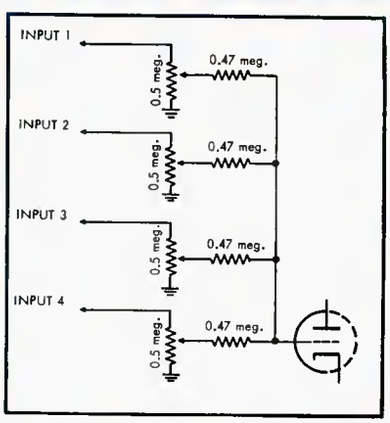
AUDIO

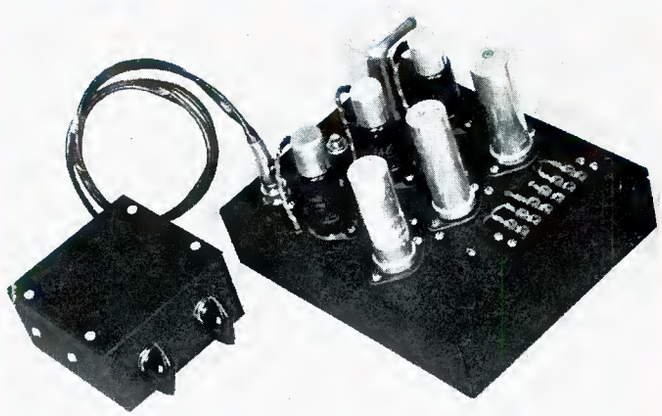
ENGINEERING MUSIC SOUND REPRODUCTION

FEBRUARY, 1957

50¢



Proper operation of a number of inputs fed into a single tube depends on the circuitry and *the construction.* See page 15.



Giving close adherence to actual recording characteristics, this amplifier, shown with its separate control unit, will be the answer to many a record collector's needs. See page 18.

ELECTROSTATICS, WATTS, REALISM, AND CONCERT HALLS

HOW AN OUTPUT TRANSFORMER CAUSES DISTORTION

PROFESSIONAL EQUALIZER-PREAMP FOR HOME USE

HIGH-QUALITY TAPE RECORDER AMPLIFIER

SKITCH . . . on his Presto Turntable

"MY CUSTOM HI-FI OUTFIT is as important to me as my Mercedes-Benz sports car," says *Skitch Henderson,* pianist, TV musical director and audiophile. "That's why I chose a PRESTO turntable to spin my records. In my many years working with radio and recording studios I've never seen engineers play back records on anything but a *turntable*—and it's usually a PRESTO turntable.

"My own experience backs up the conclusion of the engineers: for absolutely constant turntable speed with no annoying 'Wow' and 'Flutter,' especially at critical 33⅓ and 45 rpm speeds, for complete elimination of motor noise and 'rumble,' I've found nothing equals a PRESTO turntable. It's heavy . . . it's brilliantly machined . . . . it's the only instrument on which the genuine audiophile should ever allow his records to be played."

Visit the Hi-Fi Sound Salon nearest you to verify Mr. Henderson's comments. Whether you currently own a conventional "one-piece" phonograph—or custom components—we think you'll be gratified with the difference you'll hear when you play your records through custom hi-fi components teamed with a PRESTO turntable. Write for free brochure, *"Skitch, on Pitch,"* to Dept. AN, Presto Recording Corporation, P.O. Box 500, Paramus, N. J.

MODEL T-2 12" "Promenade" turntable (33⅓ and 45) four pole motor, $49.50

MODEL T-18 12" "Pirouette" turntable (33⅓, 45 and 78) four pole motor, $75.00; with Hysteresis motor (Model T-18H), $131.00

MODEL T-68 16" "Pirouette" turntable (33⅓, 45 and 78) four pole motor, $99.00; with Hysteresis motor (Model T-68H), $170.00

WALNUT "PANDORA" Turntable Cabinet by Robert W. Fuldner, $42.50

Hear the difference when you play your records on **PRESTO TURNTABLES**

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THE BRITISH INDUSTRIES

Sounding Board

The Quality-Endorsed Products of the

B.I.C. GROUP

In response to many suggestions, we present a convenient listing of B.I.C. products you will find at leading parts distributors and sound departments throughout the country . . . every one fully guaranteed, with service facilities and spare parts available at all times.

TEAR OUT AND CARRY THIS CARD WITH YOU WHEN BUYING

■ **GARRARD**
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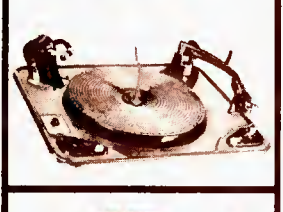
Professional 3-speed transcription turntable. Each speed variable and adjustable. Each player with its own inspection report.

■ **GARRARD**
Model RC88
World's finest record changer. Automatic and manual operation. True-turret drive . . . no belts. 4-pole motor. Foolproof pusher platform.



■ **GARRARD**
Model RC98
The Super Changer! All RC88 features PLUS continuous + or — variable control on each speed.

■ **GARRARD**
Model RC121
Mixer Changer . . . manual and automatic operation. Garrard's most compact, economical unit. 4-pole motor.

■ **GARRARD**
Model "T"
Manual player with automatic start and stop. Compact, efficient units, playing features of famed RC80 changer.

■ **LEAK**
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Britain's finest amplifiers and pre-amplifiers. Amazingly low harmonic distortion of 0.1%. BBC standard setters.

■ **LEAK ARM & DYNAMIC PICKUP**
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■ **GENALEX**
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The Sounding Board

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Loudspeakers
Built under the personal supervision of world-famous engineer, G. A. Briggs. Unique soft suspension of cone.

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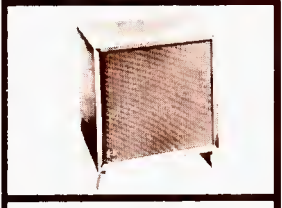
BRIGGS ENCLOSURE
Exclusive sand-filled non-resonant corner enclosure for 3-way speaker system.

■
BOOKS BY G. A. BRIGGS
"Loudspeakers," "Sound Reproduction," "Pianos, Pianists and Sonics," and new book "High Fidelity, the Why and How for Amateurs."



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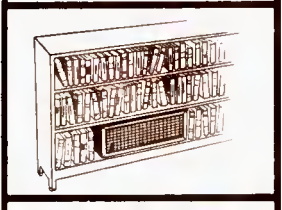
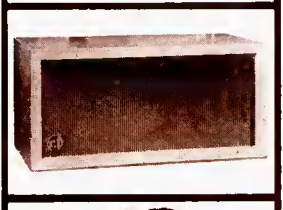
R-J ENCLOSURES
(Floor Model)
The original small space loudspeaker enclosures. Patented R-J design principles. Full, smooth bass; unobstructed highs.



■
R-J ENCLOSURES
(Single & Double Shelf Models)
"Maximum Bass; Minimum Space." Thrilling performance from any loudspeaker because of patented design.



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Equipment and loudspeaker cabinets with panels cut to fit components of all manufacturers.

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RIVER EDGE
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"Do-It-Yourself"
Kits, and assembled, but not painted units. Birch hardwood, takes fine furniture finish.

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Internationally famous for precision, sensitivity, fine workmanship and ruggedness.

■
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World's finest cored solder, made with exclusive Ersin Flux . . . non-corrosive, extra active.

All B.I.C. components are illustrated and fully described in the BIC High Fidelity Plan Book, a useful guide in planning any hi-fi system.

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SIMPLE AS A B C

To make it just as easy as possible for AUDIO's readers to subscribe, order books, get further information about the new products and the new literature mentioned in the pages of the magazine, or to get catalog sheets and brochures describing articles advertised, we provide herewith three cards. We know that many readers are loath to cut coupons from the pages of their favorite magazine because they have told us so. And we know that many times one would like to have complete and thorough data about something he sees in these pages, yet he considers it too much trouble to hunt up paper and envelope—not to mention the stamp—and write a long letter detailing what he wants to know. This is just as simple as we know how to make it with the exception of stenciling each subscriber's name and address on each of the postcards—an operation which would be highly impractical from the printing standpoint. But from now on, when you want more information about something you have seen advertised or mentioned in AUDIO you need only indicate it on the appropriate card, print your name and address, and drop it in the nearest postbox. We pay the postage, and it goes without saying that we wouldn't include these cards if we didn't welcome your use of them. And, for the first time, you can enter your subscription without sending a penny with your order—we'll bill you later. For books, we'll have to ask for the money in advance, but only for books.

