AUDIO

MARCH, 1959
50¢

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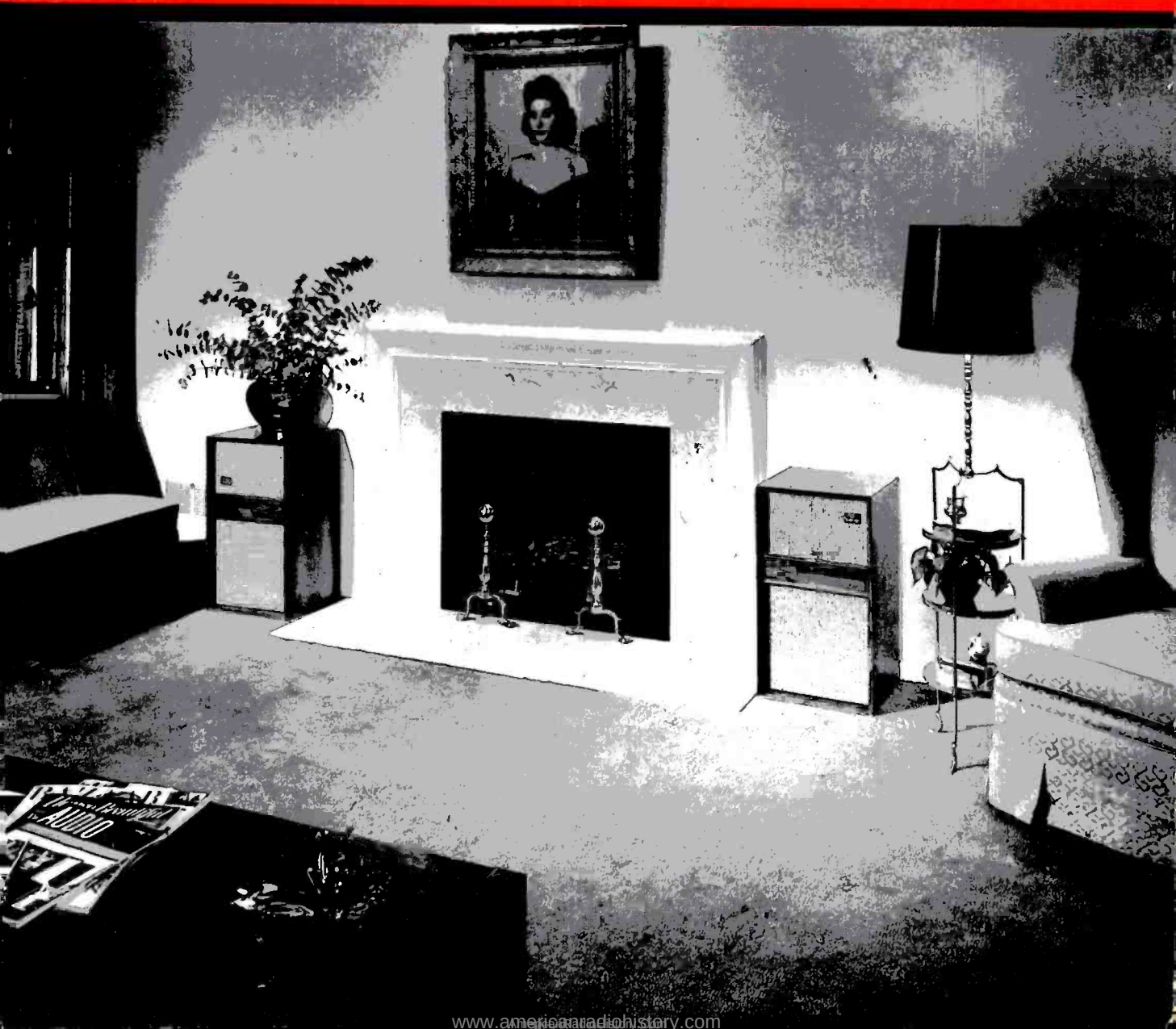

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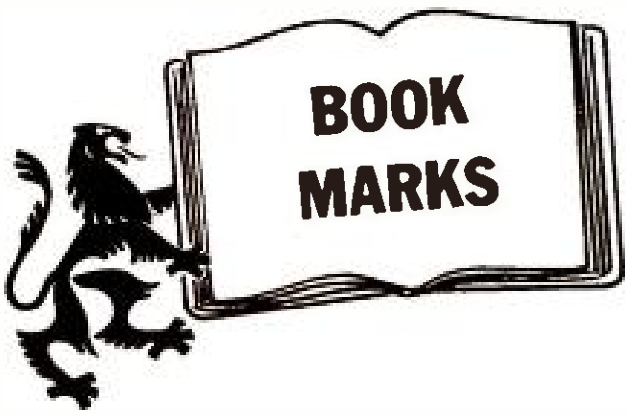

..."In the autumn of 1947 I happened to be in London with Mr. A. Smith, our London manager, when we paid a routine visit to Webb's Radio in Soho Street. A man came in and asked for a book on loudspeakers, but none was available. The assistant came over to us and said: 'Every day somebody asks for a book about loudspeakers. Why don't you write one?' We went upstairs to see the manager, Mr. Pickard, and asked him how many copies he would buy if we brought out such a book. To my amazement he said he would place an order for 72 copies there and then..."

So wrote G. A. Briggs, England's famous authority on sound reproduction, in his new book, "Loudspeakers". This month's column is devoted to that book. It is a book we consider to be so wonderfully complete and well-written that we cannot too strongly urge that you get your copy at once.

"Loudspeakers" was initially published in 1948. A 90-page paperback first edition...it ultimately ran to four editions and 16 printings, with constant revision updating the text. *In these four editions, a total of 50,000 copies was sold!* This is an amazing record for a book on the subject of high fidelity. Moreover, "Loudspeakers" was the FIRST book of its kind on two continents.

Now, the new edition contains 336 pages, 230 illustrations, and 31 chapters, so that even those high fidelity enthusiasts who remember having seen "Loudspeakers" before will profit from owning the latest edition.

In a way, we think the title is misleading and does not do the book justice because "Loudspeakers" actually covers so much more territory than its title implies. Since the book has just been published, there has not yet been time for many reviews on it in the press, but we take pleasure in reprinting excerpts of those reviews which have appeared.

ELECTRONIC TECHNICIAN

"The text contains a wealth of practical data, made all the more lively by the personal touch of the author. Among the many topics covered are magnets, housings, cones, coils, impedance, phase angle, frequency, distortion, power, resonance, cabinets, transients, electrostatics, crossovers, feedback and lots more....For anyone interested in audio, this book is a valuable—and interesting—source."

HIGH FIDELITY TRADE NEWS

"...deals exhaustively with all aspects of speaker design and performance. Mr. Briggs is to be complimented on his comprehensive coverage of a broad subject. He writes with authority on the development of the modern speaker, magnets, cones and coils, baffles and cabinets, frequency response and room acoustics. The work is liberally illustrated for clarity and is written in an easily read (at times, most humorous!) style. A 'must' for both audiophile and sound technician."

HI FI REVIEW

"Not often are urbanity and humor found among the qualities of technical writing. A notable exception is provided by this book, which now appears in a most welcome updated and expanded revision. It is largely by virtue of his writing style, clear without being elementary, and laced with his native Yorkshire wit, that the author easily brings accurate understanding of the finer points of loudspeaker design even to the relatively non-technical reader.

"Being the designer and manufacturer of the famous Wharfedale loudspeakers, Mr. Briggs speaks with the authority of twenty-five years experience in all aspects of loudspeaker design. From a historic survey of loudspeakers and an amusing autobiographic sketch, Mr. Briggs takes the reader into the intricacies of cones and coils, resonance and vibration, volume and watts, power handling and efficiency, magnet structures and the many other factors determining the sound of a speaker.

"From the detailed discussion of speakers as such, Briggs goes on to several illuminating chapters on different types of baffles. As the designer of many unconventional baffles, including a sand filled corner enclosure, column-type baffles and open-back baffles, Mr. Briggs holds forth on this subject with a depth of knowledge equal to his expertise on loudspeakers themselves.

"Some sections of the book are also devoted to the electrical factors affecting loudspeaker performance, such as negative feedback, output transformers and crossover networks.

"Particularly useful to the hi-fi fan are the chapters relating to room acoustics and speaker placement. Based on years of actual experimentation under a variety of circumstances, these chapters offer valuable points of improving the acoustic situation in almost any kind of room.

"Of great timeliness are chapters on stereo sound and electrostatic speakers, new to this fifth edition of the book. In common with many other British designers, Mr. Briggs favors omnidirectional sound radiation for stereo, a viewpoint now finding increasing support also in America. His fairness in discussing the relative merits of the new electrostatic loudspeakers with the conventional cone designs is exemplary.

"For the serious audio fan, pleasure and profit commingle in the reading of this book."

Here is a book which no one interested in high fidelity can afford to be without. At the approximate cost of one record album ($4.50), it is certainly a wonderful source of profit and pleasure.

LEONARD CARDUNER

P.S. We are pleased to make the following special offer to readers of this column:

British Industries Corporation will send you 50c as a refund for buying a copy of the Fifth Edition of "Loudspeakers" at your dealer. Here's all you have to do:

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The Sounding Board

MARCH, 1959 VOL. 43, No. 3
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

COVER PHOTO—"Unobstrusive" Electro-Voice Regal speaker systems in "The House of Music," home of E-V's sales veep Lawrence LeKashman. Except for the lavatories, which have monophonic systems, every room in the house is equipped with stereo, some using large speakers, some small. Main equipment is housed in a rack in the living room, with a secondary system in the dining room for independent programming when desirable.

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AUDIOCLINIC??

JOSEPH GIOVANELLI*

Connecting Headphones to Amplifiers

Q. I would like to know how to connect a pair of 600-ohm headphones to my Brook amplifier. John Sabritt, Philadelphia, Pa.

A. The Brook amplifier is a special case in that it includes a 500-ohm winding in its design. Furthermore, this amplifier is fitted with an octal plug, rather than the conventional tie strip used to connect loudspeakers and other devices to most other amplifiers. Pins 7 and 8 on this output plug represent the 500-ohm winding, and your phones may be connected directly to these pins.

However, there is another factor which should be taken into account. Earphones are placed very close to the eardrums, thereby creating a very efficient coupling network. This means that only a small amount of power is necessary for good listening level in the headphones. In fact, the power required for adequate listening level is approximately 9 milliwatts, or 9/1000 of one watt. This means that the volume control need be turned but slightly to produce such a low power level in its output circuit. This small degree of volume control rotation will make it difficult to operate your amplifier smoothly.

This difficulty may be overcome through the use of a pad. It may be constructed as follows: Connect a 500-ohm resistor across pins 7 and 8 of the output plug on your amplifier, the 500-ohm tap. Use a 5-watt wire wound resistor. Connect a 4700-ohm, 1-watt resistor to pin 7. Connect a similar resistor to pin 8. Connect the free ends of these resistors to the headphone terminals. By this means you will have introduced a loss into the system, a voltage division of 20 to 1. Naturally, considerably more power will be needed to drive the headphones with this pad in the circuit.

The pad has another advantage. Because of the high sensitivity of the headphones, any residual hiss level in the amplifier will be present as an annoying background to the program material being listened to. The pad will attenuate this background noise to a level such that it will be barely noticeable.

Other amplifiers are not provided with a 500-ohm winding, but these also may be connected to 600-ohm phones. The amplifier again should be properly loaded with a resistor connected across the output tap selected. If, for example, the 8-ohm tap is to be used, it should be of perhaps 5 watts capacity. A similar voltage-dividing network should be used between the 8-ohm resistor and the headphones. If you wish to experiment in order to obtain the best signal to noise ratio, make the resistances variable. Once you have selected the desired settings, measure the resistors and substitute fixed values.

The headphones may also be connected directly to the output of your preamplifier. 600-ohm headphones will unfortunately load down most cathode-follower circuits, and this loading will cause a degradation of low-frequency response, which is already badly degraded because of the nature of most of the headphones employed. High-impedance phones, especially crystals, may be connected directly to the output of the preamplifier without such degradation.

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

Speaker Efficiency

Q. Would you please enlighten me as to the relationship between power output of an amplifier and the efficiency of a speaker? For example, I am using a speaker whose efficiency is 10 per cent. How powerful an amplifier do I need in order to drive the speaker sufficiently to obtain 20 watts of musical program level? Can it be that we only obtain two watts output from a 10 per cent efficient speaker when this speaker is driven by a 20-watt amplifier? Fernando Sim, Manila, Philippines.

A. When a speaker has a maximum power handling capacity of 20 watts, it means that 20 watts is the top amount of power which can be fed into the speaker without damaging it or causing serious distortion. If the speaker is 10 per cent efficient, it will when supplied with this maximum of 20 watts, produce 2 watts of acoustical output. Remember that, by definition, efficiency is equal to the power fed into a device, divided by the power output, or yield, of that device. 2 watts output, as in this example, sounds like a small amount of power, but bear in mind that a full symphony orchestra playing at top fortissimo only develops about a watt of acoustical power. Because of this, you will not need a 20-watt program level from your speaker system. (Such a level would most certainly injure your ears, were you to stand near the system when it is giving out with that much sound.) However, assuming that for some reason you do need such high program levels, and further assuming that your speaker system is 10 per cent efficient, you would need an amplifier capable of delivering a power output of 200 watts in order that these conditions be met. Further, you would need a speaker system whose power input capabilities are at last equal to 200 watts, and if this program level is to be maintained over long periods, you would need a system capable of peak power levels of from 250 to 300 watts.

Volume Controls and Power Amplifiers

Q. I have a power amplifier having an input grid resistor of 1 megohm. I also have two preamplifiers and I would like to connect a volume control to each of their outputs in order to improve signal-to-noise ratio. What value of volume control would you recommend that I use? Neither preamplifier has a cathode follower. Would it be better to locate the volume control at the end of the preamplifier or locate it at the input of the power amplifier? What are the general principles involved in determining the resistance of a volume control? S. W., New York City, N. Y.

A. First, remove the input grid resistor from the power amplifier. Connect a volume control of the same value in its place. (Later in this answer I will outline the means of determining the correct value of control. Check to see whether the control you substitute conforms to this procedure.) Be sure that the grid of the amplifier is connected to the arm of the control. The leads of the input connector on the power

THE Garrard PAGE

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amplifier are connected across the full resistance of the control. The method of determining the value of a volume control is the same as that employed when determining the value of a grid-load resistor. It should be at least twice as large as its preceding plate-load resistor. The value of the interstage coupling capacitor is also a factor. Its reactance at the lowest audio frequency you wish to pass should be considerably lower than the grid resistance.

It would be better if the control units employed cathode-follower outputs. This is especially true when the control units are to be located some distance from the amplifier because the length of the interconnecting cable will then be great enough to introduce considerable capacitive reactance which, in turn, will cause some degradation of the high frequencies. This condition does not prevail with cathode-follower circuits largely because their impedance is much lower than the capacitive reactance of the shielded cable, and hence, the shunting effect of this reactance is negligible.

Matrixing

Q. I have heard much lately about matrixing. Just what is it? G. Best, Long Island City, N. Y.

A. Matrixing is a system whereby two signals are combined to form their sum and their difference; later they are reconstituted into their original components. This technique is employed in the Crosby multiplex system. The sum of two stereo channels is fed into an FM transmitter in the normal manner. (Those who don't have multiplex adapters may, by this means, receive the monophonic broadcast.) The difference signal is impressed upon a subcarrier, which is transmitted on the main FM carrier. This subcarrier is undetectable with unmodified FM receivers, but this difference information can be recovered by adding a multiplex adapter to the tuner. Some circuit modification will be needed on tuners which were not provided with a multiplex jack. One of the things which is included in the adapter is a matrixing circuit, which serves to recover the difference signal and recombine it with the sum signal in such a way that the original stereo information is recovered and can be fed to the stereo preamplifier in the usual manner.

Another use found for this technique is the Columbia Record stereo system, which matrixes the signal and records the sum signal laterally and the difference signal vertically, with compression on the difference, or vertical channel. Æ

Live vs. Recorded Concert

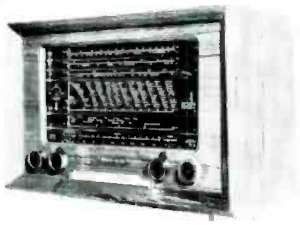
Occasionally put on in a large scale by much bigger organizations, live vs. recorded music concerts are always interesting to the serious audiofan. On a smaller scale—from the point of view of number of musicians—a concert staged last January 10 at Carnegie Recital Hall was no less informative and entertaining.

The participating organizations were: The Fine Arts Quartet, shown below, comprised of Leonard Sorkin and Abraham Loft, violins, Irving Ilmer, viola, and George Sopkin, cello; Concertapes, Inc., with its professional recording equipment and techniques; Dynaco, Inc., with two Dynakit preamplifiers and two Mark III amplifiers; and Acoustic Research, Inc., with two AR-3 speaker systems. The concert was actually presented three times to accommodate those who were invited to attend, this in itself being a record.

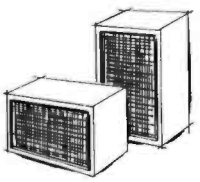
Just prior to the concerts, a tape recording was made of the quartet playing the programmed selections. The reproducing system was then adjusted for the same sound volume as that from the quartet. Synchronization between the tape and the musicians permitted the latter to stop playing while the tape took over. Even while watching the musicians carefully, many of the audience were unable to determine which source they were listening to. The program notes for the concert suggest that such a comparison is the final test of "high fidelity" recording techniques and reproducing equipment, and that if the audience cannot detect the switchovers the demonstration would be successful. By this criterion we would have to say that it achieved at least 90 per cent of success.

—*CGMcP*

The HULDRA 5 is an AM-FM Shortwave Tuner, Preamplifier, Power Amplifier and Intercommunications System with FM Multiplex Output combined in one beautiful Scandinavian "package." More extraordinary than styling is the technical brilliance it represents. Probably the most sensitive tuner ever designed and manufactured, Huldra 5 positively assures wide range, distortion-free response made possible by its carefully designed circuitry. No other tuner has the versatility nor unlimited quality of Huldra 5.



Perfectly matched to the Tandberg Stereo playback amplifiers, **Tandberg Model 266 Speaker Enclosure** is truly an outstanding performer in faithfully reproducing sound over a wide frequency range with lowest distortion. Functional in design, it is beautifully finished with mahogany on all sides to enable either horizontal or vertical placement. With the Tandberg 5, two Model 266 enclosures make up a complete Stereo tape system.



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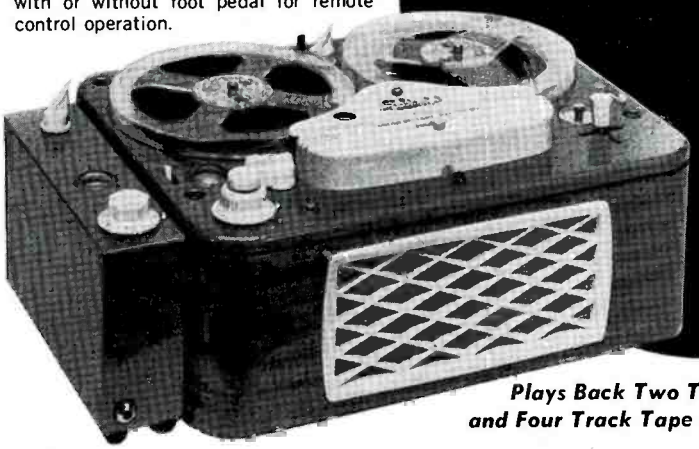

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LETTERS

Styli for Stereo and Mono Records

SIR:

I do not understand why a 0.7-mil stylus should be so much less wearing on a record than a 0.5-mil stylus with equal tracking force. Several of your authors mention this. It is surely here a matter of how much of the stylus is in contact with the record material, which is largely a matter of the flow of the material. Ideally speaking, with a hard record material, one should only get a point contact between stylus and record.

After the first mention of the fact, one does not find reference to the fact that to hear monophonic records with a stereo cartridge it is possible to connect the cartridge so that the vertical component is cancelled out and the cartridge acts as a true monophonic cartridge. What would ETC say to the use of stereo cartridges if they were so connected for monophonic use.

I also find that there is little technical data on rumble filters, though of course with stereo records they are more important than ever. This subject should be good grist for Cdr. Harrison's mill.

P. S. HIRSCHMANN,
Rehov Hagefen,
Tivon, Israel.

SIR:

For playing monophonic LP records, will better results be obtained with a top-grade 0.7-mil stylus of the stereo type, using a proper switch, or from a top-grade 1-mil stylus in a monophonic pickup?

For stereo-monophonic playing, two cartridges will be used if your answer favors the 1-mil stylus for monophonic use.

J. B. KADEL, JR.,
217 N. Grant St.,
Waynesboro, Pa.

(A common question, with an iffy answer. Actually, the theoretical point contact does not exist in practice—there is some deformation of the record material, and the smaller the stylus the more it will depress the record. Since the area of the contact is the important factor, stylus force should be proportional to the square of the radius for the same distortion of the record surface. Therefore, if we reduce the stylus radius by one-half, we should reduce stylus force by one-quarter; a reduction from 1 mil to 0.7 mil should be accompanied by a force reduction to one-half. Pickering has long had available a 0.5-mil stylus which gives better high-frequency performance on the more recent records which have been cut with a V stylus—that is, without any rounding of the point. Similarly, the Shure Studio Dynetic was introduced with a 0.7-mil stylus as standard because of the better performance—both of these being intended for monophonic records. However, it is not likely that the 0.5- or 0.7-mil styli would perform satisfactorily, with respect to record wear, with an arm or turntable which required a stylus force of, say, 6 grams.

As to whether the stereo cartridge will give as good performance on monophonic records as a good mono cartridge is still to be determined. We believe that the finest stereo cartridges are perhaps not yet equal to the finest monophonic cartridges, but we also believe that the average *stereo cartridge is still better than the* average *monophonic model.*

We trust Cdr. Harrison will take notice of the suggestion in the first letter. ED.)

More on Multiplex

SIR:

A multiplex stereo system with advantages of both Crosby and Halstead is to transmit the sum signal on the regular FM channel and the signal for one speaker on the subcarrier.

This proposed system provides a complete signal for the monophonic listener while assuring the simplest matrixing circuit for the receiver. Noise output of the subcarrier detector is applied equally to the two speaker systems resulting in a minimum of listener discomfort.

IRVING D. RICHMOND,
2230 Grand Concourse,
Bronx 57, N. Y.

(Sounds as though there might be some merit in this suggestion. However, it does not allow for any possibility of a narrower band width for the subcarrier, which is one of the things to be desired in any multiplex system if it can be obtained without degradation of quality. ED.)

SIR:

In this listener's opinion, both Audio and Mr. Canby are on the wrong track in reference to the current debate on Crosby *vs.* Halstead multiplex.

Instead of compromising the Crosby system by reducing the 25-kc bandswing, why not approach the problem of "pirating" by making it impossible for the home listener with a Crosby-type converter to hear the commercial stuff, which Mr. Crosby so aptly labels "musical dishwater." Wouldn't it be feasible for the commercial broadcasts to be scrambled or keyed in such a manner as to prevent eavesdropping?

Any final decision on multiplex which (1), prevents the listener without a converter from hearing a full monophonic signal, or (2), degrades one or both of the stereo channels, would be a disservice to the major portion of the listening public, and would, in my opinion, reduce the growth potential of FM radio which an unadulterated Crosby stereo system could bring about.

H. S. ROBISON,
3 Devonshire Drive,
White Plains, N. Y.

(We couldn't agree more with items 1 and 2 in the last paragraph. It would appear, however, that scrambling would entail an unnecessarily high cost to the background operators, and in many areas it is this background operation which pays the freight for the "good music" broadcasts on the main channels. ED.)

SIR:

The Editor is to be commended for opening and continuing to stimulate discussion of stereo broadcast standards by publishing the very valuable contributions of Bert Cowlan and Murray G. Crosby in the November issue. Should any avenue toward a possible solution be left fallow now, the

(Continued on page 10)

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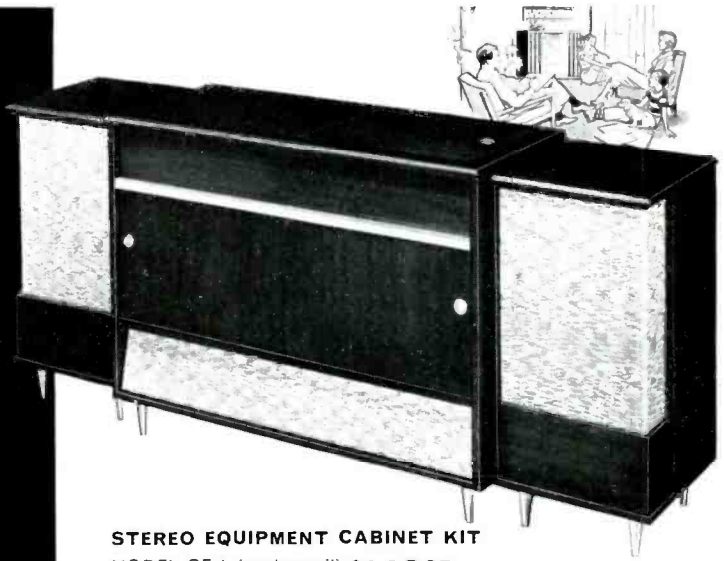

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MODEL C-SP-1 (converts SP-1 to SP-2) **$21.95** Shpg. Wt. 5 lbs.

Special "building block" design allows you to purchase instrument in monaural version and add stereo or second channel later if desired. The SP-1 monaural preamplifier features six separate inputs with 4 input level controls. A function selector switch on the SP-2 provides two channel mixing. A 20' remote balance control is provided.

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Turntable quality with fully automatic features! A unique "turntable pause" allows record to fall gently into place while turntable is stopped. The tone arm engages the motionless record, and a friction clutch assures smooth start. Automatic speed selector plays mixed 33⅓ and 45 RPM records regardless of sequence. Four speeds available: 16, 33⅓, 45 and 78 RPM. Changer complete with GE-VR-II cartridge with diamond LP and sapphire 78 stylus, changer base, stylus pressure gauge and 45 RPM spindle. Shpg. Wt. 19 lbs.

PROFESSIONAL STEREO-MONAURAL AM-FM TUNER KIT

MODEL PT-1 **$89.95**

The 10-tube FM circuit features AFC (automatic frequency control) as well as AGC. An accurate tuning meter operates on both AM and FM while a 3-position switch selects meter functions without disturbing stereo or monaural listening. Individual flywheel tuning on both AM and FM. FM sensitivity is three microvolts for 30 db of quieting. The 3-tube FM front end is prewired and prealigned, and the entire AM circuit is on one printed circuit board for ease of construction. Shpg. Wt. 20 lbs.

"EXTRA PERFORMANCE" 55 WATT HI-FI AMPLIFIER KIT

A real work horse packed with top quality features, this hi-fi amplifier represents a remarkable value at less than a dollar per watt. Full audio output at maximum damping is a true 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Featuring famous "bas-bal" circuit, push-pull EL34 tubes and new modern styling. Shpg. Wt. 28 lbs.

MODEL W7-M **$54.95**

"BOOKSHELF" 12 WATT AMPLIFIER KIT

MODEL EA-2 **$28.95**

There are many reasons why this attractive amplifier is such a tremendous dollar value. You get rich, full range, high fidelity sound reproduction with low distortion and noise . . . plus "modern styling". The many features include full range frequency response 20 to 20,000 CPS ±1 db with less than 1% distortion over this range at full 12 watt output—its own built-in preamplifier with provision for three separate inputs, mag phono, crystal phono, and tuner—RIAA equalization—separate bass and treble tone controls—special hum control and it's easy-to-build. Complete instructions and pictorial diagrams show where every part goes. Cabinet shell has smooth leather texture in black with inlaid gold design. Shpg. Wt. 15 lbs.

HIGH FIDELITY AM TUNER KIT

MODEL BC-1A **$26.95**

Designed especially for high fidelity applications this AM tuner will give you reception close to FM. A special detector is incorporated and the IF circuits are "broadbanded" for low signal distortion. Sensitivity and selectivity are excellent and quiet performance is assured by a high signal-to-noise ratio. All tunable components are prealigned before shipment. Your "best buy" in an AM tuner. Shpg. Wt. 9 lbs.

HIGH FIDELITY FM TUNER KIT

MODEL FM-3A **$26.95**

For noise and static-free sound reception, this FM tuner is your least expensive source of high fidelity material. Efficient circuit design features stabilized oscillator circuit and broadband IF circuits for full fidelity with high sensitivity. All tunable components are prealigned before shipment. Edge-illuminated slide rule dial. Covers complete FM band from 88 to 108 mc. Shpg. Wt. 8 lbs.

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MODEL WA-P2 **$19.75**

All the controls you need to master a complete high fidelity system are incorporated in this versatile instrument. Features 5 switch-selected inputs each with level control. Provides tape recorder and cathode-follower outputs. Full frequency response is obtained within ±1½ db from 15 to 35,000 CPS and will do full justice to the finest available program sources. Equalization is provided for LP, RIAA, AES, and early 78 records. Shpg. Wt. 7 lbs.

"UNIVERSAL" 12 WATT AMPLIFIER KIT

MODEL UA-1 **$21.95**

Ideal for stereo or monaural applications, this 12-watt power package features less than 2% total harmonic distortion throughout the entire audio range (20 to 20,000 CPS) at full 12-watt output. Use with preamplifier models WA-P2 or SP-1 & 2. Taps for 4, 8 and 16 ohm speakers. Shpg. Wt. 13 lbs.

HIGH FIDELITY TAPE RECORDER KIT

MODEL TR-1A **$99.95**

Includes tape deck assembly, preamplifier and roll of tape.

MODEL TE-1 **$39.95**

Shpg. Wt. 10 lbs. (Tape Preamplifier Only)

The model TR-1A provides monaural record/playback with fast forward and rewind functions. 7½ and 3¾ IPS tape speeds are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-6,500 CPS. The model TE-1 record/playback tape preamplifier, supplied with the mechanical assembly, provides NARTB playback equalization. A two-position selector switch provides for mike or line input. Separate record and playback gain controls. Cathode follower output. Complete instructions provided for easy assembly. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. (Tape mechanism not sold separately). Shpg. Wt. 24 lbs.

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MODEL MF-1 **$26.95**

Replace your present pickup with the MF-1 and enjoy the fullest fidelity your library of LP's has to offer. Designed to Heath specifications to offer you one of the finest cartridges available today. Nominally flat response from 20 to 20,000 CPS. Shpg. Wt. 1 lb.

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The SS-1B employs a 15" woofer and super tweeter to extend overall response of basic SS-2 speaker from 35 to 16,000 CPS ±5 db. Crossover circuit is built in. Impedance is 16 ohms, power rating 35 watts. Constructed of ¾" veneer-surfaced plywood suitable for light or dark finish. Shpg. Wt. 80 lbs.

MODEL SS-1B
$99.95

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The modest cost of this basic speaker system makes it a spectacular buy for any hi-fi enthusiast. Uses an 8" mid-range woofer and a compression-type tweeter to cover the frequency range of 50 to 12,000 CPS. Crossover circuit is built in with balance control. Impedance is 16 ohms. Power rating 25 watts. Tweeter horn rotates so that the speaker may be used in either an upright or horizontal position. Cabinet is made of veneer-surfaced furniture-grade plywood suitable for light or dark finish. All wood parts are precut and predrilled for easy assembly. Shpg. Wt. 26 lbs.

MODEL SS-2 **$39.95**
Legs: No. 91-26 Shpg. Wt. 3 lb. $4.95

LEGATO HI-FI SPEAKER SYSTEM KIT

MODEL HH-1 **$299.95**

The startling realism of sound reproduction by the Legato is achieved through the use of two 15" Altec Lansing low frequency drivers and a specially designed exponential horn with high frequency driver. The special crossover network is built in. Covers 25 to 20,000 CPS within ±5 db. Power rating 50 watts. Cabinet is constructed of ¾" veneer-surfaced plywood in either African mahogany or white birch suitable for the finish of your choice. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

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Sound Talk

by Dr. W. T. Fiala
Chief Physicist

LOUDSPEAKER DISTORTION AT LOW FREQUENCIES

Lord Rayleigh, in his famous "Theory of Sound," had shown that the acoustic power generated by a cone in an infinite wall is proportional to the square of the frequency and to the square of the air volume displaced per second. This relation indicates that at low frequencies considerable amplitudes are required to produce acoustic power. A 15" cone speaker, for example, has to move approximately one-half inch, peak to peak, in order to generate one acoustic watt at 40 cps.

However, it is not sufficient to design a speaker which is only able to move with the required amplitude. In order to avoid distortion, it is also necessary that this movement follows exactly the driving current in the voice coil. To achieve this, the suspension system has to be linear for the required amplitude. This means that the displacement of the cone has to be proportional to the driving force produced by the voice coil or, more specifically, if the transfer characteristic is plotted in linear coordinates, it should be represented by a straight line so that each doubling of the force on the cone also doubles the displacement. This force, generated by interaction of the current in the voice coil and a magnetic field, must also be proportional to the voice coil current. Thus, each doubling of the voice coil current should double the driving force. When these two requirements are met, the displacement of the cone is proportional to the driving current in the voice coil. In other words, the transfer characteristic of the speaker, which relates cone displacement versus voice coil current, has to be linear.

Present day technology and carefully controlled assembly techniques make it practical to build linear suspension systems for large excursions. The use of sufficient magnet to produce a long enough uniform magnetic field so that the voice coil always remains in that field for the required amplitude will secure the necessary linear force-voice coil current relation.

LETTERS

(*from page 6*)

opportunity may be lost forever, for precedent is a cruel tyrant indeed.

Industry-wide discussion is especially needed in this era of influencing interested commissioners. The F.C.C. will need all the help it can get from an informed public opinion.

The Editor's questioning that the public interest, convenience, and necessity are well served by many AM stations, or for that matter, network TV, is extremely well taken. Certainly it should be the responsibility of the licensees to lead the public taste rather than to follow. Few, very few, do so, some even attempting to rise to BBC standards in this respect. But fortunately, so far, FM licensees tend on the average to discharge this responsibility more diligently than others. It is this precarious situation that Cowlan and Crosby would not disturb.

It seems to me that the critical element toward decay in the broadcast picture are the advertising agencies, both local and Madison Avenue. They tend to promulgate both explicitly and implicitly, pathological values of a romantic, infantile, fantasy world, sterile and materialistic. The Editor's original point of view is no doubt explained by his need and desire to keep the agencies happy, not as suggested by Crosby, lack of engineering data. The Editor's reference to "*presumed* public ownership of the air" is rhetorically deferent to the same interests; as public ownership is firmly established and universally recognized.

Personally, I am thoroughly in accord with the statement of Cowlan of WBAI. Also, that 69-per-cent range mentioned by Crosby would be fatal to San Diego listening, producing a monopoly in the quality listeuing field. It should be noted that in addition to FM-AM, and now multiplex, there is in the Los Angeles area FM-FM stereo, in which two co-operating licensees transmit the A and B channels. Before closing discussion, let's complete the roster.

RUSS LINTON, Electrical Engineer,
2524 44th St.,
San Diego 5, California

Small-Box Loudspeaker Systems—again

SIR:

In answer to Mr. Villchur's comments (LETTERS, February) it *is* possible to design a high-compliance, long-travel woofer for both small and large boxes. We recommend Jensen P12NF and P15LF with bellows suspensions, voice coils ¾ in. longer than airgap, and symmetrical magnetic field, for small, medium, or large enclosures. Rather than restrict excursion and thereby reduce output, it is preferable to let the cone move the required distance. It *must* move the same distance for *a given loudness at a given frequency*, regardless of size with a closed box. The use of a "protective device" such as higher resonance to reduce distortion will be defeated if bass boost is used to overcome resulting loss in output.

A better method of reducing excursion and distortion *without reducing output* is to vent the box. A properly proportioned vent increases speaker damping without losses in bass because the vent *also* radiates sound. The linear vent elements and reduced voice-coil excursion greatly reduce distortion. The experiment of converting a good high-compliance vented speaker system to a closed box system demonstrates the principle. With single tones from slightly below woofer resonance to an octave and a half above, the cone movement increases as the vent is closed. A drop in bass output is observed, ranging from slight or imperceptible for a small box to many db for a large one. Short of horn loading, we know of no better way to limit excursion at lower frequencies, without losing output, than to open the vent again.

There can be no question of superiority of the large box in vented design. In the closed box, Mr. Villchur answers the "more bass" part by saying the small box limits excursion below resonance, at constant input. Theory and practice compare distortions as follows:

1. Large box delivers more low bass per watt, so system distortion is lower, less amplifier power being required.
2. With the cone having to move a fixed distance in either case, harmonic distortion is the same.
3. Larger box delivers lower system Q, all else being equal, so transient distortion is lower.

Dr. Beranek's suggestion of Q of 1.36 or less was based on tests under certain conditions which may not be universal. In the same text quoted, he also says that Q of 0.5 gives critical damping, and that it is not known just *how* low Q should be.

It would appear to be better to start with critical damping, and raise Q if desired by series resistors or other means. Then the optimum Q is possible for any condition.

