffuser element. Thus, it is found that by the choice of the proper pulp material and shape of the Diffusicone element, in conjunction with complementary considerations for the woofer section that maximum high-frequency vibration is obtained for the high-frequency excursions of the voice coil which is attached at its apex area.

Another important consequence of the steeper contour of Diffusicone is control of the spatial distribution of the higher frequencies which are generated by the rear surface of the auxiliary diaphragm. This control is obtained by interposing in the acoustic path of this rear wave a diffraction ring. As shown in the illustrations, this ring is comprised of a series of apertures of discrete size. This structure serves as an element in the mechanical crossover of the system in addition to its function as a high-frequency dispersing element.

The necessity of baffling any loudspeaker to prevent front-to-rear cancellation of energy is well recognized. If a loudspeaker is not baffled, there is quick deterioration of response below that frequency at which doublet operation takes place between the rear of the diaphragm and the front. Thus, if this diffraction ring is left off, the front-to-rear cancellation from the auxiliary diaphragm will introduce deterioration of its response at some frequency determined by its dimension, as is also the case, naturally, in even large loudspeaker pistons. Thus if the area between the auxiliary diaphragm and the woofer section itself is left entirely open, there will be very sharp dipole attenuation action between front and rear. On the other hand it may be closed partly to give a more gradual front-to-rear dipole attenuation depending upon the needs. In this instance a mean open area was struck to give the desired low-frequency roll off from the auxiliary diaphragm yet to allow the diffraction apertures to operate upon the high frequencies coming out of the back of the auxiliary diaphragm for optimum dispersion.

As shown in previous literature and in the subject patent disclosures, this diffraction ring interplaced between the auxiliary diaphragm and the main body of the diaphragm amounts to a series of point sources for frequencies which are large compared to the size of the apertures. Thus if the holes in the diffraction ring are small compared to the wavelength of the frequencies being transmitted, then as those frequencies strive to get through these holes they find themselves coming through what may be considered a point source, which gives rise to a spherical wave front pattern, in sound as well as sight. Therefore, the high frequencies emanating from these point sources ultimately become radiated in a wider spherical area than they would if they were allowed to emanate unobstructed.

We can finalize our concept of the mechano-acoustic crossover functions of these two diaphragms driven by the same voice coil and draw our analogous circuit for the system. The elements which will show up in the analogy will be: (a), the compliances in the woofer circuit which limit its high-frequency *input,* and consequently its output; and (b), the low-frequency rolloff of *output* from the high-frequency diaphragm due to its small piston size and partially unbaffled open back. These are combined in an electrical analogy in *Fig.* 7 where it is indicated that the woofer with its high-frequency *input* attenuated, and auxiliary diaphragm with its accenuated high-frequency drive and its low-frequency rolloff, together form essentially a complete two-way system, with *L–C* element characteristics. It functions acoustically truly as a two-way system as illustrated in *Fig.* 4. Thus, even though both diaphragms are driven by the same voice coil, there is a differential radiation between the low-frequency diaphragm and the auxiliary high-frequency diaphragm which makes this Diffaxial assembly a true two-way radiator.

The Three-way Diffaxial

Since the Diffaxial concept concerns itself with a structure where the woofer and Diffuser elements are axially symmetrical, it becomes possible to transform the speaker to a three-range transducer by the introduction of a third element that will be functionally coordinated with the other radiating element. Still following the precepts of multi-speaker design where the individual speakers are specialized for the range in which they are to work, it is necessary in this multirange assembly that the added speaker element also be specialized for its intended function and to be compatible with the other components.

In the three-way Diffaxial, the added element is a top-range tweeter of the compression type coupled to a projector designed both for maximum efficiency and optimum wide-angle dispersion of high frequencies. The efficiency of a transducer is a function of both its driving mechanism *and its load.* That is what makes the well designed horn-loaded system so efficient. Since high efficiency means that less electrical driving power is required to energize the unit, and reduced diaphragm excursions of the diaphragm occurs, the resultant radiation is cleaner and less distorted. However, horns per se, are not all inherently equal in transduction efficiency. They must have the proper mouth dimensions, and they must have a length consistent with the band width for which they are designed. Even though the flare rate of a horn may be correct, it will be inefficient if it is too short or its mouth is too small. It will, in essence, be a *baffle* of insufficient size around which there will be excessive diffraction and loss of efficiency. To overcome the pitfalls of the too-short horn and too-small mouth, the tweeter driver horn projector assembly designed into the Diffaxial makes use of the long available section through the main speaker magnetic assembly. Such *through* axial assembly then permits a horn of proper length to be used to provide adequate and efficient loading for the compression driver to which it is coupled.

The added horn length which is made possible by placing the horn *through* the axis of the speaker in turn permits the horn mouth to be developed to a size where it may be shaped subsequently to provide wide-angle dispersion of the radiated high frequencies. The structure shown is designed around the reciprocating flare principles,[4] wherein optimum horizontal dispersion is obtained at maximum efficiency without diffraction losses, the mouth dimensions in both planes being such that adequate baffling

[4] U. S. Patent #2,690,231, Levy, White, Cohen.