Readers have told us that they often want to know more about some of the items mentioned in the *New Products* and *New Literature* pages of the magazine, but that they do not want to take the time and effort to write to each one of the sources individually to get all the information they need. As a matter of fact, in an average issue there are usually ten items in the *New Literature* column, and between ten and fifteen on the *New Products* pages. It is conceivable that the average reader might want information on at least ten of these items, since they are selected with the interests of most of AUDIO's readers in mind. Thus one would have to have ten envelopes, ten sheets of paper, and ten three-cent stamps, together with the need for writing the ten letters and inscribing each with name and address. We do it all for you, assuming that you are willing to circle the items about which more information is desired and to write your name and address once. We will forward your inquiries to the organization involved, and you will receive the data you want with only one inquiry. Isn't that as simple as A B C?

In just the same way you can get more information about any product that is *advertised* in the pages of AUDIO. Note the page on which the advertisement appears and circle it on the back side of this card. When there are two or more ads on the same page, the page number is followed by a letter, and the designation appears under each individual advertisement. Write your name and address clearly—someone has to decipher it—and it is a good idea to mark the card for all the information you want the first time, for there is only one card in each copy of the magazine. Of course, you *could* subscribe to two copies.

B

FOR OFFICE USE

Audio, P. O. Box 629, Mineola, N. Y.

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PLEASE ENTER MY SUBSCRIPTION TO **AUDIO**

FOR:

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2 YEARS - $7 (FOREIGN-$10)

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First Class Permit No. 142, Mineola, N. Y.

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Postage Will be Paid by Addressee

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Please send me the books checked below, postage paid. I enclose check ☐ money order ☐ for $ in full payment.

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☐ **the 3rd Audio Anthology**
Board cover, $3.50

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☐ **Electronic Musical Instruments**
$7.50 in U. S. (All others $8.00)

☐ **AUDIO—Bound Volumes—1955 issues**
$10.00 (In U. S. only)

NAME _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____

To start receiving **Audio** monthly without any effort on your part to locate one on the newsstands or at your jobber's, mark the appropriate boxes with crosses, tear out the card, and drop it into a handy postbox. If you are one of those who always pays in advance, we will accept your check or money order—we do not recommend cash to be sent through the mails—enclose the card in an envelope, and mail. This will cost you an extra three cents, so if you wait until we send you a bill, we'll enclose a business reply envelope for your convenience. We try to make it as easy for you as we know how.

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AUDIO — Please send me further information about the coded items circled below and about those advertised on the circled pages of the February issue.

(PLEASE DO NOT USE THIS CARD AFTER JUNE 1, 1957)

B-1	B-10	C-2	8	29	46	55	63	70	75b
B-2	B-11	C-3	9	31	47	56a	64a	71	75c
B-3	B-12	C-4	10	33	48	56b	64b	72a	75d
B-4	B-13	SB	11	35	49	57	65	72b	75e
B-5	B-14	1	13	39	50	58a	66	73	75f
B-6	B-15	2	14	41	51	59b	67a	74a	75g
B-7	B-16	3	23	43	52	59	67b	74b	75h
B-8	B-17	4	25	44	53	60	68	75a	76
B-9	B-18	5-7	27	45	54	61	69		

NOW IT IS EASIER — ONLY ONE CARD

is necessary to get more information about any New Product or New Literature item, or about any product advertised in these pages.

At the end of each item of **New Literature, New Products,** or **Equipment Reports** you will notice a letter and a number—the letter indicates the month and the number indicates which item it is. All you have to do to get full information about the product or to get the literature described is to circle the appropriate number, add your name and address and mail it to us. We'll do the rest, and you may be sure that we'll be prompt because we are just as anxious for your inquiries to get to their destination as you are—and besides, we don't have room enough around the office to accumulate a lot of cards. Circle one item, if you wish, or all of them—we'll carry on from there. This whole system breaks down if there is a charge for the **New Literature** described, so if you can suggest any improvements in this service, we would appreciate hearing about them.

To get more information about the products that are advertised in each issue of AUDIO—use the new card at the left. Fill in your name and address clearly and circle the number of the page on which the advertisement appears. When there are two or more ads on a page, each one has under it a notation such as Circle 23a, Circle 48b, or Circle 76c and the same numbers appear on the card. Numbers C-2, C-3, and C-4 refer to the covers—C-2 is the inside front cover, C-3 the inside back cover, and C-4 is the outside back cover. SB is "The Sounding Board."

The only way to derive any benefit from this service is to use the card for all the information you want. We think you will find this new system more convenient and that you will use it more and more.

FEBRUARY, 1957 VOL. 41, No. 2
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

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

AUDIOCLINIC ? ?

JOSEPH GIOVANELLI*

NOTE: I have received many letters from readers who felt that perhaps I might not answer a particular question, either because it was too simple or because it was on a non-technical subject. For example, I received a letter from a foreign exchange student who simply wanted to know where, in the city in which he now resides, he could hear stereophonic sound. I answered this for him. It goes without saying that I could not use such a question in my column, since it was a specialized problem, but *all* questions will be answered by mail. The only ones which I cannot answer are those which don't arrive here because of incorrect address, handwriting that cannot be read, and so forth. Nor can I hope to answer a question such as: "Please give me a description of a complete recording studio and FM broadcast station, complete with schematics and instructions for building all parts of the installation." In other words, I answer just about every letter that comes in. If your particular question has not yet received an answer, it is probably because of a considerable amount of correspondence which must be processed. However, please be patient; an answer will come.

Cutting Heads

Q. *I own a disc recorder. I cannot obtain sufficient modulation of the grooves. I suspect that the head is responsible for this, since the amplifier is in working condition. It is not an expensive unit, and there are no markings on the head indicating whether it is crystal or magnetic. Is there any way I can find out? Leonard Sciacca, Davenport, Iowa.*

A. Before abandoning the head as lost, clean the contacts leading from the record-playback switch. A dirty contact will cause a voltage drop across the switch, leaving insufficient voltage to drive the head to normal output. This is more serious with low-impedance units than with those of high impedance, since more current must flow through the switch; any unwanted resistance will, because of the large current, create a larger voltage drop. Check all solder joints on the switch and the connector used to supply signal to the head. Cold joints can act in a manner similar to that of dirty switch contacts.

If all this does nothing except cause strain on your patience, it is more than likely that the head is bad, and now comes the problem of determining what type of head it is. Trace the signal path to the cutting head, working from the head back through switching circuits. If the far side of the switching circuit is fed from a capacitor which, in turn, is connected to the plate of the output tube, the head is a crystal type. If further proof be needed, look for a 50k to 100k resistor connected across the head. This resistor is used to load the head properly. If the circuits lead to a secondary of the output transformer, the winding to which the speaker is attached, the head is a low-impedance magnetic. If the head is fed to a secondary other than that used to actuate the speaker, it might be either kind of head. If the 80,000-ohm resistor is connected across the head, this again indicates a crystal unit. I have seen circuits where this has not been incorporated, so it would be just as well to try a couple of additional things. If you have equipment for resistance measurement, measure the resistance of the secondary of the transformer. If the resistance should be in the range of 75–200 ohms (d.c. resistance), this is probably a high-impedance winding, associated with a crystal cutting head. If the resistance of the winding is 2–10 ohms, it is probably a 500-ohm secondary used with a magnetic cutting head of similar impedance. It is, of course, possible to measure the internal resistance of the head. A crystal head has a high d.c. resistance, perhaps a half-megohm, while that of a magnetic head will be only a few ohms. But if the coil in such a head were defective, it is conceivable that its resistance could rise to approach that of a crystal or could go even to infinity.

If the head can be taken apart, it is extremely likely that it is a magnetic type, a fact which can be easily tested by simply looking for a magnet. The magnet itself might well be the source of trouble. Take the head to a place where magnets are manufactured and have the magnet remagnetized without removing it from the head assembly.