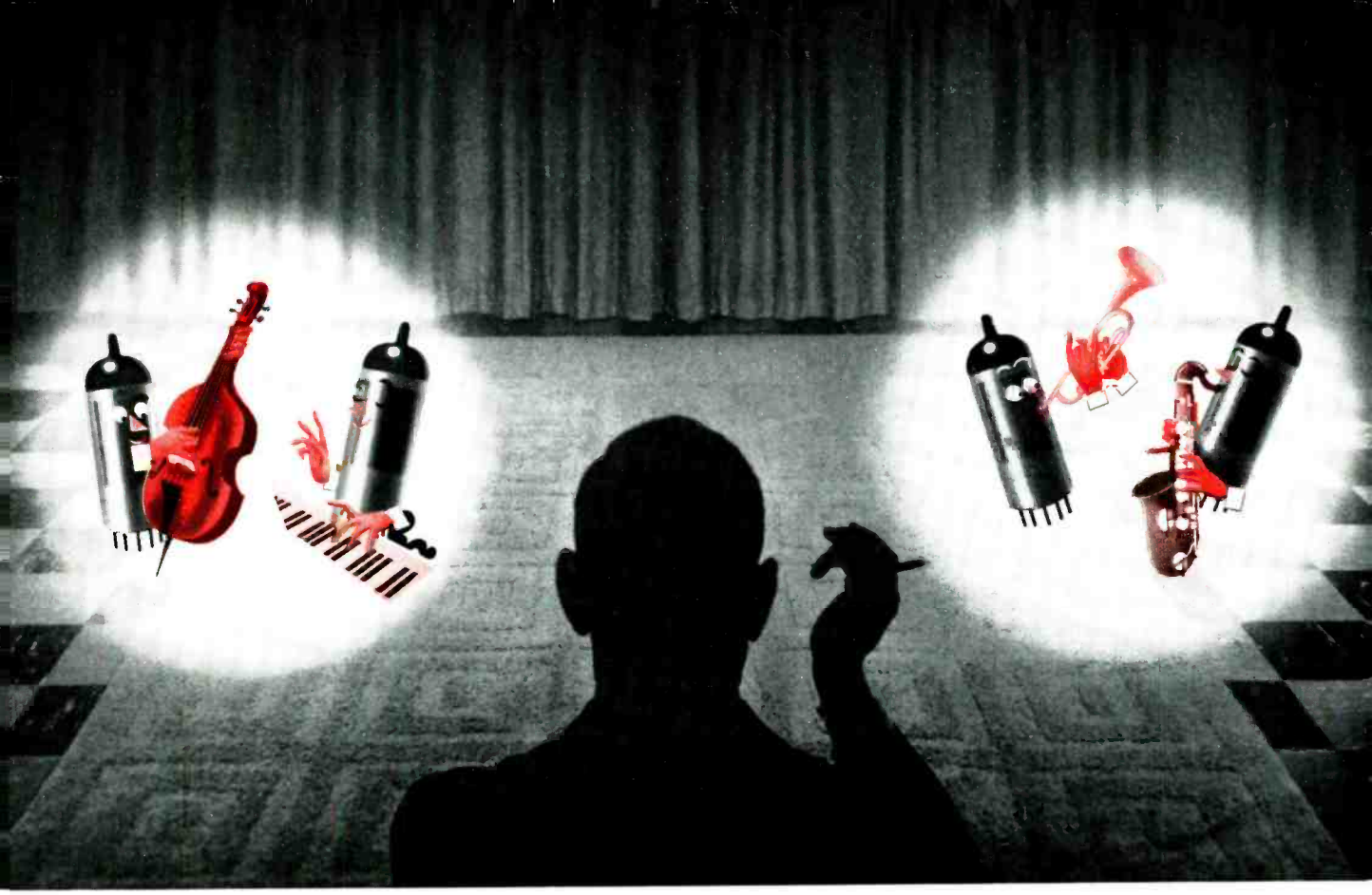
PHILIP B. WILLIAMS and JAMES F. NOVAK,
Jensen Manufacturing Co.,
6601 S. Laramie Ave.,
Chicago 38, Illinois.

AM Detection

SIR:

An erroneous statement regarding half-wave detection of AM signals was made in Mr. Canby's AUDIO ETC. column in the December issue. In actuality, all home-type "standard" AM receivers *do* detect *both* sidebands of an AM signal, whether or not the detector circuit is half-wave or full-wave.

DONALD HALFORD, Chief Engineer,
Radio Station WFMT,
22. N. La Salle St.,
Chicago, Ill.



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UCL82/50BM8—Series string (100 ma. 50v) version of ECL82/6BM8.

PCL82/16A8—Series string (300 ma. 16v) version of ECL82/6BM8.

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EF86/6267—High-gain pentode with exceptionally low hum, noise and microphonics.* Particularly suitable for pre-amplifier and input stages. Similar to the Z739 and the 5879.

ECC81/12AT7—Medium-gain dual triode with low hum, noise and microphonics. Replaces the 12AT7 without circuit changes.

ECC82/12AU7—Low-gain dual triode with low hum, noise and microphonics. Replaces the 12AU7 without circuit changes.

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6DJ8/ECC88—Frame grid, sharp cut-off twin triode. Particularly suitable for cascode circuits, RF & IF amplifiers, mixer & phase inverter stages. Features high transconductance and low noise.

***6ES8**—Similar to 6DJ8/ECC88. Has remote cut-off characteristics.

***6ER5**—Frame grid shielded triode with remote cut-off characteristics. Suitable for RF amplifiers in TV & FM tuners. Features high transconductance and low noise.

†**ECC85/6AQ8**—High gain dual triode for FM tuners with shield between sections for reducing oscillator radiation.

EBF89/6DC8—Duo diode-pentode with remote cut-off characteristics. Suitable for RF & IF amplifiers.

ECF80/6BL8—High gain triode-pentode for RF amplifiers.

RECTIFIER TYPES

EZ80/6V4—Indirectly heated, full-wave rectifier with 6.3 v, 0.6 amp. heater, 90 ma. output capacity and 9-pin miniature construction.

EZ81/6AC4—Indirectly heated, full-wave rectifier with 6.3 v, 1 amp heater, 150 ma. output capacity and 9-pin miniature construction.

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Also Available: INDICATOR TUBE TYPES

EM84/6FG6—Indicating pattern is a varying length bar. For use in broadcast receivers and tape recorders.

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GERMANIUM DIODES

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**300, 450 & 600 ma series string versions available.*
†300, 150 & 100 ma series string versions available.

AUDIO ETC.

Edward Tatnall Canby

THE OTHER KIND OF STEREO

"IT IS WITH a great deal of pleasure that I read your recent article pertaining to stereo photography. I, too, am the owner of a stereo camera. . . ."

"I read with . . . interest, on p. 10 of the January AUDIO, of your success with stereo projection. I have enjoyed stereo pictures for years . . . but have tried unsuccessfully to get a recommendation, even from the Eastman Kodak Company, on a projector. I think you would please many AUDIO fans if you would tell us what equipment you use . . ."

"So you also are keen on colour photography! (This from England.) I'm just starting to play with stereo pictures . . . I've not yet got around to projecting them . . ."

Well, there you have a few yelps of delight from an obviously frustrated minority and, you see, it's just as I said. Stereo photography, big biz has decided, is not for the Great American Public, and so, down with it; the People say, NO. But some of them, in small, anguished voices, still say yes. With a pious hope that our own stereo sound will never, but *never*, be reduced to this sad state (as per the January AUDIO, ETC.) I bow to the inevitable, invoke my useful escape clause—that "etc" in its alternative meaning of *et cetera*—and herewith toss a few ideas to the ravening hordes of stereo camera bugs. I'm probably the only guy left who has a kind word to say in print for stereo. Stereo pictures, that is. And I am dead-certainly the only person who has ever come out for stereo projection in a magazine about audio. Deny that if you dare.

1. VIEWERS

Projection, in fact, is what's on my mind but first a bit of foreground. Anybody can look at stereo through a viewer, and get the best possible stereo in this imperfect world. Nothing can beat it. Only those who have (a) one eye or (b) two eyes that habitually don't operate together (one goes psychologically blind) will find themselves constitutionally unable to get a stereo effect.

The second category, I've found, includes a remarkably large number of souls, most of whom don't even know they lack stereo vision. They always exclaim how pretty the pictures are and it's only when you quiz them *very* specifically about certain perspective details, like say, a branch of a tree that seems to be hitting you in the eye in the foreground, that you uncover a certain vagueness. Pretty soon you begin to suspect that something isn't right, but it is amazing how hard it is to pin down the stereo-less pair of eyes. It's like color blindness, which even in this day of red and green traffic lights can go unsuspected for an astonishingly long slice of life in many people.

I usually shut up and say no more when I begin to realize that a given person simply is not seeing stereo. That's the only tactful thing to do. After all, if they can't tell the difference, why be brutal. Some stereo newcomers are so very polite that it may take you a dozen pictures to find out that they are actually seeing everything double, and unregistered. These nice people, after oohing and aahing about the beautiful photography and the lovely colors for ten or fifteen minutes, are apt to disclose, purely incidentally, that of course they are closing one eye—aren't you *supposed* to do that? "Why, I see double if both eyes are opened. I thought it was so you could rest one eye at a time. . . ." Amazing what sheeplike virtues some people have!

And no wonder stereo photography was sold down the river by the big operators. Even sheep protest, eventually.

Ink-blue

The only proper type of viewer is that which has a built-in house-current light supply, via a small 80-volt bulb and a rheostat to adjust the amount of light. The bulb may be small but its light is still enormously more powerful that that of the battery-powered viewer light, the flashlight type. Once you've used the plug-in house current system, you'll never go back to batteries except for emergencies or extreme portability.

There's a major trouble with the plug-in light. Its color is wrong. Too yellow. (The flashlight bulb is beautifully white, at least for the first few minutes, before it begins to run the batteries down). When you reduce the light's brightness via the silly "volume control," the color gets yellower still. The only proper rheostat position is wide-open, at full voltage. I have a simple "solution" for this, speaking quite literally. Take out your bulb and dip it in blue ink, let it drip off and dry. Then you'll have a fine, soft, blue-white light that is exactly right.

True, the bulbs blow sooner (you'll need a half-dozen extras on hand) and the ink tends to turn dark. But you can wash it off and start again any time. With the inky bulb you'll finally get away from those yellow-orange sky effects that mar stereo viewing in so many viewers. (Why don't they make a blue bulb? Too much trouble, I guess.)

You'll note two adjustments on viewers, that for the separation of the lenses and that for focus. They can throw any new user into a tizzy, unless you demonstrate them one at a time. Start with a fixed focus—i.e., don't mention it at all—and have the viewer wiggle the separation lever until he begins to find a good resting place that joins the two pictures comfortably. (Be sure the slide is in all the way, the two pictures aligned; better try it yourself first, to be sure.)

Then when conjunction is accomplished—if you get that far—point out the focus knob and let him play with it. After that, don't move *anything*. And if the pictures just won't join, or the person starts saying how lovely, with that vague, uneasy smile that says trouble is being concealed, just quietly change the subject. Maybe it's time for dinner; or have you seen my new stereo hi-fi system yet? Pardon me—I mean heard. No use going on if the patient evinces symptoms of anastereoitis.

Details

The viewer, one-person-at-a-time, is the only way really to see stereo. The viewed image is far superior to the projected image in a number of ways. It is sharper and clearer, but also, more important, it is relatively much larger; it fills a far greater area of the visual field. A stereo picture inside a viewer is, let's say, roughly equivalent to a nine-foot-square image on a screen at about ten feet. Huge. Details are infinitely better in the resolution via the viewer than via projection, and (with Kodachrome) details are the very essence of good stereo. To be able to recognize a person at a distance of a quarter mile via a stereo viewer is really something, but the magnification and the sharp detail (via a good lense) makes it quite possible. Same with distant mountains, pin-point houses across a wide valley, distant signs, etc.

Incidentally, I use only Kodachrome. Grainy color films are taboo in stereo—the magnification (via viewer) is enormously too great and you can practically count the dots. Kodachrome has no dots; it is a dye picture and, if I'm right, has practically infinite detail resolution. It is absolutely amazing to look at a Kodachrome 35-mm picture with the naked eye and see how incredibly tiny are some of the clear details that can be seen and resolved via the huge viewer magnification.

Incidentally too—while I'm at it—I use Kodachrome not because it gives a true color value but because the exaggerated Kodachrome colors are absolutely first rate for dramatic emphasis in the peculiar stereo visual medium. This is an interesting point and has a direct analogical relation to the same thing in sound recording. In stereo pictures, there are many missing elements—motion above all, but also the more subtle sense of actual happening, of life itself, including the accompanying sounds. The picture has depth, but is still a picture. For emphasis and dramatic force, then, a stereo picture—any sort of picture—must make up for the lack by plugging, exaggerating what it has. That's where the art comes in. Same thing in recording.

Kodachrome rightly plays up color values (though with good color balance) and legitimately gives a heightened sense of drama to good stereo photography. In the same way, close-up mike technique, blown-up volume on solos, on opera singers, solo instruments with orchestra, distorts "reality" but adds legitimate drama and force to reproduced sound, for a truer emotional projection of the musical effect. So I'm all for Kodachrome's color, though many people deplore it, just as I am all for dramatic mike techniques in recording, though they are far from literal-minded.

Back to the stereo viewer. It is best for one major reason above all others—it is the only form of stereo viewing that does not distort the optical values of the pic-

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Monaural Power Amplifiers: 60, 50, 35, 30, 22 and 14-Watt (use 2 for Stereo)


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tures. It sees virtually what the camera saw, the depth and width in proper relation, and this even though in some cases the point of infinity—the sky, or background—is actually at a distance of only six inches or so. In effect, you look at a small model of the actual scene in these cases; but it is an accurate model with the basic spatial relationships essentially correct from side to side and front to back, give or take a bit of false curvature. In a viewer rightly built and rightly used the infinity point for your eyes is at infinity, and all nearer points are very nearly where they should be. Your "model" is as large as life. (Differences between camera configurations and viewer opties account for these effects.)

Antisocial

So—today's big question—why project? Why, if projection fuzzes up the details, grossly distorts the spatial effect most of the time, gives far too small a picture, requires messy glasses that cost too much (Polaroid's tight little monopoly) and generally hurts the eyes beyond bearing—why bother?

For only two reasons. One is overpoweringly important. Stereo projection is *social*. Two or more people may enjoy a picture at the same time. I've coped with as many as sixty.

Viewer stereo is strictly antisocial. One person at a time, exclusive, solitary—or just a plain nuisance, when several people are trying to get into the act. If you've stood next to a joyful friend, buried in your stereo viewer, who keeps shouting "Oh, and what's *that* little thing up there, and who's this, down in the right hand corner?" when you haven't the faintest idea what picture is being looked at, you'll know what I mean.

Or if you've seen a flock of avid souls tearing your pictures apart, pushing them in and out of the viewer, upside-down, backwards, reversed, greasy fingers always squarely on the film surface, dropping slides on the floor and stepping on them in their eagerness to be next in line . . . well, that's antisocial viewing. It's anti-*you*, more than anything else. It hurts.

So stereo picture makers tend to develop into hermits. They retire to a safe, lonely place and lose themselves happily in their solitary hobby. Wonderful, but not for parties. Even one extra is trouble enough. I have two suggestions here—before I get to a second pro-projection argument. First, write *brief* captions on your slides, and do it on the slide face that must be towards your eyes. Make them short, readable, simple. It's hard enough to get people to look out of their viewer anyhow—it hurts the eyes; the quick change from the inner infinity focus to the outer close-up is tough on most people and they won't read your titles at all unless prompted. But if you say to them, "Just put the slides in with the captions facing you and right-side-up" —then they'll more or less have to read them. And you'll have a minimum of upside down, backwards pictures.

Don't write *"View towards the Southwestern corner of the Sierra Madre range, taken from our little summer cabin on the slopes of Mount Dinkydoodle, July, 1958."* (You won't have room anyhow.) But compress: *"Sierra Madre. Cabin. 1958."* That does it.

Secondly, if you are showing pictures to a friend in person, the thing to do is to have your own viewer (that's where my old battery-powered viewer comes in handy). Look at each picture yourself first, in the viewer; then pass it on to your friend with its image fresh in your mind. This works wonders. You can even do it with two people, in tandem, if you hold back each new picture until *both* have seen the preceding one.

2. PROJECTION

To return to where I was—the second good reason for stereo projection is utterly simple. For all its faults, with all its grave difficulties, it can be made to work—if you are lucky. You *can* be social, and you can do it successfully. You can entertain from six to sixty simultaneously and emerge with a good passing grade of blessings and a minor proportion of curses, plus a few blissful sleepers—somebody always takes advantage of the darkness for a quiet snooze. If stereo projection works at all, it's worth the time and trouble.

But, boy, do you have problems en route. The first is to get a stereo projector over the loud objections of the photography dealers, who will tell you, of course, that it is hopelessly impractical and they wouldn't touch a stereo projector with a fifty-foot pole. The second is to get a stereo screen, which must be silvered, since beaded screens will not work. The third is to get stereo glasses. Plastic ones, fragile as air, a blasted nuisance at best and they cost around 20 cents a pair. I use 'em. Glass ones cost a mere $3 or so apiece, which will put you in the broke category before you even get started. I have *one* glass pair—for myself. At least it doesn't fall off my nose when I'm trying to work the projector. The rest are plastic, some of the clip-on type, some entirely frameless (wear your right arm out holding 'em—I use these on kids) and a few with plastic side-arms that keep falling off. Phooey! They do make things hard for you.

Whether you can still buy this sort of equipment, as things now stand, I don't know. When a commercial boomlet like stereo collapses, it busts wide open. (Again, keep my moral in mind.) Maybe you can't find any of it and the discussion is academic. But the chances are that you'll find what you want if you persist. The reputable stereo makers—those from the pre-boom days—still make cameras, notably the Stereo Realist people, and if you look hard, and brave the dealers' displeasure often enough, you'll locate the rest even if it has to be in the second hand market.

My first stereo projector, a pure boom product and a disgrace to any industry (like some of our present gimcrack stereo phonographs) was nearly a total flop. It was an outrageously crude bit of expensive gadgetry. For $100 or so you got a shaky pair of 300-watt optical systems in a giant framework, intended tantalizingly to project stereo on a screen or, via a reflector, onto a rear-facing ground glass about a foot square. The ground glass was useless (too small for good viewing, even by one or two people) and the machine itself was so flimsy that if you picked it up too hastily the frame buckled and the ventilating fan blades sideswiped their crude mountings with a screetch. It was pinned together with those little flat pieces of metal split in the middle that pass for nuts in gimcrack construction. What's more, 300 watts per "channel" was not enough for projection (with those lenses, anyhow). And the picture adjustment controls promptly stripped their gears, letting one picture suddenly drop down a foot on the screen each time a cog slipped.

But I had seen possibilities (I must have been the only person who did). I went forth again, licking my wounds, and got me a real prize. The Nord stereo projector, costing me half as much, was smaller, neater, lighter, with two 500-watt bulbs and

plenty of screen illumination. (You need a lot because of the double loss in the two pairs of Polaroid filters, one in the projector, the other in the glasses you wear). It was solid, rigid, adequately ventilated and with good controls—an excellent machine. Unfortunately, it was being discontinued. The stereo boom was already about to die. Just in case, the Nord stereo projector was made by the North Star Specialties Co. of Minneapolis. Maybe you can dig one up, or persuade the company to turn out a few more. This was a fine example of a legitimate consumer product orphaned, so to speak, by the ruthless overexploitation that killed the stereo boom. We could see the same in stereo sound.

My only complaint about the Nord is that I haven't figured a way to operate it without getting a blast of hot air in my face from the ventilating slats on top—not to mention a bright beam of light. Maybe it's just because I'm left handed. I don't mind too much, as long as my guests are happy with the pictures.

Glasses? I offer you little hope, but maybe you can locate some in one or another store. I keep picking them up, a few at a time. They still sell, here and there. If you're desperate, you can stage a raid on one of the current revivals of those dreadful 3-D movies ("The House of Wax"—was that one?) and collect the glasses they pass out there. Or you can always get the $3 glass models.

Screens? No problem except in cost. Silvered screens aren't hard to get. But be sure to *get the biggest screen you can possibly afford.* This is vital for stereo projection. I don't recommend *any* stereo projection on a screen less than 50 inches square. That's big, though bigger is even better. You can probably get a "stereophile net" discount if you're lucky, about as in the audio field. I did.

Depth Distortion

And so—stereo projection. First of all, you must understand that the stereo picture on the screen is variously distorted, at times to an almost ludicrous extent. The optics involved are just plain cockeyed. Not easy to figure out in detail for most of us, but one thing is immediately clear as you move about your stereo room. There is a single theoretical point where distortion is reasonably minimum and that is the spot where you are as "close" to the picture as you would be inside the stereo hand viewer. A nine-foot picture at ten feet—or a four-foot picture at about five feet, roughly speaking! All other, more distant positions offer compromises, and it isn't just a matter of brightness and image-size, either. Distortion of perspective is fantastic.

As you move away from the stereo screen, the sidewise dimension seems to get smaller. So does any screened picture. The further back you sit, the smaller the picture.

Now in the conventional projection, you are dealing only with the two flat dimensions and the entire picture on the screen is reduced strictly in proportion. The only distortion you find is the relatively slight effect of watching your pictures from one side, at an angle. Not too serious until the angle becomes acute, as we know from movie theatre experience. In fact, the main practical difficulty is a loss of brightness in the image. We can take the sidewise distortion aspect without even noticing it.

But stereo projection is utterly different. It involves the third dimension—depth. And in the projection, that dimension never varies in apparent measurement, *regardless of your distance from the screen!* As you move back in the room, the

sidewise and up-and-down size of the picture decreases, but the depth remains exactly the same.

Therefore, a stereo picture from a distance has a violently distorted and grossly exaggerated depth. By "gross" I mean a lot. For if your picture is reduced (as you see it) to one quarter size, the depth dimension is relatively quadrupled. A picture of a square plot of grass shows as an oblong, four times as long in depth as in width—and a city block is four blocks long. Nearby backgrounds, recede to near-infinity, foregrounds are monstrous.

I'll never forget my first stereo projected picture, in a large lecture hall! It was of the Taj Mahal, and the ratio of dimensions from where I sat was about 1:16. The photo showed a huge, wide plaza that stretched about ten miles back and at the far end was a tiny little building as big as your thumb. That projectionist didn't have the faintest idea what he was doing.

Close-up Window

So you will begin to see where all this leads to. If you are to have something near a 1:1 relationship between the dimensions in your picture, you must be *really* close to the screen, so that the sidewise dimension is big enough to match the unchanging front-to-back one. As I say, that means right down in front. Or, alternatively, further back, with a LARGE screen, the projector far enough away to fill it to the maximum. You must at once throw out all your ordinary conceptions of picture projection, start thinking from scratch. In this medium, you don't look *at* the screen; you look through it—or sometimes in front of it.

Since you look *through* the stereo screen, this immediately poses another new conception. It is, of course, a window, not a flat surface. The window concept is essential in your stereo thinking.

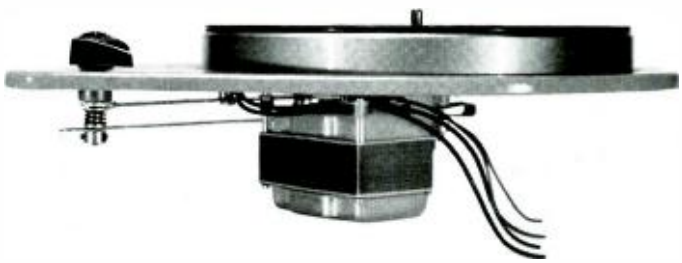
Now, how big must a window be, to see out of? If you will visualize for yourself the "size" of an actual window, related to your own inner field of vision, you'll see at once that an ordinary home movie screen, maybe three feet on a side and ten or fifteen feet away, is like looking outdoors from your living room armchair through a six-inch hole in the wall, more or less. Your overpowering need in such a circumstance (given a pretty view to look at) is to get up closer, make the window seem bigger. Or to cut a larger hole in your wall and stay in the same place.

One odd feature of this aspect. You'll find that you can walk right up to a stereo screen and look at parts of the picture (*into*, I should say) from only two or three feet away. The only limitation is the graininess of the screen surface and the fuzziness of the projected image itself. This is due to a curious psychological fact. If the depth dimension is *less* than the sidewise one—if the picture is wider than it is deep—you are not aware of distortion. We are entirely used to this situation. We see it as a sort of low-relief effect, a step between normal depth and no depth at all, i.e., the ordinary "flat" picture. We accept partial depth and, indeed, find it very natural and satisfactory. But just try a wee bit of exaggerated depth and your eye goes crazy. Dreadfully distorted!

—Which only goes to show that in this particular area, as in our own area of reproduced music, the objective facts of "hi-fi" reproduction must *always* be tempered by the strange interpretations of the human mind. If it seems good to us, then it

(*Continued on page 65*)

easily assembled in half an hour with no special tools...



Now for the first time you can get a Thorens TD transcription turntable in kit form—at big savings to you.

It's the new TDK-101 featuring the same precision Swiss craftsmanship that made the now-famous TD-124 an immediate success on the American market. Just examine the mirror-finished machining on this kit turntable (or for that matter on any of the Thorens "TD" units) and compare with that of any other make of turntable. You'll see the reason for the TDK's extremely low rumble, wow and flutter. See the TDK-101, newest member of the TD family of fine turntables, at your Thorens hi-fi dealer's.

Features:
Same compliant belt-plus-idler drive as on more expensive TD units; provides complete motor isolation. Single, retained, ball-thrust bearing, plus mirror-finished main bearing, for absolute minimum of rumble, both vertical and horizontal—so necessary for stereo. Single-speed 33⅓. Adjustable speed (±3%, a total of about one musical semitone). Built-in strobe allows setting to exact speed. Automatic disengagement of idler when unit is switched off. Drive mechanism completely enclosed—no "string" belts or external belt shields. Accessory wooden base is available in walnut, blond, or mahogany; $9.00 net.

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TD-124. Absolute tops for stereo or mono records quietest, smoothest, most exact. 11½ lb. table; clutch for fast, noise-free starts with needle in groove. 4 speeds, all adjustable (±3%) for perfect pitch; built-in illuminated strobe; built-in level. All assembled TD turntables are 100% tested electronically and aurally for wow, rumble and flutter before shipment. **$99.75 net. Base $9.00.**

TD-184. This 4-speed high-quality turntable with integral arm has same precision-machined adjustable speed drive as Thorens TD-124. Semi-automatic operation—one dialing motion selects 7", 10", 12" record size. Arm literally floats down to record on air. Absolutely no connection between arm and table. **$75.00 net. Base $6.00.**

TD-134. 4-speed turntable with integral arm for manual operation. Same high-performance tone arm as used on TD-184 equals tracking performance of arms costing as much as half the price of this entire unit. Same adjustable speed drive mechanism as on more expensive units. **$60.00 net. Base $6.00.**

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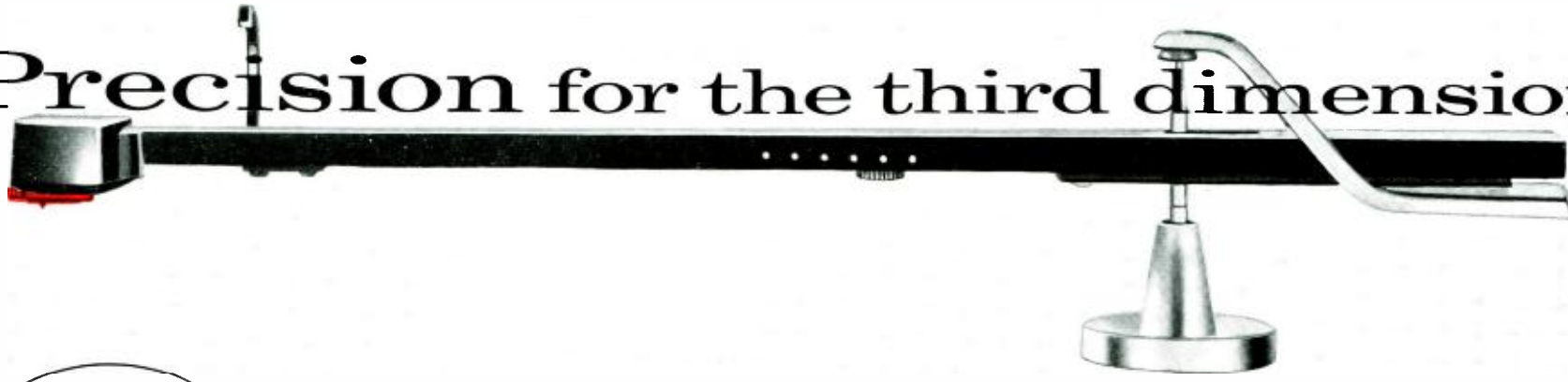
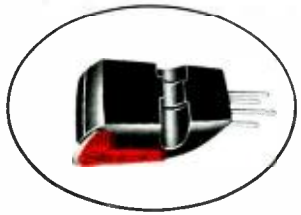
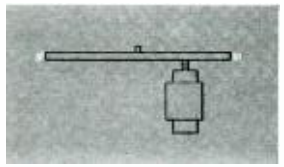




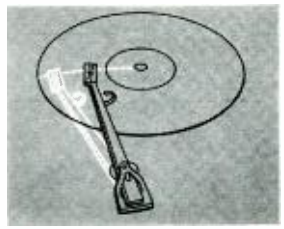
FLUXVALVE, T-GUARD, GYROPOISE, STEREOTABLE, UNIPOISE ARE TRADEMARKS USED TO DENOTE THE QUALITY OF PICKERING & COMPANY INVENTIONS.

TRUE STERLO depends upon *accuracy* in three dimensions. Since the very first development of the phonograph, more than half century ago, only two *dimensions* were required in the mechanical system of a reproducer. Now, with the development of the *stereo record*, a *third dimension*, more meaningful and important, is not only required...*it is essential!*

1 **The first dimension** in a record reproducing system is the linear movement of the record groove under the stylus in the cartridge... **accurately** rotated by a quality changer or turntable, such as the STANTON Gyropoise 800 Stereotable. Its **only** contribution to the system must be **precise** motion, **accurate** to within 2/1000 of the correct record speed... with absolute silence and freedom from vibration. Virtually, it must revolve on a **bearing of air!**



2 The **second dimension** in a record reproducing system is the horizontal angle of the phonograph cartridge in relation to the record groove. **Horizontal Tracking Accuracy** is determined by the angle between the axis of the cartridge and a tangent to the record groove. **Any significant deviation in Horizontal Tracking Accuracy results in distortion and increased wear of record and stylus.** This deviation is called—**Horizontal Tracking Error.** While it is not possible to fully reduce **Horizontal Tracking Error** to zero...the offset angle of the STANTON UNIPOISE Arm reduces this error to a negligible factor.

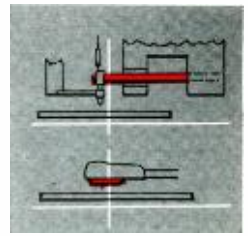


3 The **third dimension** in a record reproducing system...**is the dimension which makes stereo possible!** Since the stereo record also has **vertical information,** a new requirement—**Vertical Tracking Accuracy** has become **absolutely essential** to the performance of a stereo cartridge. In order to provide the proper relationship between recording and reproducing styli, the angle of correspondence between the two must be near 0 degrees. Any deviation in this angle of correspondence is called **Vertical Tracking Error.**

To avoid **Vertical Tracking Error** and accurately simulate the original recording process, the reproducing element in the pickup must be almost parallel to the record surface!

Only the Stereo-FLUXVALVE has the parallel reproducing element contained in the exclusive "T-GUARD" Stylus Assembly, a proprietary* product of Pickering & Co. It assures proper correspondence between recording and playback styli with **maximum** Vertical Tracking Accuracy and **minimum** Vertical Tracking Error.

When a record master is made (top, right) the cutting stylus bar of most stereo recording heads is virtually parallel to the record surface. Ideally, to reproduce the vertical information in the stereo recording with full fidelity, the stylus bar of a stereo playback cartridge must be similarly parallel to the record surface, and at an angle corresponding to that of the cutting stylus bar. Only the STANTON Stereo-FLUXVALVE (bottom, right) has the parallel bar reproducing element contained in the "T-GUARD" Stylus Assembly to assure proper correspondence between the recording and playback stylus. Actually, it is the vertical information which contributes the **added dimension** to high fidelity for true stereo. **Unless the stylus bar of a stereo cartridge is similarly parallel and at a corresponding angle to the cutting stylus bar... vertical tracking error will be introduced, generating a distortion of the same kind produced by horizontal tracking error!** The amount of this distortion increases with any increase in Vertical Tracking Error.



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EDITOR'S REVIEW

RED FACE DEPARTMENT

HARDLY ANYONE IS PERFECT, but we sometimes wonder why we keep trying to prove the truth of this old saying. In particular, we are referring to a New Products item at the bottom of page 76 in the February issue which commenced, "Hardly any desirable audio control function is incorporated in the Pilot Model 216 stereophonic preamplifier. . . ."

Now we don't think any of AUDIO's readers would take this at its face value—anyone ought to know that if we *thought* the product had no desirable features we would simply ignore the publicity release and leave everything unsaid. However, two people were mislead and mentioned it to us, so we could rectify the error.

Actually, the original release was correct; our New Products editor wrote it correctly; the printer set the type correctly; and finally, one of our own proofreaders spied the "not," thought it was in the wrong place, and marked it to be deleted. The obliging printer, not being expected to edit the magazine too, removed the "not," which was not right. So now we have to write about the not that was not written in the mgaazine, and we hope it will not happen again. Not that we expect it not to.

Anyhow, Pilot gets another mention of the SP-216—which is a slightly improved model of the SP-215 about which we have commented favorably many times.

While we are in an apologetic mood, we offer the following corrections to the November article by Philip B. Williams and James F. Novak, "Improvements in 'air suspension' speaker enclosures with tube venting." Equation (8) should have had a radical sign over the first 2 in the denominator; in *Fig.* 2, M_{MR} should have been shown as equal to "Total *air* load mass, kilograms," instead of "Total *IR* load . . ."; the abcissa of *Fig.* 7 should have read "Frequency in cycles per second" instead of ω/ω_s; and the abcissa of *Fig.* 8 should have been ω/ω_s instead of ω/ω_o. The *Fig.* 2 error was our fault; and the authors are kind enough to say that the other mistakes were theirs.

No matter how hard we try, these errors will etc. etc. etc. etc.

STEREO RECORD QUALITY

We still hear comments from some readers—with, possibly, short memories—relative to the alleged poor quality of stereo records. To be sure, we have heard some poor stereo records, but we have also heard some superb ones. Furthermore, we have seen consistent improvement in record quality since the first ones were introduced over a year ago. By and large, we believe the record industry has taken a new tool and within the short space of a year has learned new techniques of record cutting and processing, to say nothing of microphone techniques, which are not yet standardized but which are being employed rather dramatically in many instances to produce excellent records.

When we consider how many times we have heard poor stereo *reproduction*—and so often due only to an out-of-phase condition of the speakers—we can understand why the records are often blamed. But when the system itself is right—and that proves itself if at least some records sound good—there are many, many good stereo records. Our own collection is not large, compared to the monophonic collections of the average music lover, but at last count it numbered about 65 records. And of those 65 we would say that at least half are excellent, and only a dozen poor.

One would not think of evaluating monophonic LP record quality by playing the discs on a table model phonograph of the $29.95 "hi fi" variety. And it is just as important that the system be of top quality for stereo—if not more so—than for monophonic reproduction. Remember, furthermore, that some of the first LP's were far from perfect.

Occasionally we receive an irate letter from a reader who says he would never buy a stereo record because "they are no good" or that "they have a false stereo perspective," or for some other reason. We do believe that there is a variation in recording and microphoning techniques, but we also believe that it is necessary to take a little more care in setting up a stereo system —both electrically and acoustically, with the accent on the latter—than it is for a good monophonic system. Perhaps we have been lucky in either records or equipment, or both, or perhaps we have expended more effort in getting what we consider satisfactory reproduction. But the result is that we think many stereo records are excellent, we have dropped our membership in the Metropolitan Opera Record Club until they are in stereo, and we will not buy any more monophonic records unless some performer we want is not yet recorded stereophonically.

But that is only our opinion.

WEST COAST SHOWS

Unfortunately, the San Francisco and Los Angeles shows were too late for any report in this issue. The Cow Palace show in San Francisco differed from the typical room shows held heretofore, and readers will undoubtedly be interested in how the new type of show building went over. We would too, but we will also have to wait a while longer.

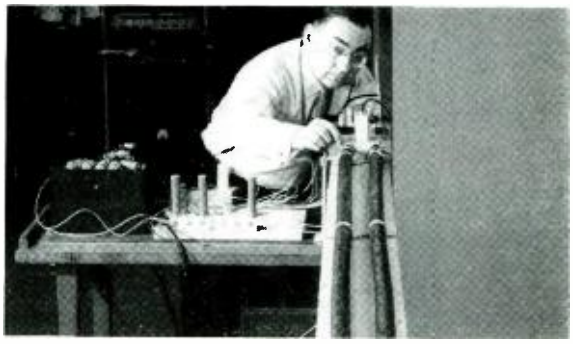
THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.



Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.

Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS
RESEARCH AND DEVELOPMENT

Loading the Piezoelectric Cartridge

HERMAN BURSTEIN*

Optimum performance from ceramic or crystal phono pickups may be obtained when they are matched to the amplifier input correctly. Here are the reasons, and some of the cures.

THE PIEZOELECTRIC phono cartridge, once disdained for high fidelity service, has become a full-fledged member of the high fidelity family, particularly in view of the facility with which it lends itself to stereo design. However, its suitability very much depends upon its being properly loaded. Essentially, the loading problem is one of maintaining proper equalization of the RIAA recording characteristic; at the same time, output level and distortion are also at stake.

Voltage output of a piezoelectric cartridge (usually ceramic, though sometimes crystal) is proportional to recorded amplitude, rather than to velocity as in the case of a magnetic pickup. Hence the equalization requirements differ radically from those for a magnetic cartridge. Whereas the magnetic requires bass boost and treble cut, the piezoelectric needs *bass cut* and *treble boost* in order to match the RIAA recording curve. See *Fig.* 1.

To obtain bass cut that reasonably compliments the RIAA recorded *amplitude* characteristic, the total circuit capacitance—cartridge, cable, and input tube—and the load resistance should have a time constant of about 1000 to 1300 microseconds. For example, assume that a piezoelectric cartridge has 500 μμf capacitance, which is typical, and works into a typical load of 500 ohms. But in order for RC to be, say, 1300 microseconds, total circuit capacitance should be 2600 μμf instead of 500 μμf. Allowing 500 μμf for the cartridge and about 200 μμf more for the cable and input-tube capacitance, another 1900 μμf is required across the cartridge in order to achieve the correct amount of bass cut; that is, to avoid too much bass cut. The equivalent circuit is shown in *Fig.* 2. This of course is a high-pass filter, producing a decline in response below the frequency at which total capacitive reactance equals load resistance.