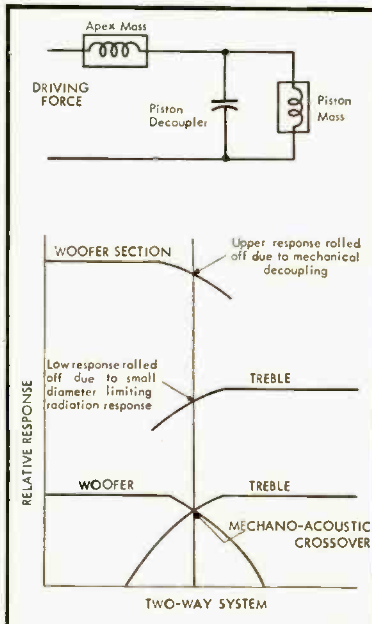

Fig. 7. High-frequency rolloff of woofer diaphragm and low-frequency rolloff of treble diaphragm combine to produce a mechano-acoustic crossover.

in the air, and as I say, this means refinement of technique.

And there is only one major area in which that refinement can occur. It is not in the engineering area, but outside it. For, remember again, the sound microphonist is the new-style artist who is charged with reinterpreting musical sounds in terms of the unique recording art. The major development still to come, then, is historical.

We have some extraordinary sound on records now. We have extremely effective techniques, systems, set-ups. But they are still too often all-embracing, covering too many types of sound, of music. What suits Mozart is wrong for Beethoven; what is ideal for a concerto grosso of Handel or Vivaldi is out of place in a concerto by Paganini—or by Stravinsky.

Reinterpretation

Needless to say, there is already a great deal of thought being put into this matter of appropriateness by the sound men who are responsible. (And this includes the front-office directors who often have a hand in the final result.) Reinterpretation is the business of the day, and reinterpretation has now got to the stage where, the techniques having been well established, we must turn more and more to the music itself, to its backgrounds, style, meaning, place, history—and reinterpret all of this in terms of the microphoning art.

In other words, it is no longer possible for a good microphone man to be a technician only—unless he has a musician at his elbow to fill in for him. (Teamwork again, and entirely appropriate.) At every recording session, the ghost of the composer must somehow sit in, and with him an evocation of the whole historical era in which the music had its place. People didn't listen to harpsichord solos in concert halls, nor to string quartets in opera houses; ballet music plays in a theatre with dead acoustics, where symphonic music is for live halls; Wagner's orchestra played in a deep pit below the stage whereas his singers performed out in the open and so were able to make themselves heard. Much of our older music was played informally with the "audience" practically hanging over the musicians' shoulders. Some church music was meant for a vast Gothic echo, other types uncompromisingly demanded the brighter, harder acoustics of the Baroque churches. A large body of the music for winds is outdoor music, never intended to be heard within four walls at all.

All of these factors and a thousand more must be weighed in the new reinterpretation, for the recorded medium. Never, not once, can we reproduce the original effect, neither as of the concert hall nor as of anywhere else. Every recorded sound must be a new sound, a new balance, a new effect. But the process of translating the original intentions of the music into the new terms of recording technique is a boundlessly exciting one and it requires every bit of ability, imagination, knowledge, sensibility, intuition—and technical know-how—that our recording men can scrape together.

Perhaps you see why I feel that sound recording is now an art and a potentially big art.

SPEAKER ENCLOSURES

(*from page 36*)

cabinet back is not closed off by a rear panel. Thus the elastic stiffness of the air does not raise the resonant frequency of the speaker mechanism.

The Acoustic Suspension System

The acoustic suspension system, a relatively recent development, applies the infinite baffle principle to a special speaker-enclosure combination in which the speaker mechanism and enclosure must be designed as a single unit.

We have referred, in the chapter on loudspeakers, to the high values of bass harmonic distortion which are tolerated in speakers, compared to values considered as acceptable maximums in amplifiers and pickups. These high values of distortion have two principal causes, both of which are related to the large excursions which the cone makes at low frequencies. (In the case of a direct radiator the speaker cone must quadruple its distance of travel for each lower octave, if it is to keep up constant power output.) The causal factors referred to are:

1. The voice coil tends to move out of the uniform magnetic field on large excursions, and the magnetic force is reduced at the peak of the cycle.
2. The mechanical speaker suspensions become non-linear on large excursions (they begin to "bind" in the axial direction, repressing cone movement on cycle peaks).

The first of these causes of distortion may be taken care of, in good bass speakers, by overhanging the voice coil past the magnetic gap. The voice coil may be made as much as ½ inch longer than the gap, so that even on large movements the same number of turns of copper wire is immersed in the magnetic field.

The second factor—non-linear speaker suspensions—has been with us for years in spite of repeated redesign of these suspensions, and is thus the major single cause of bass distortion in speakers. The acoustic suspension speaker system cuts the Gordian knot rather than unravelling it—the suspensions are almost done away with.

The first design step is to eliminate most of the elastic tension of the mechanical suspensions, so that the speaker mechanical system is very loose. It can then be moved back and forth without having to overcome any appreciable mechanical spring tension. Only a small fraction of the normal elastic stiffness is built into the speaker (enough must be retained so that the voice coil can be centered in the gap without rubbing), and the resonant frequency of the unmounted speaker mechanism is subsonic.