If the head is indeed a crystal type and uses the above-mentioned capacitor to feed it, replace the capacitor. It may have opened, causing there to be too little signal transfer. If this capacitor had shorted, the plate voltage would have passed through the element and destroyed the head, so look at this capacitor before replacing the head with a new one, lest it suffer the same sort of destruction.

If there is still some doubt, write the manufacturer of the recorder, being sure to give the model number, and he will be able to tell you what head to use.

Prefixes

Q. *Since I am new to the audio and electronics hobby, I get rather confused about all these prefixes like micro, kilo, etc. Would you explain them and maybe this time I'll get what the whole thing is all about. Lewis Roxby, Centralia, Illinois.*

A. In electronic work, there are many basic units which we use all the time, such as the volt, ohm, farad, henry, watt, cycle, ampere and mho. In practical applications, we use fractions and multiples of the basic units. It is fortunate that all the coupling and bypass capacitors in a modern high-fidelity amplifier are not one farad each, as a paper capacitor of that value would fill a good-sized living-room. Because of this decimation and multiplication of the basic units, we use prefixes to denote the amount of such alteration. The strength of signals in

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

an area of fringe FM reception might be in the order of two one-millionths of one volt. Our streamlined ways tell us that this is just too much to write, especially when one deals with this type of signal all the time in receiver design work. Thus, we use the prefix *micro,* which denotes one millionth of a something. Thus, two millionths of one volt may be written: two microvolts, or 2 μv. In the case of capacitors, we might have one whose value is one millionth of one millionth of one farad. Since one microfarad is one millionth of one farad, we need only write one millionth of one microfarad. But now the microfarad can be considered a basic unit, and therefore we can write our small fraction of a large unit as one micromicrofarad, or 1 μμf.

Now that you have some idea as to the reasons for their use, all that need be done is to list the prefixes most commonly used, together with their meanings: *Micro* means one millionth of a basic unit, as 3 micromhos. *Milli* means one thousandth of a basic unit, as 6 milliwatts, 6 mw. *Kilo* means one thousand times the basic unit, as one kilowatt, 1 kw. In the parts list for many circuits a resistor may be marked 47k ohms. It is from this root *kilo* that we interpret this to mean 47,000 ohms. *Mega* means one million times the basic unit, as 1 megacycle. In the case of one million ohms, we do not write one megaohms, since the juxtaposition of the two vowels renders it difficult to say. It is therefore written: one megohm. Although it may sometimes appear to be ambiguous, we often write and say one meg when we mean one megohm, but this is never used in any other context, and therefore all ambiguity is removed.

Bypass Capacitors

Q. *Why is a cathode bypass capacitor used with cathode resistor bias in vacuum tube circuits? Arthur Belsen, Brookline, Mass.*

A. Assume a typical circuit with a plate load resistor of 27,000 ohms and a cathode resistor of 3000 ohms. The amplified signal will appear across the plate resistor and the cathode resistor which, for the signal, is in series with it. Since for this example, the ratio of the two resistors is nine to one, 10 percent of the amplified signal will appear across the cathode resistor. This fraction of the amplified signal will appear at the grid of the tube (for the same reason that bias appears at the grid) and 180 deg. out of phase with respect to the original signal. If the gain of the tube were, let us say, five, then for each volt of signal input, 0.5 volt would appear at the grid out of phase and "cancel" part of the original signal. The next result of this is to reduce the amplified output of the tube. If we shunt the cathode resistor with a suitably large capacitor, whose a.c. impedance at the lowest signal frequency is very small, no appreciable fraction of the signal would appear across the cathode resistor and the full gain of the tube would be realized.

The bypass capacitor is also used in places where the common cathode resistor for several circuits might cause common coupling which, in turn would cause negative or positive feedback, depending upon phase relationships of the circuits involved.

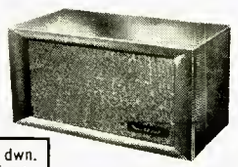
"We're building a HEATHKIT.®..

BECAUSE IT'S SUCH GREAT FUN . . . AND BECAUSE WE GET SO MUCH MORE FOR OUR MONEY!"

Every day more and more people (just like you) are finding out why it's smart to "do-it-yourself" and save by building HEATHKIT high fidelity components. These people have discovered that they get high-quality electronic equipment at approximately one-half the usual cost by dealing directly with the manufacturer, and by doing their own assembly work. It's real fun—and it's real easy too! You don't need a fancy work shop, special tools or special knowledge to put a Heathkit together. You just assemble the individual parts according to complete step-by-step instructions and large picture-diagrams. Anyone can do it!

Heathkit Model SS-1 Speaker System Kit

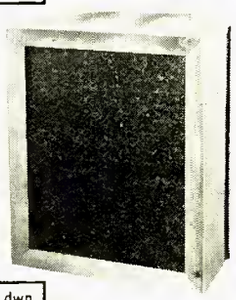
This high fidelity speaker system is designed to operate by itself, or with the range extending unit listed below. It covers the frequency range of 50 to 12,000 CPS within ± 5 db. Two high-quality Jensen speakers are employed. Impedance is 16 ohms, and power rating is 25 watts. Can be built in just one evening. Shpg. Wt. 30 lbs. **$39.95**



$4.00 dwn.
$3.36 mo.

Heathkit Model SS-1B Speaker System Kit

This high fidelity speaker system kit extends the range of the model SS-1 described above. It employs a 15" woofer and a super-tweeter to provide additional bass and treble response. Combined frequency response of both speaker systems is ± 5 db from 35 to 16,000 CPS. Impedance is 16 ohms, and power is 35 watts. Attractive styling matches SS-1. Shpg. Wt. 80 lbs. **$99.95**



$10.00 dwn.
$8.40 mo.

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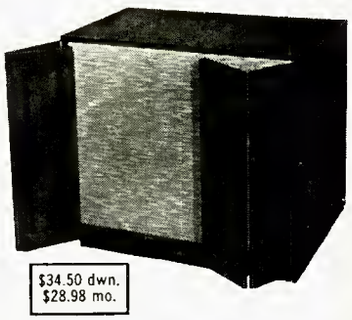
Months of painstaking engineering by Heath and Altec-Lansing engineers has culminated in the design of the Legato, featuring "CP" (critical phasing) and "LB" (level balance). The result is a *new kind* of high fidelity sound, to satisfy even the most critical audio requirements. Two high-quality 15" theater-type speakers and a high-frequency driver with sectoral horn combine to cover 25 to 20,000 cycles without peaks or valleys. "CP" and "LB" assure you of the smooth, flat audio response so essential to faithful reproduction. Choice of two beautiful cabinet styles below.

"Legato" Traditional Model HH-1-T

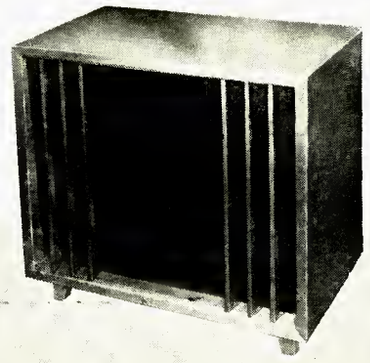
Styled in classic lines to blend with period furniture of all types. Doors attractively paneled. African mahogany for dark finishes unless you specify imported white birch for light finishes. Shpg. Wt. 246 lbs. **$345.00**



$34.50 dwn.
$28.98 mo.

"Legato" Contemporary Model HH-1-C

This fine cabinet features straightforward design to blend with your modern furnishings. Slim, tapered struts run vertically across the grille cloth to produce a strikingly attractive shadowline. Wood parts are precut and predrilled for simple assembly. Supplied in African mahogany for dark finishes unless you specify imported white birch for light finishes. Shpg. Wt. 231 lbs. **$325.00**



$32.50 dwn.
$27.30 mo.

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By Choosing the Heathkit Components
That Best Suit Your Particular Needs.

As the world's largest manufacturer of electronic equipment in kit form, Heath Company can provide you with a maximum variety of units from which to choose. You can select just the amplifier you need from five different models, ranging in power from 7 watts to 25 watts, some with preamplifiers, and some requiring a separate preamplifier. You can pick your speaker system from four outstanding high fidelity units ranging in price from only $39.95 to $345.00. You can even select a fine Heathkit FM or AM Tuner! Should there be a question in your mind about the requirements of an audio system, or about planning your particular hi-fi installation, don't hesitate to contact us. We will be pleased to assist you.