Instead of adding a shunt capacitor across the cartridge, the required time constant could be obtained by adding a 1.4-megohm resistor in series, as shown in *Fig.* 3. However, the disadvantage of this method is that the input capacitance of the input tube and the parallel resistance of the 1.4-megohm and 500-K resistors form a low-pass filter, causing a loss in response at high frequencies. The equivalent circuit at high frequencies appears in *Fig.* 4. Assuming an input capacitance of 50 μμf for the input tube, a reasonable figure for a triode such as the 12AX7, response would be 3 db down at about 8600 cps, declining thereafter at a rate approaching 6 db per octave.

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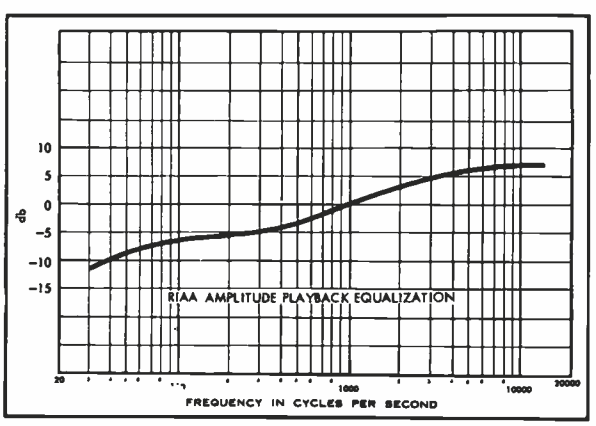

Fig. 1. RIAA amplitude playback equalization.

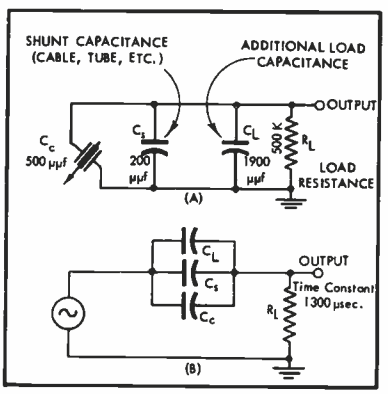

Fig. 2. (A), Loading for a piezoelectric cartridge to produce RIAA equalization and (B), its equivalent circuit.

Methods of Correcting

Thus it is preferable to obtain the required time constant by means of a shunt capacitor. Both methods will result in signal attenuation because either a capacitive or resistive voltage divider is formed so far as signal output is concerned. *Figure* 3 already shows how a resistive voltage divider is formed, while *Fig.* 5 shows how a capacitive voltage divider results from the preferred method.

The loss in output voltage is in many cases a good thing, insuring that the signal is sufficiently low to prevent overloading the input tube. The writer has come across situations where cartridge signal was so great relative to the sensitivity of the control amplifier that the gain control could barely be turned up

(*Continued on page 74*)

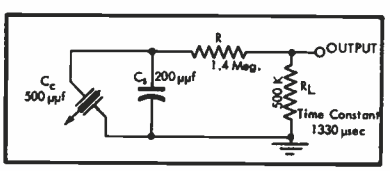

Fig. 3. Alternative means of loading a piezoelectric cartridge to produce RIAA equalization.

Design of the Wide-Range Ultra-Compact Regal Speaker System

ROBERT C. AVEDON,
WAYNE KOOY, and
JACK E. BURCHFIELD*

Since small loudspeakers have become particularly popular for stereo installations, it is only natural that different concepts of design would be reached by different manufacturers; all, however, directed toward achieving a high degree of performance in a minimum of volume.

IN RECENT MONTHS the ultra-compact loudspeaker system has become popular where space limitations must be met. Most people are reluctant to sacrifice sound quality for extreme compactness. The ultra-compact loudspeaker must preserve much of the sound quality available in present day larger systems in order to be acceptable for high fidelity use. Unfortunately, many misconceptions exist concerning this type of speaker and include matters of efficiency, size, distortion, and a variety of constructional details.

The ultra-compact cabinet has one big advantage: small size. However, no diminutive speaker system can perform *because* of its size. On almost every point of performance the small cabinet speaker is at a disadvantage. These performance problems must be solved on a compromise basis.

It is the purpose of this article to dispel the present misconceptions and to arrive at the optimum design requirements for the ultra-compact loudspeaker.

The reader is invited to follow a series of experiments and to participate in the arrival at the optimum solutions that are found in the Electro-Voice Regal.

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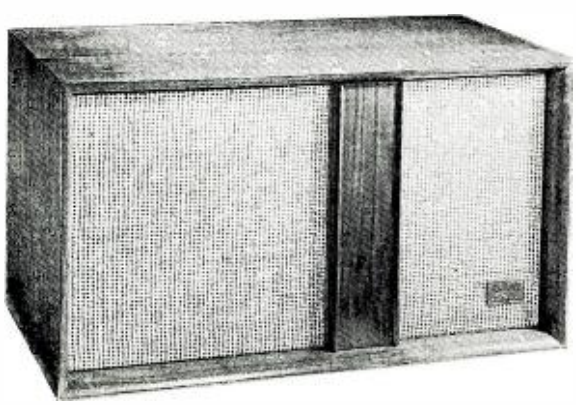


The Electro-Voice Regal III

Bass Response and Efficiency

The well known problem encountered in preserving high fidelity sound quality in a very compact enclosure is achieving a flat bass range with reasonable efficiency. The objective treatment below will illustrate the bass-range problem.

A cabinet which was built for the experiments enclosed 2500 cubic inches or about 1.4 cubic feet, excluding the volume taken up by drivers and crossover networks. This volume is the generally accepted size for bookshelf type speakers.

All frequency-response curves were machine run with the speaker placed in a free field corner. The free field corner consisted of 8 foot high false walls built on a flat roof. These walls extended 10 feet in either direction from the corner.

A conventional dynamic 12-inch cone driver of high quality having a free air resonance of 39 cps was "infinitely" baffled in the 1.4 cubic foot cabinet. (A free air resonance of 35 to 45 cps is representative of a 12-inch driver of this type.) The primary or first resonance of the system occurred at 88 cps. When swept with an oscillator at constant voltage the acoustic output began to fall with decreasing frequency below 88 cps, becoming at 40 cps about 12 db down from the nominal output above 88 cps. Obviously, a system which reaches to only 88 cps before its output begins to diminish cannot be acceptable for high fidelity reproduction because of lack of musical balance.

How, then, is the bass response to be extended flat below 88 cps in this experiment? The most obvious attack (and, in fact, the very crux of the matter when dealing with sealed cabinet systems) is simply to lower the first resonance of the system. Unfortunately, simply lowering the system's first resonance is a matter requiring consideration of sacrifice in efficiency and transient response. A digression dealing with equivalent electrical circuits will show why efficiency and transient response must be sacrificed to accomplish lower bass range.

Equivalent Circuits and the Bass Range

The electrical circuit analogies pertaining to the driver in free air and to the sealed cabinet system will now be examined.

The free-air resonance of a cone driver is determined by the mass of the entire moving assembly and its mechanical suspension compliance. The equivalent circuit of a cone unit, operating in free air, is shown at (A) in *Fig.* 1. M_c represents the moving mechanical mass, M_a represents the air mass load, and C_s is the combined compliance of the suspension (spider and rim rolls). R_r represents the radiation resistance component of the air load as seen in the mechanical circuit, and R_m represents any mechanical resistances in the moving assembly. This circuit shows an impedance at resonance of just the radiation resistance plus the mechanical re-

sistance. At this frequency the cone velocity will be maximum, limited only by this radiation and mechanical resistance.

When the driver unit is baffled in a small sealed volume the mechanical system has the equivalent circuit shown at (B) in *Fig.* 1. Because the rear of the driver piston is now enclosed, front to back cancellation is eliminated, and the radiation resistance, R_r, is increased and appears wholly on the front of the cone. The radiation to the rear into a small cavity at frequencies in the bass range is essentially non-existent. R_m, the mechanical resistance of the moving assembly, remains the same. M_a, the air mass load, is increased by virtue of the presence of the baffle. But the most significant change as far as this discussion is concerned is the addition of another series compliance component, C_a. This addition is due to the sealed cavity behind the cone. Recall that the primary resonance was higher for the driver in the sealed cabinet than for free air operation. This is caused by the addition in series of the air cavity compliance, C_a, which affected a *reduction* in the total compliance seen by the driver.

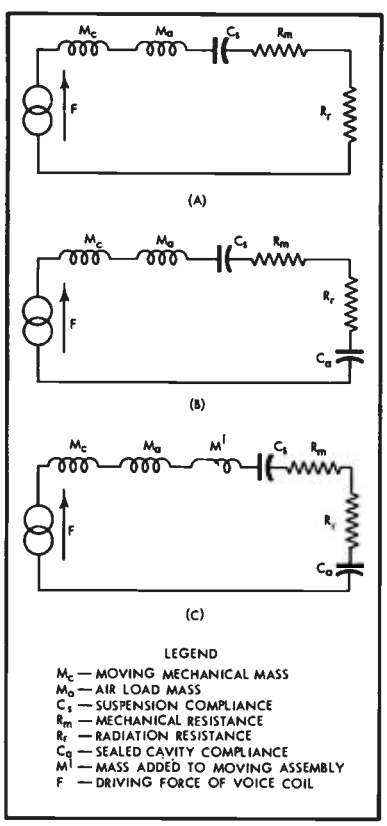


Fig. 1. Equivalent circuits: (A) Conventional cone driver in free air, and (B), "infinitely" baffled in small sealed cabinet; (C) Weighted cone driver "infinitely" baffled in small sealed cabinet.

Returning to the experimental system it will be seen that for a constant applied voltage on the driver voice coil the system will exhibit a flat energy output from resonance (88 cps) to approximately 1000 cps. Although the mechanical velocity of the piston is falling with increasing frequency above resonance at approximately 6 db per octave, the radiation resistance component, R_r, of the air load is rising 6 db per octave (taken as a power ratio). The radiation resistance is a function of frequency up to about 900 or 1000 cps for a nominal 12-inch cone, quadrupling each time the frequency is doubled. At this frequency it reaches an ultimate value and is constant for all higher frequencies provided the cone still operates as a rigid piston. But all 12-inch cones break up at approximately 1000 cps. Therefore, the considerations at present must be limited to frequencies below 1000 cps for the single degree of freedom circuits of *Fig.* 1 to be valid.

The falling cone velocity just complements the rising radiation resistance for frequencies between resonance and 1000 cps. Such a fortuitous combination of circumstances leads to flat acoustic energy output in this range. Below resonance, however, the cone velocity drops nearly 6 db per octave with decreasing frequency while the radiation resistance also drops 6 db per octave with decreasing frequency. Thus, in the frequency range below resonance a complementary situation between the radiation resistance and the cone velocity *does not exist* and the result is falling response below resonance at the rate of about 12 db per octave. The exact roll-off characteristic below resonance depends on the cone size and, hence, the relative value of the circuit parameters.

Now that it is clear exactly what problems exist and why the system's first resonance must be lowered, a discussion of resonance-lowering techniques can proceed.

Lowering the Resonance

It is contended by some manufacturers of ultra-compact speaker systems that when the conventional driver is baffled into a small sealed volume the total stiffness as seen by the driver piston is increased, resulting in greatly raised primary resonance for the system with bass response lacking below this resonance.

The previous discussion has shown this to be quite true. This school further contends: To lower the resonance and obtain a flat bass response the total stiffness can be reduced sufficiently by virtual elimination of the mechanical stiffness of the driver suspension, leaving the sealed cavity as the only stiffness. It is claimed also that elimination of the

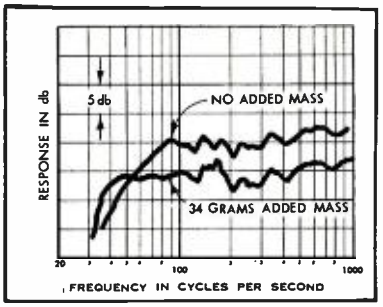


Fig. 2. Effect of added mass on cone driver "infinitely" baffled in small sealed cabinet.

mechanical suspension provides extreme linearity of cone movement due to the linear air spring of the enclosed cabinet volume as compared with the extremely non-linear mechanical cone suspension.

Are these presumptions correct? Further experiment will reveal that this is *not* correct.

Attention will now return to the experimental cabinet and the 12-inch driver used with it. A series of experiments were performed to determine how much the resonance could be lowered by *completely* removing the driver's mechanical suspension. The description of these experiments to follow will show how moving-mass, mechanical-compliance, and air-cavity-compliance data were collected and used to find the new resonance *without* a mechanical suspension.

The moving mass was found by the following method. Recall that the free air resonance of the driver was 39 cps. A metal ring serving as an added mass and weighing 28.2 grams was cemented firmly to the cone at its apex. The free air resonance was now observed to be 28.5 cps.

The equation shown describes resonance under these circumstances:

$$f = \frac{1}{2\pi\sqrt{MC}} \qquad (1)$$

where f is the resonant frequency, M is all the moving mass involved, and C is the total compliance.

The new free air resonance obtained with the added mass in conjunction with the former free air resonance applied to Eq. (*1*) will allow computation of the mechanical suspension compliance and the total moving mass of the driver and air load.

Two independent equations will be necessary and are derived from Eq. (*1*).

$$f_1 = \frac{1}{2\pi\sqrt{MC}} \qquad (2)$$

$$f_2 = \frac{1}{2\pi\sqrt{(M + 28.2)C}} \qquad (3)$$

where f_1 is the resonant frequency *without* added mass and f_2 is the resonant

frequency *with* the added mass of 28.2 grams.

Simultaneous solution of Eq's. (*2*) and (*3*) for M obtains the expression

$$M = \frac{(28.2) f_2^2}{f_1^2 - f_2^2} \qquad (4)$$

Substitution of the resonant frequencies yields for the total moving mass *including* air load: $M = 32.3$ grams.

It is noteworthy that the moving mechanical mass of the driver determined by weighing the moving assembly on an analytical balance is just 15.0 grams.

One concludes, then, that the air-load mass for free-air operation must be 17.3 grams. Rearranging Eq. (*2*) and substituting for the total moving mass a value of 32.3 grams along with the unweighted free-air resonant frequency of 39 cps, the mechanical compliance is found to be:

$$C = \frac{1}{4\pi^2 M f_1^2} = 0.514 (10^{-6}) \frac{cm.}{dyne} \qquad (5)$$

This means that the application of one dyne of force will move the cone about one-half millionth of a centimeter.

At this juncture there has been determined the total moving mass and the suspension compliance for the free-air case. The total moving mass and the total compliance (suspension plus air cavity) has also been determined at this time by the same method for the same driver sealed into the experimental cabinet. Recall that the primary resonance was 88 cps for this case (no added mass). With the same added mass of 28.2 grams the resonance dropped to 65 cps. By the same method of solution as for the free-air case the total moving mass was found to be 33.7 grams (an increase of 1.4 grams over the free-air case) and the *total* compliance was 0.097 $(10)^{-6}$ cm/dyne.

The compliance actually contributed by the cabinet air volume will now be found. From the equivalent circuit of (B) in *Fig.* 1 recall that the suspension compliance adds in *series* with the cabinet-air-volume compliance. The total compliance of two series compliances is *not* their arithmetic sum. But the total stiffness (reciprocal of compliance, $1/C$) *is* the arithmetic sum of two series stiffnesses. Then it can be said:

$$\frac{1}{C_{t(TOTAL)}} = \frac{1}{C_s} + \frac{1}{C_A} \qquad (6)$$

Now knowing the values of the suspension compliance, C_s, and of the total compliance, C_t, the compliance of the air volume is found to be 0.119 $(10)^{-6}$ cm/dyne by Eq. (*6*).

The reader can see that the total of two series compliances is always *less* than the smallest of either of the two compliances individually.

At this point a simple computation will be made to find the new resonant frequency obtainable, conceding that the mechanical compliance could be completely removed.

Return to Eq. (*1*) and calculate the resonant frequency of the driver with its unaltered mass of 33.7 grams sealed into the example cabinet volume of compliance 0.119. Notice that the mechanical compliance of the suspension has *not* been included.

Frighteningly enough, by completely eliminating the suspension compliance the resonance drops to 79.5 cps, a mere 8.5 cps decrease from the situation including the suspension compliance! Is this the improved result desired? Such a reduction in resonant frequency of only a little over 10 per cent is a piddling effort at best!

It is quite obvious that mere elimination of the suspension compliance is not enough to effect a large reduction in resonant frequency. Re-examination of the equivalent circuit of (B) in *Fig.* 1 and Eq. (*1*) will reveal the only other alternative to reducing the resonant frequency. Further lowering of resonance can be accomplished only by addition of mass. Here is where the supreme sacrifice in efficiency comes. Referring to (C) in *Fig.* 1 a mass is added in series in the form of additional weight of cone material (thicker cone) or say, a machined metal ring affixed to the voice coil form. It is seen plainly that this additional reactive element will reduce the velocity circulating through the radiation resistance, R_r, above resonance with consequent reduction in acoustic output for the same driving force. The driving force is produced by electrical current circulating through a voice-coil wire containing electrical resistance. Thus, with the same driving force the electrical losses remain the same but the acoustic output drops as mass is added to the moving system. Consequently, the over-all efficiency of the system drops.

It is worth noting that each time the moving mass is doubled the acoustic output above resonance drops 6 db for the same voice-coil current. If this is true, then the addition of exactly 33.7 grams to the moving assembly of the driver (in its original form "infinitely" baffled in the experimental cabinet) should reduce its output just 6 db. Recall that the total moving mass was previously determined to be 33.7 grams. The addition of a like mass of 33.7 grams reduced the output, on an average, about 6 db for frequencies above 100 cps in this case. The curves shown in *Fig.* 2 are reproduced from machine-run charts.

So it is seen that the decision the design engineer must make in the ultra-compact cabinet is to make an optimum compromise between loss of efficiency and lowered resonance. A resonance of 55 to 60 cps with an efficiency loss of 7 or 8 db would be an excellent optimum compromise and is the situation existing

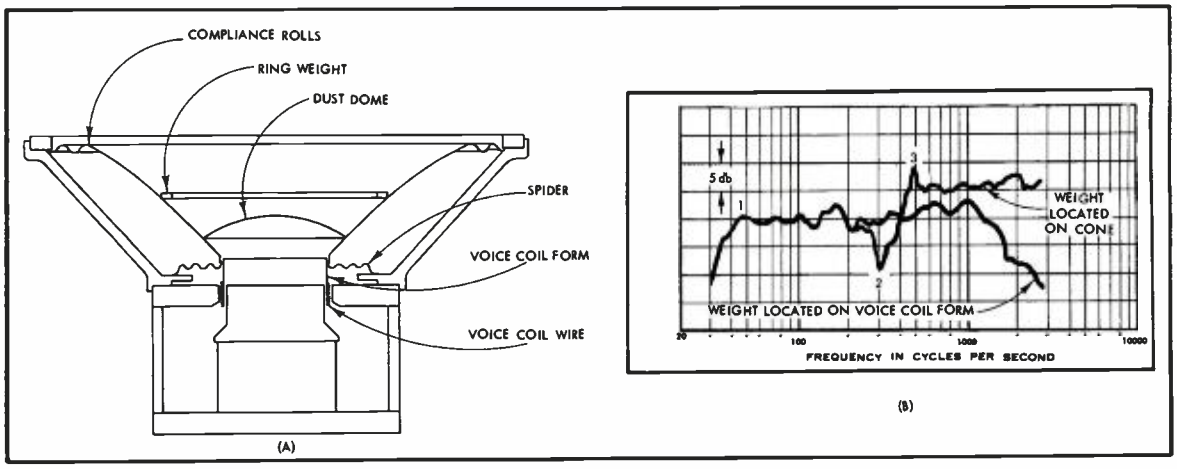


Fig. 3. Adding mass to cone driver moving assembly. (A) Cross section of driver showing ring weight added to cone. (B) Effects on frequency response of added weight location.

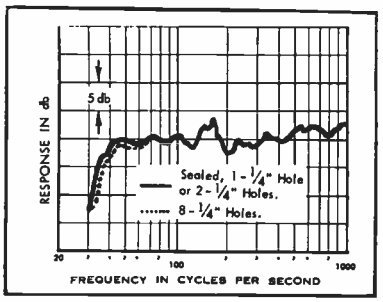


Fig. 4. Effects of cabinet leaks on frequency response.

in the Regal system. Because the resonance in this system shows up as a very broad effect in the acoustic output the level at 35 cps is down from the resonance level only 5 db measured in the free field corner.

How can the additional mass required to lower the resonance be added to the moving system? The problem in adding mass to the moving system is maintenance of a smooth frequency response which is uniform from speaker to speaker. A cone which is constructed so that it is heavier than a conventional cone can be used. Molded paper cones are made by placing forms in a slurry. It is difficult to maintain a uniform thickness when forming a heavy section by this method. A more precise way to add extra mass is just the way it was done in the experimental case discussed —in the form of a machined metal ring affixed to the cone and concentric with the voice coil. However, a problem arises in the placement of this extra mass.

Locating the Mass

In *Fig.* 3, (A) shows a ring of arbitrary diameter on the cone, and (B) shows the response of this driver in the experimental cabinet. Point 1 on the curve is the primary or first resonance. Point 2 is the frequency at which the ring weight goes into resonance with the effective compliance of the cone surrounding it. At this frequency, the voice coil sees an anti-resonant condition and a dip is produced in the response. Point 3 on the curve is the frequency at which the cone has "broken up" and the ring is nearly standing still while the voice coil and central cone area are in vigorous motion. This frequency is a new resonance for the moving system as seen from the voice coil. Here the effective compliance of the cone from ring to voice coil along with the spider compliance is in resonance with the distributed mass of the cone from ring to voice coil, the air mass load on this part of the cone, and the voice coil mass. As the ring is made of smaller diameter (but the mass held constant) and as it comes closer to the voice coil, points 2 and 3 move higher in frequency. When the ring is mounted directly to the voice coil form the system returns to a single degree of freedom and Points 2 and 3 on the curve disappear. Under this condition the system returns to its original operation up to 1000 cps with the exception that the level is lower due to the added mass.

Note the higher output above Point 3 in (B) of *Fig.* 3 with the weight placed somewhere out on the cone as compared with the output for the same frequencies with the weight attached to the voice-coil form. With voice-coil form mounting the weight never "decouples" and the system has always one degree of freedom up to the frequency where the cone would normally break up. With the weight mounted somewhere on the cone it goes through the process of decoupling between Points 2 and 3 in the curve. Above Point 3 the system operates with reduced mass with the ring and cone area outside the ring essentially inoperative. Hence, the higher output.

Another important consideration is that a cone has a lower effective mass above 1000 cps because of breakup. *All* of the cone does not move, and therefore the effective mass is less. This causes the difference in curve shape above 1000 cps between the original driver and the unit weighted at the voice coil form. When the cone breaks up a higher ratio of added mass to original moving mass exists. As a result the output above the breakup is reduced (by comparison to the original driver) in greater proportion than is the output below breakup. If the breakup frequency is adjusted by choice of cone geometry to coincide with the frequency of crossover into the next driver this phenomena can be put to good use by letting it aid the electrical networks in attenuating the output of the low-frequency driver above crossover.

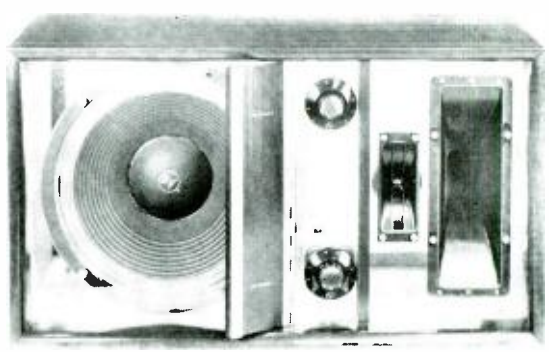
Non-linearity and the Sealed Back Cavity

It has been contended that the mechanical suspension non-linearity is much greater than the extreme linearity of the air spring or sealed air volume of the cabinet. This is not true. In any good physics text one can find proof that sound is an adiabatic process. This means that when air is compressed or rarefied in the sealed air cavity behind the speaker there is no heat transfer to or away from the cabinet walls or interior components.

It is extremely difficult to make this process anything other than adiabatic. The physics text will also show that adiabatic compression is inherently non-linear. However, for small pressure variations relative to the ambient atmospheric pressure the non-linearity is vanishingly small. Consider a conventional 12-inch speaker in a 6-cubic-foot box. When undergoing the excursions required for satisfactory bass response the pressure variation relative to ambient atmospheric pressure is indeed small. However, when a 12-inch piston in an extremely small box undergoes these necessary excursions there are much larger pressure variations relative to ambient atmospheric pressure. These larger pressure variations must cause greater distortion for a given excursion of the cone due to the inherent non-linearity of the adiabatic process. This is an unavoidable consequence of the laws of physics. So when it is said air suspensions are inherently more linear than mechanical suspensions a misstatement has been made, for mechanical suspensions are often made that are more linear than these compact air springs.

Leaks in the Back Cavity

Need the cavity behind the driver be sealed absolutely air tight, resorting even to a stethoscope to detect minor air leaks? Even at the lowest usable frequencies the inductance of a small leak is high enough to prevent any loss in output. A test to prove this has been conducted in the following manner: A frequency response curve was run on a perfectly sealed cabinet containing a 12-inch loudspeaker. A small hole of a ¼-in. diameter was drilled into the cabinet and another response curve was run. This process was repeated many times with more holes and more fre-



Rear view, Electro-Voice Regal III

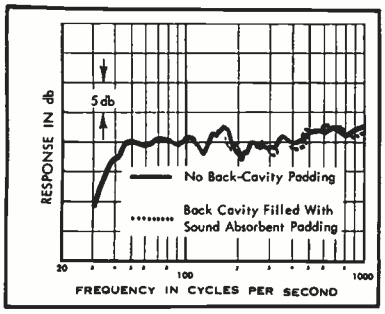


Fig. 5. Effect of filling small sealed-back cavity with sound absorbent material.

quency response curves. The results are shown in *Fig.* 4.

It is seen that nowhere was the output reduced by more than 1 db with a total of eight ¼-in. holes. This represents a substantial air leak. Therefore, a well crafted box with reasonable joinery is all that is necessary.

While on the subject of cabinet construction it might be noted that for a box of this size ¾" lumber stock is entirely adequate. No panel vibration of any consequence whatever will be experienced.

Use of Absorbent Material in Small Cabinets

At this point mention should be made of filling the back cavity of ultra-compact cabinets with sound absorbent material. A test was conducted in the following manner: Curves were run on a sealed box system in the free field corner with and without the interior of the box filled with sound absorbent material. The two curves are shown in *Fig.* 5. With accurate recording equipment the results show a negligible difference between the two curves. Filling the interior of small cavities with sound absorbent material is unnecessary.

Long-Throw Voice Coils vs. Efficiency

The throw of the voice coil is defined as the maximum excursion it can execute without distortion due to non-linearity of movement. At any particular frequency the excursion will be proportional to the voice-coil current as long as the same number of turns of the voice coil always remain in the dense flux field. In *Fig.* 6, (A) shows the voice-coil flux configuration for maximum efficiency. However, this arrangement will not be able to move without causing distortion because any excursion will remove turns from the gap; (B) shows a voice-coil arrangement where a constant number of turns will be maintained in the flux field with excursion. Twice the amount of overhang, *X*, will be the total excursion available without non-linearity. Overhang results in a loss of efficiency, and the greater the overhang the greater the loss of efficiency. Turns of the voice coil outside the dense flux field do not contribute to the driving force but do add d.c. resistance, an undesirable condition.

A compromise must be struck between linearity and efficiency. The maximum total excursion is dictated by the lowest usable frequency and the maximum practical listening level. The excursion is limited by the maximum tolerable distortion which is caused by the non-linearity of the air spring. This non-linearity is due to excessive pressure variation in the back cavity. For a 12-inch direct radiating speaker operating at 35 cps, ⅜-in. total excursion will provide room shaking level. The low-frequency driver in the Regal system employs a voice coil with a 3/16-in. overhang. This provides ⅜-in. total linear excursion. Any more linear excursion than this is unnecessary and results only in further loss of efficiency. The non-linearity of the air suspension overshadows any reduction in distortion derived from a throw longer than ⅜-in.

Transient Response and Series Resistors

To increase the bass level it is sometimes recommended that a resistor in series with the system be used. This is not good, for under these conditions the benefits of the high damping factor in a quality amplifier are destroyed. Without sufficient damping the low-frequency driver at resonance is essentially "free wheeling" (undamped), resulting in a peaked output at primary resonance along with greatly increased transient distortion. In some ultra-compact systems the transient characteristics have already been degraded by the excessive addition of mass. Anything which further degrades the transient response is retrogressive.

Additionally, series resistance results in another loss of efficiency which cannot be afforded in the ultra-compact loudspeaker.

The Mid and High Frequencies

The reader's attention is now directed to the mid and high frequencies. The following design features are considered desirable, and are especially effective for stereo reproduction: smooth response, good distribution, and low distortion of the mid-range and high frequencies. Excess efficiency in the treble and high-frequency drivers along with continuously variable controls allow the listener to compensate for room conditions and his own individual taste. Many compact systems provide a switched variation of only ± 2 db which is inadequate.

A horn-loaded radiator provides a good match of the diaphragm to the air load and more than enough level to balance the lower frequencies. If the horn has a small lateral dimension compared to the wavelength of the lowest frequency it is to reproduce, the dispersion will be excellent. The flat response curves frequently published do not tell the complete story unless dispersion or polar pattern is taken into account. It can be seen that a flat curve on the axis with progressive beaming at the higher frequencies would sound deficient in highs unless the listener were directly in front of the speaker. The dispersion of horns of the diffraction type is the best by far that is available and a smooth off-axis frequency response is easily obtained. A superior advantage of horn loading is that a small movement of the diaphragm will provide high acoustic output. This small movement allows completely linear operation of the diaphragm. If care is taken in loading the horn to the diaphragm, annoying dips and peaks found undesirable in many horn units are completely removed.

Some alternate efforts to achieve good high-frequency performance are inadequate. Attempts to promote smooth dispersed high frequencies by using a small dome radiating directly into the air have been tried. While these domes give good dispersion, they fail miserably in delivering efficiency, and low distortion. To illustrate, a unit was made from a 2-in. dome and a 1-lb. Alnico V magnet. The response was only fairly flat on axis and the distortion content averaged 20 times higher for the same acoustic output than that derived from a comparable horn-loaded unit. The efficiency was 15 db below the horn unit. This means that for the same output the diaphragm was moving many times further than in the horn unit. This extreme excursion made linear movement practically impossible

(*Continued on page 68*)

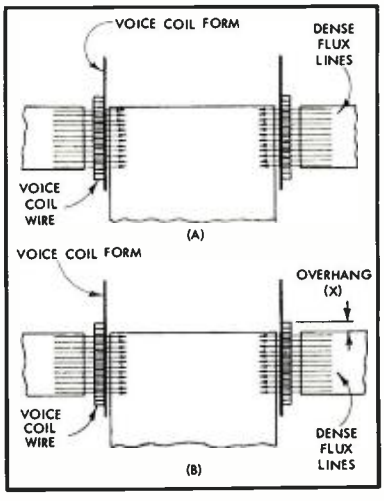


Fig. 6. Voice-coil geometry. (A) Voice coil no longer than dense flux field. (B) Voice coil overhanging the dense flux field.

The Decibel—Fact or Fable?

WALTER R. WESTPHAL*

Although repeated many times in audio literature, the information about the decibel and its uses—and misuses—must be thoroughly understood by anyone who wishes to understand specifications.

THE DECIBEL has long been the subject of a hazy issue in electronics. It is used a dozen times in each issue of electronics and high-fidelity magazines and each time it seems to be used in a different way. The reader imagines that a wealth of higher mathematics is needed to understand its use. And a lot of careless usage has made him wonder if anyone really understands the decibel either!

What does it mean to read that an amplifier has a frequency response of "5 cps to 160 kc, within 1 db" or that an oscilloscope response is "down only 3 db at 200 kc"? A microphone is said to have an "output of – 60 db." An amplifier has a "hum level – 90 db below 20 watts." What do these statements mean? Are these different uses of the decibel or is there some common denominator present in all of these statements? The decibel is an important concept in the analysis of electronic equipment and one which should not be left to the imagination.

In every case the decibel is a ratio of two electrical powers. This ratio, like any other ratio, is really a fraction having a numerator and a denominator. The two values of power then become the numerator and denominator of this fraction. One of these values is known as the reference power and in any situation is either expressly stated or what is more common, is understood. In many cases the difficulty is in knowing what value of power is being used as the reference.

Definition

We now turn to a modern definition of the decibel and see how it is used in some examples.

Two power levels, P_1 and P_2, are said to differ by n decibels when the following equation holds:

$$n = 10 \log P_1/P_2$$

where n is the number of decibels

P_1 is the larger of the two powers

P_2 is the smaller of the two powers

Both P_1 and P_2 must be measured in the same units (watts, milliwatts, etc.). The ratio P_1/P_2 is always arranged so that its value is greater than 1. To signify a power gain we prefix a + sign and a power loss is expressed by prefixing a – sign. Contrary to some textbooks it is not necessary to remember two separate formulas and a little checking with numerical values will show this. It is only necessary to add the + or – sign depending upon whether a gain or loss is encountered and this can always be determined by inspection.

We can now put this equation to work by using it in a simple example. *Figure* 1 illustrates an audio power amplifier whose power gain is to be measured. The output power is seen to be

$$P_{out} = E^2/R = 8^2/16 = 4 \text{ watts.}$$

The input power can be found in a similar fashion once the input impedance (assumed to be a pure resistance) is known. The manufacturer usually supplies this data and in this case it is 1 megohm. Therefore,

$$P_{in} = E^2/R = 2^2/1{,}000{,}000 = 0.000004 \text{ watts}$$

The power gain is then

$$n = 10 \log (4/0.000004)$$

$$n = 60 \text{ db}$$

A power gain is indicated here by output being greater than input. The fact that this amplifier has a gain of 60 db is of limited value in comparing it with another amplifier or against certain arbitrary standards. What is of greater importance is the relationship between the power output at some reference frequency (usually 1000 cps) and at many other frequencies above and below this. Let's illustrate this with another example using the same amplifier as shown in *Fig.* 1.

Suppose that the input signal remains constant at 2 volts but that the power output drops to only 1 watt at 50 cps. Using the 4 watts (at 1000 cps) of our original example as the reference, n would indicate a power loss of approximately 6 db.[1]

Presenting the Information

If we could calculate the power output at many different frequencies and plot these data on semi-logarithmic graph paper our results would look like *Fig.* 2. Here zero db represents the power output at some reference frequency (here 1000 cps). Any output lower than this would represent a power loss (– db) and these values could be plotted versus frequency. *Figure* 2 is known as a universal response curve and shows us something about the response of an amplifier without regard to the actual power output. This is convenient when comparing several amplifiers as to frequency response alone. In fact, absolute values of power are of small importance in studying response curves.

The reader has probably noticed that in the above calculations power was found by using E^2/R. And when two values of power were being compared (to find their ratio), one value of E^2/R was divided by another value of E^2/R. With the two values of R being the same in both cases (16 ohms) we could have saved some effort by simply dividing E_1^2/E_2^2 to obtain the power ratio. This can be carried one step further because

$$10 \log (E_1^2/E_2^2) = 20 \log (E_1/E_2)$$

There are two very important points to notice in regard to this formula. First, it is simply a short-cut to finding power gain; the result is not "voltage gain." Secondly, the value of resistance across which the two voltages are measured must be equal. The neglect of these two restrictions has led to much of the confusion regarding decibels.

(*Continued on page 77*)

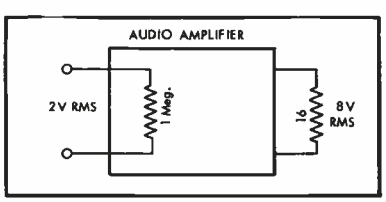


Fig. 1. The gain of an amplifier can be expressed in decibels if input and output power are known. The value of input resistance is usually supplied by the manufacturer.

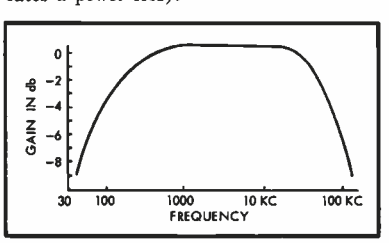


Fig. 2. A universal response curve. See text for details of how the curve is determined.

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[1] $n = 10 \log 4/1 = -6.02$ db (– sign indicates a power loss).

Acoustic-Front Damping in Dynamic Microphones

W. T. FIALA*

To provide smooth, flat response, all microphones require some form of acoustic damping on the diaphragm. The author describes a new method which is claimed to give superior performance.

ACOUSTIC-FRONT DAMPING is a new arrangement of the controlling acoustic resistance in dynamic microphones which is distinctly different from that found in conventional microphones. This article will describe the mechanics and advantages of this new design. It should be observed that the moving-coil microphones, as developed years ago[1], already include the intricate details of design that are found with scarcely a change in the microphones of that generic type in widespread use today. The intricacy of the design is illustrated by the fact that about *twelve* acoustical or mechanical elements require correct proportioning in relation to each other to produce the excellent frequency response available with a correctly designed instrument of this type.

There have been changes in relatively superficial details. For example, the Altec 21B Condenser Microphone and M-11 Microphone System set a new pattern for small physical size that brought the performer back into view, and several moving-coil microphones have since appeared with external dimensions made narrower and longer with the object of obtaining some measure of the same benefits. The interplay of the acoustical and mechanical elements in a dynamic microphone at high frequencies is rather complex to the average non-specialist, so a general description of the over-all action is given in rather easy stages. Although this description might be found quite elementary, it may still prove useful as a brief refresher.