This first step gives us a speaker which is, so to speak, a crippled unit. Mounted in any conventional way the voice coil would not be inhibited from travelling out of the bounds of its linear magnetic path, or even from "bottoming" against parts of the magnet structure, on high-power, low-frequency signals. It is an incomplete speaker.

The second step is to reintroduce the spring tension that has been removed. However, the spring that is introduced is pneumatic rather than mechanical: we use the enclosed air of a sealed, rigid, Fiberglas-filled enclosure. The same effect that was a problem previously—raising of the resonant frequency of the speaker due to the elastic stiffness of the enclosed air of the cabinet—is here used to give the system the characteristics that it needs. The pneumatic stiffness of the enclosure substitutes for the decimated mechanical stiffness of the speaker suspensions, and the resonant frequency of the total mechanical system is raised to the value that it would have had originally, if it had been designed in the conventional way.

The enclosed volume of air, compared to conventional speaker suspensions, is an almost ideal spring, and does not create the non-linearity and distortion of the latter. Speaker bass harmonic distortion is thus radically reduced. In the octave below 50 cps this reduction is claimed[2] (depending on the frequency, and on the speaker systems to which it is compared) to be by a factor of between 2 and 10.

Unlike the totally enclosed cabinet, in which there is no upper limit to the cubic volume of the enclosure for optimum performance, the acoustic suspension system requires a cabinet of just that volume which will raise the resonant frequency to its proper value. This means that for a given speaker mechanism there will be an *optimum* rather than *minimum* cabinet size. The optimum cabinet size is fortunately conveniently small—in the case of the existing commercial unit built to this design it is slightly over two cubic feet over-all.

It can be seen that the acoustic suspension system is not really a separate speaker and enclosure, and may be thought of as a loudspeaker whose outside material happens to be of wood.

Figure 10—3 illustrates commercial applications of the types of direct-radiator mounting discussed.

Part 2 of the chapter on enclosures, which will discuss horns and resonant-type enclosures, will appear next month. It will be seen that there is another approach to reducing speaker distortion other than making the moving system linear for large excursions—that of reducing the excursion required for a given sound output.

[2] The claims are made by the manufacturers of the system, and by the person who filed the patent application on the system, who happens to be the writer.

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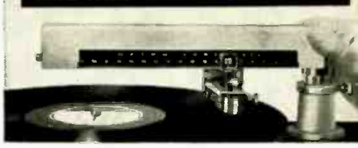
Industry Notes . . .

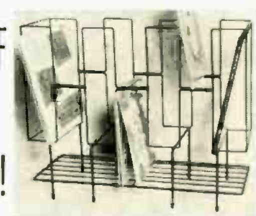
STEPHENS REORGANIZES. Bert Berlant and Bernard Cirlin have taken over management of Stephens Manufacturing Company of Los Angeles. For a consideration in excess of $500,000 Robert Stephens, company founder and president, will retire from active management but will remain with the firm as chairman of the board of directors and engineering consultant. He will be responsible for the creation and development of new products. Under the new set-up, Stephens Manufacturing will embark upon an extensive expansion program. Berlant is well known in the audio industry for the development of the Berlant-Concertone tape recorder. Cirlin is the former general manager of Dumont Aviation Associates and is prominent as a management consultant and merchandising specialist.

PERSONNEL NOTES. Gil Demsky, long known for his many associations in the audio industry, has joined the sales staff of Fisher Radio Corporation; he will cover the metropolitan New York area . . . **Harold Weinberg** has resigned from the hi-fi sales staff of Harvey Radio Company . . . **Charles W. Hosterman** is the newly-appointed general manager of the electronics division of Sylvania . . . **Jay C. Fonda,** who pioneered the first continuous recorder-reproducer, held an introductory showing of the latest "Con-Corder" in New York on May 18.

Herbert O. Wilson has been appointed works manager of the Astatic Corporation . . . **Stanley L. Rudnick** has joined the National Company, Inc., as general sales manager of the Commercial Division; George E. Magrath, a National Company veteran, has been promoted to eastern manager of industrial sales . . . **Vinton K. Ulrich** has resigned as general sales manager of the David Bogen Company, Inc. . . . The entire audio industry shares with ORRadio Industries, Inc., its distress in the loss of **Frank Adams,** ORRadio eastern sales manager, who passed away recently in Philadelphia after a lengthy illness.

William E. FitzGerald has been appointed new product sales director of AMI Incorporated, Grand Rapids, Mich., manufacturer of coin-operated phonographs. He will continue to serve as advertising and sales promotion manager, a post he has held since joining AMI in 1950. In his new position Mr. FitzGerald will direct the promotion, marketing and sale of new products which include a quality line of high-fidelity home radio-phonographs, shown last winter at audio shows across the country and soon to be on the market.





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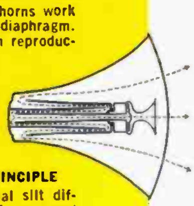

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*Pat. D169, 904 and Pat. Pend.

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