MATCHING CABINETS . . .
The Heath AM Tuner, FM Tuner and Preamplifier are housed in matching satin-gold finished cabinets to blend with any room decorating scheme. Can be stacked one over the other to create a central control unit for the complete high fidelity system.

MODEL FM-3A MODEL BC-1 MODEL WA-P2

PRE-ALIGNED TUNERS . . .
A unique feature of the Heathkit AM and FM Tuners is the fact that both units are pre-aligned. A signal generator is not necessary! IF and ratio transformers are pretuned at the factory, and some front-end components are preassembled and pretuned. Another "extra" to assure you of easy kit assembly.

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EASY TIME PAYMENTS . . . We invite you to take advantage of the Heath Time Payment Plan on any order amounting to $90.00 or more. Just 10% down and the balance in twelve monthly payments. WRITE FOR COMPLETE DETAILS.

HIGH FIDELITY SYSTEM

1 HEATHKIT HIGH FIDELITY FM TUNER KIT Features AGC and stabilized, temperature-compensated oscillator. Sensitivity is 10 microvolts for 20 db of quieting. Modern circuit covers standard FM band from 88 to 108 mc. Employs ratio detector for efficient hi-fi performance. Power supply is built in. Illuminated slide rule dial for easy tuning. Housed in compact satin-gold enamel cabinet. Features prealigned transformers and front end tuning unit. Shpg. Wt. 7 lbs.

MODEL FM-3A Incl. Excise Tax (with cab.) **$25.95**
$2.60 dwn., $2.18 mo.

2 HEATHKIT BROADBAND AM TUNER KIT This fine AM Tuner was designed especially for use in high fidelity applications, and features broad bandwidth, high sensitivity and good selectivity. Employs special detector circuit using crystal diodes for minimum signal distortion, even at high levels. Covers 550 to 1600 kc. RF and IF coils are prealigned. Power supply is built in. Housed in attractive satin-gold enamel cabinet. Shpg. Wt. 8 lbs.

MODEL BC-1 Incl. Excise Tax (with cab.) **$25.95**
$2.60 dwn., $2.18 mo.

3 HEATHKIT HIGH FIDELITY PREAMPLIFIER KIT This preamplifier meets or exceeds specifications for even the most rigorous high fidelity applications. It provides a total of 5 inputs, each with individual level controls. Hum and noise are extremely low, with special balance control for absolute minimum hum level. Tone controls provide 18 db boost and 12 db cut at 50 cps, and 15 db boost and 20 db cut at 15,000 cps. Four-position turnover and four-position rolloff controls for "LP", "RIAA", "AES", and "early 78" equalization. Derives power from main amplifier, requiring only 6.3 VAC at 1A and 300 VDC at 10MA. Beautiful satin-gold enamel finish. Shpg. Wt. 7 lbs.

MODEL WA-P2 (with cab.) **$19.75**
$1.98 dwn., $1.66 mo.

4 HEATHKIT ADVANCED-DESIGN HI-FI AMPLIFIER KIT This fine 25-watt high fidelity amplifier employs KT66 output tubes by Genalex and a Peerless output transformer for top performance. Frequency response ± 1 db from 5 to 160,000 cps at 1 watt. Harmonic distortion less than 1% at 25 watts, an IM distortion less than 1% at 20 watts. Hum and noise are 99 db below 25 watts. Output impedance is 4, 8 or 16 ohms. Extremely stable circuit with "extra" features.

MODEL W-5: Consists of W-5M *plus* WA-P2 Preamplifier
Shpg. Wt. 38 lbs. Express only **$79.50** $7.95 dwn. $6.68 mo.

MODEL W-5M
$59.75 $5.98 dwn. $5.02 mo.
Shpg. Wt. 31 lbs. Express only

5 HEATHKIT DUAL-CHASSIS HI-FI AMPLIFIER KIT This 20-watt Williamson-type amplifier employs the famous Acrosound model TO-300 output transformer, and uses 5881 tubes. Frequency response is ± 1 db from 6 cps to 150 kc at 1 watt. Harmonic distortion less than 1% at 21 watts, and IM distortion less than 1.3% at 20 watts. Output impedance is 4, 8 or 16 ohms. Hum and noise are 88 db below 20 watts.

MODEL W-3: Consists of W-3M *plus* WA-P2 Preamplifier
Shpg. Wt. 37 lbs. Express only **$69.50** $6.95 dwn. $5.84 mo.

MODEL W-3M
$49.75 $4.98 dwn. $4.18 mo.
Shpg. Wt. 29 lbs. Express only

6 HEATHKIT SINGLE-CHASSIS HI-FI AMPLIFIER KIT This 20-watt Williamson-type amplifier combines high performance with economy. Employs Chicago-Standard output transformer and 5881 tubes. Frequency response ± 1 db from 10 cps to 100 kc at 1 watt. Harmonic distortion less than 1.5% and IM distortion less than 2.7% at full output. Output 4, 8 or 16 ohms. Hum and noise—95 db below 20 watts.

MODEL W-4A: Consists of W-4AM *plus* WA-P2 Preamplifier
Shpg. Wt. 35 lbs. Express only **$59.50** $5.95 dwn. $5.00 mo.

MODEL W-4AM
$39.75 $3.98 dwn. $3.34 mo.
Shpg. Wt. 28 lbs. Express only

7 HEATHKIT 20-WATT HIGH FIDELITY AMPLIFIER KIT Features full 20 watt output using push-pull 6L6 tubes. Built-in preamplifier provides four separate inputs. Separate bass and treble controls. Output transformer tapped at 4, 8, 16 and 500 ohms. Designed for home use, but also fine for public address work. Response is ± 1 db from 20 to 20,000 cps. Harmonic distortion less than 1% at 3 db below rated output. Shpg. Wt. 23 lbs.

MODEL A-9B **$35.50**
$3.55 dwn., $2.98 mo.

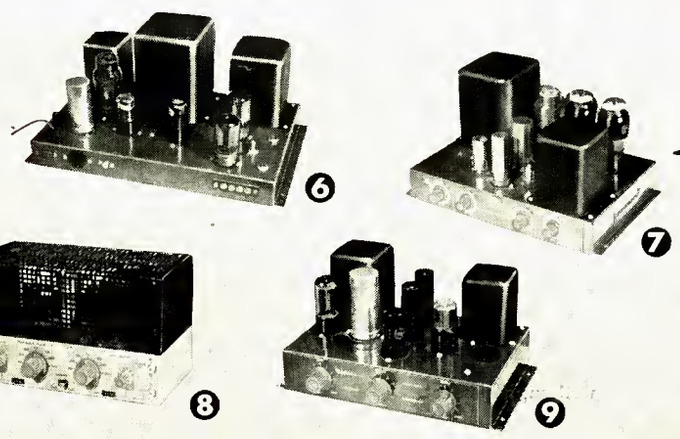
8 HEATHKIT ELECTRONIC CROSS-OVER KIT This device separates high and low frequencies electronically, so they may be fed through two separate amplifiers driving separate speakers. Eliminates the need for conventional cross-over. Selectable cross-over frequencies are 100, 200, 400, 700, 1200, 2000 and 3500 cps. Separate level controls for high and low frequency channels. Attenuation 12 db per octave. Shpg. Wt. 6 lbs.

MODEL XO-1 **$18.95** $1.90 dwn., $1.59 mo.

9 HEATHKIT 7-WATT ECONOMY AMPLIFIER KIT Qualifies for high fidelity even though more limited in power than other Heathkit models. Frequency response is ± 1½ db from 20 to 20,000 cps. Push-pull output and separate bass and treble tone controls. Good high fidelity at minimum cost. Uses special tapped-screen output transformer.

MODEL A-7E: Same as A-7D except one more tube added for extra preamplification. Two inputs, RIAA compensation and extra gain.
Shpg. Wt. 10 lbs. Incl. Excise Tax **$19.95** $2.00 dwn. $1.68 mo.

MODEL A-7D
$17.95 $1.80 dwn. $1.51 mo.
Incl. Excise Tax
Shpg. Wt. 10 lbs.