In microphones of the moving-coil and the ribbon types, energy is converted from the acoustical to the mechanical form by forces of the sound field acting on a movable mechanical system, and from the mechanical to the electrical form by the movement in a magnetic field of an electrical conductor forming a part of the mechanical system. The voltage induced in the conductor is proportional to its velocity.

The ribbon microphone derives its name from the fact that the moving conductor is in the form of a ribbon, a fraction of one-thousandth of an inch in thickness, positioned in a uniform magnetic field. The ribbon is free to move under the forces of the sound pressure in the case of the ribbon pressure-type microphone, or the sound-pressure difference between two sides of the microphone in the case of the ribbon-velocity type. Acoustical forces act directly on the ribbon which comprises the entire mechanical system. In the moving-coil microphone the conductor is in the form of a coil (of round wire or edgewise-wound ribbon) attached rigidly to a diaphragm and positioned in an annular gap to move in a radial magnetic field. The forces of the sound field act on the diaphragm.

In both types of transducer, the conductor or the conductor-diaphragm assembly forms a simple mechanical system. When driven by a force the movement of the system is controlled by its mass, its stiffness, and the power it dissipates in the mechanical or acoustical resistance associated with it. Depending on which of the three factors is predominant in controlling the movement, the system is commonly described as mass-controlled, stiffness-controlled, or resistance-controlled. For either type of moving-conductor microphone a flat frequency response requires resistance control. The driving force may be proportional either to sound pressure or to sound-pressure difference, but we will restrict the discussion to follow to microphones in which the driving force is proportional to sound pressure.

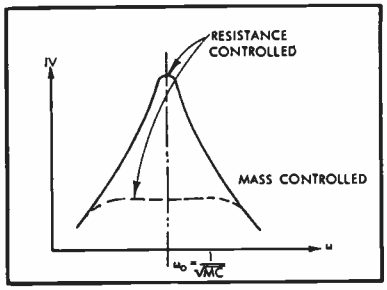


Fig. 2. Velocity amplitude vs. frequency for typical mechanical structure to show resonance.

Figure 1 shows, at (A), the schematic cross-section of a mechanical system typical for the moving-coil microphone. The diaphragm is given a dome-shaped center portion to provide maximum piston rigidity with minimum mass, and a compliant edge zone formed in corrugations. The voice coil is cemented to the base of the domed center portion and the total oscillating mass M is the sum of diaphragm and voice-coil mass. The compliance C is that of the edge zone. R represents the losses of the system. If the system is driven by a force F, the velocity V follows the same law as the current I in the familiar electrical L-C-R series resonant circuit, driven from a constant-voltage source E as indicated at (B) in *Fig.* 1. The so-called impedance analogy is used throughout this

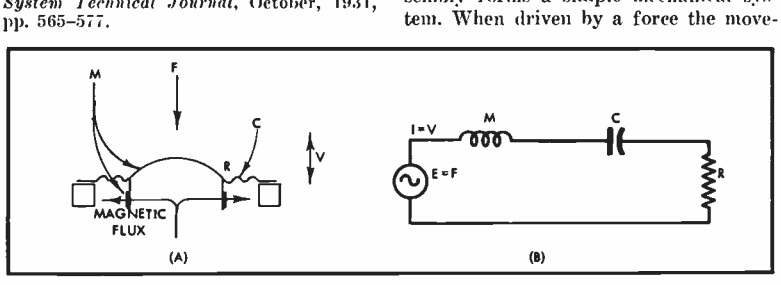
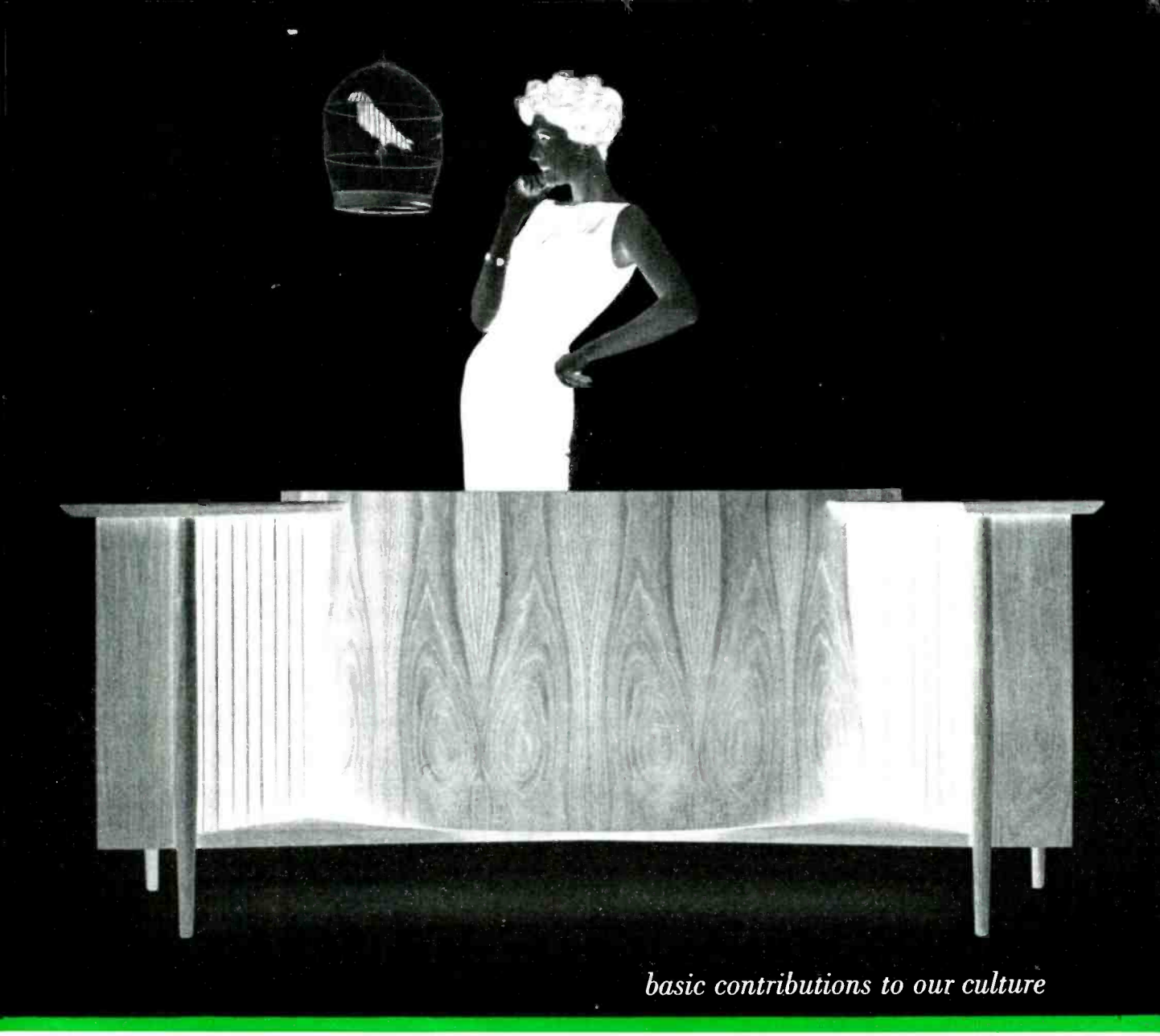


Fig. 1. (A) Schematic cross section of typical moving-coil microphone, and (B), its equivalent circuit.

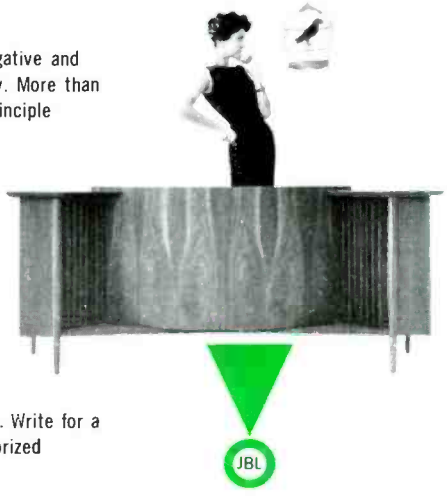
* *Altec Lansing Corporation, 1515 S. Manchester Ave., Anaheim, Calif.*

[1] E. C. Wente and A. L. Thuras, *Bell System Technical Journal*, October, 1931, pp. 565–577.



basic contributions to our culture

We are indebted to William Henry Fox Talbot for the invention of the photographic negative and discovery of the latent image. His work greatly advanced the art-science of photography. More than a hundred years later the laboratories of James B. Lansing Sound, Inc., developed the principle of radial refraction, a break-through which may prove to be equally significant in the field of stereophonic music reproduction. First applied to the magnificent JBL Ranger-Paragon, an instrument originally designed for use as a monitor in perfecting stereo recording techniques, radial refraction has now been used in a more compact, home-sized stereophonic loudspeaker system called the JBL Ranger-Metregon. The curved refracting panel on the front of the dual acoustical enclosure integrates two precision loudspeaker systems. A wide-angle stereo field is radiated throughout the listening area. Radial refraction obviates the hole in the middle, ping-pong effects, and split soloists which plague expedient stereo arrangements. No less than seven different speaker systems, including one with new high frequency drivers, exponential horns, and dividing networks may be installed in the Metregon. You may very well be able to use some of your present JBL loudspeakers. Write for a complete description of the JBL Ranger-Metregon and the name and address of the Authorized JBL Signature Audio Specialist in your community.



JAMES B. LANSING SOUND, INC., 3249 Casitas Ave., Los Angeles 39, Calif.

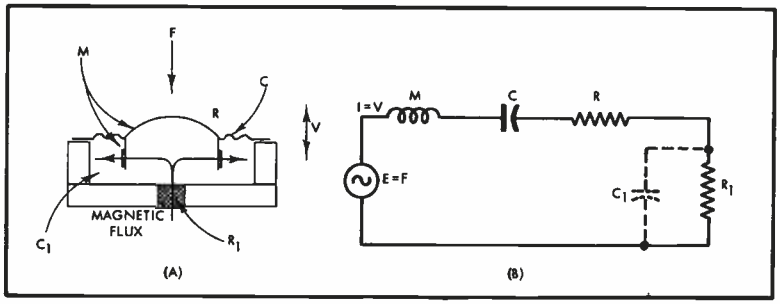


Fig. 3. (A), Schematic of moving-coil microphone with added acoustic damping, and (B), its equivalent circuit.

article. Plotting the velocity amplitude as a function of frequency gives the well-known resonance curve depicted by the solid line in *Fig.* 2. For frequencies high compared with the resonant frequency, ω_o, velocity is controlled by the mass of the system; and for frequencies low compared with ω_o, by its stiffness. The maximum velocity at resonance depends on the acoustical and mechanical resistance of the system.

Air Damping Added

As a further step towards the more complicated mechanical-acoustical structure of the moving coil microphone, (A) of *Fig.* 3 shows the same basic mechanical system with added acoustical components. A case over the back of the diaphragm encloses a small air volume. The case is provided with a hole (for example, ⅛-in. diameter) which is covered or filled with felt, designated R_1 in *Fig.* 3. If the diaphragm moves in the direction of the force F, the enclosed air will be partly compressed and partly forced through the felt. The ratio of the amount of compression to the amount of air moved through the felt will depend on the ratio of volume to the flow resistance of the felt. The compression of the air will establish an additional stiffness for the mechanical system. The air forced through the felt will dissipate energy due to viscous friction and thereby provide additional damping. In the electrical analogue, (B) of *Fig.* 3, the two acoustic components are represented by C_1 and R_1. Provided the coupling volume is small enough that its compression can be neglected compared with the amount of air moved through the resistance, only a series resistance R_1 has to be added in the electrical equivalent circuit. In this case the increased resistance decreases the velocity at resonance but provides a substantial range where the velocity is independent of the frequency of the driving force (dashed curve, *Fig.* 2). In this frequency range the movement of the system is resistance-controlled. If R_1 is further increased, the flat range can be widened at the cost of further reduction of velocity. If the voice coil of such a system moves in a constant magnetic field which has a direction as indicated by the arrows in (A) of *Fig.* 3, the voltage generated will be proportional to its velocity and therefore independent of the frequency of the driving force in the range where the velocity is constant. This illustrates that the movement of the mechanical system of the moving-coil microphone has to be resistance-controlled.

Figure 4 shows, at (A) a more complete schematic cross-section of a moving-coil microphone. Magnet, magnet structure, pole plate and pole piece form the magnetic circuit, which provides a radial magnetic field in the annular gap between pole piece and pole plate. The diaphragm voice-coil assembly is cemented to the pole plate so that the voice-coil can move freely in the annular gap perpendicular to the radial field. On the other side of the gap, the controlling acoustical resistance R_2 with its mass component M_2, consisting usually of a narrow annular slot or a felt or silk ring, communicates the small volume C_2 with the volume inside the magnet structure. The whole system is enclosed by a case which seals the back side of the diaphragm from the sound field and allows the sound pressure to act only on the front side of the diaphragm, through a protective screen. The volume of the case C_3 must communicate freely with the volume inside the magnet structure.

In the equivalent electrical circuit, (B) of *Fig.* 4, if the components enclosed by the dashed lines are disregarded for the moment, M_1 is the mass of diaphragm plus voice-coil, C_1 the compliance of the edge zone, C_2 is the compliance of the small volume between diaphragm and pole piece, which couples the acoustical element R_2M_2 to the diaphragm. C_3 is the compliance of the volume enclosed by the case. In the frequency range where R_2 is large compared with the reactive components M_1C_1 and M_2C_2, and where the reactive component of C_2 is large compared with R_2, the current through M_1C_1, which represents the velocity of the diaphragm will be resistance controlled and therefore independent of the frequency of the driving sound pressure. It follows that the output voltage of the microphone will be constant in this frequency range.

At higher frequencies, diaphragm mass M_1 resonates with the air volume C_2 at, for example, 7000 eps. This resonanee proves to be much less damped than the natural resonance of the diaphragm and causes an undesired peak in the frequency response of the output voltage. The main reason why the damping resistance R_2 is less effective in this frequency range is that the reactance of its mass component M_2 becomes comparable with R_2.

The equivalent circuit discussed so far assumes that the sound pressure acts directly on the diaphragm. It is necessary, however, not only to protect the diaphragm aaginst mechanical damage, but also to provide a fine enough screen between diaphragm and sound field to

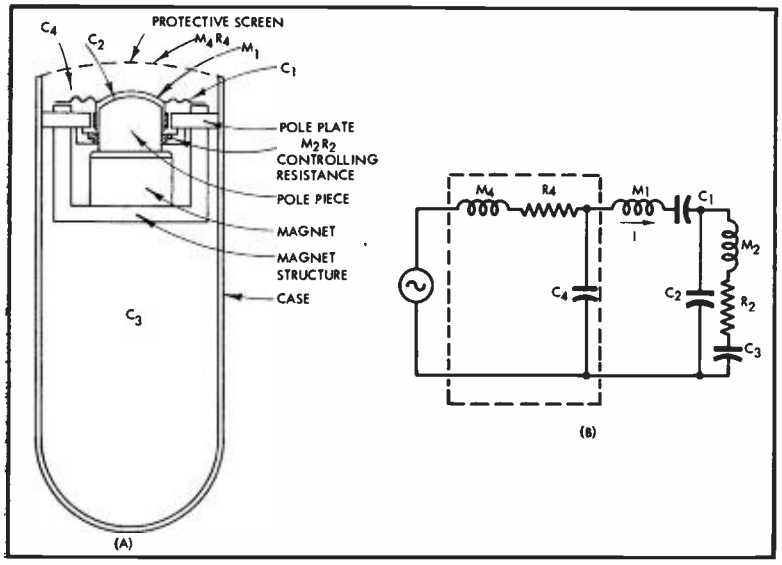
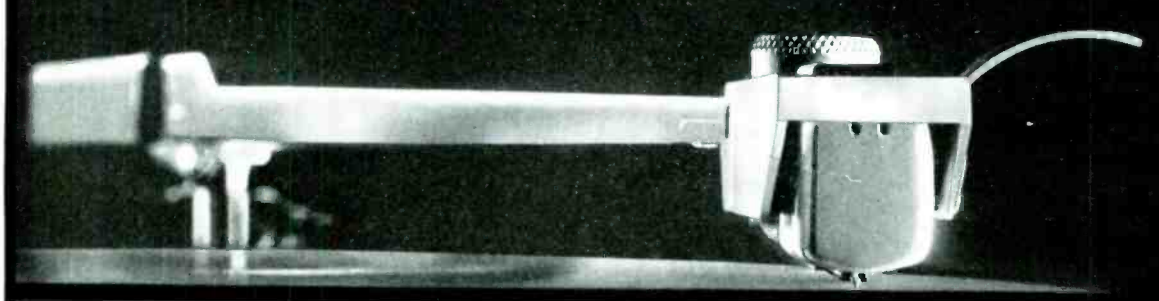


Fig. 4. (A), Schematic of moving-coil microphone showing additional acoustic compliances, masses, and resistances, and (B), its equivalent circuit.

Reduce record wear...

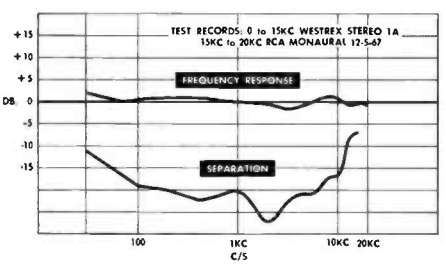


Less mass, higher compliance with G.E.'s "Golden Classic" stereo-magnetic cartridge

The more moving parts, the more resistance to groove motion. General Electric's "Golden Classic" has only one moving part—the stylus—which "floats" freely in special-formula damping cushions. This means freer motion in the record groove. You get less wear on records and stylus, and superior sound at all frequencies. Hear the "Golden Classic" GC-5 or GC-7 soon. You'll agree they are a fitting climax to the famous General Electric cartridge tradition.

● Plays both stereo and monaural records ● Frequency response, 20 through 20,000 cycles ● Output 8 mv ● Effective mass of stylus about 2 milligrams ● Lateral compliance 4 x 10^{-6} cm/dyne; vertical compliance 2.5 x 10^{-6} cm/dyne ● Recommended tracking force with professional-type tone arm 2 to 4 grams. (Specifications for Model GC-5.)

Model GC-5 (shown) with .5 mil diamond stylus, **$26.95.** Model GC-7 with .7 mil diamond stylus, **$23.95.** Model CL-7 with .7 mil synthetic sapphire stylus **$16.95** (Manufacturer's suggested resale prices).



Smooth response on both stereo and monaural records. Consistently high channel separation, because the stylus is *magnetically* linked to the coils.

TM-2G "Stereo Classic" tone arm

A professional-type tone arm designed for use with G-E stereo cartridges as an integrated pickup system. Unusual two-step adjustment permits precise setting of tracking force from 0 to 6 grams. Lightweight, brushed aluminum construction minimizes inertia. Statically balanced for minimum friction, reduced stylus and record wear **$29.95** (Manufacturer's suggested resale price).

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prevent minute iron particles from being accumulated on the diaphragm by the magnetic stray field. This protective screen represents additional and mostly unwanted acoustical elements. In the equivalent circuit, these elements are M_4, R_4 (the mass and the resistive component of the screen) and C_4 (the volume between screen and diaphragm). The magnitudes of these elements are such that again the high-frequency response is undesirably affected. In most cases a drop of high-frequency sensitivity and additional irregularities result.

Frequency-Response Improvement

These problems in the high-frequency range of the conventional moving-coil microphone have been solved in the design herein described by placing the controlling resistance R_2 between sound field and diaphragm. A schematic cross-section of this microphone is shown at (A) in *Fig.* 5.

The mechanical-acoustical system is essentially the same as that of the conventional microphone except that the controlling resistance R_2 is now interposed between diaphragm and sound field. This resistance may take the form of a narrow circular slot formed between an edge of the pole plate and a solid cap. In the equivalent electrical analogue, (B) of *Fig.* 5, M_1C_1 again are mass and compliance of the diaphragm voice-coil assembly and C_3 is the compliance of the volume enclosed by the case. R_2 is the resistive component of the controlling resistance and M_2 the mass associated with it. C_2 is the compliance of the small volume between cap and diaphragm coupling R_2M_2 to the diaphragm.

The current I through M_1C_1 which again represents the velocity of the diaphragm will be independent of frequency as long as R_2 is large compared with the reactive components M_1C_1, M_2C_3, and as long as the reactive component of C_2 is large compared with the impedances of the other elements. But now, contrary to the conventional design, R_2 is also effective at the higher frequencies because it is always interposed between the sound field and the diaphragm. It can be shown that even the resonance between the diaphragm mass M_1 and the coupling air volume C_2 is sufficiently damped by this resistance. It is further possible to choose the mass component M_2 of the controlling resistance in such a way that an additional resonance M_2C_2 above the resonance of the diaphragm M_1 and volume C_2 can be obtained, thus extending the high-frequency range of the microphone. As the narrow air gap of the acoustical resistance is of the magnitude of a few thousandths of an inch, it forms an excellent protection for the diaphragm. Therefore, no additional protective means, with its disturbing acoustic elements, is required, as can be seen in *Fig.* 6. The new arrangement provides an extremely smooth and extended high-frequency response. Another means for providing the acoustical damping resistance on the incident side of the diaphragm is through the use of felt at the sound entrance. The significant difference between the use of felt and the extremely narrow annular slot lies in the ratio of mass to resistance of the acoustical entrance. These two means may be employed together to secure an optimum combination. Felt used at the sound entrance must be, of course, completely waterproof, and non-hygroscopic.

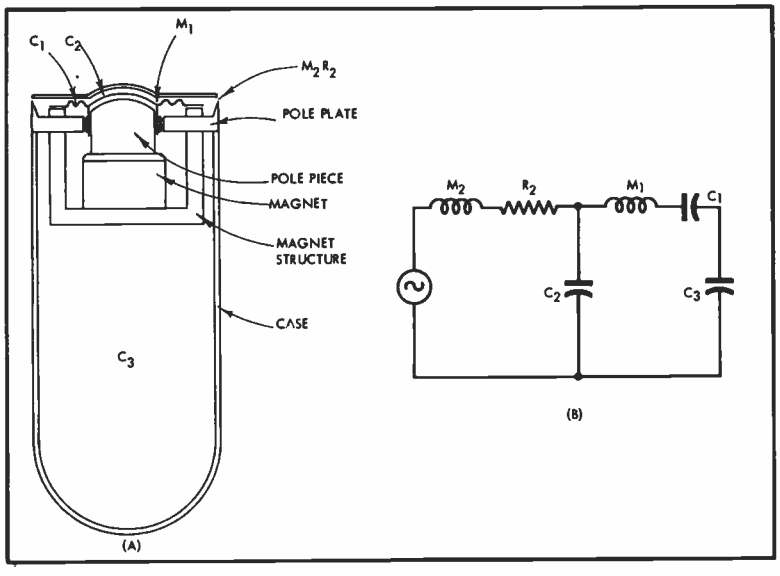


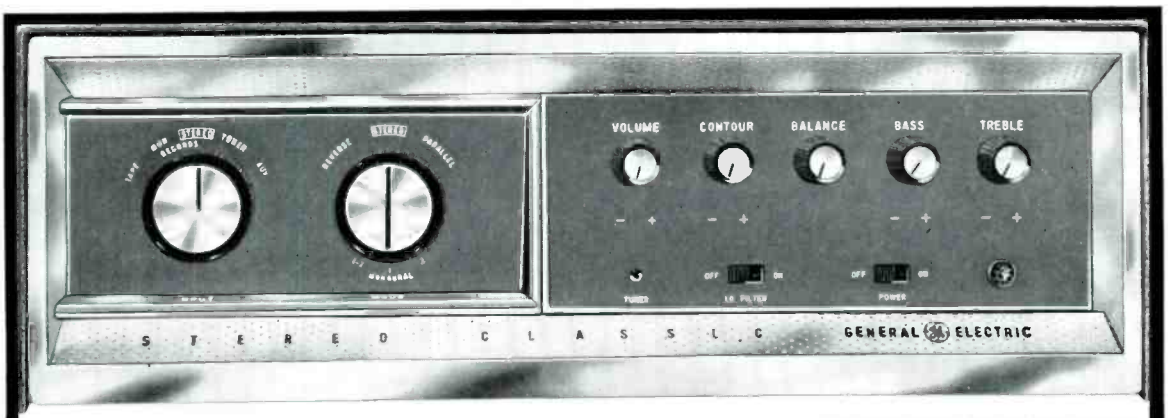
Fig. 5. (A), Schematic of microphone in which acoustic resistance is provided by narrow annular slot, and (B), its equivalent circuit.

Fig. 6. Altec 680A "Acoustic Gate" microphone using principles described in text.

A sintered bronze or sintered stainless steel screen in the cap over the diaphragm is also used to form the resistance between the sound field and the diaphragm, as seen in *Fig.* 7.

A serious restriction to the outdoor use of microphones is their susceptibility to wind noise. The excitation of a microphone by wind is due to three possible sources. There may be pressure fluctuations in the wind stream due to fluctuations of the stream velocity, or pressure fluctuations may be produced by turbulence around the microphone. The extremely small sound entrance of the new design allows the streamlining of the microphone so that turbulence is safely avoided, thereby eliminating one source. Complete streamlining of the microphone, however, might result in a shape which is not acceptable from the standpoint of appearance. The resistance in front of the diaphragm between sound field and the diaphragm provides another possibility of very effective wind noise suppression. A cap of approximately ⅛-in. thickness made of felt of medium density fitting snugly over the head of the microphone not only suppresses turbulence effects, but also reduces wind noise due to velocity fluctuations. It has been found that a cap of this kind gives a wind noise suppression better than 20 db. If such a felt cap is used, it should be remembered that the opening of the base tube has either to be closed or protected by felt similar to that applied to the head of the microphone because most of the wind noise lies at the low end of the audio spectrum.

(*Continued on page 85*)



G-E "Stereo Classic" Amplifier Model MS-4000

40 watts of balanced stereo power

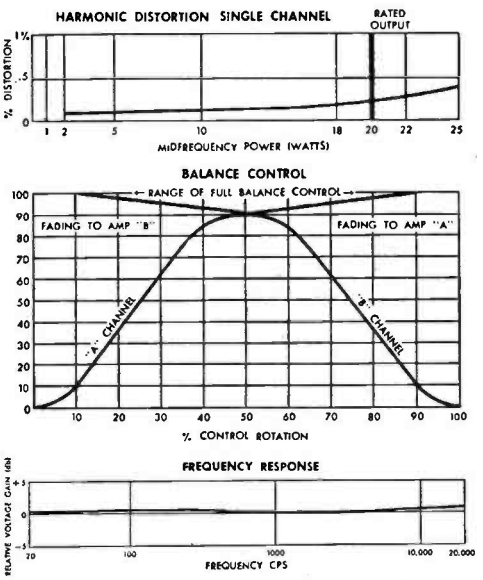
. . . only $179.95

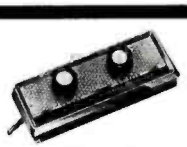
General Electric's MS-4000 40-watt Amplifier gives you power to spare for clean stereo reproduction, with less than 1% distortion. It offers 40 db or higher channel separation, a rumble filter effective on all inputs, and maximum output stability at all frequencies.

For top stereo performance at a sensible price, hear G.E.'s "Stereo Classic" Amplifier soon.

OUTSTANDING PERFORMANCE FEATURES

• Full, balanced 20-watt output from each channel (28 watts per channel music power) • Flat response within 0.5 db from 20 to 20,000 cycles • Extremely low hum and noise level • Single-knob controls for easy adjustment of both stereo channels at same time • Contour control provides smooth, gradual bass boost without apparent change in sound intensity. Only **$179.95*** MS-2000 (28-watt Amplifier) **$139.95***

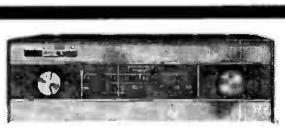




New G-E Remote Control RG-1000

Now you can change the stereo perspective without moving from your chair! Two knobs permit adjustment of channel balance and volume up to 30 feet from the amplifier. Especially useful in stereo because of individual preferences for channel balance and variations in room acoustics. May also be used as volume control with monaural amplifier. 30-foot cord included. **$14.95***. *Manufacturer's suggested resale prices.

FM-AM Tuner FA-12



Receives even weak signals with unusually low distortion, hum and noise level. No audible drift. Visual meter provides center channel tuning of FM and maximum AM signal. RF amplifier stage in both FM and AM increases sensitivity. FM multiplex jack for stereo adaptor. Built-in AM antenna; folded FM dipole included. **$129.95***

See and hear the G-E "Stereo Classic" amplifier and tuner at your Hi-Fi dealer's now. For more information and the name of your nearest dealer, write General Electric Company, Specialty Electronic Components Dept., 46A3, W. Genesee St., Auburn, N. Y.

GENERAL ELECTRIC

New York's Audio Workshop

SIDNEY NORINSKY*

Business opportunities are where you find—or create—them. And there is always room for an enterprising idea like this one.

TO START any familiar enterprise takes stamina and perseverance. But to open a brand new kind of business based on an untried idea takes no small additional measure of courage and imagination.

The two young men who founded New York's Audio Workshop last May appear to have all of these virtues. Dave Muirhead and Elliot Gordon opened this unusual center in the belief that enthusiastic beginners in audio would welcome a place where they could receive instructions and guidance in building and testing their amplifiers, preamps, tuners, and even complete systems. Experienced audiofans would have to be attracted to the Workshop if it were to grow in reputation.

Most important of all, Workshop atmosphere had to be relaxed, friendly. Fees were to be modest, with test equipment, tools, and expert counsel thrown in; electronic kits, as well as parts and supplies would also be available.

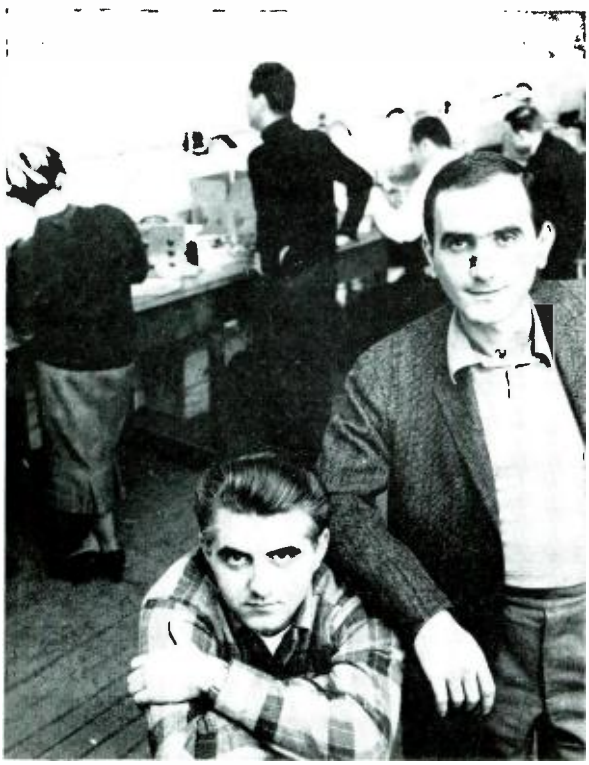
* *304 Middle Road, Hazlett, N. J.*

They opened in a large, well-lit loft one flight up at 732 Broadway, just opposite Waverly Place, a location which abuts the New York University campus, Greenwich Village, a bustling business and industrial area, and which is also convenient to two subways.

First objectives have been achieved. Several slow starting months were followed by two important publicity breaks. Articles in the Sunday *New York Times* and in *Cue* magazine told millions of readers about the Workshop. The response was heartening. Beginners and experienced audio-ists began to appear and now, nearly any night, half-a-dozen and more people are to be seen seated before the 22-foot long worktable fitted with individual goose-neck lamps and power outlets at each work-place. They work on kits, run frequency *vs.* power and distortion checks on their gear, and perform the inevitable hum-reduction operations on stereo rigs.

Available to all are oscilloscopes, an intermodulation meter, audio signal generators with sine- and square-wave outputs, an r.f. generator, vacuum-tube voltmeters, and a wattmeter calibrated across 16 ohms. Some parts are also maintained in stock.

Personal attention is a feature of the Audio Workshop. Here Elliot Gordon helps a Workshop "customer" over the first stages of wiring a preamplifier.



Dave Muirhead, left, and Elliot Gordon, shown before a section of the long workbench, are partner-owners of the Audio Workshop.

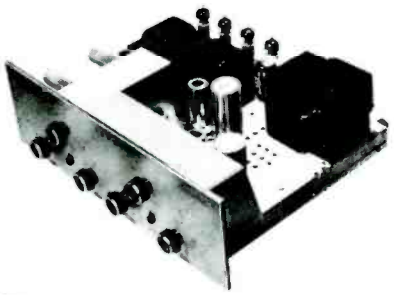
Who are the "Customers"?

The people who come to the Audio Workshop range from a transistor specialist and editors of technical magazines, to a biochemistry researcher, a physiotherapist, and a semi-retired bar owner. "We have to teach many of them to solder, and some don't know the difference between a resistor and a capacitor. But once they've started, they generally raise their sights to more powerful amplifiers or additional components and many begin to study basics of electronics and audio" say both partners.

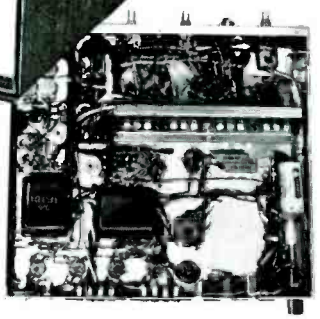
The projects in work at any time range from simple wiring of a basic power amplifier under close guidance from Dave or Elliot, to the full-fledged development of a 3-tube simplexed stereo amplifier. Experimenters at the Workshop seem to have that healthy disdain for authority, coupled with a belief in their own ability and ingenuity, which has kept the audio field fresh and exciting. For example, in December, 1958, a Workshop denizen produced—lo and behold—a three dollar electrostatic

(*Continued on page 75*)

So much better, you can hear the difference!



Model X-101 **$189.50***
Cabinet **$24.95***



THE FISHER

STEREOPHONIC MASTER AUDIO CONTROL and DUPLEX AMPLIFIER

IT IS BUT LOGICAL that only a high fidelity instrument using the finest materials can produce the finest sound. When you look inside THE FISHER X-101, you will see an immaculate wiring and component layout—you will see massive, low-flux density transformers, with interleaved windings to prevent hum and noise (and *guarantee* the power response that others cannot)—and you will see the world's finest, low-tolerance capacitors and resistors. Compare the X-101—feature for feature and part for part—and you will know instantly why it is outselling every other brand, *regardless of price*. Its superior quality is obvious to the eye . . . irrefutable to the ear, objective in design, to bring you the music INTACT . . . *the music itself.*

WRITE TODAY FOR NEW STEREO BROCHURE!

INCOMPARABLE FEATURES

- 40 watts in stereo, 75-watt peaks.
- 12 inputs for all stereo and monophonic program sources.
- Record-Monitor facilities.
- 8-position Function Selector: 78, LP, RIAA-1, RIAA-2, Tape, Tuner, AUX-1, AUX-2.
- 4-position Output Selector: Reverse, for transposing the two channels; Standard stereo; Channel A and Channel B for two-speaker operation from monophonic source.
- Single-knob Channel Balance control.
- Full-range, Bass and Treble controls.
- Hum and noise, *inaudible.*
- Rumble Filter. Loudness Control.

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*Slightly Higher in the Far West

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Transformer Distortion

DUNFORD KELLY*

In two parts—Part 2

The causes of distortion in transformers are fairly well known to transformer engineers, but there is little the user can do to avoid it. However, a thorough understanding of the parameters which cause distortion and the effect of core material, size, stacking, and operating conditions will help engineer and experimenter alike in their choice and use of transformers.

THE CORE MATERIALS discussed have all been suitable for use in output transformers by virtue of high saturation flux densities. The silicon steels saturate at about 20,000 gauss, the 50% nickel iron at about 16,000 gauss.

Another material of importance is known as Mumetal.[8] It is not useful in output transformers, saturating at 8,000 gauss, but is superior at lower flux densities, having the highest permeability of the lamination metals. It is the most expensive and the most fragile, but in a core completely free from air gaps, it has initial and maximum permeabilities 2 to 4 times as great as 50% nickel iron measured in the same form.

The Mumetal curves of *Fig.* 4 are not directly comparable with the first three figures because the core is very much smaller and the impedance relations are different. This transformer was designed for line matching. It is the small size sometimes enclosed in microphone cases. It was measured with one winding driven by a source of rated impedance and the other winding unloaded. This is not the design condition for a line matching transformer, but in the ordinary case where the gain controls follow the first stage of amplification, the line transformer is generally followed by an input transformer and the source is the only loading resistance. This is the condition that was approximated.

The Mumetal distortion curves, *Fig.* 4,

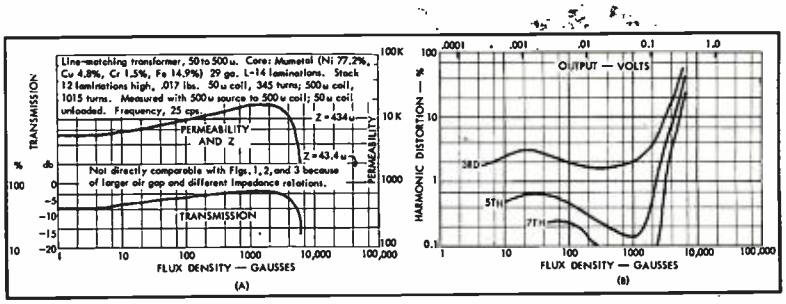


Fig. 4. Curves of transmission, permeability, distortion, and impedance vs. flux density for Mumetal core material.

are very similar in shape to the 4750 curves of *Fig.* 3 except for an 8,000-gauss saturation point instead of 16,000 gauss. This reduces the power-handling capacity to one fourth that of the 4750 alloy, precluding output transformer use. By coincidence, the low-level distortion of the Mumetal is the same as for the 4750 alloy. This is because of the difference in test conditions. If this Mumetal had been measured in the EI-75 laminations of *Fig.* 3 the permeability would have been about twice that of the 4750 alloy. The transmission loss in decibels would have been about half as great as *Fig.* 3 and the distortion about half as much as *Fig.* 3 at low levels. At high levels the Mumetal also produces about half as much distortion as the 4750 if compared at half the flux density of the 4750, due to the 2 to 1 ratio of saturation flux densities. The advantage of Mumetal diminishes at higher levels. It is not often used above 2,000 or 3,000 gauss.

It must be remembered that production variations for high-permeability materials are large and cause corresponding variations in transformer characteristics.

The distortion of *Fig.* 4 is the actual distortion produced by the transformer at 25 cps when used in the usual manner. The distortion is much too high for a good-quality sound channel, despite the Mumetal core. To reduce the distortion the energizing current must be reduced. One approach is added turns on the coil, but this means finer wire and higher resistance loss. A larger core is a more satisfactory solution. If the original coil resistance is duplicated, the larger transformer has higher impedance and reduced distortion.

Figure 7 is an example of a large transformer with a Mumetal core. The maximum low-level distortion is about 0.4 per cent third harmonic. This is much improved over the 3 per cent third for the small transformer. To accomplish this improvement, along with improved low-frequency response, and greater power-handling capacity, the core of this transformer weighs 40 times as much as the core in the small transformer.

A line-matching transformer used in an instrument was required to be nearly distortionless. The measured low level distortion peak was 0.08 per cent third harmonic at 20 cps. The core of Mumetal weighed 33 pounds. This huge core was unavoidable if this low distortion level at 20 cps were to be attained. Actually a really good power amplifier has as low distortion at 20 cps as this one transformer. This immense, very expen-

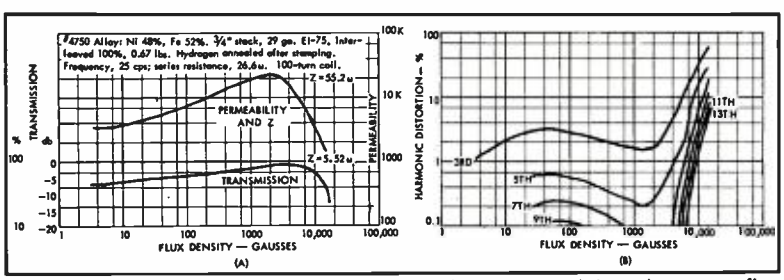


Fig. 3. Curves of transmission, permeability, distortion, and impedance vs. flux density for No. 4750 alloy core material.

* *4638 10th Ave., Los Angeles 43, California.*

[8] Bulletin EM-16, *"Allegeny Mumetal."* Allegeny Ludlum Steel Corp., Brackenridge, Pa.

"Now, I must tell you, I have heard a speaker system that approaches the authenticity of concert hall performance."

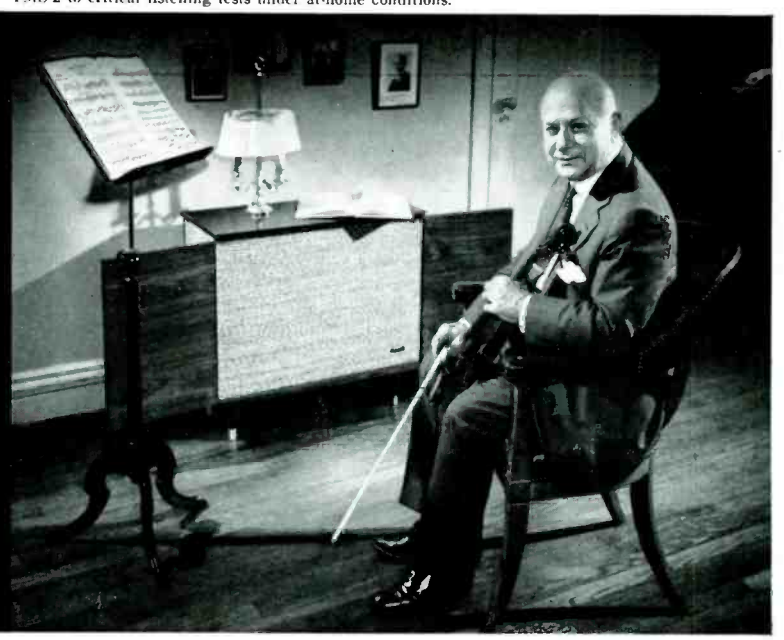
. . . says Mischa Elman, the internationally renowned violinist, now celebrating the 50th anniversary of his American debut. Mr. Elman is an artist whose preference for concert hall performance over recorded music is a matter of public record. His enthusiasm after hearing the TMS-2 in his home is shared by many other leading artists, musical authorities and audio experts who also subjected the TMS-2 to critical listening tests under at-home conditions.

THIS IS IT!

University's 'Trimensional' Stereo Speaker

THE NEW TMS-2

PATENT APPLIED FOR



TMS-2 with deflector doors closed for monophonic use

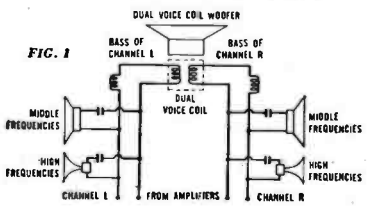
A STEREO SPEAKER SYSTEM THAT COMBINES . . .

- Two complete speaker systems in one enclosure
- Unprecedented compactness - only 30" wide, 25" high, 12½" deep
- A third dimension to stereo sound . . . DEPTH
- Placement **anywhere** in a room
- Use for **both** monophonic and stereophonic reproduction
- Uncompromised quality at an attractive price

Here is the most significant loudspeaker achievement since the advent of popular stereo . . . a University development which, at last, actually eliminates *all* the problems of placement, space limitations, decor and cost . . . but most important of all, produces a new kind of stereo sound . . . the authenticity of concert hall *depth*.

COMPACT By utilizing the exclusive *dual voice coil* feature of the C-12HC woofer, only one bass enclosure and woofer are required to handle the entire low frequency range of both stereo channels. Extended, undistorted bass is superbly reproduced by making use of the RRL enclosure design so successfully employed in University's Ultra Linear Response systems. *See fig. 1.*

FIG. 1



REALISTIC STEREO Unusual breadth, depth and clarity of stereophonic sound is accomplished by utilizing the walls of a room, just as the symphony orchestra uses the acoustical properties of the concert hall. The woofer sound emanates from the rear of the enclosure; specially designed separate mid-range and tweeter units for each channel project sound from the sides of the cabinet. By adjusting the deflector doors, the amount of stereo spread can be increased or decreased, as desired, according to the nature of the program . . . full deflection for opera or major orchestral works, less deflection for chamber music or soloist. By thus deflecting all frequencies, in proper relationship, to the rear and side walls of the room, multiple sound sources are created that not only provide the otherwise missing dimension of depth, but also preserve the stereo effect virtually throughout the room. *See fig. 2.*

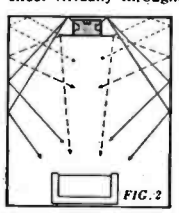


FIG. 2

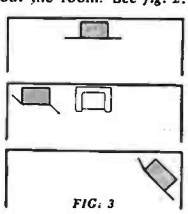


FIG. 3

USE ANYWHERE The unique design of the TMS-2 provides you with two distinct advantages: place it in a corner or *anywhere* along a wall, by merely positioning the deflectors as shown in fig. 3, and since there are *no particularly critical listening positions*, you, your family, your friends—any number of listeners—can enjoy the TMS-2 from most anywhere in the room.

MONOPHONIC OR STEREOPHONIC With deflectors closed, the TMS-2 is an outstanding, wide-range monophonic speaker system. "PRESENCE" and "BRILLIANCE" controls are provided for both sets of mid and high frequency speakers. In addition to being used for balancing the system to room acoustics and personal taste, these controls and the deflectors may be adjusted to produce a full, very pleasing stereo-like effect when using monophonic program material. Whether you start your high fidelity system with monophonic equipment, or go right into a stereo setup, the TMS-2 is the best investment you can make, because it is equally "at home" with any kind of program material, and no further additions to the speaker system are ever required.

DESIGNED RIGHT - PRICED RIGHT Flawlessly designed along simple, classical lines, beautifully proportioned to compliment the most exacting taste, the TMS-2 will enhance any decor. In fact, it looks more like a piece of fine furniture than a typical speaker cabinet. Breathtaking in its performance . . . beyond the scope of conventional monophonic or stereophonic reproduction, the engineering concept of the TMS-2 eliminates redundant components; makes use of the latest, most advanced acoustic principles. RESULT: the ultimate in uncompromised value. *In Mahogany —$258, Blonde or Walnut—$263, User Net.*

See and hear the TMS-2 at your dealer . . . NOW! You too, will agree with musical and audio experts that it marks one of the most extraordinary advances in high fidelity and stereo history!

University®

UNIVERSITY LOUDSPEAKERS, INC., WHITE PLAINS, N.Y.

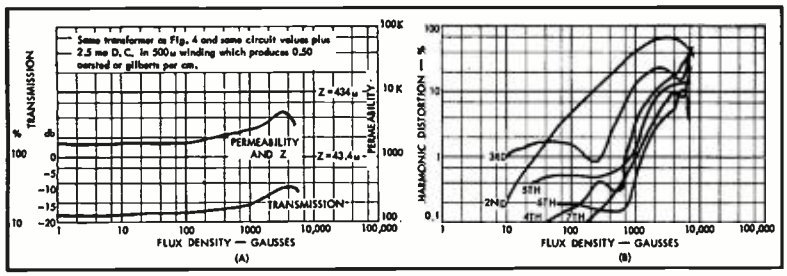


Fig. 5. Curves of transmission, permeability, distortion, and impedance vs. flux density for Mumetal core with d.c. polarization.

sive transformer illustrates how nearly impractical is a distortionless transformer.

The disparity in variations of amplifier and transformer distortion with level is an important consideration. Amplifier distortion is measured at maximum power and usually drops rapidly with reduction in signal. As a result, the amplifier in use contributes very little distortion most of the time. In contrast, a line transformer functioning over the range from a few gauss to a few thousand gauss, distorts at all levels, and in use distorts all signals at low frequencies.

Direct Current Polarization

The effect of direct current in a transformer is intricate but will be briefly considered. Audio transformers are never required to carry direct current when this can be easily avoided, but an output transformer must usually carry the direct current for its stage. In the case of push-pull circuits, the direct current largely balances in the transformer, subjecting the core only to the unbalance current. This can be made negligible and is generally ignored in transformer design. In a single-ended power-output stage the direct current is equal to the largest alternating currents, excepting overload, and profoundly limits the low-frequency capability of the transformer. With alternating currents alone, the core material contains no flux at no signal. With sine wave excitation the core will saturate at the same signal level with either instantaneous signal polarity. In contrast, direct current biasing adds to one polarity of alternating current and subtracts from the other polarity, so that the core saturates first in the direction of additive currents. Consequently direct current polarization reduces the power handling capacity of the core, because a part of the magnetization range is no longer utilized. Another consequence is a reduction in alternating current permeability, due to partial saturation of the core. If the transformer is constructed with an interleaved core providing a minimum air gap and is tested both with and without direct current, in the usual case the transformer core is nearly saturated by the amount of direct current required by the amplifier stage. Therefore the inductance is drastically reduced. A partial remedy is an increased air gap. The air gap regrettably adds to the reluctance of the magnetic path, but it reduces the direct current magnetization of the core material. With substantial direct current polarization, the added reluctance of the air gap will be more than offset by the decreased reluctance of the core material, providing a net increase in inductance.

The transformer of *Fig.* 4 is a size now in use with transistors. In transistor circuits, direct current is usually carried by the transformer. *Figure* 5 is of the same transformer carrying 2.5 milliamperes of direct current. With the direct current polarization, the low-level alternating current permeability with Mumetal is about twice as great as with silicon steel, and about the same as with 4750 alloy. Calculating the proper air gap with the direct current present[9] results in a figure of .0004″ compared to the actual .000128″. The next larger gap commonly used is the butt gap which produces a minimum air gap on the order of .003″ with small laminations. One intermediate gap size could be produced by interleaving the laminations two by two, instead of one by one. This should double the air gap, because only half as much lapped surface would be available. Gaps smaller than the butt gap could be produced by coating the laminations with insulating coatings of proper thickness and interleaving them. This is awkward and certainly not in general use.

The .000128″ gap in this core, although smaller than optimum, was not altered. Thus the result of added direct current is not obscured by other changes.

Direct current polarization adds the even numbered unsymmetrical harmonics to the odd numbered symmetrical ones produced by alternating current alone. The result, *Fig.* 5, is a horribly full harmonic spectrum. Beside the addition of the even-numbered harmonics, the total distortion is very much greater at all flux densities above 100 gauss. The cause of this excessive distortion is the asymmetry of polarized core material which responds differently to the two polarities of signal, and the reduced transformer impedance which impresses a larger part of the core distortion on the circuit.

The permeability, *Fig.* 5, with the polarization is quite different from the unpolarized permeability, *Fig.* 4. At low flux densities the permeability is determined by the d.c. polarization, while at the highest flux densities the polarization has slight effect. In this case the low level permeability is reduced from 6000 to 1600. This approximate ratio holds up to about 2500 gauss, while the permeability is only slightly reduced at 6000 gauss. This reduction in low and moderate level permeability raises the low-frequency cutoff in the same ratio, as for example from 40 to 150 cps.

An output transformer for a 6V6 was designed on the core of *Fig.* 1, using the same material, Audio A silicon steel. The low-level inductance, with the proper .007″ air gap, was 0.3 as great as the inductance without d.c. and without an air gap.

With single-ended audio output transformers of ordinary size, an inductance decrease by a factor of three due to the direct current and the appropriate air gap, seems typical. In the region of maximum permeability the decrease is greater. To compensate completely for this handicap, a much larger transformer would be required. Even so, a large part of the even-numbered harmonic distortion would remain. Direct current is thoroughly undesirable in audio transformers.

Core Insensitivity to Frequency

The impedance of a coil is proportional to frequency, but the permeability and distortion generation of core materials are largely unaffected by moderate frequency changes. To verify this, Audio A was tested first at 25 cps, then at 100 cps. Impedances were adjusted to the same relative values at each frequency. Both at 55 gauss and at 10,000 gauss, the permeability and distortion decreased less than one part in 20 due to this large frequency increase. Eddy current losses, which act as a distortionless shunt, increase with frequency, causing these small permeability and distortion reductions. Higher permeabilities are more frequency dependent, but for all practical purposes the core characteristics measured at 25 cps apply to any low audio frequency.

Distortion Variation with Frequency

Figure 6 indicates the variation of transformer characteristics with fre-

[9] *"Magnetic Core Materials Practice,"* pp. 68–88. Allegheny Steel Company, Brackenridge, Pa.

HARMAN-KARDON MAKES STEREO SENSIBLE

THE TRIO, Model A-224, Stereo Amplifier – actually embodies *three* excellent instruments in one handsome, compact unit. The Trio is: A complete stereo preamplifier with two separate 12 watt power amplifiers (24 watt peaks each.) A complete 24 watt monaural amplifier (48 watt peak.) A 24 watt monaural amplifier with complete stereo preamplifier arranged to convert an existing monaural amplifier to stereo. Outstanding features include: Separate ganged treble and bass controls, balance control, mode switch, speaker selector switch for local and remote speaker systems, contour control, tape output for recording application and rumble filter.

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the Cage (AC-24) optional 7.00

THE DUET, Model T-224, Stereo Tuner: Monaural! Binaural! Whatever the application, this new tuner is designed to give maximum performance. A superb monaural tuner—the T-224 incorporates separate AM and FM channels for receiving stereo broadcasts through this *one* unit. Rear jack makes it adaptable for multiplex reception.

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Harman-Kardon stereo instruments are the most flexible on the market today. Intelligent design assures ease of operation. The new Duet stereo tuner and Trio stereo amplifier — make stereo attractive, effective, inexpensive — and sensible.

For additional information on Harman-Kardon stereo and monaural units, simply send a postcard with the word stereo on it to Harman-Kardon, Dept. A-3, Westbury, N. Y.

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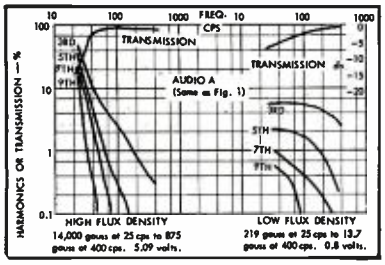

Fig. 6. Curves showing transmission and distortion on Audio A core material at both high and low flux densities.

quency at constant voltage, or flux density inversely proportional to frequency. This is the usual situation in audio equipment. At high flux densities the permeability increases with frequency, at low flux densities it decreases with frequency. High series resistances were used in these measurements. They can be applied to lower circuit resistance applications by simple calculations.

The high-flux-density curves, 14,000 gauss at 25 cps, approximate the flux density in a small, inexpensive push-pull output transformer. At 25 cps the transmission is 0.20 and the third harmonic is 59 per cent. At double the frequency the transmission is 0.80 and the third harmonic is 14.5 per cent. The higher harmonics drop even more abruptly. This very rapid improvement results from a permeability increase with frequency accentuating the increasing inductive reactance.

The low-flux-density curves, 219 gauss at 25 cps, typify input transformer operation. Doubling the 25-cps frequency moderately increases the transmission from 0.45 to 0.60 but only slightly decreases the third harmonic from 5.4 per cent to 4.5 per cent. The frequency effect is small because the increasing inductive reactance is diminished by the decreasing permeability.

The two parts of *Fig.* 6 are indicative of the most rapid and least rapid change of characteristics with frequency likely to be encountered.

Other Audio Core Materials

Beside the core materials previously discussed, others should be mentioned. The prospect for a material with a much higher saturation flux density is very poor. The best very-high-flux-density material now available is an alloy of cobalt and iron, Permendur or Hiperco,[6] which saturates at nearly 24,000 gauss. This material is very difficult to fabricate and very expensive. It has not been used extensively in transformers. A related material, Supermendur, has the same high saturation point combined with lower core losses at very high flux densities than any other material. It would be useful in high-level audio transformers except for a rectangular hysteresis loop which makes it extremely non-linear.

Ferrites are magnetic oxides which have very high volume resistivity, allowing the use of solid cores without excessive eddy losses. They are widely used at frequencies above the audio spectrum, but practically unused at audio frequencies because of low permeability and limited power-handling capacity.

Many special core materials are used for such applications as high-storage-factor inductances and magnetic amplifiers. They are generally unsuited for audio transformer use. Perminvar and Conpernik have nearly constant permeabilities at low levels, and are used in precision inductances. Deltamax, Square Permalloy, and Supermendur have rectangular hysteresis loops especially advantageous in magnetic amplifiers. Cores of compressed powdered Molybdenum Permalloy or iron are used in low loss coils at audio and higher frequencies, but have no particular merit in audio transformers, because of low permeabilities.

Supermalloy

The lowest distortion and the highest permeability at low levels is produced by Supermalloy,[10] a nickel-iron alloy with additional ingredients. It is not suitable for laminations due to the limitations on very high permeabilities imposed by air gaps, and because the material is highly sensitive to mechanical strain. It is produced in tape form and wound into gapless toroids. Coils for such transformers must be wound by hand or by toroid winding machines. This material is used when the ultimate in performance is required. It has an initial permeability of at least 45,000 and a maximum permeability of several hundred thousands. These figures are several times as high as those for good Mumetal. The saturation flux density is about 7500 gauss, similar to Mumetal, but the permeability peak is near 4500 gauss in contrast to a peak near 2000 gauss for Mumetal. Supermalloy accordingly retains its desirable properties to higher levels than Mumetal.

A large Supermalloy core yielded far the lowest distortion measured. The very high permeability would cause this, but additionally the magnetization curve is more linear than the curves for the lamination metals, further reducing the distortion. Measured under conditions equivalent to *Figs.* 1, 2 and 3 the third harmonic was .08 per cent at 22 gauss, 0.18 per cent at 27 gauss, 0.26 per cent at 1085 gauss, and 0.48 per cent at 5210 gauss. There was no low level distortion peak. Due to the high permeability and resultant high impedance the transmission was 99 per cent even at initial permeability. The cost of this transformer was several hundred dollars.

Supermalloy will not generally displace Mumetal in low level transformers. It is superb core material but it is too difficult to use and too expensive.

Useful Relationships

When the physical constants of a transformer are known, the distortion can be determined from these curves by making allowance for the relative circuit impedances.

Even with nothing but the transformer terminals available, useful distortion information can be deduced. Comparison of the distortion and permeability curves of *Figs.* 1 and 3 shows remarkable similarity in shape, not absolute value, although the materials are very different. Even *Fig.* 4 for Mumetal has similarly shaped distortion curves. The permeability curve for Mumetal measured with a small air gap is also similar in shape to *Figs.* 1 and 3. The measurements on low-grade silicon iron laminations showed the same similarity. Excepting grain oriented material, *Fig.* 2, which is not in lamination form, the distortion produced by high-level lamination materials depends on flux density and circuit impedances, and is largely independent of the type of core metal.

If the transformer impedance curve is plotted at a constant frequency and variable voltage, the point of highest impedance is the peak of the permeability curve and can be referred to *Fig.* 1 for example, to determine distortion. (If the core were grain oriented silicon, the shape of the impedance curve would immediately identify it. The peak would be broader, and closer to the saturation point, and the slope would increase at low flux densities, rather than decrease as with the lamination materials.)

Measurements of the distortion components of the energizing currents were

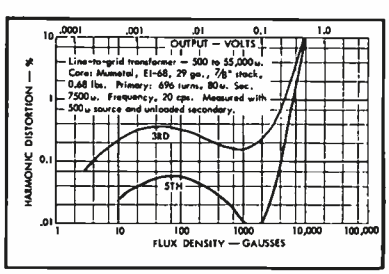

Fig. 7. Curves showing distortion vs. flux density for low-level input transformer with Mumetal core.

[6] *"Westinghouse Metals and Alloys,"* Westinghouse Electric Corp., East Pittsburgh, Pa.

[10] Bulletin TC-101A, "Properties of Deltamax, 4-79 Permalloy, and Supermalloy." Arnold Engineering Co., Marengo, Ill.

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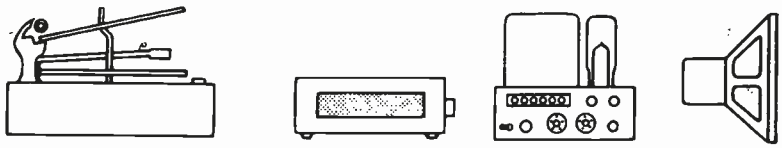

THE BELL "CARILLON" STEREO AMPLIFIER

SEVERAL YEARS AGO, long before announcement of the stereo disc heralded a new era in audio reproduction, Bell was one of the very first—perhaps *the* first—to market an integrated stereo amplifier. The Carillon is the latest succession to Bell's original model and contains a number of refinements of features and design, provides about three times as much power, is good to listen to, just as good to look at (as handsome a unit as this reviewer has seen), and, considering its power, is relatively light and compact.

The Carillon provides almost all the special stereo features and functions that can prove useful. There is a balance control, a master gain control, and a function switch with three positions: stereo, reverse stereo, and monophonic. The first two positions are self-explanatory. In the mono mode, the two channels are combined, which is desirable when playing a mono disc with a stereo pickup, for this causes the audio signals (lateral information) to add and rumble (vertical) to cancel. If it is desired to feed one source to both channels, the function switch is set to mono and the balance control is turned to one extreme or the other, depending upon whether the left or right source is to be cut off; since the balance control permits infinite attenuation, this results in shutting off one source.

To balance the left channel against the right all the way from the program source (disc, tape, or tuner) to the sound emanating from each speaker, it is highly desirable to be able to alternate rapidly between two conditions: left channel on and right channel off; left channel off and right channel on. The Carillon allows one to do exactly this, although the instructions fail to mention the fact. There is a speaker switch that connects speaker A or speaker B or both; this applies to each channel. The original purpose is to enable one to connect an additional speaker, to each channel for the den, playroom, or wherever. On the output terminal strip for each channel, there are terminals marked A and B, intended for the speaker in each room. If instead one connects the left stereo speaker to terminal A on one terminal strip, and the right stereo speaker to terminal B on the other terminal strip, switching between positions A and B will alternate the sounds of the two speakers. In the A-B position of the speaker switch, both speakers will be on. (If one employs the switch for balancing at high levels, there is the possibility of damaging the output transformers if their loads are suddenly removed. Therefore it is advisable to connect a 50-ohm 10-watt resistor across each output transformer. Power consumption by this resistor will be relatively slight.)

The only significant omission in terms of stereo functions is that of phase reversal. Fortunately, this omission is easy to correct by installing a double-pole double-throw switch at the speaker or elsewhere to reverse leads to one of the speakers, although for stereo records this function no longer seems to be necessary.

For each channel, there are seven outputs. Three are high level, and two of these—TUNER and TAPE AMPLIFIER—have input level sets. The low-level inputs are for high-impedance microphonic (magnetic), tape head, magnetic phono cartridge, and ceramic phono cartridge. Although ceramic pickups are actually high-level, amplitude devices, in the Carillon the signal from such a cartridge is fed through a small capacitance, which in effect converts the cartridge into a low-level, velocity device, so that the same preamplification and equalization may be employed as for a magnetic cartridge. The amplifier can accommodate either a ceramic or magnetic pickup, but not both, inasmuch as the input jack for each leads to the same point on the selector switch.

There are no level sets for the low-level inputs. To this reviewer's way of thinking, a level set following the preamplifier stage would be useful for equating the volume obtained from a low-level source with that from the high-level sources and for achieving balance between the two sections of a stereo phono pickup (differences between sections can be as much as 4 to 6 db) or the two sections of a stereo tape head. Inasmuch as most tape amplifiers and most tuners contain gain controls, which in a pinch can serve the same purpose as input level sets on the amplifier, it would seem preferable if one of the two pairs of level sets in the Carillon had been used for the preamplifier section instead.

The Carillon follows the trend toward separate rather than ganged tone controls, permitting one to compensate for differing tonal characteristics of unlike speaker systems, for different effects of room acoustics upon each speaker, for different tonal balance in each channel of the program material, and so on. On the other hand, the low filter for reducing rumble and the high filter for reducing noise are ganged devices, each one controlling both channels.

The Carillon is rated at 30 watts per channel. This reviewer measured about 25 watts output at mid-frequencies before clipping became apparent on an oscilloscope. The difference between 30 and 25 watts is quite minor, less than 1 db. At the frequency extremes of 20 and 20,000 cycles, each channel was able to deliver 20 watts of a well-formed sine wave before clipping occurred, and this is very good. Clipping was symmetrical, and the amplifier gave no sign of distress, such as oscillation or radical change in waveform, when driven into the clipping region—also very good.

Circuitry of the Carillon is straightforward and follows design principles of proven worth. The unit may be termed an "all-feedback" amplifier inasmuch as there is feedback in the preamplifier (between two sections of an ECC83/12AX7) for equalization, feedback in the following stages (ECC83) in connection with tone controls and the high filter, and feedback from the output transformer over the remaining stages.

The left channel provides equalization for the LP and "European" phono recording characteristics as well as for the RIAA curve. The right channel supplies only RIAA compensation. The thought is that all stereo discs are recorded RIAA, so that LP and European equalization are needed only for mono discs, i.e., only for one channel. But, as previously pointed out, the best way to play mono discs with a stereo cartridge is to parallel the outputs of both cartridge sections in order to cancel vertical rumble. However, if one sets the Carillon's selector switch to the LP or European position, equalization will instead be RIAA on the right channel, with a consequent tonal unbalance between channels. This would be alleviated if the user switched cartridges to a mono pickup (properly wired to the head) when playing mono records.

The high-level sources and the output of the preamplifier stage feed into the selector switch. Connected to the arm of the switch are: an output jack for feeding a tape recorder; the low filter circuit; and the high end of the volume control. The signal goes from the arm of the volume control to the balance control, to the function switch, and to the first grid of the ECC83 associated with the tone controls and high filter. Following this tube is the loudness control and then the power amplifier section, using an ECC83 as a voltage amplifier and split-load phase inverter. The output stage employs 6CA7's connected in Ultra Linear fashion and using cathode bias. This results in less power output than with fixed bias (some amplifiers obtain 50 watts and more with 6CA7's), but on the other hand one does not run the same risk of tube destruction if the bias supply should fail.

All heaters but those of the output tubes are d.c. operated. This is done by connecting the cathodes of all four output tubes (for the two channels) in parallel and running part of the cathode current through the heaters, which are arranged in a series-parallel configuration.

In a stereo amplifier, it is important not only that each channel provide good performance in terms of frequency response, distortion, equalization, etc., but also that the two channels be very similar to each other in performance characteristics. Following are measurements taken by this reviewer with respect to a number of functions, showing that on the whole the Carillon maintains excellent correspondence between channels, along with very creditable performance in absolute.

1. *Treble controls.* At 15,000 cps, the left channel provided a maximum of 9 db boost and a maximum of 21 db cut. For the right channel, the respective figures were 10 db and 20 db.

2. *Bass controls.* At 30 cps the left channel provided a maximum of 16 db boost and a maximum of 18 db cut; the right channel, 15 db and 19 db.

3. *Master loudness control.* Following

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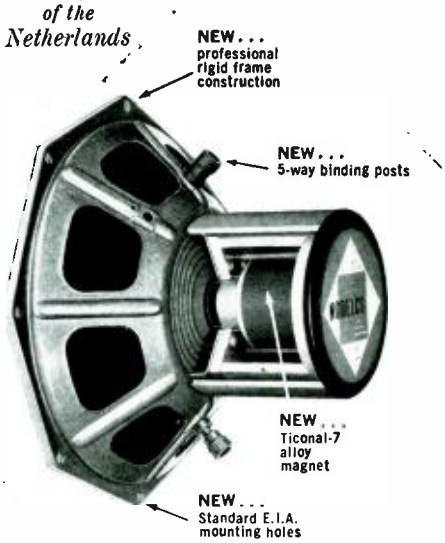

This new line of 5" to 12" loudspeakers is designed to match the quality requirements of the discriminating music lover . . . at a surprisingly moderate price. The world's greatest buys on the basis of listening quality, the T-7 series incorporates voice coil magnets of Ticonal-7 steel, the most powerful of modern magnet alloys, for maximum efficiency and damping . . . dual cones for wide frequency response . . . constant impedance resulting in an extremely straight response curve . . . longer effective air-gaps and extra high flux density to provide exceptional transient response and to eliminate ringing and overshoot.

Model	Size	Power (watts) Continuous	Peak	Impedance (ohms)	Efficiency at 400 cps	Total Flux (Maxwells)	Flux Density (gauss)	Frequency Response (cps)	Audiophile Net
AD-5277M	12"	20	30	8	14%	134,000	11,000	35-18,000	$72.50
AD-4277M	12"	20	30	8	7%	98,000	8,000	35-18,000	39.00
AD-4877M	8"	6	10	4-6	10%	58,300	13,000	50-20,000	26.00
AD-3800M	8"	6	10	4-6	6%	26,200	11,000	75-19,000	9.90
AD-3500M	5"	3	5	4-6	4%	26,200	11,000	130-19,000	8.34
AD-3690M	6x9"	6	9	4-6	5.5%	26,200	11,000	70-18,000	7.95
AD-2690M	6x9"	6	9	4-6	2.5%	15,200	8,500	70-16,000	6.75

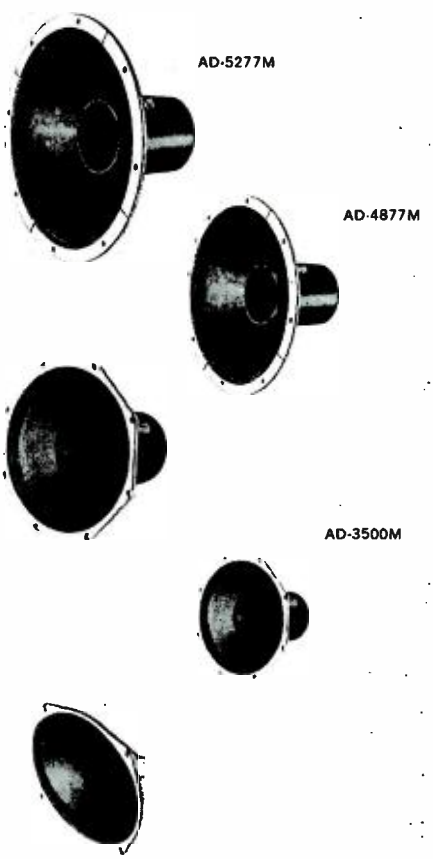

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Fig. 1. Bell "Carillon"—a new stereo amplifier.

were the amounts of bass boost at 50 cps relative to 1000 cps for various degrees of attenuation:

Attenuation At 1000 cps	BOOST AT 50 CPS Left Channel	Right Channel
10 db	6 db	6.5 db
20	12	13
30	18.5	19
37.5	24	25

Unlike most other loudness controls, which provide unlimited attenuation, the Carillon's loudness control confines attenuation to a rated 40 db (actually 37.5 db according to the reviewer's measurements). This should be sufficient for virtually all circumstances. Limited attenuation makes it possible for the control to maintain the excellent balance indicated by the above figures. The importance of such balance cannot be overempbasized.

4. *Master gain control.* Its ability to maintain balance between channels was very good on the whole, but, because it permits infinite attenuation, not quite so good as that of the master loudness control. During the first 5 db of attenuation, balance in the reviewer's unit changed by 3.5 db, witb the right channel dropping in level below the left one. But between 5 db and 55 db attenuation—which is apt to be the working range 99 per cent of the time —balance remained virtually within 2 db. Thus if one were to adjust the balance control for equality between channels with the master gain control at mid-setting, one would have inter-channel balance within 2 db at any normal setting of the gain control. It may be pointed out that even at 60 db attenuation, one would have balance within 3.5 db.

5. *Low filter.* This provided the following attenuation at selected frequencies:

	Frequency	ATTENUATION Left Channel	Right Channel
40-cps position:	100 cps	.5 db	.5 db
	40	4	3
	20	9	7.5
80-cps position:	200	.5	.7
	100	2	2
	40	7	8
	20	13	15

6. *High filter.* This provided the following attenuation at selected frequencies:

	Frequency	ATTENUATION Left Channel	Right Channel
8000-cps position:	4,000 cps	1.5 db	2 db
	8,000	10	10
	15,000	15.5	15
4000-cps position:	2,000	1	0.5
	4,000	8.5	7.5
	8,000	16.5	15
	15,000	21	19

7. *RIAA equalization.* The difference between channels was 2.5 db at 50 cps and only 0.5 db at 10,000 cps. The maximum absolute error was 3 db excess bass boost at 50 cps and 2 db insufficient treble cut at 10,000 cps.

8. *NARTB (tape) equalization.* The difference between channels was 2 db at 50 cps and only 0.5 db at 15,000 cps. The maximum absolute error was 3.5 db insufficient bass boost at 50 cps and 2 db insufficient treble cut at 15,000 cps. Since most playback heads have at least 1 or 2 db loss at 15,000 cps, the variation at the treble end is of no consequence.

9. *IM distortion.* The following readings were obtained at various amounts of equivalent sine wave power, using 60 and 5000 cps in 4:1 ratio:

Equivalent Sine Wave Output	IM DISTORTION Left Channel	Right Channel
1 watt	0.4 %	0.25%
5	0.5	0.65
10	0.65	0.8
15	0.8	0.95
20	1.05	1.2
25	1.8	1.6
30	3.6	2.55

10. *Sensitivity.* As measured on the basis of a signal fed into the tuner input and with the master gain control full on, sensitivity on the rigbt channel was about 1.5 db lower than on the left channel.

11. *Frequency Response.* With the tone controls set to mid-position and with the master gain control at maximum, frequency response of each channel was extremely flat, better than within 1 db, from 20 to 15,000 cps. With the gain control set for 6 db reduction in volume, the worst position for high-frequency response, there was a drop of 1.5 db at 10,000 cps.

Based on 25 watts output at 1000 cps, the reviewer measured a signal to noise ratio of 74 db on high-level input, which is superior to the manufacturer's claim of 71 db. The ratio measured 55 db on magnetic phono input in RIAA position, 48 db on tape head input, and 61 db on microphone input. Crosstalk between channels measured 66 db isolation at 1000 cps, 61 db at 50 cps, and 45 db at 10,000 cps.

As a final measurement, the reviewer fed square waves into the amplifier and viewed the output on an oscilloscope for signs of ringing. None at all were evident at 100 and 1000 cps, and only one slight ripple was observed on a 10,000-cps square wave.

Considering the complexity of a stereo amplifier, a well-written instruction book is of considerable importance to the purchaser's successful use of the unit. The Carillon comes with such a book, which contains four drawings showing how to connect one set of stereo speakers, how to connect two sets of stereo speakers, how to wire a complete stereo system to the Carillon, and how to use the Carillon as a monophonic 60-watt amplifier. Even though the booklet is written on a completely nontechnical level, it contains a schematic, a laudable recognition of a fact of life—that any piece of audio equipment may some day require servicing and that the serviceman to whom the equipment is brought may not have the schematic on hand. C-28

KNIGHT-KIT 83YX776 STEREO PREAMPLIFIER

By their very nature, a stereophonic preamplifier must become a rather complicated device, when one considers the number of individual tube circuits involved. About the minimum number of stages required for a monophonic preamplifier employing tone controls is six—two for the phono preamp, two triode sections for the tone-control circuitry, an additional gain stage to make up for the use of both level-set and loudness controls, and a final stage as a cathode follower. Some configurations of circuitry reduce the total number of tubes required to only two—a pentode preamp stage followed by a second pentode which is followed in turn by the tone and volume controls. Others make use of only two double triodes, with four tube circuits. The majority of control units, however, do employ six triode sections, which makes for a simple straightforward design with plenty of isolation between the various control circuits so that there is no interaction. When the circuitry is duplicated for stereo, there are then twelve stages, and anyway you look at it, this means a lot of connections.