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LETTERS

Crossover Networks

SIR:

Mr. Boegli's article "Interference Effects with Crossover Networks" in the November issue was quite interesting, and his point that speakers should be connected out of phase to parallel constant-resistance crossover networks is quite valuable, as many writers fail to point this out in articles on this subject. Few people seem to be aware of this important point, I have found.

However, I must disagree with his *Fig* 2, based on Eq. (*4*), which indicates that there is a twofold increase in sound output at the crossover point. Mr. Boegli's equation is correct, but when he applied it he overlooked the fact that each speaker works into the air load independently of the other so that the vector sum or difference of the two speaker voltages is working into double the impedance of either speaker alone. Under these conditions, each speaker is giving out half the total power at the crossover frequency. If phased correctly, the total sound output is unity relative to either end of the frequency spectrum.

Unfortunately, Mr. Boegli has carried his error into later parts of his work, and shows total power outputs at certain frequencies which are higher than the total input to the network. This defies energy considerations, as I shall attempt to show.

If we assume resistive speakers, dissipationless networks, and a constant-voltage source, as Mr. Boegli has done, and solve the expression for the input impedance of the network with speakers connected, we obtain a pure resistance, equal to the resistance of one speaker, which is a constant at all frequencies.

Hence, the power delivered to the network is constant at all frequencies. Since the network has no dissipation in its elements, except for the speakers, this power must ultimately find its way to the speakers, the fraction of the total power reaching each speaker depending on the frequency as determined by the network.

The important point to note, however, is that there is a constant amount of power available, which must be absorbed by the speakers and their air load. It is seen, then, that no matter how the sound of the two speakers is phased, the total sound power output cannot exceed a fixed value, which is approached at either end of the frequency spectrum, assuming perfect speakers of constant efficiency as Mr. Boegli has done.

The only effect of phase differences between the sound from each speaker is to make the total sound output assume some value less than, or equal to, this limiting value.

Mr. Boegli shows rises above this limiting value of power (0 db on his curves). This would require an increase in the power input to the network, which we have seen does not occur for a constant-resistance network, or else it would require an increase in efficiency, which is contrary to our necessary assumption of ideal, constant-efficiency speakers. The only remaining explanation would be that the Conservation of Energy law does not hold.

In spite of presenting this viewpoint, I do not wish to detract in any way from the value of Mr. Boegli's article.

S. PENSTONE, Prof. Eng.,
Queens University,
Department of Electrical Engrg.
Kingston, Ontario, Canada

Baffle Credit Baffling

SIR:

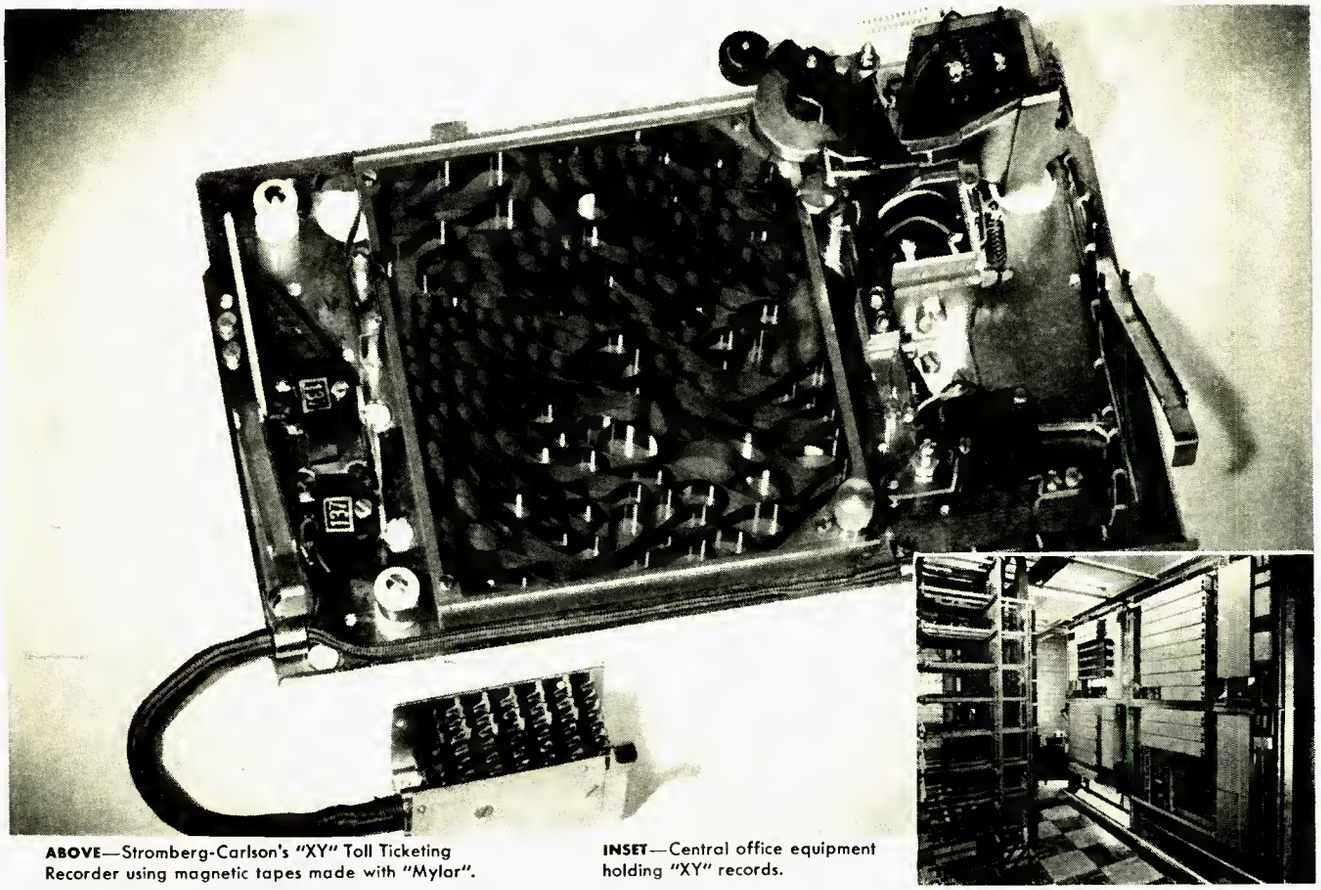
I read with considerable interest Mr. Jordan's article on "Baffles Unbaffled" (part 2) in the September issue. But is he not wrong in saying that corner horn loudspeakers were "first introduced" by Klipsch? Should not priority be awarded to the Voigt loudspeaker which Mr. Jordan also describes. True, in the Voigt instrument the lowest frequencies of all were handled by the tapered-pipe bass chamber but most of the audio range was handled by the horn which had a mouth area of nearly four square feet and was arranged for corner mounting in order to quadruple this area in effect. This loudspeaker was introduced in 1934.

This was a remarkable instrument for that date—and is still, for that matter—for mine, though with a newer diaphragm, still produces results which I regard as hard to beat. Even the original diaphragm, with twin cones, had a very wide range and was used with a magnet which produced over 17,000 gauss, though it needed 40 watts of energising to do it. The diffusing cone over the horn produced high-note distribution which was well nigh perfect.

W. J. CLUFF,
2, Beech Walk,
London, N. W. 7, England

New Stromberg-Carlson equipment speeds up telephone service...cuts cost!

Heart of system is automatic recorder using tape made of Du Pont "Mylar"



ABOVE—Stromberg-Carlson's "XY" Toll Ticketing Recorder using magnetic tapes made with "Mylar".

INSET—Central office equipment holding "XY" records.

Thanks to Stromberg-Carlson's new "XY" Toll Ticketing system, independent telephone companies are now able to speed up service while cutting equipment and operational costs.

The system works like this: When a customer dials, all pertinent data—such as numbers involved, rate and duration of call—is recorded on magnetic tape formed into an endless loop in its own magazine. The tape, 35 feet long, holds up to 50 completed calls. When the "read-out" equipment is ready, the recorded information is translated into impulses that actuate billing equipment.

Why tape made with "Mylar"?

"We selected magnetic recording tape made with 'Mylar'* polyester film after a long period of testing," reports Mr. J. D. McKay, design engineer of Stromberg-Carlson, division of General Dynamics Corporation. "We had to be sure the tape was tough enough to withstand the grueling stops and starts of the recorder. We had to be sure the tape was dimensionally stable—not be affected by humidity. But, most important, the tape had to be economical—it had to provide long-lasting service with a minimum number of magazine changes."