The Knight-Kit Stereo Preamplifier—with the unlikely model number 83YX776 (actually a catalog number), employs this type of circuitry, but does it in such a manner that the work involved in putting it together is reduced to a reasonable minimum. We have seen some complicated kits which take as much as twice the construction time as this one. In addition to placing most of the audio components on printed wiring panels, Knight uses rotary switches designed to "plug in" to the ready-made panels, which reduces the work considerably. Instead of making connections to 45 of the somewhat delicate terminals of wafer switches—and with often more than one connection to each terminal—the switches are simply inserted into the ready-punched holes and the projecting pins soldered to the printed wiring. Not only does this simplify the work, but it also eliminates the possibility of making wrong connections to the switch terminals, which can be done easily when as many as 36 or 48 terminals appear on one switch.

use this check list when selecting the record changer for your stereo/mono high fidelity system

RUMBLE, WOW AND FLUTTER—These mechanical problems, especially pertinent to stereo reproduction, require maximum attention to design and engineering for suppression. Check the new GS-77.

RECORD CARE—Dropping record on moving turntable or disc during change cycle causes grinding of surfaces harmful to grooves. Check Turntable Pause feature of new GS-77.

STYLUS PRESSURE—Too little causes distortion; too much may damage grooves. Check this feature of the new GS-77: difference in stylus pressure between first and top record in stack does not exceed 0.9 gram.

ARM RESONANCE—Produces distortion and record damage. Cause: improper arm design and damping. Check new GS-77 for arm construction and observe acoustically isolated suspension.

HUM—Most often caused by ground loops developed between components. Check new GS-77 and note use of four leads to cartridge, separate shields per pair.

MUTING—To maintain absolute silence during change cycle both channels must be muted. Check new GS-77 and note automatic double muting switch, plus R/C network for squelching power switch 'clicks.'

STEREO/MONO OPERATION—Stereo cartridge output signals are fed to separate amplifier channels. Record changer should provide facility for using both channels simultaneously with mono records. Check new GS-77 Stereo/Mono switch.

These are just a few important criteria to guide you in selecting the best record changer for your stereo and monaural hi-fi system. Some of these features may be found in changers now on the market, but only one changer incorporates them all—the modern Glaser-Steers GS-77. Only $59.50 less cartridge.

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A-3.

GLASER-STEERS GS-77 THE MODERN RECORD CHANGER
superb for stereo... and better than ever for monophonic records

Circuit Description

Among its many features, the Knight-Kit Stereo Preamp accommodates five pairs of stereo inputs and four monophonic inputs —the latter being arranged for three different types of pickups and for a microphone. Bass, treble, and volume controls are clutch-type units which permit independent adjustment of each element simply by holding one knob while turning the other, though both may be turned together as though they were conventional dual controls. Sharp cutoff scratch and rumble filters are provided, and to minimize hum, all heaters are operated on direct current.

From left to right, as shown in *Fig.* 2, the controls are: selector equalizer, channel selector, bass, treble, level, and loudness/power. The slide switches are the rumble and scratch filters.

The selector equalizer switch has four stereo positions (tape head, phono, tuner, and auxiliary), and seven mono positions (microphone, and phono equalizations for RIAA, European, 250-cps crossover, ffrr, old AES, and NAB). These monophonic phono positions apply to the inputs labeled GE, PICkering, and CERamic, and designed to accommodate medium and high-level magnetic cartridges and the ceramic types.

The second control from the left is the channel selector, which has six positions—two for stereo and stereo reverse, two provide for individual channel operation with the other channel inoperative, and two provide for outputs on both channels (monophonically) from inputs to either channel A or B. This switch has 360-deg. rotation.

The third and fourth controls are bass and treble, respectively, followed by the level control. These three controls have separate knobs for each channel, and a soft rubber washer between them serves as a clutch and permits either independent or common operation. The sixth control is loudness, and is common to both channels.

The preamplifiers consist of dual triodes with losser-type equalization between stages. These are followed by the tone control pair which feed the level controls, and the arms of the level controls feed the loudness controls. A gain stage and a cathode follower, with feedback around both, come next, with their outputs fed to the channel selector, and its outputs are fed in turn to the scratch filter and to dual output jacks for each channel. The rumble filter works only on phono and tape head inputs, and consists of a two-section RC network in each channel. The power supply consists of a single-secondary transformer with selenium rectifiers, followed by a low-resistance high-capacitance filter for the heater circuit, with all six heaters and the pilot light being fed in series; plate supply is filtered by a conventional RC filter. One a.c. receptacle is provided ahead of the power switch, and another is switched. Line noise is filtered from the primary circuit by two .01-μf capacitors from line to ground. Tape recorder feed jacks connect ahead of tone and volume controls.

Level-set controls are provided for the two tuner inputs, and a calibrated dual control is used to set the phono pickup load on the stereo phono inputs, with a range from 5000 to 105,000 ohms. These three controls are accessible from the bottom of the unit, as is also the line fuse.

Construction

The Knight-Kit Preamplifier is housed in a crackle-finished metal cabinet 13¼ in. long, 8 in. deep, and 4¼ in. high, plus another ¾ in. for the brass legs. The front panel is aluminum, with a "graph-paper" design, and knobs are black with chromium-plated inserts. The back of the cabinet is perforated metal, and in an operating position no jacks or connections are visible from the rear. All connections are made on a small sloping panel in a recessed area in the bottom of the cabinet, so that for table-top use all cables could be brought up through a hole in the supporting surface and none would show anywhere. This would also apply when installing the unit in a bookcase, for example, with the leads carried through the shelf behind the books on the next shelf below.

Aside from the power supply, the input and output jacks, and the volume and tone controls, practically all of the component parts are mounted on the printed wiring panels. There are two of these, one carrying the six amplifier tubes and most of plate and cathode resistors and the coupling capacitors, while the other carries the two switches, and the equalizing-network components. The two panels are assembled separately, and interconnections between the panels and the other elements of the preamplifier are made after the panels are mounted in place. The tubes mount in a vertical position, and are accessible by turning the cabinet over. The power-supply section is housed in a separately shielded section of the chassis.

There are some 355 separate operations to the assembly of this unit, which is less than half of what would be expected from equivalent circuitry if assembled in the conventional manner. There are 106 resistors and 56 capacitors (one is a dual ceramic and two are triple-section electrolytics, which makes 61 capacitors in effect), so many connections are obviously necessary. Our construction time was just under fifteen hours.

Aside from the circuit design, which we consider to be excellently thought out and to provide a high degree of flexibility in switching, the physical layout of the unit seems to be efficient. It is just possible that it might be difficult to service in case of any part failure or in case of a mistake in construction. Fortunately, the instructions are extremely clear, and our test unit performed perfectly from the first time it was turned on.

Performance

Performance measurements made include input levels for a 1-volt output; frequency response curves for the various types of equalization (both stereo and mono inputs were checked), including tone and loudness controls; frequency response of the rumble and scratch filter; crosstalk between channels; and harmonic distortion at a 1-volt output.

While specifications claim a sensitivity of 2.5 mv for tape-head and phono inputs, we measured both at a sensitivity of 1.85 mv for a 1-volt output, and with a hum and noise output of 64 db below 1 volt. Sensitivity of the ceramic phono input was measured at 65 mv for 1 volt output, the same output was obtained from the auxiliary input from a 500-mv signal, and from a 150-mv signal at the tuner input with the level-set control at maximum. On the monophonic inputs, the "GE" jack required a 1.9-mv signal and the "Pickering" jack required a 5.7-mv signal for the standard 1-volt output; the microphone jack required a 25-mv signal for the same output.

As to frequency response, the "flat" inputs (auxiliary and tuner) were flat within 0.5 db from 10 to 100,000 cps. All equalized inputs were within ±2 db of the standard throughout, and differences between channels were less than 2 db. Level differences between channels did not exceed 3 db anywhere except at the extremely low settings where they reached 6 db in the worst condition. Tone control curves were within 3 db on both channels, and loudness control compensation was within ±4 db at the measured points—20, 30, and 40 db below maximum output. Hum and noise on the high-level inputs was 82 db below 1 volt. Crosstalk was measured at 42 db at 1000 cps, and 35 db at 10,000 cps.

The rumble filter provides a cutoff of approximately 5.5 db/octave below 100 cps, and the two curves were within 2 db. The scratch filter—which consists of a choke and capacitor circuit—gives a 10 db/octave attenuation beginning at 2500 cps, and both channels were within 4 db of each other at 6000 cps, within 6 db at 10,000 cps. Harmonic distortion was measured only on the "flat" inputs, and was 0.2 per cent at 1 volt output, reaching 1.1 per cent at a 3-volt output signal.

The tube complement includes two 12AY7 tubes for the preamplifiers, with four 12AU7's making up the remainder of the circuit.

At its relatively low price and reasonable construction time, this preamplifier offers practically any feature that could be desired. We might have preferred the addition of a phase reversal switch six months ago, but they do not seem to be so necessary now, since records all seem to be standardized. C-29

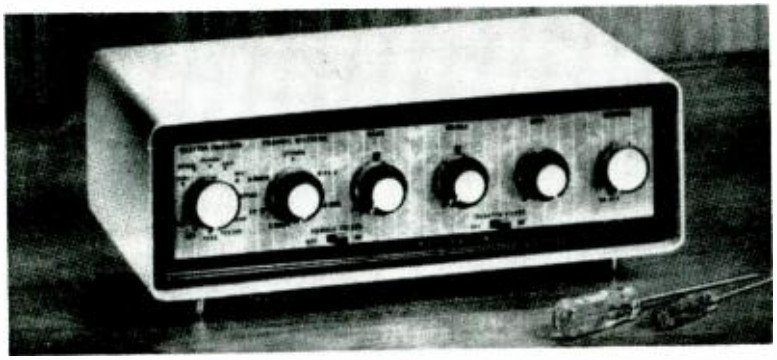

Fig. 2. Knight-Kit Stereo Preamplifier.

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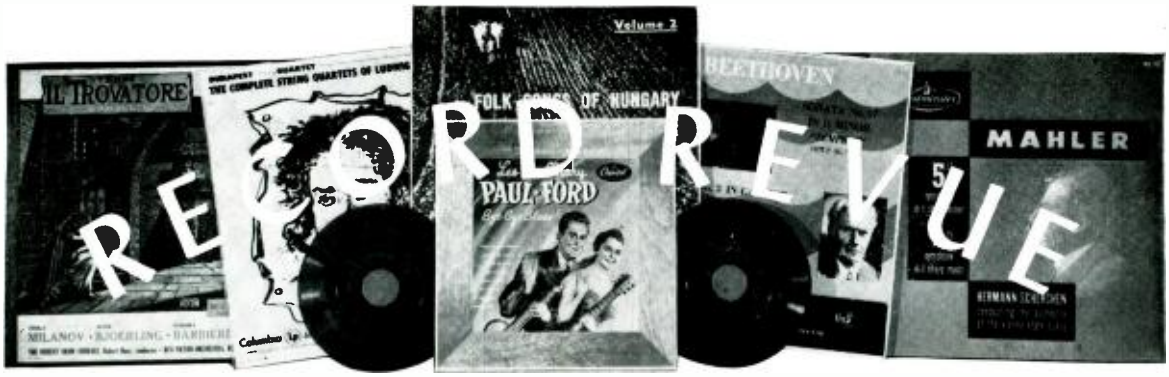

EDWARD TATNALL CANBY*

Scouts Wha ha' wi' Canby Bled

NOTE: It's been a while since I called in my helpful Scouts to assist me in wading through the piles of worthy new records that come in on the daily tide from the Post Office. Stereo sort of balled things up last fall and the pickings were thin all the way around—but suddenly, in December, the industry got its wind back and WHAM! the biggest load of new records I ever staggered under began to pile up for Xmas. It was sparked by London's shipment of more than fifty stereo discs just for that one month. Phew!

Scouts I and II aren't yet equipped for stereo. In this they are simply statistically typical of many record listeners. Scout I, it turned out, had a GE VR II cartridge in his system and, after some consultation with advisers who shall remain anonymous, I decided to risk all and let him play my stereo discs as though they were monophonic, via the GE. It seems to have worked; no damage noticeable so far. His judgments are strictly non-stereo—but after all, there still remains the content of a record to judge, stereo or no.

As a matter of fact, Scout I's success in playing and enjoying a large batch of stereo discs via a wholly mono system can be taken as a reassurance by some of our more hesitant listener-readers. It's quite possible, you see, with some cartridges.

Scout II, on the other hand, turned up a different situation. I tossed him a couple of stereo discs (expendable) and said see what happens. Horrors! He came back presently and said the sound was sort of fuzzy and he didn't like it as much as his regular records. I went over to check and ouch! he was using a mono cartridge with about as much vertical compliance as a flat tire, or maybe a wheel without a tire. The stereo disc screetched like a train on a curve and for just as good reason.

Now, we're installing a stereo cartridge in Scout II's mono system, connected in parallel, mono-style (removing the vertical response) and all will be well, monophonically at least.

I've launched a stereo conversion campaign on both Scouts but have got absolutely nowhere. Maybe later, they both say; it's too much trouble now. And is it worth it? I'll keep on trying.

E. T. C.

1. THRU LONDON WITH SCOUT I

Espana (Rimsky-Korsakoff: Capr. Espagnol; Granados: Andalusia; Chabrier: Espana; Moszkowski: Spanish Dances.) London Symphony, Argenta.

London CS 6006 stereo

Berlioz: Symphonie Fantastique. Paris Conservatory Orch., Argenta.

London CS 6025 stereo

Falla: El Sombrero de Tres Picos (Three-Cornered Hat). Turina: Sinfonia Sevillana. Orquesta Nacional de Espana, Argenta.

London CS 6050 stereo

The young Spanish conductor Ataulfo Argenta died recently and has had many a fulsome eulogy since. As I hear him on discs, his Spanish music is tremendously good, his French music often excellent, but his German and other music isn't outstanding to my ear by any means.

Scout I, ploughing through all this Argenta, is enthusiastic about his "Three Cornered Hat" recording, calling it "a fitting memorial to the blazing talents of Ataulfo Argenta," and he doesn't think such other conductors of the same music as Mitropoulos and Jean Martinon can even approximate the "inner pulse, the insinuating beat and shape" of Argenta's performance here. As for the Turina piece on the same disc, a pleasant bit of minor Spanish entertainment, Scout I says it "sounds like a million pesos," which ought to be plenty for you and me. All in all, this is likely to be a top-rank Spanish record—and be sure to look up others by Argenta in the same series.

However, Argenta's "Symphonie Fantastique," full of pep in the loud, brilliant outer movements, as Scout I has it is finicky in detail, uncertain, ill-defined, in the inner slow movement and the waltz movement. Considering the dozens of competing versions, this is not exactly a three-star recommendation.

As for the light-hearted record entitled "España," Scout I—full of metaphor—says of the Chabrier "España", one of its items, that it "is more redolent of the faubourg than the plaza." By which he means, in case you don't get it, that the playing is more French than Spanish in style. This is all right with me; for, after all, Chabrier was French. The Rimsky-Korsakoff "Capriccio Espagnol," says Scout I, thrusting his metaphor to the hilt, is "more evocative of the Neva than the (*ugh*) Guadalquivir." (The ugh is mine.) "And so," he concludes, "Argenta has delineated this light, harmless music exactly as it is. . . . which leaves me floundering somewhere near the mouth of the Volga, or maybe the Mississippi. Clear as mud, but the disc sounds like a real hot one, anyhow.

Tchaikowsky: Violin Concerto. Campoli; London Symphony, Argenta.

London CS 6011 stereo

Mendelssohn: Violin Concerto. Bruch: Violin Concerto #1. Ruggiero Ricci; London Symphony, Gamba.

London CS 6010 stereo

Phew! As is easily to be seen, London set out to compass just about the entire conventional concert repertory in its massive initial stereo releases. Scout I is a blessing to me, for I am, at this point, simply unable to take in more than a few of these well-aged war horses at a time. He thrives on 'em—and so, I suppose, will many a record buyer.

For your information (in case you are the thriving sort), the Campoli version of Tchaikowsky's concerto ranks high, but not tops, according to Scout I. He prefers (stereo aside) the versions by Erika Morini (Westminster) and Heifetz (RCA Victor) as the top two; they are more penetrating, especially in the slow movement where, he feels, Campoli is pretty perfunctory. (Nothing, but nothing, is worse than a casual, perfunctory approach to Tchaikowsky!)

If you'd like to quibble about this—then go right ahead; there are exactly twenty-six different standard LP recordings of the concerto in last December's *Schwann* catalogue, including six by Oistrakh, one by his son Igor Oistrakh and three by Heifetz! (On second glance, you'll find that these boil down to about two thirds as many, the Oistrakh recordings being actually only two—one of them apparently issued on no less than four different labels, of which perhaps one is licensed by Leeds, the official Russian import concern.)

To go back to Campoli, I remember some earlier recording of his with considerable pleasure; he has a fabulously expert Italian technique, clean as a whistle, plays rather coolly but with fire, is extremely accurate and is apt to please those of us who get annoyed at too many violinistic tricks. Argenta, the late young Spaniard, "whips up n climax" here and there in this recording but, as Scout I has it, the composer himself probably wouldn't mind this too much.

Mendelssohn-Bruch is a favorite London combination, the earlier ffrr disc of the same being already reissued on the low-priced Richmond label; this replaces it. These two performances are "in every way superior to the earlier ones," says Scout I. Ricci, I will add, is a first rate fiddler with a superb musical ear and a very true sense of pitch, a classic accuracy of technique and, if I am right, considerably more warmth than Campoli. Scout I likes the way that the youthful Pierino Gamba gets the London strings to sing out with Mendelssohn, too.

Chopin-Douglas: Les Sylphides. Delibes: La Source. Paris Conservatory Orch., Maag.

London CS 6026 stereo

This is the sort of disc about which I find I never can think of anything to say of any great importance; just some nice, old fashioned ballet music. Scout I seems to have had a similar reaction. I can't figure out *what* he meant. The music of "La Source" he says is "not as dimensionally realized as later works" (by Delibes)—whatever that may mean; but he does opine that Delibes as a ballet composer is second only to Tchaikowsky, and I'll go along with him there. Delibes writes lovely, easy, listenable French ballet music. What's more, it's my expectation that the Paris Conservatory Orchestra ought to be about as

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good a bet as any orchestra the world over for this particular music. It should be lovely in stereo, too, and especially lovely in fine stereo, with its emphasis on sharp, clean string sound.

The familiar "Les Sylphides" music of Chopin has been fixed up for orchestra (from piano originals) by various musicians, including Stravinsky. This is a British version which, Scout I continues cryptically, "smells of horse hair and patchouli." He's not sure whether Mr. Douglas, the British arranger, or the conductor, Peter Maag, is responsible; but what *I* want to know is, what is patchouli?

Brahms: Symphonies #1, #2, #3, (separately). Vienna Philharmonic, Kubelik.

London CS 6016, 6004, 6022, stereo

Dvorak: Symphony #5 ("New World"). Vienna Philharmonic, Kubelik.

London CS 6020, stereo

One of the most interesting geographical contrasts, musically speaking, is that which we keep hearing over and over again on discs, between the North German music makers and those of South Germany and Austria—notably Vienna. Maybe they don't even notice it themselves, but as we hear it, the North Germans do a lean, lithe, tempered job on music such as Schubert, Brahms, Mozart, whereas the Viennese school of performance (symphonic, choral, operatic, chamber music or what have you) tends towards a solemn, measured, slow presentation, somewhat heavy-handed (to our ears, that is) and yet very musical.

I tossed these four Vienna Philharmonic discs to Scout I with this in mind, to see what would happen to the Vienna Philharmonic under the Czech-ancestry conductor who was briefly at Chicago a few years back. 'Twas just as I expected.

Of the Brahms Third, Scout I says "unhurried, untense . . . phrase carefully moulded on phrase . . . this is grave Brahms, occasionally bordering on the portentous." But he likes the playing all the same, reacting rightly to the highly musical feeling of good Viennese playing. The Second of Brahms which, he says, can have a certain sunny innocence and exuberance to it (I agree), here follows "a grave, dark-hued path." The First Symphony, too, is played with a "very deliberate approach, not much in key with current tastes but . . . legitimate."

And there you have the key to these London Brahms discs, for Scout I also praises the beautiful sound of the orchestra and the fine recording. If you like the measured, serious, weighty, yet musical Viennese approach, you'll find that Kubelik goes along with it and with the Viennese orchestra here.

The Dvorak "New World," with the same forces, has "the most deeply felt, beautifully projected second movement these ears know" —Scout I's ears—and he suggests merely that in other parts of the symphony Kubelik lets his orchestra get a bit out of control in an enthusiastic way.

No doubt about it, Kubelik does well in the Central European tradition. Maybe that's what was the matter when he was at Chicago. There, they like things snappy. They have Reiner now, who plays all of this music, and most else too, with the steel whip approach that seems so popular in these United States. Take your chree.

Brahms: Variations on a Theme of Haydn; Academic Festival Overture; Tragic Overture. Vienna Philharmonic, Knappertsbusch.

London CS 6030 stereo

Beethoven: Piano Concerto #5 ("Emperor"). Clifford Curzon; Vienna Philharmonic, Knappertsbusch.

London CS 6019 stereo

And here's another case of Viennese performing, with a conductor who, Scout I says, is addicted to even slower tempi than anybody, anywhere.

Take a slow-speed-minded conductor and a slow-speed orchestra and what do you get? In Brahms, at least, you have yourself a great, solemn, dark-brown effect, like an old fashioned Victorian mansion with stained glass windows and polished wood—that's my own idea. Scout I doesn't see how this conductor with the crackly name, Knappertsbusch, can get away with it; he thinks that Fürtwängler used to be able to do it this way because of his method of "building from the inside"—quite right—but he finds that the Knappertsbusch readings are "endless and dreary beyond salvage, not recommendable."

Well, I'd go a bit slow on that, myself. As explained above, there is a Viennese and South German tradition that takes much of this sort of music at what seems at first to us to be very slow speeds. Not all of the playing is dull, by any means. Even Knappertsbusch. Just don't expect any Toscanini lightning here, and if you can take the leisurely effects, you'll find this disc pleasing, though not as good a bet as the Kubelik Brahms above.

Beethoven's greater energy, plus a good pianist, seems to have made a better thing of the other Knappertsbusch disc, the Beethoven "Emperor" Concerto with Clifford Curzon. Scout I likes this one, finds it a "gravely songful reading of many felicities" though it probably won't please everybody. I suggest it probably won't please those, again, who like high-tension, powerhouse Beethoven in the Toscanini-Horowitz manner. Something for everyone, though, and this record, in addition to a clear and well-styled approach, has pianistic glitter and masculinity, excellent teamwork between conductor and pianist, and good sound balance in the recording. So says Scout I.

Never forget that Beethoven, though from Bonn, spent most of his life in Vienna, where this music comes from.

Rimsky-Korsakoff: Scheherezade. Paris Conservatory Orch., Ansermet.

London CS 6018 stereo

Stravinsky: The Firebird. L'Orch. de la Suisse Romande, Ansermet.

London CS 6017 stereo

The bearded Ansermet is now re-doing just about everything he ever did, in the new stereo format—thereby keeping London's catalogue lists jumping madly. Here are two in interesting contrast. With the Paris orchestra, Ansermet evidently shows his strongest French side—his own habitat is French Switzerland—and as an outstanding elder statesman of conducting makes the French players turn out their characteristic best. Scout I thinks this is a terrific "Scheherezade": "The sound is stunningly articulate, the orchestral attack is highly disciplined, its tone so smooth it would seem to be homogenized . . ." Well, if you can take that metaphor in your stride, you'll likely find you agree with his ears—and London's stereo should do wonders for "Scheherezade" and all its orchestral glitter.

As for the Firebird (sometimes called the Fire Bird in this slightly inconsistently spelled recording) there's a different story, one that makes sense to me. Scout I feels that Ansermet's "bird" is a lyric one, all polished and pastel colors, suavely played; he doesn't think this goes down too well as far as Stravinsky is concerned—would rather hear Bernstein or Mitropoulos sail into it, for more pep.

I think I know what Scout I means, but I'm not so sure about Bernstein—who does a rather old-fashioned sounding job on Firebird. (It *is* an old fashioned piece to him, after all.) Ansermet takes all this early Stravinsky in a style that may have been radical in its day—he did the first performances of a number of these works—but which for our ears tends to sound too soft, too lush, too Romantic.

Well, maybe not for *your* ears, whoever you may be. I suspect that most listeners who want to acquire another "Fire Bird" will find this one just what the doctor ordered. If, however, you prefer a more modern-sounding approach, steer away.

Rossini-Respighi: La Boutique Fantasque. Dukas: L'Apprenti Sorcier. Israel Philharmonic, Solti.

London CS 6005 stereo

Scout I took over large numbers of the fifty-odd stereo discs London threw out last

December (and plenty more since) with never a bat of his eye. Played straight through 'em. So I'll continue with some of the proceeds of his playing.

This well known piece of re-written Rossini, decked out in fancy Respighi orchestration, gets, according to Scout I, a "strongly rhythmed, arresting performance with a personality of its own." The Israel orchestra is best in its strings, he thinks, and these are played up in the recording, for a slightly unbalanced effect that, however, works out fine in the listening. (I suspect, myself, that this has to do with the traditional "ffrr" string recording, always brilliant, here in its new "ffss" stereo form and sounding much the same as always.) The familiar "Sorcerer" is a "bang-up job" in Scout I's book, highly colored too, with proper drive and force.

The "Boutique" is played complete, on a side and a half; the leftover half, a bit less, is enough for the Dukas.

Tchaikowsky: Symphony #6 ("Pathétique"). Vienna Philharmonic, Martinon.
London CS 6052 stereo

This is one of those odd projects that London occasionally sets going—a purebred Viennese orchestra, *the* Viennese orchestra, led by a thoroughly French conductor, in a Russian symphony! With all this, what would you expect? The results are "startling, if nothing more"—which is not exactly top praise from Scout I. The old warhorse gets pulled and pushed about "like taffy candy" but, he thinks, this happens most of the time anyhow to the "Pathétique" these days. (I agree, again). The sound is lustrous here, the playing full of ardor. Not too bad, I'd say.

Tchaikowsky: 1812 Overture; Marche Slav; Capriccio Italien. London Symphony, Alwyn; Band of the Grenadier Guards.
London CS 6038 stereo

As Scout I says, these "purple old essays" are an inevitability for the well-adjusted stereo set. As almost anybody knows, too, the "1812" depends mainly on cannon power for its stereo (not to mention mono) effect. The louder the real, live cannon, the better the 1812.

Well, I haven't been in a cannon-fodder mood lately so I haven't tried either this one or the Mercury 1812, Mark II, the new one in stereo. But maybe Scout I will put you on the right track when he says that (a) the results here, in London's version—including cannon, bells, brass—are "staggering;" and (b) that London's cannon sounds "much more modern than Mercury's period piece."

Now Mercury went to a lot of trouble to round up its authentic Napoleonic cannons, right out of the 1812 era. If London has gone and used, maybe, a World War I monster, perhaps Big Bertha herself, it's downright unfair. Unless, of course, you want an even BIGGER noise than 1812. If so, you'd better get this one. Throw in a couple of new fifteen-inch woofers and a pair of corner horns, while you're at it.

2. SCOUT II IN HIGH CLASSICS

Brahms: Piano Concerto #1. Leon Fleisher; Cleveland Orch., Szell.
Columbia BC 1003 stereo

I sent this on to my high-classic repertory man, Scout II, after I had played it myself. Just out of curiosity. I had found it unexpectedly (the performers not being superfamous) to be perhaps the finest Brahms recording of the last ten years. Terrific. I listened in stereo, of course, and was mightily pleased, too, at the very professional competence of Columbia's concerto sound, with a big but not too big piano, balanced for conveying an optimum musical intelligence in the listening.

Well, Scout II begins his report "SUPERB!" So you see, sometimes people do agree on musical performance. "The very first note tells you the story," he says, "a real roaring-bear Brahms, growling and gnashing his teeth. Exquisite in the slow movement!" More adjectives, then. "The pianist is real terrif! So is Szell. Do you have an extra copy of this anywhere?"

Enough said. Just keep watching this young Leon Fleisher, though, and keep an eye on George Szell when he conducts the North German type of music, and even the Viennese. He combines a real feeling for those areas (he comes from thereabouts) with an overlay of American efficiency that makes his Brahms-type language easier for us to follow than, say, that of Knappertsbusch, as reviewed above.

Sibelius: Symphony #2. Phila. Orch., Ormandy.
Columbia MS 6024 stereo

This, too, I had played myself, but sent it on for curiosity and double-check. Scout II, in his particular area of musical knowledge, seems to be an automatic reflection of my own feelings—which is just fine. This is the most Tchaikowsky-like of all the Sibelius symphonies, full of expertly effective, big-style Romanticism plus lots of the famed "Northern" sound of the Finnish composer. I thought Ormandy did a marvellous job at revivifying a sort of music that is getting pretty dated now and can easily be hashed into sheer bombast by a less expert conductor.

Says Scout II: "A fulsome, beautifully phrased performance. Even this war horse takes on life when given a chance . . . Big and grand in the sound, yet nicely controlled—it pulsated intelligently." Which is to say, it is full of expression, but expertly done. "Most of all, it gives you a chance to hear the inside workings of the piece, and Sibelius gains by this." He sure does—and, as Scout II did not know, the stereo effect makes it gain even more in the very same way. A superb "inside look."

Oh yes—Scout II mentions, in passing, that "you can almost see the ice floes and churning. Finlandian sea." A slight geographical confusion there—he's thinking of Greenland, which belongs to Denmark, not Finland. But all's fair in love and musical geography.

Beethoven: Violin Concerto. Fritz Kreisler; London Philharmonic, Barbirolli. (Recorded in 1936).
Angel COLH 11.

For more years than I can remember, this was THE recording of Beethoven's only violin concerto. There just weren't any others worth fussing too long about.

In those days, the usual thought was that if a piece had been recorded, and well recorded, why bother with a duplication. Too many 78-rpm records were involved in such undertakings to make them feasible, anyhow. So the repertory on 78 grew up with but one or two versions of each famous piece, and these lasted as long as, say, the old front-wheel-drive Citroën model, same period, replaced only after a quarter-century or so of continuous production. So it was with this ultra-famous recording.

Scout II, being somewhat younger than myself, was a good bet to try this out on—he didn't know it from its early days. Again—predictable reaction. "*Beautiful,*" he writes. "Sensitive, thoughtful, big and open-sounding; delicate violin playing." And he notes the fine sense of continuous flowing melody, which is the toughest thing to get over in the long stretches of this concerto.

Only further note I need add is that the recording will be smooth, lacking in highs but entirely pleasant in sound (with plenty of bass); the acoustics, like most of the period, will seem rather dead to your ears.

Berlioz: Symphonie Fantastique. A. Orch. Nat. de la Radiodiffusion Francaise, Cluytens.
Angel 35448

B. Orch. Nat. de la Radiodiffusion Francaise, Beecham.
Capitol-EMI G 7102

Seeing double? Nope—these two are by the same orchestra, from the same European company, EMI (it includes both Capitol and

(*Continued on page 66*)

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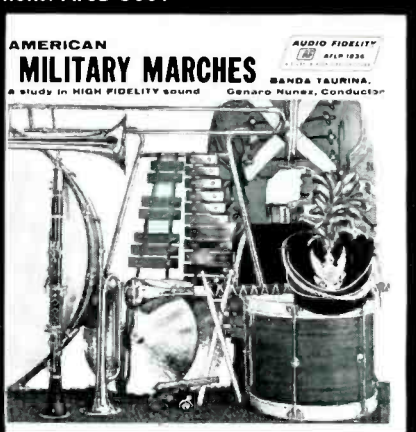

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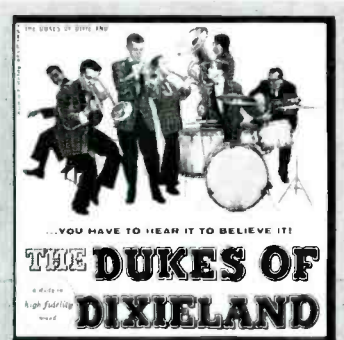

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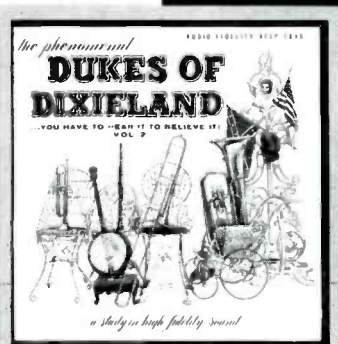

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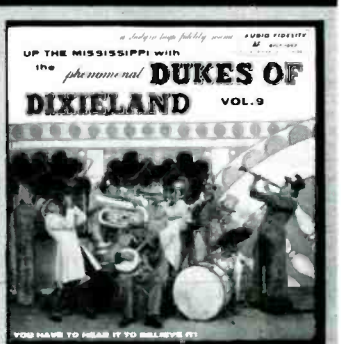

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STEREOPHONIC

The Drinkard Singers: A Joyful Noise
RCA Victor LSP1856

Back Home Choir: I Do Believe
RCA Victor LSP1857

Something in the air of northern New Jersey must be quite salubrious for gospel songsters and they flourish there in evergrowing chorus. Its environs served as a center in the development of the vital and driving gospel singing of the present day. Both of these units rose to prominence in Newark and were singled out to appear at the Newport Jazz Festival, where they demonstrated the close bond between the two idioms. The seven members of the Drinkard Singers are all brothers and sisters, except for Judy Guions, an exciting soloist who is the youngest of group. Under the leadership of Lee Warrick, the eldest sister, they sing their own arrangements of spirituals, some of which go as far back in tradition as *Just a Little While to Stay Here, Wade in the Water,* and *Ring Those Golden Bells.* Tricky and infectious rhythms shine throughout much of their work, and the deep reverence of their approach is characterized by *Sweet Hour of Prayer,* and *Use Me, Lord.*

The massed voices of the Back Home Choir, an ensemble of sixty selected mainly from among the members of the Abyssinian Baptist Church, incorporate the same righteous qualities. The greater size may make it slightly less fluid, although this is not apparent certainly on *Roll Jordan Roll,* and the vibrant *Waiting For Me.* The increased power is well-controlled, however, and has its own compensations. Also, the group boasts a number of full-throated soloists, headed by Carrie Smith and Robert Ross, whose wife, Janie, is listed among a cast which includes the Reverend Richard Baker, Terry Patrick, William Thomas and Bessie Lewis. They contribute greatly to the colorful interpretations of *Walk in the Sunlight, I Cried Holy,* and *Coming Home.*

Recorded in Webster Hall, the stereo sound has a spaciousness that is both live and natural. It allows for less congestion than in the monophonic versions and the soloists are nicely centered, with the organ well balanced and spread out in the background. The interplay between the choral sections is cleanly defined and the climaxes are free from distortion. A rewarding effort, in sum, on the part of all concerned.

Ahmad Jamal, Vol. IV
Argo LP636S

When Ahmad Jamal developed the formula for his trio, he took into consideration the setting of an intimate supper club and its sophisticated patrons. His style is subtle and departs from the customary practice of keeping the pianist and leader always in the limelight. He realizes the value of silence and knows when to transfer the melodic line to Israel Croby's bass, or call on Vernell Fournier to tattoo a graceful figure on the drums. Each member is an engrossing soloist and in combination they operate with a skill that can mesmerize an audience. All these qualities are more adaptable to stereo than the format of most trios, as is stunningly brought out by this first appearance in the medium.

The location is Washington's Spotlite Club, and engineer Malcolm Chisholm came in from Chicago for the date. Instead of centering on the piano, as might appear logical and would be the procedure in most cases, he focuses on the bass, placing the piano on the left and the drums on the right. Whenever one of these last instruments is heard in a solo, it fills out the center and the bass is directly behind. In this manner the melodic line and a firm, pulsing beat are always predominant, with the miscellaneous embroidery clearly defined on either side. This particular setup might not work on all trios, but Jamal's commercial appeal is bound to result in more pianists adopting his format.

His last recording, made at Chicago's Pershing Lounge, was a bestseller and this one seems likely to repeat that success. There is a colorful reading of Lecuona's exotic *Taboo,* and a romping *Stompin' At The Savoy.* His ballad style is revealed on *Autumn In New York, Secret Love,* and *Should I.* Jamal knows how to please the customers, but an after-hours session might reveal another aspect of his talent.

Four French Horns
Elektra 234X

Mat Mathews idea of joining his accordion to four French horns and a rhythm section has distinct possibilities for stereo. Most of them are realized in the recording, previously reviewed in this column in the monophonic version, particularly in the mellifluous blend of the ensembles. Separation tends to make some of the solos sound less full, depending upon the placement of speakers and the flexibility of your controls. The natural tendency of the horns is toward a distant, haunting effect and stereo works to accentuate it. Julius Watkins and Dave Amram are the featured players, helped out by Fred Klein and Tony Miranda.

Pee Wee Erwin: Oh Play That Thing!
United Artists UAS5010

Jelly Roll Morton: King Of New Orleans Jazz
RCA Victor LPM1649

These days the house bands slip in and out of Nick's, a Greenwich Village institution from the time of speakeasies, without benefit of publicity in the jazz press. One of the best is headed by Pee Wee Erwin, who held a trumpet chair in the original Benny Goodman band of 1934 and later joined Tommy Dorsey. High among his current interests is the work of Jelly Roll Morton and his search for copies of the scores led him to the warehouse where the Melrose publications now repose. Among those unearthed are *Kansas City Stomp, Georgia Swing, Granpa's Spells,* and *Black Bottom Stomp.* They are affectionately recreated here, along with an arrangement of Morton's reading of *The Chant.* Ken Davern, an admirer of Omer Simeon and George Lewis, aids greatly on clarinet in establishing an authentic style, and solos engagingly on *Big Pond Rag.* Lou McGarrity, on trombone, fills out the front line.

The fine temper of the recording is spoiled, unfortunately, by a liner writer who finds it necessary to refer to the place and its music as Nicksieland. His cute remarks about what was played there in the 30's, when Muggsy Spanier and Sidney Bechet were on the stand, must be considered in the light of a youthfulness which would have denied him admittance. And he perpetuates the myth that Eddie Condon engaged actively in the proceedings. Anyone who was there knows the nominal leader was busy furthering the cause of jazz among customers in Julius' Bar, thereby encouraging them to go back across the street.

Stereo distributes the horns and engineer Bill Schwartau achieves an excellent balance for the five-man rhythm section, which includes a banjo and tuba. The original Morton versions will never be available in stereo, but they are now restored to the catalogues in monophonic form. All the tunes selected by Erwin are listed and there are eleven others, some with alternate masters. When reissued several years ago on the "X" label, the sound failed to match the early 78's. In this remastering, Victor improves on the originals and you might try it on your stereo rig.

Larry Fotine: Take Five
Bel Canto SR1009

Calling his crew the Beale St. Buskers, Larry Fotine makes no pretensions to playing anything more than pure dixieland hokum. In answer to any critic's remark that it might be suitable for silent movies, he definitely proves the point on *Rink Tink Piano Man,* and *Old Time Movies.* The balance of the recording and the placement of the instruments in stereo are as good as you will find anywhere. It is ideal for purposes of demonstrating your equipment at a gathering where other types of music might seem out of place. It recalls the days when Clara Bow and Gilda Gray were the life of the party, dancing to the rhythms of *Goodbye Blues, Mama's Gone Goodbye,* and *Yes, We Have No Bananas.*

MONOPHONIC

Knocky Parker: Old Blues
Audiophile AP60

For a sequel to his ragtime volume of last year, Knocky Parker is back at the keyboard of the Boesendorfer at Carroll College for a program of fully matured blues. The depth of his research into the subject is shown by his tributes to several early pianists. Cow Cow Davenport is represented by *Chimes Blues,* and Little Brother Montgomery by *Vicksburg Blues.* Complete with the descriptive vocal is Wesley Wallace's *No. 29,* and a whole school of playing is recalled on *Boogie Woogie Blues,* and *Make Me a Pallet on the Floor.* All of these were specialties of the originators, used to display their individual styles. Rather than copy recorded versions with exactitude, Parker transforms them to conform with his own ideas and complements, in each case, a work which belongs in every jazz piano collection.

How many tunes now known mainly in instrumental form were first thought out by an unknown pianist is a matter for conjecture. Parker pursues this line of inquiry back to what he believes might have been the primarily pianistic impulse behind *Sister Kate, West End Blues,* and *Willie the Weeper.* His explorations are consistently interesting and the traditional standbys are seen in a new light. Their sentiments are beautifully revealed and the piano sound is superb.

Tambourines To Glory
Folkways FG 3538

Langston Hughes wrote these songs to help tell the story of a gospel church in "Tambourines to Glory," the novel and play which are companion pieces to this recording. The choir of Harlem's Second Canaan Baptist Church under Hugh E. Porter, director and a powerful pianist, is augmented by the composer Jobe Huntley, who alternates as featured soloist with Ernest Cook. Instrumentalists include organist Hampton Carlton, guitarist Yvonne Cumberbatch, gospel saxophonist Carl McWilliams, and teenage tambourinist Benjamin Snowden. They make a joyful sound and give substance to the novel-

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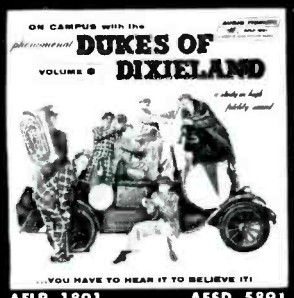

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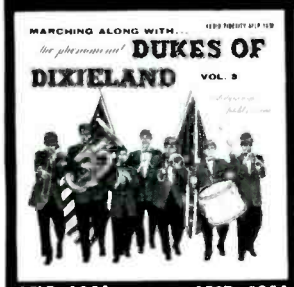

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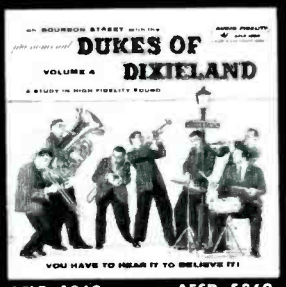

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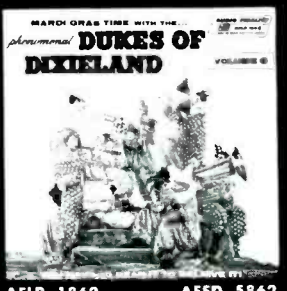

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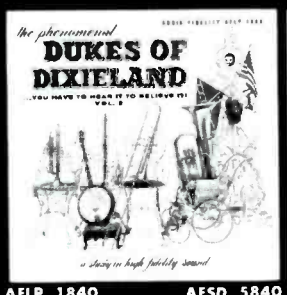
YOU HAVE TO HEAR IT TO BELIEVE IT!



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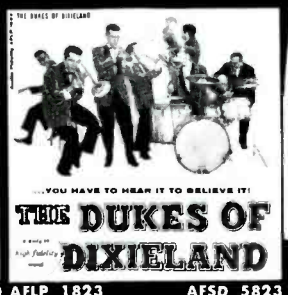

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list's expressed opinion that the gospel church is the last refuge of uninhibited Negro folk singing. Improvisation also plays its part and even composed pieces allow for individual statements or elaborations which must give the participants a sense of satisfaction similar to that experienced by creative jazz instrumentalists.

For this reason, the performers show no constraint in the presence of both writer and composer at the recording session, held at the church and admirably engineered by Dave Hancock. The words and tunes are serviceable, and the arrangements are built along lines familiar to the singers. They are completely at ease in the solemn *Home to God*, or the furious rhythms of the title song. Hughes is much more successful here than in his recent effort to combine poetry and jazz, due to the naturalness of the Porter ensemble. In his next such experiment, he should be impelled to entrust it with some of his verse.

Andy Griffith: Shouts the Blues and Old Timey Songs — **Capitol T1105**

Back Country Blues — **Savoy MG14019**

It often happens that a blues singer will operate under wraps in a concert hall or recording studio, especially just after someone has informed him of the ethnical value of his work. Andy Griffith claims the person who introduced him to the blues regretted it, classing him later as "the worst blues singer he ever heard." If anyone has commented since on his cultural importance, it served to inhibit him no more than the first remark. He treats the blues like an old pair of shoes and they are just as comfortable on him. Among the dozen songs are several recollected from his birthplace in the mountains of North Carolina, including *Little Maggie*, *Molly Darlin'*, and *The Crawdad Song*.

Besides helping out on guitar, Brownie McGhee sings along on *Pick a Bale of Cotton*, and an unidentified harmonica player sounds remarkably like Sonny Terry. Both of these performers have been impressed with their worth as folk artists. When they made the dozen blues assembled by Savoy, they were more concerned about filling juke-boxes and making a little money. The result is one of their most rewarding and unrestrained albums. By the time a small band joins in on four numbers, you will know what the blues are all about.

Benny Golson's New York Scene — **Contemporary C3552**

With this album, Contemporary extends its operations to the East Coast, having commissioned jazz critic and philosopher Nat Hentoff to supervise a series representative of jazz happenings in that part of the country. To ensure engineering comparable to the high quality established at the company's California studios, Dave Hancock was engaged to handle the sessions and tapes were sent west for mastering. When it was recorded in October, 1957, Benny Golson had yet to appear as leader on an LP. Since then the dam has burst and several estimable productions are gaining him wider recognition. This one presents one of the broadest views of his many talents, casting him as composer, arranger, soloist on tenor sax with rhythm section, and as leader of a quintet and nine-piece band.

The Golson compositions are *Whisper Not*, *Step Lightly*, *Blues It*, and *Just By Myself*, the first three played in his own arrangements. *You're Mine You* is chosen to display his warm, sensitive ballad style. Trumpeter Art Farmer is the other horn in the quintet, with Gigi Gryce, Sahib Shihab, Jimmy Cleveland and Julius Watkins added on the three band numbers. Gryce contributes *Capri*, and arranges Ray Bryant's *Something In B Flat*. The recording places Charlie Persip's brilliant drumming in excellent perspective.

Johnny Richards: Experiments In Sound — **Capitol T981**

For the album which introduced his new orchestra, Johnny Richards used the title "Wide Range," choosing it as a term descriptive of the massive effects and rich tonal palette employed in his arrangements. In another sense it would be equally suitable for his current effort, a pleasant concoction of Afro-Cuban rhythms, ballads, show tunes, and an extract from an orchestral suite. More space is devoted to melodies that are romantic and plainly danceable. They account for some of the most successful moments, possibly because both the leader and his sidemen seem more relaxed than when playing Richards undiluted. He should be prevailed upon to compile an entire set along the lines of his styling of *What Is There To Say*, *No Moon At All*, *This Time*, and *How Are Things In Glocca Morra*.

Despite his affection for complex forms, Richards never stints the soloists and his writing provides ample room for the likes of Billy Byers, Burt Collins, Jim Dahl, Gene Quill and Frank Socolow to show their wares. Recorded at Riverside Plaza, the seventeen pieces sound with a deep resonance that is a delight to hear.

Art Blakey and the Jazz Messengers — **Blue Note 4003**

Max Roach: Deeds, Not Words — **Riverside RLP12-280**

A rejuvenated Jazz Messengers, under the musical direction of Benny Golson and with Lee Morgan taking over on trumpet, produce their best record since Horace Silver left the group and set out on his own. By way of celebration, Art Blakey has a new showpiece, *Drum Thunder Suite*, born of his desire to play a set making exclusive use of mallets. Written by Golson in three parts, it combines several revealing facets of drumming in a more attractive setting than is usually provided for such forays. Another aspect of this talent emerges in *Blues March*, where a New Orleans street beat underlines the bugle-call theme.

Additional contributions from Golson are a bouncey *Along Came Betty*, and *Are You Real?* Also a fine tenor sax solo on *Came Rain or Come Shine*, and his steadying influence on Morgan whose choruses, in consequence, are less flashy and more simple and melodic. The change in personnel involves a clean sweep

and Blakey has the support of Bobby Timmons, a pianist who demonstrates his strength on an original blues, and bassist Jymie Merritt. That the Messengers are back in form is a major jazz event and this recording is its landmark.

Since the departure of Sonny Rollins and Kenny Dorham, Max Roach has engaged in a similar talent hunt. His new planoless quintet is composed of younger musicians, and he seems intent on seasoning them until they fit his requirements of a new sound and approach to jazz. Ray Draper, on tuba, and bassist Art Davis move freely from rhythmic to melodic lines. Booker Little, trumpet, and George Coleman, tenor sax, show a continuing development. To satisfy the Roach fans, there is a substantial unaccompanied drum solo.

Glen Gray: Sounds Of The Great Bands, Vol. 2 — Capitol T1067

The second installment in Glen Gray's review of the foremost recordings by famous bands of the fairly recent past is better than the first. The Hollywood studio stalwarts which constitute the Casa Loma orchestra for these recreations enter into the spirit of the assignment with greater zest and even improve on some of the originals. Several exceptional performances are added to the convenience of having them tied in one neat package with immensely improved sound. Cappy Lewis, a Woody Herman alumnus, again plays his trumpet solo on *Blues on Parade*. Plas Johnson takes over the Dick Wilson tenor solo on *Moten Swing*. Bunny Berigan's trumpet part on *The Prisoner's Song* goes to Shorty Sherock, and Pete Candoli spells Manny Klein at being Erskine Hawkins on *Tippin' In*.

Raymond Scott, a sound fancier before hi-fi was knee-high, should be thrilled by the treatment of *Huckleberry Duck*, with clarinetist Gus Bivona in the lead. Other bands revisited in this chapter are those of Larry Clinton, Count Basie, Tommy Dorsey, Glen Miller, Jan Savitt, Charlie Spivak, and Bob Crosby.

The Music From Peter Gunn — RCA Victor LPM1956

By television standards an adult mystery-adventure series, "Peter Gunn" has probably introduced as many youngsters to the sounds of jazz as any of the lavishly produced jazz shows. The identifying themes and background music are the work of Henry Mancini, who at the age of thirty-four has credits on such films as "The Benny Goodman Story," and "The Glenn Miller Story." He conducts the same jazzmen employed on the sound track in an excellent sampling of the smartly-tailored writing which characterizes all the programs. They consist of some of Hollywood's outstanding modernists, although this term is relative as several made their reputations before the coaxial cable stretched coast-to-coast.

The attractive openiug motif is stated by drummer Jack Sperling and the walking bass of Rolly Bundock. Ted Nash's alto sax is a feature of *Dreamsville*, and Ronnie Lang lends apt phrases on baritone sax to *Sorta Blue*. Other participants are Pete Candoli, Milt Bernhart, Dick Nash, Johuny Williams and Larry Bunker. The sound is sleek and chrome fitted.

Jack Marshall: 18th Century Jazz — Capitol T1108

The rococco packaging of this album may fool you for a moment, but only until bassist Red Mitchell and drummer Shelly Manne are detected lurking in the background. Then you might suspect the presence of a swinging beat, no matter what period the instrumentation. Auditioning any track will prove that point and give a clue as to the chamber group Jack Marshall imagines he heard two centuries ago. Apart from certain personal embellishments, his arrangements conform in style to those introduced by Chico Hamilton units, and are just as modern. The similarity extends to the personnel, with Milt Raskin added on harpsichord to form a sextet.

Marshall plays unamplified guitar and flute. Flutist Harry Klee doubles on bass flute and recorder. The cellist is Edgar Lustgarden and the tunes are a dozen of today's standards. No *Eighteenth Century Drawing Room*, and who will miss it. The present Hamilton outfit had better look to its laurels. This group can match it now and if organized on a permanent basis would soon put it in the shade.

The Kingston Trio: From the "hungry i" — Capitol T1107
The Folk Singers: Run Come Hear — Elektra 157

Since turning professional in May, 1957, for an engagement on the campus of Stanford University, The Kingston Trio achieved fame on the folk music circuit before hursting out with a success of hit parade proportions in their first album. In a performance recorded live at San Francisco's fabled "hungry i," they detail the reasons for their popularity, from the breezy, informal introductions to the group participation of *When The Saints Go Marching In*. All are accomplished guitarists, and Dave Guard, leader and arranger, doubles with Boh Shane on guitar, while Nick Reynolds switches to bongos and conga drums to heighten the pulse of *Zombie Jamboree*, and *Wimoweh*, a Zulu hunting chant. They range from *Gué, Gué*, a French lullaby, to the Appalachians for *Shady Grove*, and *Lonesome Traveler*. Less familiar is *The Merry Minuet*, a cogent comment on the Space Age not likely to be broadcast by many radio stations. To enjoy its wry humor, you must go to the source.

An equally versatile group is the Folk Singers, each of whose male members is heard taking the lead on one or more of the sixteen numbers. Erik Darling, along with his country style banjo, is in charge of *Poor Howard*, *Run Came See*, and *Pay Me my Money Down*. Dylan Todd sings *Hullabaloo*, *Little Maggie*, and adds new verses to *Deep Blue Sea*. Don Vogel comes to the fore on *Peat Bog Soldiers*, a dramatic reminder of the concentration camp at Dachau. Carol Wilcox completes the

quartet and adds her voice to such joint efforts as *By'm By, Keep Your Hand on That Plow*, and *Michael, Row the Boat Ashore*. Both groups ably fulfil the basic requirements of folk music—that of communicating with an audience.

South Seas Adventure
Audio Fidelity AFLP1899
Na Mele O Hawaii
Capitol T1092

The current Cinerama opus is a resplendent travelogue of a voyage across the South Pacific to Australia, complete with stopovers at various enticing islands. The sound track is a montage of Alex North's richly descriptive score and the realism of native spectacles recorded on location. Both are transferred to the recording, and the traditional strains of *Aloha Oe* echo across the water as the ship reaches Hawaii. Polynesian maidens engage in a dancing contest in Tahiti, while the young men test their skill at coconut spearing. At Tonga, four hundred school girls demonstrate the effect of missionary teaching on their choral singing and a church group sings a translation of *Onward Christian Soldiers*. Visits are made to the Fiji Islands, New Hebrides and New Zealand. The finale comes at the festivities of a picnic in the outback country of Australia. The composer conducts an orchestra of ninety-seven pieces and Cinerama employs its best recording techniques. A stereo version is available.

For those desiring a longer stay in Hawaii, the Wesley Edwards production for Capitol features the Kamehameha Alumni Glee Club. The twenty-four voices of the mixed chorus are heard in the rare harmonies of fifteen native songs. There is the inevitable *Aloha Oe*, coupled with *Song Of The Islands*, but the others are less familiar.

Meredith Willson: Marching Band
Capitol T1110

The basis of Meredith Willson's recreation of six Sousa marches is the three seasons he played under the March King, commencing at the tender age of eighteen, and he prefaces them with the observation that "the distinctive qualities in his music were often startling accents and dynamics . . . when it came to publishing his marches Mr. Sousa not only *left out* as many of those unique effects as he possibly could, but he often threw a few red herrings in there for good measure." He uses a lavish hand to restore the accents, as he recalls them, and expands the dynamics to the limits of modern recording techniques. With the power of forty-odd bandsmen at his command, he affords stirring performances of such rousers as *Washington Post*, *Liberty Bell*, and *Manhattan Beach*. Also revived is his personal favorite, *The Free Lance*.

As an introduction to his own *Freedom Song*, he assembles a medley of ten marches linked with struggles for freedom in various parts of the world, including *Colonel Bogey*, *Marching to Pretoria*, and *Scotland the Brave*. A work dedicated to the cause of international goodwill, the word freedom is pronounced in forty-four different languages during its course. A warranty that it is sounded each time in true native style comes from the composer.

Mexico: Its Sounds and People
Capitol T10185
F. Moreno Torroba: Plays Agustin Lara
Seeco SCLP9149

The latest entry in Capitol's series of "international sounds" is as colorful as the mosaic-patterned facade of the University of Mexico Library on the cover. Carlos Gastel, vacationing manager of Nat "King" Cole, acts as guide and visits a football game, bullfight, an Independence Day celebration, and spends a Sunday with the vaqueros at the Rancho Del Charro. Ricardo Rodriguez, a champion race driver at sixteen, wheels his Porsche before the microphones and children play games or struggle with English in a classroom. Engineers Juan Campo and Eduardo Baptista tie the sequences together with bits from a street organ, marimbas, a mariachi band, and an assortment of street noises, including realistic church bells. Tourists bargain with a bracelet peddler, show faint heart at climbing the Pyramids, and journey to a movie set. Border towns and customs guards, the most painful part of their trip, are thoughtfully omitted.

The popular compositions of Mexico's Agustin Lara possess an international flavor and *You Belong To My Heart*, *Be Mine Tonight*, and *Granada* are favorites in this country. They are listed among the dozen melodies recorded in Spain by Frederico Moreno Torroba, who arranged them for a large orchestra in the Kostelanetz mold.

Bud Shank: I'll Take Romance
World Pacific WP1251
Joe Bushkin: Blue Angels
Capitol T1094

These two meetings of jazz soloists and strings, gratifying for the richness of sympathetic backgrounds, are most productive of lyric swing. During a European tour last spring, Bud Shank recorded in Milano with an ample orchestra led by Len Mercer, who collaborated with Giulio Libano on the arrangements under the name of Ezio Leoni. Said to be the first combined studio effort in modern jazz by musicians of the two countries, it finds the Italians on their mettle and they ended by cheering their guest's performance. Shank alternates on flute and alto sax with customary lucidity on *These Foolish Things*, *Someone to Watch Over Me*, the title tune and eight others.

Aviation enthusiast Joe Bushkin dedicates a dozen tunes, each containing the word blue in the title, to the Flight Demonstration Team of the USN, shown streaking across the cover in new Grumman F11F-1 Tigers. His piano shading ranges from the bright colors of *Blue Room*, *My Blue Heaven*, and *Beyond the Blue Horizon* to the darker hues of *Blue and Sentimental*, and his original *Blue Angel Blues*. The third album in his association with arranger and conductor Kenyon Hopkins, it swings more vigorously than its moody forerunners, sounding like Bushkin of the 40's. Two sections of four trombones each, six violas, four cellos, and two drummers indicate a stereo version is in the offing. AE

AUDIO ETC

(*from page 16*)

is good. As old readers know, this has always been my philosophy concerning "hi-fi."

Setting Up

You now have the basic material to anticipate my own variety of stereo projection set-up. I threw out my first screen, normal room size, and got me a 50" x 50", the largest I could dig up in regular stocks. I would prefer something at least six feet by six, but haven't the loose cash to sink into one.

Take the longest possible throw you can find, between screen and projector, in your home—usually a diagonal, possibly involving a hallway. Put the projector *back*, the screen forward, and a bit high. Fill the screen full-size, even slightly larger, cropping off a few minor details around the edges. (You can lift the projector occasionally, if need be.) It won't matter if the viewers in front have to look uphill a bit.

Your chairs should, as always, be clustered around the center line (mount the projector high, too, to send the beam over the taller heads) BUT, put *everybody* up forward. Concentrate the entire audience well in front of the projector. Put the majority, if you can, near or beyond the point where the size ratio is 1:1—which means practically at the screen. Resist people's natural tendency to sit around the back and sides of the room. They'll get that six-inch window effect and the distorted depth. Put all the kids on the floor, practically at the foot of the screen. They'll love it. Keep the picture BIG, for each and every member of your audience.

Except, of course, yourself. You have to be back at the projector, and you'll have a job trying to focus and blend the pair of pictures at this disadvantageous distance. Try to stand in front of the projector and reach back towards it. Not easy! Leave a space so you can walk forward a few feet to view the effect at a better nearness.

And there you have it. I won't impose on our audio friends much further except to suggest a couple of adjustments that are vital. The projector has, in addition to a joint focus knob (like a ganged stereo volume control in "our" stereo), a separation control, spreading the two pictures sidewise, and an up-and-down adjustment, to register the inevitable misfits, where one picture comes on the screen higher than the other. It takes a lot of knack to operate these quickly and surely. And the focus must be adjusted constantly, too, for accurate detail in the relatively enormous enlargement you are producing for your viewers—much greater than with "flat" screen projection. Three knobs, all to be juggled at once.

In showing pictures (you will have checked them over ahead of time, if you are a better man than I), start with the up-and-down alignment. That hurts most when it is out. As the picture appears, quickly move the up-and-down knob until some visible point in both pictures is level—say a mountain top or the peak of a house roof, or a human head. Look over the top of your glasses, so you can see both images. This is the absolute first necessity—and virtually every picture will need adjustment. The two pictures overlap dizzily—but they *must* be on a level with each other.

Second, quickly adjust focus, if needed. Many films tend to "pop" with the sudden heat and must be re-focussed, a problem common in all projection.

Third, SLOWLY adjust the sidewise separation of the picture for optimum effect. And thereby hangs my final pointer.

Push-pull Perspective

In the pair of stereo pictures no two points are precisely the same. Join together a post in the foreground so the two pictures coincide on the screen, and the mountains in the background will be separated a couple of inches in the actual images. Join the mountains (infinity) and the posts will stand apart, as you look without glasses. These differences, of course, constitute the stereo element itself, the depth-producing effect, and they correspond very closely to the differences in phase between Channel A and Channel B in our stereo sound signals. They can't all be in phase at once—or the two photos would be identical, as would our two sound channels. A striking and interesting parallel here, to think about.

There is even "phase reversal" in stereo photography. If you mount your picture wrongly left to right—"reverse the speakers"—you will get inverted depth. Trees are at the back of deep slots in the sky, which is in the foreground. Mountains are cardboard cut-outs standing in front of the clouds above them. (Black-and-white, or shadow perspective remains normal, of course, and the two types fight each other. Same is true of stereo sound in reversed phase. Some effects are more or less normal; others are reversed, inside out.)

How (to return) do you know which parts of the overlapping images on the stereo screen to make coincide? Should the background match, the two pictures actually hitting the same spot on the screen? Or foreground objects? You have a very wide range of choice, via the separation control. (It moves the lenses.) And you have a fairly wide range of choice in the viewing itself. The eye is remarkably adaptable.

Think of it in this simple way. You are looking *through* your screen, into depth—you may even look in front of it, at a virtual image in the air. The screen itself is merely an accidental point, the frame of the window, the window glass.

The point at which your two images coincide is always seen at the screen. Other points are in front or in back, according to their natural separation.

Therefore, if you wish your infinity to be where it belongs—through and beyond the screen—you must make some of the nearer points coincide. With projection's exaggerated sort of perspective, some nearby points may be too close for the eyes to join—you have to push them back a bit.

As you turn the separation adjustment (sliding the overlapping pictures together or apart by about a foot or more in normal viewing) the screen-point, in the viewed picture, is nearer or further. Bring them closer together (looking at them outside of your stereo glasses) and you move the entire picture forward. You can put your mountains right at the screen if you want, the rest floating in front of them, sort of miniature; but don't do it.

The best technique for average pictures is to choose a *nearby* object, perhaps eight or ten feet away from the camera, and join its two images so they coincide on the screen. Then all the rest of the picture will fall into place, most of it behind the screen, with infinity in its proper distant location. The eyes can take a certain amount of nearer foreground in front of the screen without noticing it.

If, however, there are violent contrasts, with some objects very near—a close-up leafy branch, a person's arm—you must push the whole picture further back, or the exaggeration will be too much for the eyes and the pictures won't join. Wider separation. Same with close-up pictures of people, minus distant background: push them back behind the screen, via wider separation.

You'll quickly find that in most ordinary outdoor pictures you can take a quick look (outside your glasses) at the background, spread its points apart about two or three inches, and infinity will be where it belongs, the rest in place. But you must be ready for quick adjustments.

And if your two loudspeakers seem to spread that string quartet out into a twenty-foot line of players five feet apart, if the stereo Steinway sounds as if the keyboard were forty feet wide, then slide your two speakers closer togeth— hey! I've slipped into the wrong kind of stereo.

From here on, we'd better keep them well separated. Æ

RECORD REVUE

(*from page 58*)

Angel) and both are non-stereo versions. Which only makes us wonder the more why there are now three U. S. labels in this combine—Angel, Capitol and Capitol-EMI. Maybe it's the old Ford-Edsel-Mercury overlapping competition, or GE-Hotpoint, deliberately applied to recordings? Who knows?

Anyway, Scout II took over these, while I managed a third version from France (Omega stereo) in an earlier issue and Scout I took over still a fourth version, as reviewed above. You gotta have a team, these days, to keep afloat.

Well, darn it, here we go—Scout II finds *both* these versions extraordinarily good, though remarkably different. What can you do but go out and buy 'em both. He says that the Beecham version is "superbly intelligent" (he's running out of adjectives); the orchestra is exquisite, the climaxes powerful, perfectly timed, the whole thing both passionate and yet completely controlled. This, of course, is Beecham all over. He is an outstanding stickler for fantastic accuracy of detail, for exact phrasing and ensemble, beyond any other living conductor; he can even take his music slower than others, simply in order to

get over the inner details that he insists upon which might be lost in the excitement of a more impetuous performance. Yet Beecham is not ever less than exciting, even when he is obstinate and annoying, as occasionally in some of his Mozart and Haydn.

The best thing about Beecham's work is that he hires native musicians and knows what to do with them—hence the beauty of this all-French performance under his leadership. That's what Scout II hears.

The Angel recording, same orchestra but under a leading younger French conductor, is "more modern," Scout II says, more taut, more rhythmic, seems to be "held together by electric wires—it's sharp, explosive and very exciting." Also, however, it is less Romantic in feeling than Beecham's, less large, less sympathetic. But, he says, this puts forth another aspect of the big piece, and it is not a bit less worthy than Beecham's. Very fine recorded sound in both of these, by the way.

So—crank up your dollar budget and go out and buy both. The contrast should be well worth it.

Strauss: Don Quixote. Phila. Orch., Ormandy.

Columbia ML 5292

I know—this and both the two Fantastic Symphonies reported on by Scout II were on our recommended list last December. But since Scout II did play them, we might as well mention them again. The recommendations, you see, turned out to be well founded.

You can put this alongside of the Sibelius Second Symphony as another surprisingly lively and expert version of an old war horse from the versatile Philadelphia-Ormandy combo. Scout II finds this "full-blown, gorgeous-sounding, good humored, sympathetic," the garish aspects of the score tactfully kept down, the gimmicky parts never getting the best of the total effect. He's probably thinking of the sheep-bleating episode, the wind machine and other musical gadget-mongering that seemed dreadfully modern back in the 1890's but which don't really cut much ice now.

"Don Quixote" can be terribly long and horribly dull in a less-than-imaginative performance; Ormandy is the man to keep it alive, shape it for today's listening. I suppose this is available in stereo too, or will be; my copy was mono.

Haydn: The Salomon Symphonies, Vol. 1 (Symphonies #93–#98). Royal Philharmonic, Beecham.

Capitol-EMI GCR 7127 (3)

This is the sort of album that I could enjoy listening to over a period of weeks at a time, with nothing else to bother me. It was painful to have to turn it over, lock stock and barrel, to Scout II—who loves the stuff as much as I do. But I could tell you ahead of time exactly what is in the recording, and he has merely confirmed it for me.

The Haydn symphonies are now well known mainly in two great series—that is, the late Haydn symphonies are those in the eighties and nineties and on up to #104. One series is that on Westminster with the German conductor Scherchen, his finest work to date. Scherchen for the first time, in our day, brought out the remarkably Romantic latencies in these great works, the Beethoven aspect of them. Formerly, they were treated as "classic" works entirely, on the pig-tailed and uniformed side out of the Eighteenth Century. Scherchen rendered them—and us—a tremendous service, placing these symphonies in a much truer and more meaningful light in the present-day scene. The Scherchen success with the Westminster series reflects this along with the famous "fl," which was only part of the story.

Beecham is the other (and older) great interpreter of Haydn, reflecting the point of view of an earlier day when Haydn Symphonies were scarcely heard at all—or if any, then always the "Surprise" or maybe the "Farewell," complete with red-coated musicians blowing out the candles on their quaint music stands, one by one. Beecham was thus a Haydn pioneer and I still enjoy his pre-war 78 records, which introduced me to this very wonderful composer.

Thus, here you'll find the quintessence of Beecham's long Haydn experience, in collected form, three records in this album and more to come. The music, as always, will be meticulously, beautifully tailored, impeccably played. It will be somewhat reserved and classic in sound, emphasizing the perfect proportion and structure that is so very much a part of Haydn.

"Dignified . . . . no *sturm und drang*," says Scout II. "But this is no loss—these symphonies are performed with depth and self-restraint—but they are never strait-laced or dull; the orchestra is lovely, the music sounds intelligent (Scout II's highest praise), sharp and full, because the symphonies themselves are so magnificent."

Just about what I would expect.

Mahler: Das Lied von der Erde (Song of the Earth). Grace Hoffman, Helmut Melchert, Symphony Orch. Southwest German Radio, Baden-Baden, Rosbaud.

StereoVox ST-PL 10.912 (2)

This is the collection of songs for tenor, contralto and orchestra that was the famous subject of an enormous pre-war 78-rpm album, weighing a ton and a pioneer recorded monument. Now, recordings of it are relatively frequent.

Mahler may be big but he is always subtle and wonderfully delicate in detail. Scout II doesn't think much of this version. It is large, noisy, exciting, lacking totally in the delicate, fairy-tale quality of the music. No subtlety, no poetry, just much "*sturm und drang*"—lots of beefy tearing-of-hair. The singers, he says, are "OK but not special."

There's no beef from Scout II concerning the recorded sound, which is a good sign since some of Vox's stereo discs at the beginning were under par in clarity. This one is evidently of the later and much improved vintage. Æ

DESIGN OF WIDE RANGE SPEAKER SYSTEM

(*from page 26*)

at usual listening levels. It is retrogressive to tolerate unnecessary distortion in a speaker system when care and pains are taken to keep it out of the amplifier, cartridge, and records. To get enough output with direct radiating domes to match the low-frequency driver a great amount of magnet and iron structure must be used. All these problems can be overcome simply by the use of proper loading structures and horns. The high-frequency drivers in the Regal system employ the Sonophase throat design and exhaust into diffraction horns.

Power Requirements

Many ultra-compact systems have an EIA sensitivity rating of about 38 db. Conventional size enclosures using medium efficiency drivers have a sensitivity rating of about 50 db. This means that these compact systems must be 12 db less efficient than medium efficiency systems. To produce a given sound level these compact systems require 16 times the amplifier power. It is generally accepted that 20 watts is a minimum requirement for sufficient room levels and dynamic range with systems having EIA sensitivity ratings of 50 db. By this criterion a system which requires 16 times this power would need a 320-watt amplifier. This is a horrendous power requirement. Such an amplifier is not available for home use.

Most manufacturers of ultra-compact speakers recommend a 50 to 70 watt power amplifier. A 70-watt amplifier capacity is the highest that can be obtained within reasonable economy of size and cost.

Also the 12-inch ultra-compact loudspeaker cannot safely handle an amplifier of larger output than 70 watts because of heat dissipation requirements in the voice-coil area.

The Regal system is three times as efficient as most of the ultra-compact loudspeakers. Therefore, it requires one-third the amplifier power to produce the same acoustic output. For the Regal, then, a 20-watt amplifier rating will suffice to produce the same output as lower efficiency systems requiring 50 to 70 watts.

Conclusion

An effort has been made in this article to dispel misconceptions regarding ultra-compact speaker systems.

It has been shown that in order to obtain flat bass response the efficiency of ultra-compact speakers *must* be reduced. However, if the efficiency is reduced excessively, impossible power-amplifier requirements or excessively compressed dynamic range results. A happy compromise between loss of efficiency and flat bass response *must* be met.

It has also been shown that conventional 12-inch drivers in 1½ cubic foot cabinets will not produce flat bass response because of an inordinately high primary resonance. It has been proved that removal of the driver suspension stiffness *cannot* sufficiently reduce the primary resonance to effect a flat bass response. Some mass *must* be added to the moving system to produce the desired results. It is this mass addition which reduces the loudspeaker efficiency.

It has been found that the addition of mass to the moving system is not necessarily just a simple matter of utilizing a heavier thicker cone. A precise way of adding mass while maintaining

flattest possible frequency response is through the use of a machined metal ring of exact weight located at or very near the voice coil.

Misconceptions concerning the inherent linearity and consequent freedom from distortion of air springs has been dissolved. Attention has been called to any elementary physics text to find formal proof that the adiabatic air compression and rarefaction is *inherently non-linear*. Distortion produced by this non-linearity *must* be greater in ultra-compact sealed cabinets than in larger systems. Too, there is a practical limit of 3/8-in. to the excursion for 12-inch drivers with 1½ cubic foot sealed back cavities no matter how linear the voice-coil structure and mechanical suspension is. Under these conditions a voice-coil overhang in excess of 3/16-in. is a flagrant waste of precious efficiency.

It has been proved that workmanlike cabinet joinery will sufficiently seal the back cavity. Minute air leaks detectable only with a stethoscope *cannot* have an effect on the performance.

High damping factor is an imperative in ultra-compact systems and the insertion of series resistances not only negates the high damping factor of a quality amplifier with resultant degradation of transient response, but wastes precious amplifier power.

The absolute necessity for good high-frequency dispersion, even more important for stereo than monophonic, has been made clear. Diffraction horn units provide optimum distribution of sound into the listening area. These diffraction horns maintain smooth frequency response and the low distortion that can be obtained only with horn-loaded high-frequency drivers.

The ultra-compact system which embodies the features described in this article as well as optimized bass range performance is the Electro-Voice Regal. The photographs are of the Regal III three-way system. A Regal IA two-way system is also manufactured.

In the Regal III both the treble and high-frequency drivers are equipped with Sonophase loading assemblies for flat response, and diffraction horns for dispersion suitable for stereo. Behind the hinged front panel are located the continuously variable level pads which control the balance of these treble and high frequency units. Front location of these controls eliminates the necessity for removal of the cabinet from a bookshelf location for access to the back panel where such controls are often located.

The Regal is fully finished on all four sides to accommodate vertical or horizontal placement. The exterior appearance of this cabinet is designed to blend well with all decors. It is available in beautiful walnut, mahogany or limed oak.

It would appear that the Regals are optimumly designed, with consideration given to *all* factors, to deliver in an ultra-compact enclosure the maximum in frequency response range, efficiency, and freedom from distortion. Those who participated in its development look back with satisfaction on what is called, in laboratory circles, a "happy" design.