This is but one of the hundreds of new uses industry has found for magnetic recording tape made with "Mylar". Computer manufacturers, geologists, audio and video engineers for TV broadcasting, archivists, and guided missile manufacturers are switching to recording tapes made with "Mylar" because of thinner tape, better performance and longer life. If you're interested in more information on "Mylar"—or how tapes made with "Mylar" can help you speed up service while cutting costs—send in coupon below.

**Du Pont manufactures the base material "Mylar"—not finished magnetic recording tape. "Mylar" is a registered trademark for Du Pont's brand of polyester film.*

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☐ Please send your booklet listing properties, applications and types of "Mylar" available.

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NEW LITERATURE

• **Rockbar Corp.,** 650 Halstead Ave., Mamaroneck, N. Y., American distributor of the English-made Goodmans loudspeaker systems, is offering a free pamphlet of reprints of articles on the basic principles of speaker operation, Acoustical Resistance Units, and friction-loaded enclosures. This publication is certain to be of distinct interest to all hi-fi fans. **B-9**

• **H. H. Scott. Inc.,** 385 Putnam Ave., Cambridge, Mass., explains high fidelity in simple, non-technical language in a new illustrated booklet which will be mailed free upon written request. A question-and-answer section explains the advantages of component high fidelity and details the function of each component. In addition, the booklet contains a handy hi-fi planning guide. Complete specifications of all new H. H. Scott equipment are also included. Requests for free copy should be addressed to Dept. NR-12. **B-10**

• **The R. T. Bozak Sales Company,** Box 966, Darien, Conn., is now distributing a new 8-page catalog which, in addition to listing and illustrating various Bozak speaker systems, contains a wealth of material on speaker design. Handsomely printed and tastefully styled, this catalog will be found extremely informative in its discussion of the various criteria which determine speaker performance. Available free on written request. **B-11**

• **Carter Motor Company,** 2711 W. George St., Chicago 18, Ill., will mail free a copy of Bulletin No. 1256A, which describes the company's new custom converters and dynamotors for operation of industrial communications systems. Both converters and dynamotors are available in several models with a wide selection of a.c. and d.c. input voltages, and output specifications to 750 watts. The bulletin is printed in two colors and is punched for standard binders. **B-12**

• **Fairchild Recording Equipment Company,** 10-40 45th Ave., Long Island City, N. Y. has just published an interesting 16-page booklet titled "How Good Is Your Arm." Clearly written, informative and well illustrated, the booklet is an excellent treatise on the various basic problems involved in the design of a professional quality tone arm at modest price. Written in simple-to-understand language and illustrated with numerous charts, it covers such important aspects of tone arm design as resonance, tracking, tracking error, torsional resonance, and pivot construction. This is an excellent booklet, available free on written request. **B-13**

• **Racon Electric Co., Inc.,** 1261 Broadway, New York 1, N. Y., has just issued a 4-page bulletin covering four typical high-fidelity speaker enclosures which have been tested in the Racon laboratory, and whose simplicity of design permits easy home construction. The bulletin incorporates working drawings as well as wiring diagrams for multi-speaker systems. Will be mailed free on request. **B-14**

COMING EVENTS

Feb. 4–8—West Coast Convention of the Audio Engineering Society, Ambassador Hotel, Los Angeles. Annual banquet on evening of Feb. 4 in Cocoanut Grove; papers presented on Feb. 7–8. Grant Graham, Triad Transformer Co., Venice, Calif., section chairman.

Feb. 6–9—Los Angeles High Fidelity and Music Show, presented by the Institute of High Fidelity Manufacturers. Ambassador Hotel, Los Angeles.

Feb. 15–18—San Francisco High Fidelity and Music Show, presented by the Institute of High Fidelity Manufacturers. Hotel Whitcomb, San Francisco.

March 18–21—IRE Annual Convention and Radio Engineering Show. The Coliseum, New York City.

Apr. 9–11—Fourteenth Annual British Radio Component Show, Great Hall, Grosvenor House, Park Lane, London, W. 1, England. Admission by ticket only, obtainable from the Radio and Electronic Component Manufacturers' Federation, 21, Tothill Street, London, S.W. 1.

EDITOR'S REPORT

BUSY MONTH IN THE WEST

HI-FI'S BUSIEST CALENDAR MONTH for 1957 is just around the corner, so to speak, and by the time this is read it is likely that many people will have attended the Los Angeles High Fidelity Show or will be on their way there. And for those not so convenient to Los Angeles, there is also one in San Francisco. The setting in Los Angeles is the Ambassador Hotel, and the exhibit rooms are all situated in the garden apartments behind the main hotel building, providing more spacious quarters than any previous hi-fi show and considerably more attractive rooms. We look forward to an interesting show and confidently expect it will break all records for attendance. This is the first time that the Institute of High Fidelity Manufacturers has presented a show in Los Angeles, and it is sure to equal last September's New York show. The dates—February 6, 7, 8, and 9.

In San Francisco the show will be held in Hotel Whitcomb, beginning on February 15 and continuing through the 18th, and also presented by the IHFM. Most of the exhibitors in the L.A. show are simply moving north during the intervening days to attend the second affair, along with their equipment. Hope we'll see you there.

IMPACT OF AUDIO SHOWS

That the high-fidelity industry is growing apace there can be no doubt—if measured by nothing more than the attendance at shows throughout the country. With the advent of the Rigo Enterprises shows in some of the cities where none had ever been held before, attendance seems to be better in proportion to population than in those areas where the shows have become annual or bi-annual affairs. The obvious answer is that people want to know about hi-fi—no matter where they are.

Mexico City's second show was held last October, with an attendance of ourself and 18,499 other people—more than twice the previous year's crowd. After that show finished, we were privileged to circle through the Caribbean—touching at Havana, Kingston, Port-au-Prince, and San Juan. Intent on vacationing, we learned almost nothing about the Cuban show, but rumors tell us that there was one.

In Kingston, Jamaica, there had been no shows, but for at least two October Sundays there were long articles in *The Sunday Gleaner* on the subject of hi-fi. Peter Orr wrote about "The Craze for Hi-Fi" on October 14, and D. Cross offered a rebuttal on the 28th. That his thinking is like ours is best indicated by the following quotation:

"I suppose I am a 'Hi-Fi' fan, but that very expression is much abused and misused. Many dealers today, with a line of radios or gramophones to sell—good, bad, or indifferent—*dishonestly* advertise them as 'High Fidelity' goods." The italics are ours—we rarely speak so plainly in public. At least there was a lively discussion about hi-fi with considerable veiled vituperation in the conservative British Letters-to-the-Times tradition. We liked it, and would have enjoyed getting into the fracas if we had only been equipped with the leisure (and the conservatism) to do so.

In Haiti, where there are some hundred and fifty hi-fi installations in Port-au-Prince alone, and where money is scarce and import duty a mild 45 per cent, we were privileged to hear as fine an example of loudspeaker system as anyone would want. Large, to be sure, but then it works outdoors on a porch-like terrace and needs no corner for proper bass. We have a full description of this device, and it should appear in the April issue.

We will continue this next month.

VOICE IN THE WILDERNESS

The New York listeners to WBAI-FM have been fortunate over the past nine months in having a sound and clear voice speaking out for *quality, component* hi-fi in the person of one T. S. "Skip" Weshner. Only recently has his material been syndicated over WTMH-FM, Providence and WMFQ, Hartford, giving full coverage of the Boston area and southern New England. Skip—who describes himself as having been successively, a TV producer, Audio Ignoramus, frantic hobbyist, importunate purchaser, and audio salesman—produces and announces his "Accent on Sound" program on which you are likely to hear anything from Congo drums to Couperin, Palestrina to *paso dobles,* as well as airplanes, birdcalls, Chinese gongs, dogbarks, and so on through the alphabet. In other words, he brings an open mind to his programs—which, in spite of the alliteration, leans heavily toward music. Much of the material he plays you may never have heard before, and perhaps you won't want to hear it again, but at least he gives the composers a chance.

But when he begins to talk about hi-fi Skip is on solid ground, and certainly no longer an Audio Ignoramus. Bringing a practical aspect to everything he says, his talks would make a good book with the real low-down on some of the more controversial subjects. If you can plan your reading so as to spare an hour every weekday from your favorite magazine to listen to Skip we believe you would be well repaid, and we respectfully commend him to you.

ADDITION TO THE BRIGGS ARTICLE

Too late to be included in the main body of Gilbert Briggs' article in this issue is a footnote he sent back with his galley proofs, as follows:

"Since I finished writing this article, I have seen the interesting letter from Mr. Nunn which appeared in your January issue.

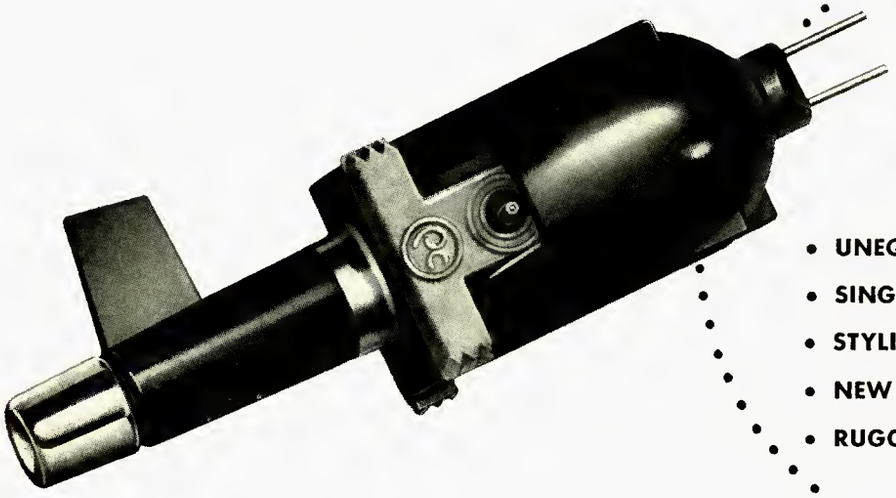
"I think it is possible that the volume levels used in his tests were 6 to 8 db higher than I should use at home, and the speaker system may be 2 or 3 db lower in sensitivity; this would balance Mr. Nunn's 120-watt requirements with my modest 10 to 15 watts.

"I was pleased that Mr. Nunn wated to come to my defence; this is Goliath defending David with a vengeance!"

FLASH!

At closing time, the Institute of High Fidelity Manufacturers announced the results of its annual election of officers and directors. Leonard Carduner (British Industries Corp.) was elected Secretary and Milton Thalberg (Audiogersh Corp.) was chosen for Treasurer, both by unanimous vote. Four Directors were elected for two-year terms: Joseph N. Benjamin (Pilot Radio Corp.), William Grommes (Precision Electronics), Walter O. Stanton (Pickering & Co. Inc.), and Lawrence Epstein (University Loudspeakers, Inc.). Bernard Cirlin (Stephens Manufacturing Corp.) was elected Director for a one-year term. George Silber (Rek-O-Kut Co.) remains in office as President for the second year of his term, as does Walter Jablon (De Jur-Amsco Corp.) as Vice-President. Avery Fisher (Fisher Radio Corp.) and Sidney Harman (Harman-Kardon) continue as Directors for the second year of their terms. ●

Fluxvalve



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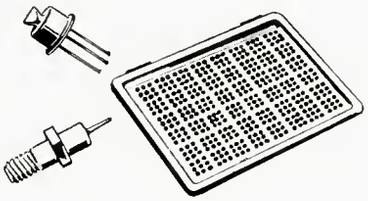
New technique shapes future of transistors...
LEADS TO THREE MAJOR INVENTIONS



Calvin S. Fuller, Ph.D. in Physical Chemistry from the University of Chicago, is a pioneer in development of the diffusion technique. Here he controls a heating current through a strip of silicon while diffusing into its surface a film of aluminum less than 1/50th of a hair's breadth in thickness.

Transistor makers have a very difficult problem. They must add a mere trace of an "impurity" to a semiconducting metal. But they must add it only in very thin layers, without affecting the bulk of the material.

Bell Laboratories scientists developed an efficient new way to produce such layers. They expose the metal to a hot gas containing the impurity. Atoms bombard the surface and—through a process known as "diffusion"—force their way into the metal to form a microscopic film which can be controlled in thickness to a few millionths of an inch.

The diffusion technique opened the way to three major Bell Laboratories inventions in the semiconductor field: the Bell Solar Battery, Silicon Power Rectifier and the Diffused Base Transistor. Right now the technique is providing a key to many other developments of great promise for telephony. It is another example of how Bell Labs works to improve telephony through fundamental research in materials.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

High-Impedance Mixing for Professional Audio Equipment

GEORGE L. AUGSPURGER*

Where cost is a factor in the construction of mixer consoles, the use of the circuitry described by the author may be advisable, particularly as it is possible to achieve equivalent results if sufficient care is taken in both design and construction of the equipment.

Recently, while flying home in a DC-6, the door to the cockpit opened and I caught a glimpse of the spectacular array of dials, levers, switches, and lights and indicators which form the control system of a modern airliner. The other passengers seemed as interested in this complex maze as myself and I heard a lady in the seat ahead of me murmur to her friend, "It looks just like my husband's hi-fi system." The comparison isn't really too far-fetched. Today almost any audiofan can nonchalantly twiddle a battery of knobs and switches which would have panicked a professional audio engineer a few years ago. As a matter of fact, one of the newer hi-fi preamps is nothing less than a small professional mixing console complete with calibrated VU meter.

In the dark ages before hi-fi only a broadcast engineer would have been interested in the design of high-quality audio mixers, but the advent of the fidelity cult has extended the use of such equipment to recording studios, schools, institutional sound systems, and even elaborate home installations. Most sound technicians, even broadcast engineers, are still afraid to trust any but well-known commercially built broadcast consoles. The truth is that any engineer capable of building a satisfactory high-quality amplifier can design and build a professional audio mixing console. If suitable circuits are used, the cost of such a unit can be held to about half that of comparable commercial equipment.

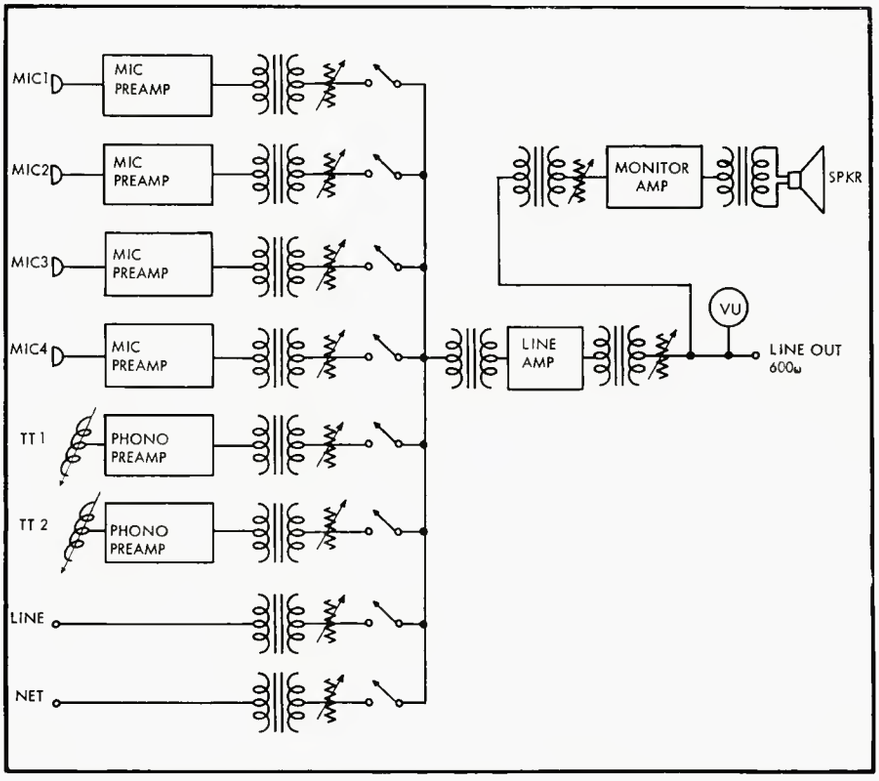


Fig. 1. Simplified functional diagram of eight-channel mixing console.