Measuring Equipment

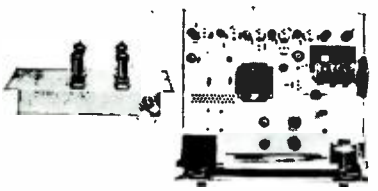
The following laboratory equipment was used for the measurements covered in this article:

Hewlett Packard Distortion Analyzer, Model 330B
100-watt Electro-Voice power amplifier, Model 6006
Electro-Voice Logarithmic Translator, Model 6700
Ballantine a.c. Voltmeter
Electro-Voice Laboratory Standard Microphone and Preamp, Model 6100 (Calibrated 10 cps to 100,000 cps)
General Radio Beat-Frequency Oscillator, Type 1304-B
D'Arsonval-movement rectilinear recorder. Æ

NEW PRODUCTS

• **Norelco Stereo Recorder.** Engineered and manufactured by Philips of the Netherlands, the Norelco stereo "Continental" tape recorder features push-button controls for ease of operation, twin track recording for economy, and three speeds—7½, 3¾ and 1⅞ ips. At each of its three speeds the stereo Continental compares favorably in performance with many machines operating at the next higher speed. This is due primarily to the Philips magnetic head with a gap of only 0.0002 in., which makes possible extended high-frequency response even at lower speeds. The machine can be used to record monophonic tapes, and to play back monophonic or stereo tapes. The unit consists of a tape drive mechanism, two preamplifiers with controls, one power amplifier, and a wide-range speaker. For stereo playback, a second power amplifier and a wide-range dual-cone speaker in a matching cabinet is available as an accessory. Frequency response at 7½ ips is 40 to 16,000 cps and wow and flutter are 0.15 per cent. Signal-to-noise ratio is 54 db. For further information write North American Philips Company, Inc., High Fidelity Products Division, 230 Duffy Ave., Hicksville, N. Y. **C-1**

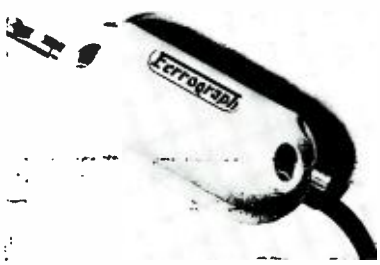
• **Harman-Kardon Multiplex Tuner.** Designed as a completely integrated multiplex receiver, the Model T250 is an AM-FM tuner which may be converted to multiplex by means of the Harman-Kardon Type MA250 multiplex adapter which plugs directly into the tuner chassis. With the MA250 installed, the tuner becomes a one-piece instrument providing single-channel plus compatible-multiplex-stereo reception. The FM front end is a new shaded-grid tetrode which combines the low noise characteristics of a triode with the sensitivity of a pentode. The T250 incorporates the new Harman-Kardon "Gated-Beam" limiter with zero-time-constant grid circuit and wide-band Foster-Seeley discriminators. A new electronic tuning bar, which functions on both FM and AM, is framed in the body of the tuner's handsome brushed-copper escutcheon. Catalog sheets containing complete information on the T250 will be mailed upon request to Harman-Kardon, 525 Main St., Westbury, N. Y. **C-2**



• **"Trombolite" Work Lamp.** Although not an audio item per se, the Trombolite will find favor with both professional audio engineers and do-it-yourself hobbyists for the ease it brings to electronic assembly and kit building. The light source of the unit is an incandescent lamp surrounded by a fluorescent tube, either of which, or a combination of both, may be switched on to obtain the tonal quality of light desired. The mounting arm may be tilted and rotated a full 360 deg. around the base, and may be extended to a length of 39 inches from its retracted length of 25 inches. The reflector may be tilted and swivelled in both vertical and horizontal planes. Manufactured in a number of models, the Trombolite is available for mounting on desk, work bench, wall, machine, or drafting board. Tech-Lite, 535 Fifth Ave., New York 17, N. Y. **C-3**

• **Irish "Continental" series Magnetic Tape.** Intended primarily for use on a number of European recorders which are being imported into this country and which do not accept a 7-in. reel, the Irish brand "Continental" series offers a 5¾-in. reel with extended lengths of tape, and correspondingly increased playing time. Tape lengths range from 850 ft. for standard thickness tape to 1650 feet for double-play. Tape recordists who have had difficulty in finding proper reel sizes and tape lengths for their European recorders may write ORRadio Industries, Inc., Shamrock Circle, Opelika, Ala., for the names of dealers that stock the Continental series. **C-4**

• **Tape Head De-Magnetizer.** Known as the Wearite "De-fluxer," this device removes residual magnetism from the tape head of any recorder/reproducer. Simple to use without removing the head screening shield, it insures maximum signal/noise ratio, at the same time protecting recorded tapes from cumulative background noise and attenuation of the upper frequencies. Made in England by the manufacturers of Ferrograph tape recorders, the de-fluxer is distributed exclusively in the U. S. by the Ercona Corp (Electronic Division), 16 W. 46th St., New York 36, N. Y. **C-5**



• **Heathkit Chairside Enclosure.** In addition to providing convenience and utility this Heathkit equipment cabinet will enhance the appearance of any living room with its striking design in either traditional or contemporary models. Designed for maximum flexibility and compactness, the enclosure is intended to house the Heathkit Models BC-1A and FM-3A AM and FM tuners and the WA-P2 preamplifier as well as most any standard record changer. Adequate space is provided at the rear for enclosing any of the Heathkit power amplifiers designed to operate with the WA-P2. Although intended originally for these components, the cabinet is not frozen to specific locations for each one. Component location can easily be worked out for the existing situation in each home. All parts are pre-cut and pre-drilled for easy assembly. For further information write Heath Company, Benton Harbor 25, Mich. **C-6**

• **Goodmans Stereo Speaker.** The Stereosfere is specifically designed as a second speaker in a stereophonic music system. It operates on the principle that the human ear cannot detect the accurate position of the source of sound at frequencies below 300 cps. Bass sound, in a system utilizing the Stereosfere, is channeled to the existing full-range speaker, with all sound above 300 cps divided equally between the existing speaker and the Stereosfere. The Stereosfere delivers clean response from 300 to 20,000 cps. Functional in design and appearance, the unit measures only ten inches in its largest dimension. It can be tilted, swivelled, rotated, hung from the ceiling or wall, or placed at normal height. Manufactured in England by Goodmans, Ltd., the Stereosfere is distributed in the U. S. by Rockbar Corporation, Mamaroneck, N. Y. **C-7**

• **Erie AM-FM Tuner.** Long known as a principal manufacturer of component parts, notably quality resistors, Erie Resistor Corporation, Erie, Pa., has entered the high fidelity field with a new AM-FM tuner. Designated Model EM-085-ER, the tuner features an etched wiring board, and includes in its circuitry two i.f. stages, a

limiter stage, and a Foster-Seeley discriminator. A 300-ohm balanced input, with trifilar matching coil, eliminates the usual dual input stage, according to company engineers. Other features of the tuner are exceptionally low noise level and strong a.f.c. control voltage. The unit is housed in a tastefully finished black cabinet with gold trim. **C-8**

• **Input Transformers.** These cased plug-in input transformers are intended for replacement or original equipment use on many amplifiers and tape recorders, such as the Ampex and RCA. They are designed to match the impedance of microphone, pickup cartridge or line to that of a high-

impedance input amplifier. All units are double Mumetal shielded to provide optimum signal-to-noise ratio. Frequency response is 20 to 20,000 cps ± 2 db. Size of the transformers is similar to that of standard octal metal tubes. Manufactured by Microtran Company, Inc., 145 E. Mineola Ave., Valley Stream, N. Y. **C-9**

• **Battery-Powered Intercom.** Operating for months on a single self-contained dry-cell battery, the Merco intercom system uses four transistors in a printed circuit and is recommended for distances up to one mile. Power is used only when the system is actually in operation. The remote

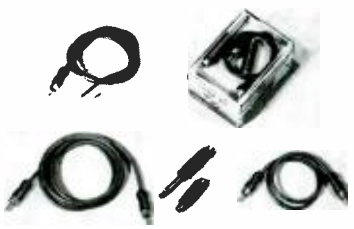
station can signal the master station even when the power is off. The system is well-suited for communication from building to building, on the farm, at sports events, or on construction jobs where house current is not available. Manufactured by Merco Recording Company, Springfield Gardens, N. Y. **C-10**

• **Telectro 3-Speed Tape Recorder.** Speeds of 1⅞, 3¾, and 7½ ips are incorporated in the new Model 350 tape recorder recently introduced by Telectrosonic Corporation, 35-18 37th St., Long Island City, N.Y. It accommodates reels up to 7 ins. in diameter, and permits up to 8 hours of playback time. A rotary-type selector makes speed selection easy, and an interlocking device prevents any change of

speeds while the machine is in operation. A solenoid-actuated automatic shut-off stops the recorder at the end of each reel and returns all control to neutral. Frequency response is stated to be 50 to 15,000 cps at the 7½-ips recording speed. Push-button controls are afforded for record, play, rewind, fast forward, and

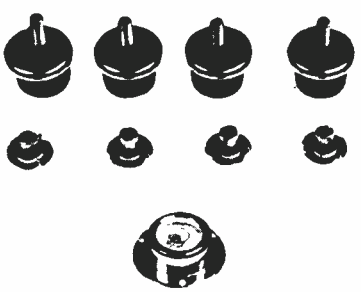
pause. Other features include output jacks for external speakers and amplifiers; inputs for microphone, phonograph, and tuner; digital-type counter; level indicator. The Model 350 is housed in a handsomely-styled portable carrying case and weighs only 27 lbs. It comes equipped with microphone and stand, and a 7-in. reel of tape. For further information write to the manufacturer at the address shown above. **C-11**

• **Hi-Fi Cable Kit.** To meet the requirements of component installations, a new cable kit has been added to the audio accessories line of Anchor Products Company, 2712 W. Montrose Ave., Chicago 18, Ill. Kit No. HK-510 consists of a 36-in.



shielded cable with pin plug and pigtails, an 18-in. shielded cable with two pin plugs, a 72-in. shielded cable with two pin plugs, a double phono pin jack adapter, and a pin jack to phone plug adapter. Various combinations can be assembled to make up a wide range of audio cables. **C-12**

• **Cabinet Levelor Kit.** Comprising a precision level and four rubber-tipped screw-type feet, the Levelor kit makes it possible to adjust a turntable or changer base to a level position, which will improve record fidelity and reduce wear. Installation re-



quires drilling of four holes for the T-nuts which are then pushed into place and the feet screwed into the T-nuts. With the circular level installed on the motor board surface, accurate leveling can be done in minutes. Cabinart, 35 Geyer St., Haledon, N. J. **C-13**

CARTRIDGE LOADING

(*from page 21*)

before volume became excessive. This inordinately large signal would often overload the input tube if it were located prior to the gain control. Even if the signal goes directly to the gain control, it is not a good idea to have the incoming signal so large that if someone, for example a child, were to turn the gain full on this would damage the speaker or one's eardrums or both.

Most modern control amplifiers have fairly high sensitivity on high level input. Seldom is this less than 0.5 volt and often as low as 0.1 volt input for 1-volt output. Assume the control amplifier has sensitivity such that 0.25 volt input drives it and the power amplifier to rated output, anywhere from 12 to 60 watts or so. A typical piezoelectric cartridge produces as much as 2 volts on peaks. To reduce this to 0.25 volt entails a reduction of about 18 db. Referring to *Figs.* 2 and 5, shunt capacitance of 2100

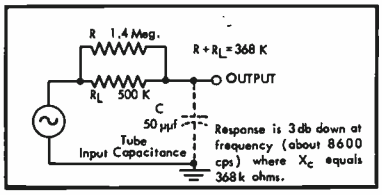


Fig. 4. Equivalent circuit of Fig. 2 at high frequencies showing how treble droop is caused.

μμf across a 500-μμf cartridge reduces its signal output 14 db by voltage divider action. This goes a long way to prevent overdriving the control amplifier.

Although the modern piezoelectric cartridge can satisfactorily match the RIAA recording characteristic when properly loaded, many people still have old records which were recorded with LP, AES, and other recording curves, and they wish to reproduce them properly. One way to meet this problem is to adjust for differences between the RIAA curve and other curves by means of the tone controls, using one's ears to decide when tonal balance is correct. Some persons prefer to convert the pickup into the equivalent of a velocity device inasmuch as most control amplifiers,

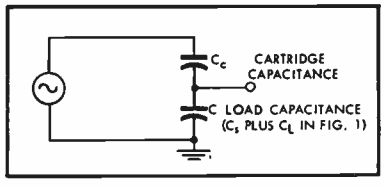


Fig. 5. Equivalent circuit showing how shunt capacitance forms part of a voltage divider to reduce signal from piezoelectric cartridge.

stereo as well as monophonic, provide a variety of equalization characteristics for velocity (magnetic) pickups.

Converting to Velocity Device

One method of converting the piezoelectric cartridge into a velocity device is by loading it with a relatively small resistor, on the order of 47K ohms or less. Such a resistor in series with the cartridge capacitance produces a high-pass characteristic, in the same manner as illustrated at (B) in *Fig.* 2 in connection with bass cut. Now, however, the very small resistor causes high-pass action through all or most of the audio range, thus producing a rising response at the rate of 6 db per octave in the manner of a magnetic cartridge. Then the signal can be fed into an input designated for a magnetic pickup.

The above procedure contains a pitfall, and care must be exercised to avoid it, for otherwise one will have an undesirable treble peak. High fidelity piezoelectric cartridges generally have a built-in treble hump, achieved by damped resonance, which produces a satisfactory approximation over most of the upper range of the treble boost required when reproducing an RIAA disc with an amplitude pickup (see *Fig.* 1). If the pickup is used instead as a velocity device, this rising characteristic remains. However, by avoiding too small a load resistor, high-pass action can be limited in the treble range, offsetting the treble hump of the cartridge. Manufacturers of piezoelectric pickups will generally supply users with information on the preferred load resistances for use of their product as a velocity device or as an amplitude device. Moreover, for smoothest response, they will frequently supply users with a schematic or ready-built adapter which contains a suitable loading network to convert the pickup into a velocity device and simultaneously reduce the treble hump to an insignificant quantity. *Æ*

WORKSHOP

(*from page 34*)

tweeter. It works, though he insists it needs improvement. A week later he confidently outlined plans for a full-range electrostatic speaker.

Some of the wilder types have gone deep into left field, turning out such jabberwocky as an electronic gunslinger who always beats you to the draw, and a perverse electronic hand which, when you turn a switch on, comes out of the box and shuts it off.

But the main theme is high fidelity. This is natural. The guiding spirits of the Workshop are both audio technicians and high fidelity fans. Elliot Gordon devotes part-time to the Workshop, func-

tioning as an audio-man at the Columbia Broadcasting System television studios. He landed at CBS in 1953 after service as a Navy communications officer and the achievement of a Master's degree in Romance languages in Paris. Dave Muirhead's story is more devious. It includes gandy-dancing on the railroad, covering MP beats in the Army, short-order cooking, and riding gain on P.A. systems in theaters.

In 1957, while at the RCA Institutes, Muirhead responded to a call for an audio technician from the well-known off-Broadway Shakespeare Theater. It turned out to be Elliot Gordon who had issued the call. The two men met and the Audio Workshop idea was born. The following spring saw its reality.

Dave Muirhead opens the place at 11 a.m. Traffic turns brisk by late afternoon and stays so all evening. (Their big trouble, both agree, is routing the patrons out at 11 p.m., closing time.) Talking shop and auditions of systems are continuous run features, and it's hard to tell just where you came in. It's easy to spend time there. One habitue finally admitted that if he stayed long enough to achieve a noise and hum level 90 db below signal he would probably also achieve a divoree. He has since decided that 60 db will be adequate so long as he can also keep his wife.

Someday—a Chain of Workshops?

Muirhead and Gordon are simply consolidating the gains the Workshop has made so far, for the present. But, of course, they have plans. There's an audition room they want to build. They are talking seriously of running lectures on all aspects of sound. They're thinking of scheduling demonstrations of new equipment. Moreover, they are interested in spreading the Audio Workshop idea to other regions. They are eager to share the valuable experience gained in this pioneer effort. And they cite the savings to be gained by several Workshops purchasing as a unit and advertising cooperatively.

Dave Muirhead expresses their approach when he explains "We went into this because we enjoy high fidelity so much that we thought others who enjoy it as much as we do but who have no facilities at home would take to the idea. We also felt it would be a pleasant and friendly way to make a living." And that feeling permeates the Workshop. It *is* friendly, no one hurries you, no salesman prods you to buy anything.

But, one thing they insist on. Woodwork is out. "No facilities" claims Muirhead. "He really means we just don't want to get involved with hammers and saws and drills" Corrects Gordon. "Besides" adds Muirhead, "who could hear the music for the hammering?" Æ

DECIBEL

(*from page 27*)

The points brought out in the preceding paragraph can best be illustrated by means of some examples. *Figure* 3 shows a step-up transformer in which the primary voltage is 100 and the secondary voltage is 500 volts. To use the above formula without regard to its true meaning and the restrictions imposed on it would lead to a "voltage gain" of almost 14 db. As there is no power gain, the use of the decibel is meaningless and shows what an indiscriminate use of a formula can lead to. Many older textbooks still contain examples in which the voltage gain is calculated in this manner. Of course, this should not be confused with the voltage gain of an amplifier stage in which the output voltage is divided by the input voltage giving rise to a number representing the stage gain. This is perfectly legitimate; the trouble arises when the decibel is made to serve as a measure of stage gain.

Figure 4 illustrates another example of the incorrect use of the formula. The input and output voltages are equal and improper use of $n = 20 \log E_1/E_2$ would give zero gain as the result. But the input power can be seen to be 0.625 milliwatt and the output power is 6.25 watts, resulting in an actual gain of 40 db.

The situations illustrated in *Figs.* 3 and 4 are typical of the results obtained when certain restrictions are disregarded. Decibels are always used to measure power gain; voltage gain in this sense is meaningless. The two expressions

$$n = 20 \log E_1/E_2$$

and

$$n = 20 \log I_1/I_2$$

are merely short-cuts to calculating power gain and furthermore can only be used when the resistances across which the two voltages were measured or through which the two currents are flowing are equal. This restriction was disregarded in a recent textbook problem on antenna gain. A folded dipole developed a signal of 150 microvolts while a rhombic antenna, receiving the same signal, developed a signal of 700 microvolts. Use of the formula in the

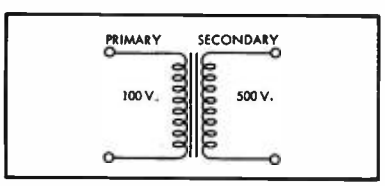


Fig. 3. A transformer can step up a voltage but cannot produce a power gain. Hence, using $n = 20 \log E_1/E_2$ to get the voltage gain in db is meaningless as the decibel is reserved as a measure of power gain.

preceding paragraph yields a gain of 13.4 db whereas the gain is actually only 10.4 db. The explanation lies in the fact that the characteristic impedance of the two antennas is not the same. A folded dipole has a characteristic impedance of 300 ohms while that of a rhombic is 600 ohms.

Recapitulation

We can now turn with profit to some of the statements mentioned at the beginning of this article and interpret them in the light of what we have learned. When amplifier specifications read: 5 cps to 160 kc., within 1 decibel," what is meant is that if the power output at any frequency in this range is compared to the power output at 1000 cps they will not differ by more than 1 decibel. Or to say that the "response is down only 3 db at 200 kc" means that the gain of the oscilloscope's amplifier at 200 kc is only one-half that of its midfrequency range. (A 3-db loss means the same as half-power, and a 3-db gain represents twice the reference power.) When the power output of a microphone is given, it always refers to a power of 1 milliwatt as the reference. For an output of −60 db, the power output would be 10^{-9} watts.[2]

Noise and Hum Ratings

When a manufacturer states that his amplifier has a hum level −90 db below 20 watts he means that when the output of the amplifier is 20 watts the power level of the hum signal is 0.02 microwatts. The hum present in the output of an amplifier is quite often measured in decibels and this might have been done in the circuit shown in *Fig.* 4 using the following procedure. Suppose the signal voltage (at 1000 cps) across the plate-to-ground circuit measures 100 volts. And further that a harmonic wave analyzer set to 60 cps measnres 5 millivolts

[2] $60 = 10 \log .001/P$
$P = 10^{-9}$ watts

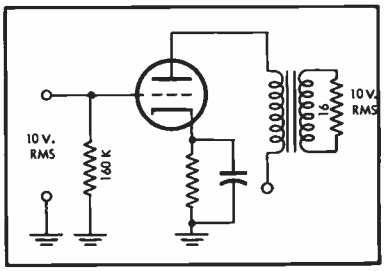


Fig. 4. This stoge has a gain of 40 db, but improper use of the same formula illustrated in Fig. 3 would indicate thot the gain is 0 db. The text points out that the voltages must be measured ocross equal resistances for this formula to be valid.

at full amplifier output. Then the hum is found to be down –80 db.[3]

Summary

Hence we see that the decibel is used as a means of comparing two values of power. It can be used to compare the input and output power of an amplifier, resulting in the db gain of the entire circuit. Or, what is usually more important, it is used to compare the power output at some specified frequency with the power output at many other frequencies in its intended range. Here the decibel is used to compare these values and the result, when plotted, becomes known as a universal response curve. Gain or loss refers to power levels above or below the reference power; input always remaining constant. The value of the decibel is in comparing power levels without the need to refer back to actual values of power.

When two voltages are measured across equal resistances they can be used to calculate the power gain. Much confusion has arisen in the past by calling the result "voltage gain." Actually, this is merely a short-cut to finding the power gain, measured in decibels.

The decibel is a useful tool in the analysis of electronic equipment. It enables comparisons to be made quite readily and "normalizes" the many variables present in a circuit under inspection. Its present use transcends the earlier concept of the logarithmic response of the human ear. Æ

[3] $n = 20 \log (100/0.010)$
$n = -80$ db (– signifing that hum power is less than signal power)

COMING HI FI SHOWS

March 6–8—Denver, Colo. Cosmopolitan Hotel, (*Rigo*)

March 20–22—Baltimore, Md. Lord Baltimore Hotel. (*Rigo*)

April 2–5—Fourth London Audio Fair, Russell Hotel, London, W.C.1, England.

April 3–5—Pittsburgh, Pa. Penn-Sheraton Hotel. (*Rigo*)

October 5–10—New York High Fidelity Show, Trade Show Building. (*IHFM*)

OTHER EVENTS

March 15–18—Annual Convention, National Association of Broadcasters. Conrad Hilton Hotel, Chicago, Ill.

March 23–26—National Convention, Institute of Radio Engineers. The Coliseum and Waldorf-Astoria Hotel, New York.

April 6–9—Radio Electronic Components Manufacturers' Federation show. Great Hall, Grosvenor House, London, England.

ABOUT MUSIC

HAROLD LAWRENCE*

The Unknown Handel—Reflections on a Bicentennial

NEXT MONTH will signalize the 200th anniversary of the death of George Frederick Handel, and since everyone seems impressed by round figures (as Howard Taubman recently pointed out in his Sunday column, "Anniversary Daze"), a little more Handel probably will be performed this year than during previous years. But judging from all indications, we are not about to witness a wholesale revival of the German composer's music. To be sure, *Messiah* will again be heard, along with the *Largo*, some of the Concerti Grossi, and a few odd excerpts from his dramatic works. Perhaps some magazine editor will get Sir Thomas Beecham to repeat his well known attacks on the Handel "purists." And, in the world of microgroove, don't be surprised to find a smattering of Handel issued piously under a Bicentennial banner.

So far, the occasion does not seem to have set the musical world aflame. No counterpart of the late Duncan Robinson (former secretary of the Berlioz Society) has been making urgent phone calls to music editors, artist-and-repertoire directors, book publishers, and conductors, pressing for more recognition, more performances, and more recordings of the shamefully neglected works of a great composer. No influential music critic has declared himself for Handel in the manner of an Olin Downes championing the cause of Sibelius. In song recitals, Handel comes first on the program, but last in importance; singers use his arias as warm-up pieces and frog-chasers, while the latecomers find their seats.

No one will challenge the fact that Handel was one of the giants of 18th-century music. Yet the picture the general public has formed of the Saxon composer bears little resemblance to the true nature of his genius. Handel usually appears on concert programs through the good offices of a trio of knight-conductors, Sir Thomas Beecham, Sir Hamilton Harty, and Sir Henry J. Wood, each of whom arranged numbers of Handelian scores for the modern symphony orchestra. These transcriptions are highly effective in their own way and have kept Handel in the orchestral repertoire, albeit in modern dress. As for the oratorios, the Crystal-Palace tradition of performing Handel is, unfortunately, still with us. Gone are the days when 4000 singers and instrumentalists participated in a single performance of *Messiah*, but the "big" approach has not been abandoned altogether. "Suppose Handel were living today and saw our large halls," stated Sir Thomas Beecham, "and had full acquaintance . . . with the resources of the modern orchestra . . . what would he have done? . . . My own personal answer: he would have used every confounded instrument there was that he could lay his hands on and a few he couldn't."

During the two centuries since Handel died in London on April 14, 1759, his music has been re-harmonized, re-orchestrated, and reshaped to conform to prevailing tastes. Time sanctified many of these revisions, and the "Handel tradition" was born. While Handelians manage to stage "authentic" revivals from time to time, the task of musical direction is usually assigned to dull, if well-meaning conductors. (There are, of course, notable exceptions, although the world's outstanding conductors seem to prefer hyphenated Handel—Handel-Harty, Handel-Wood, etc. —to pure Handel.)

As a result, only a tiny handful of works from the output of this staggeringly prolific master is heard today in its original form. Probably the most neglected area in Handel's production is that of opera. Handel composed over forty musical dramas and none of them are in the standard repertoire. This is ironical in view of the fact that he was one of the greatest dramatic composers of his time. The reasons for Handel's absence from today's operatic stage are numerous and complicated—so complicated, in fact, that even the most ardent Handelians throw up their hands in despair at the thought of coping with the difficulties of staging these fascinating, though curious works.

The element of curiousness is due partly to the rigid operatic conventions of Handel's day, and partly to the enormous popularity of the *castrato* singer.

First, let us examine the libretti that were written for Handel's operas, and for those by other composers in early 18th-century London. With few exceptions, they dealt with classical subjects, as well as with later-Roman Empire themes, and mythology. Plots were absurdly complicated, dialogue was stilted, and characterization shallow. The burden of the plot was assumed entirely by the recitative; the aria expressed only a single thought or emotion. There was little or no action throughout the work; the visual interest lay in elaborate sets and spectacular scenic effects such as waterfalls, storms and, in at least one instance, birds.

In his excellent biography of Handel (Alfred A. Knopf), Herbert Weinstock describes the castrato as a "boy's voice produced by a man's lungs with the resonance of a man's body, and projected—by the greatest castrati—with the art and comprehension of a mature musical mind." In Handel's time, the castrato was the equivalent of the later prima donna, and the mere appearance of a Nicolini, for example, in the cast virtually guaranteed a full house.

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

The *da capo* aria, so detested by modern audiences, was designed for the virtuoso singers of that period, who did not simply repeat the melody, but provided it with florid improvisations. Today's audiences would also find another convention hard to take: the leading singer always leaves the stage immediately after performing one of his big arias, which leaves the librettist in a fine dramatic pickle.

The chief stumbling block to modern performances of Handel's operas is obviously: what to do with the castrato part? One possibility is transposition to another key, giving the role to a tenor; but this wreaks havoc with Handel's key relationships. The key need not be altered, however, when the part is transposed an octave lower for a baritone, but the tone-color is radically affected. Range can be preserved by assigning the role to a soprano, but this upsets the dramatic values. There is, of course, no substitute for the sound of the castrato voice, which, according to all accounts, was of a silvery, trumpet-like texture.

These formidable problems should not obscure the fact that Handel lavished his most creative energies in opera composition for some 35 years. After all, he was not the only composer saddled with inferior texts. Handel's operas contain incredibly rich musical experiences. If, to uncover them, we must accept the conventions of another operatic age, by all means let us do so. It's a small enough price to pay for bringing to life some of the most compelling dramatic music ever written. Æ

NEW LITERATURE

● **Pilot Radio Corporation,** 37-50 36th St., Long Island City 1, N. Y., announces the publication of a new booklet titled "Stereo and You." In "Stereo and You," Pilot has endeavored to answer questions which dealers and the public have been confronted with since the introduction of stereophonic sound. Your copy of this interesting and worth while book will be mailed free upon written request. **C-16**

● **Sonotone Corporation,** Elmsford, N. Y., explains the entire process of stereo recording and reproduction in a new pocket-size booklet titled "Stereo Simplified." Intended to help music lovers who are interested in purchasing new stereo equipment as well as those planning to convert present monophonic sets, this booklet will be of great value to the person who is still wondering just what stereo is all about. **C-17**

● **Viking of Minneapolis, Inc.,** 9600 Aldrich Ave., South, Minneapolis 20, Minn., now has available for general distribution a new accessories catalog. Listed and illustrated is a wide range of items which add greatly to the flexibility of the Viking 75 and 85 Series tape decks. Of particular interest is the "88" speaker, providing as it does a small-area source along with better-than-average speaker performance. **C-18**

● **Hexacon Electric Company,** 266 W. Clay Ave., Roselle Park, N. J., announces a new catalog sheet covering Long-Life soldering iron tips. Shown are 81 new shapes and sizes, a total of 124. Included are plug tips from 1/16" to 1⅛" and screw tips from 7/16" to 1¾" diameter. Various tip shapes are illustrated, complete dimensions are given, as well as advice on use and care. Also included are list prices. If you use soldering iron tips industrially, this listing will probably mean great savings. **C-19**

TRANSFORMERS

(*from page 46*)

made for these several core materials. A pure sine-wave voltage was produced across the coil while the corresponding distorted energizing current was analyzed. To accomplish this, the transformer was included in a negative feedback loop with a very large feedback quotient from an unloaded winding on the transformer. This maintained an exceedingly pure sine-wave flux-density variation. The energizing current was passed through a resistor. The voltage across this resistor, being proportional to energizing current, was analyzed. Measured in this way, the distortion in the energizing current depends only on the core material and the flux density. These measurements were restricted to high flux densities by amplifier noise and related problems, so that complete curves could not be obtained. The high-level comparisons thus made are very helpful. In *Figs.* 1 and 3 the permeability peak occurs at 3500 or 4000 gauss. The energizing currents at 3500 gauss for Audio A silicon steel, low-grade silicon steel, and 4750 nickel alloy respectively contained 16.3, 15.5, and 13.0 per cent third harmonic. This is a rather small variation and indicates that distortion calculation at the permeability peak as determined by impedance measurements alone, without knowledge of the core material, would generally be reasonably accurate. At high flux densities the distortion varies rapidly with changing level, reducing the accuracy of such comparisons. Distortion produced in vacuum tubes does not usually agree with calculated values, or published values, much more closely.

Curiously, the distortion at the low-level peak equals the distortion at the permeability peak for these lamination materials. The maximum low level distortion for Audio A, *Fig.* 1, is about 10 per cent third harmonic. At 4000 gauss, the permeability peak, the third harmonic is again about 10 per cent. This relation is also found in 4750 alloy and Mumetal. Also the low-level distortion peak in each case is at roughly one hundredth the voltage of the permeability peak. Having determined the voltage at which the impedance is maximum, and knowing the relative impedances of transformer and circuit at the permeability peak, the distortion at any flux density can be estimated. The accuracy will be best at low flux densities because those portions of the distortion curves are nearly flat. These relations do not hold for grain oriented tape cores which have distinctly different permeability curves.

To compare transformers designed for the same application, simply measure the energizing currents at the voltage and frequency of interest. The distortion ratio is very likely to be about the same as the ratio of energizing currents. In the case of output transformers it is most unlikely that the distortion ratio will be less than the energizing current ratio, but it may possibly be greater. The transformer with lower energizing current is likely to have more turns or a larger core. In either case the flux density will be lower, further reducing the distortion at high voltage levels. With low-level transformers the exact flux density has little effect on the distortion, and the accuracy of this simple comparison will be better.

High-quality low-level transformer cores are generally a material similar to 4750 or Mumetal. Transformers designed to handle the same amount of power, using either of these materials, can be compared on the basis of energizing currents alone with particularly good accuracy because the respective distortion curves are so very similar in shape. The difference in saturation points does not enter this comparison if the transformers actually handle the same amounts of power.

In choosing transformers, the heaviest or largest is likely to have the best low-frequency characteristics in the usual case where the core materials are similar. Core material and copper account for much of the transformer cost. Additional material is not intentionally used unless it provides a commensurate improvement in the transformer. Of course a large case sometimes contains a small transformer.

Transformers Preferably Avoided

Because audio transformers introduce amplitude and frequency distortion and waste power, they should be avoided when possible. It is not unusual for the elimination of one transformer to make a noticeable improvement in sound quality.

Certain transformer types are particularly objectionable. In designing a high-impedance transformer, high-frequency considerations limit the amount of inductance which can be provided. High-impedance audio transformers depend on properly damped resonances to extend the high-frequency range. An increase in coil turns or coil sizes reduces the frequency of these necessary resonances and thus reduces the high-frequency span. Therefore the more difficult the high-frequency problem, the more the low-frequency response suffers.

Of the common transformer types, the most undesirable from a distortion standpoint is the high-level interstage transformer. The secondary impedance

Industry Notes . . .

AUDAX BUYS RACON HI-FI. George Silber, president of **Rek-O-Kut Company,** recently announced the purchase by Rek-O-Kut's Audax Division of the hi-fi speaker manufacturing facilities, inventory and tools of **Racon Electric Company.** Mr. Silber also revealed his intention of entering the packaged high fidelity field within the near future, possibly later this year. The new loudspeaker line will be marketed under the Audax trade name, along with Audax cartridges and tone arms.

MUTER ENTERS CARTRIDGE FIELD. Long known as a manufacturer of quality component parts, **The Muter Company,** Chicago, has begun production of two ceramic stereo cartridges for the original equipment manufacturers market. Produced under a license agreement with **CBS-Hytron,** the units will be marketed solely by the Muter sales organization directly to manufacturers. The two cartridges are said to have wide frequency response, low tracking force, and channel separation in excess of 20 db. The two models are identical in construction, differing only in polarization of the ceramic elements.

ARKAY IN LARGER QUARTERS. Arkay Radio Kits, Inc., has moved to new and expanded quarters at 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y. According to Irving Becker, Arkay president, the move reflects the tremendous popularity of hi-fi kit construction among music lovers and hobbyists. Arkay will have more than 30,000 sq. ft. of space at its new site. Plant and equipment will provide every modern facility for hi-fi and component production, with complete engineering, testing and servicing laboratories.

IHFM SETS TUNER MEASUREMENT STANDARDS. The Institute of High Fidelity Manufacturers has opened its program of establishing measurements standards within the industry with distribution of a booklet entitled "Standard Methods of Measurements for Tuners." Prepared by the Institute's Standards committee, the booklet defines FM and AM terminology, operating conditions, requirements and characteristics of testing devices, FM and AM test procedures, and test procedures for AM/FM tuners. The booklet is available from the Institute at a cost of one dollar.

ELECTRO-VOICE WILL REGISTER STOCK. Electro-Voice, Inc., has filed a statement with the Securities and Exchange Commission asking sanction to register 150,000 shares of capital stock. Sale by shareholders will account for 75,000 shares, while the remainder will be offered for the account of the company. Net E-V sales for the nine-month period ending November 30, 1958, totaled $8,493,419 and income was $415,826. Net proceeds from the share sales will be added to the company's general funds.

ALTEC JOINS LING GROUP. An agreement on terms for the acquisition of **Altec Companies, Inc.,** stock by **Ling Electronics, Inc.,** has been announced by James J. Ling and G. L. Carrington, board chairmen of the two companies. Upon completion of the transaction, Altec Companies, Inc., and its subsidiary, Altec Lansing Corporation, will both operate as subsidiaries of Ling Electronics, Inc., and Altec Service Company will continue as a division of Altec Companies, Inc. There will be no change in the commercial operations, management, name or policies of the Altec organizations.

ADVERTISING INDEX

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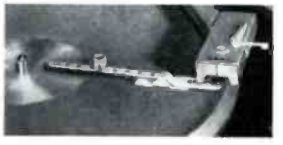
SAK-12 12" arm kit $23.95

GRAY Micro-Balanced Pressure Gauge



Indicates pressure on record surface so that adjustments can be made for proper tracking. A true balance without springs.
PG 200 gauge $2.50

Visit your friendly quality Gray dealer for a full demonstration. Write to us for complete literature.

Manufacturers of the world famous Gray tone arm.

GRAY

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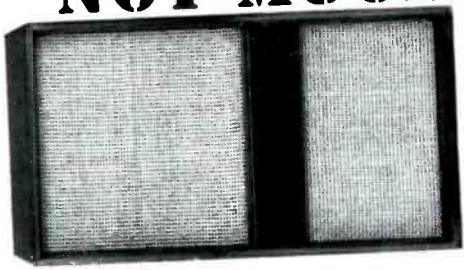
with Stereo's Standard

STEREO'S STANDARD

IF THIS IS YOUR PRESENT or PROPOSED SPEAKER SYSTEM

NOT MUCH BIGGER THAN A BREADBOX, BUT...



SIZE: 13½" deep, 14" high, 25" wide

Figure A

the amazing Electro-Voice Regal gives you bass so low you can feel it— bass sounds you'd expect from a conventional enclosure three times the size.

"OPTIMIZED BASS" is just one of the many extras in the new E-V Regal integrated speaker system. You get *balanced*, full-range flat response without attenuation or peaks, from bass-you-can-feel to beyond audibility. And, you can drive the Regal systems to concert volume with just 20 watts. (The Regal is more than 2½ times as efficient as other low-efficiency systems.) Now, double your listening area with wide, w-i-d-e dispersion, made possible by E-V's patented *Hoodwin diffraction horn. The Regal's exclusive right-up-front Presence and Brilliance controls (see A) give you infinite adjustment of treble and VHF compression-driver ranges. You will thrill to smooth, high-frequency response *without breakup* due to E-V's patented **Avedon Throat design. ¶ The Regal's ultra-compact enclosure is finished on all four sides. You can place it *anywhere*—floor or shelf, vertically or horizontally. ¶ Each Regal is a triumph of acoustical engineering . . . made up of the finest components E-V can assemble. Choose either the Regal III with separate 3-way system using precision-built E-V woofer, treble and VHF compression drivers. Just $147.00 net. Or the Regal IA separate 2-way system with E-V woofer and VHF driver. Only $103.00 net. Choose from luxurious tropical mahogany, limed oak or rich contemporary walnut. ¶ Know the excitement of the E-V Regal. Compare its sound . . . compare its price at your franchised Electro-Voice high-fidelity showroom. ¶ Electro-Voice also makes enclosures of every size, to meet every need, every budget . . . from the ultra-compact Coronet at $35.50 to the luxurious Patrician at $970.

*Patent No. 754,901 ** Des. Patent No. 182,351

Write Electro-Voice, Dept. AD3, for free illustrated booklet, "Guide to High Fidelity Speakers for Stereo"

REGAL BY Electro-Voice®

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...Electro-Acoustics ...bridges, High-Fidelity Loudspeakers Public Address Speakers, Marine Instruments, E-V Professional Electronic Instruments and Military Material.