Let's take a look at the functional diagram of a standard broadcast audio console. *Figure* 1 shows a single program console with eight input channels. Each of the eight inputs has its own transformer so that the mixing bus works at an impedance of 150, 250, or 600 ohms. Attenuators are all low-noise, constant-impedance, step-type controls. Almost all commercial audio consoles follow this basic design plus the possible addition of another program channel, phonograph cueing facilities, monitor amplifiers, speaker muting relays, and any number of other special features which prove desirable in broadcast work. The point is that transformers and attenuators are both costly components. A good audio transformer such as those feeding the mixing circuit costs from fifteen to twenty dollars. The step-type attenuators run from seven to twelve dollars each. These components alone account for about $220.00 of the cost of an eight-channel console. Of course the manufacturer probably doesn't pay that much, but if you or I decided to build such a unit the estimate is accurate.

Is there any way to eliminate some of these expensive controls and transformers without deteriorating the overall performance? Well, there's always the familiar high impedance circuit used in PA work, *Fig.* 2. Using ten-cent resistors and 75¢ potentiometers the total cost of an eight-channel high-impedance circuit is only $8.30, a saving of $211.70 —eureka! In practice, our simplified circuit has four major drawbacks:

1. Preamps, mixing bus, and line ampli-

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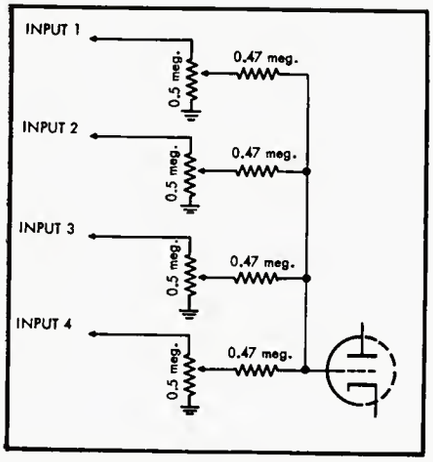

Fig. 2. Simplified schematic of input circuits employed in high-impedance mixing.

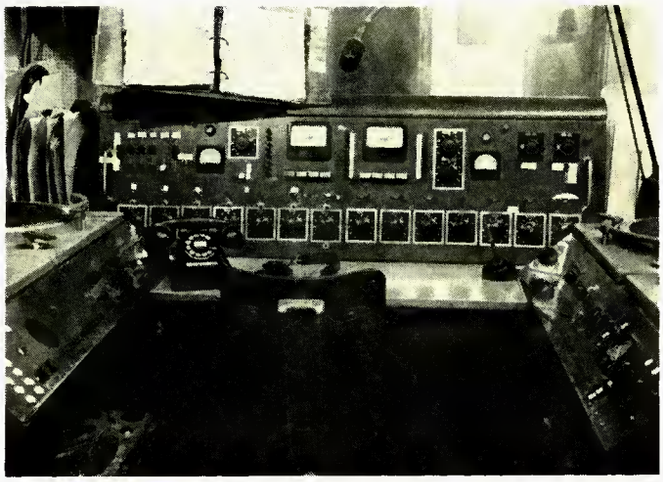

Fig. 3. (left). Complete high - impedance console in use at KTYL, Mesa, Arizona.

fier all have to be close together. The more shielded wire we use, the more trouble we have trying to keep high frequencies from vanishing.

2. Extreme care in layout and wiring is required. Crosstalk and hum precautions are much more critical than with low-impedance mixing.
3. Without the isolation provided by transformers, ground loops can easily become a source of trouble.

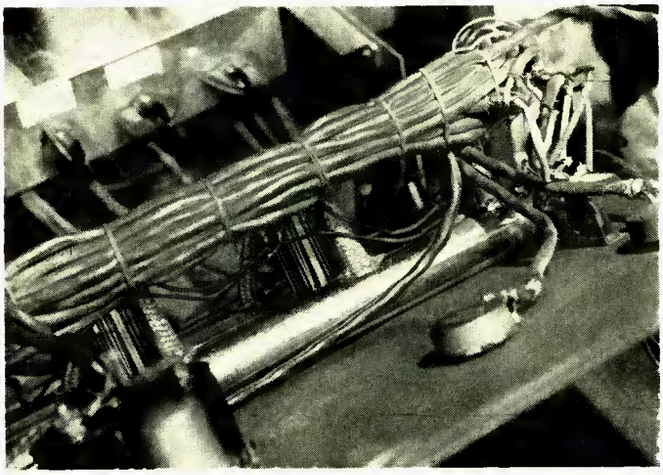

Fig. 4 (left). Low-capacitance shielding consists of 1-in. aluminum tubing.

4. Ordinary volume controls can not be calibrated accurately and tend to become noisy and intermittent after comparatively little use.

Avoiding the Disadvantages

In spite of these imperfections, the savings in dollars and cents is so attractive that it's worthwhile to see if there isn't a solution to the problems enumerated. There is no way to avoid the necessity for a compact physical layout, but this isn't really serious since nobody wants a console that spreads over half the room anyway. Only in extremely complex network control equipment is space so crowded that the preamps have to be located some distance from the mixing busses. As for careful layout and wiring, it is true that high-impedance circuits are tricky, but no more than an FM receiver for example. If low-capacitance shielding and careful grounding are used, the frequency response, hum, and crosstalk will meet the standards of factory-built equipment.

We do have to find a substitute for ordinary receiver volume controls. One possibility is to use high-quality step-type potentiometers. These are made and calibrated similarly to low-impedance attenuators, but they cost quite a bit less than their constant-impedance counterparts. Another alternative is the molded carbon control made by Ohmite. This unit cannot be calibrated as accurately as a step-type control, but I've never seen anyone use the calibration on mixer controls anyway. Molded carbon units are quiet, sturdy, and long lasting. In actual use they seem to give almost as good service as the most expensive professional attenuators.

There is another important advantage to the continuously variable control. Step-type attenuators are designed so that the jump in output level between adjacent steps is not ordinarily audible, but conditions often occur during which the audio engineer is forced to work a control in the bottom third of its range. Under this limitation smooth mixing and fading are impossible. The carbon control, on the other hand, provides smooth quiet adjustment regardless of the incoming signal level.

So far, high-impedance mixing looks fine in theory. "But if this circuit actually works and is so much cheaper," you are saying, "why don't commercial consoles use it?"[1] There are several reasons: low-impedance design is actually more stable than a high-impedance mixer, it will survive all sorts of tinkering and abuse which would send our alternative circuit into fits of indignant oscillation, and low-impedance circuits are less apt to become saturated with stray r.f. currents near broadcast transmitters.

Some high-quality equipment using high impedance mixing is in use right now. A design is described by F. Langford Smith in the latest *Radiotron Designer's Handbook* on page 792. The unit is manufactured by Amalgamated Wireless Australasia Ltd. and is known as the Consolette G-52107. The console has four input channels and a single program output. The insertion loss of the mixing circuit is 12 db, and the maximum interaction between controls is about 4 db. This unit meets broadcast standards as to distortion, noise, and frequency response. The total harmonic distortion is actually less than 1 per cent at 18 dbm output.

[1] Since this manuscript was originally prepared a new series of professional broadcast consoles using high-impedance mixing has been marketed by R.C.A.

Fig. 5 (right). Smaller high-impedance console used at KTYL's FM station.

Station-Designed Console

In contrast to the fairly simple Australian design is the massive console shown in *Fig.* 3. This is the main control console of station KTYL in Mesa, Arizona. The design provides dual programming controlling both FM and AM transmitters. Notice the fourteen input channels in this console. The task of designing a high-impedance mixing circuit having fourteen inputs, each of which can be switched to either of two program amplifiers, an insertion loss of 23 db, to be installed within ten feet of an AM transmitter seems to be almost impossible. Yet under these conditions the KTYL console, designed by station manager Dwight Harkins, gives flat response from 30 to 18,000 cps with less than 1 per cent distortion. With an output of 18 dbm from one program line and no signal on the other, there is no audible crosstalk regardless of the position of any of the gain controls. The molded carbon controls have been in constant use for over five years with no need for service or replacement.

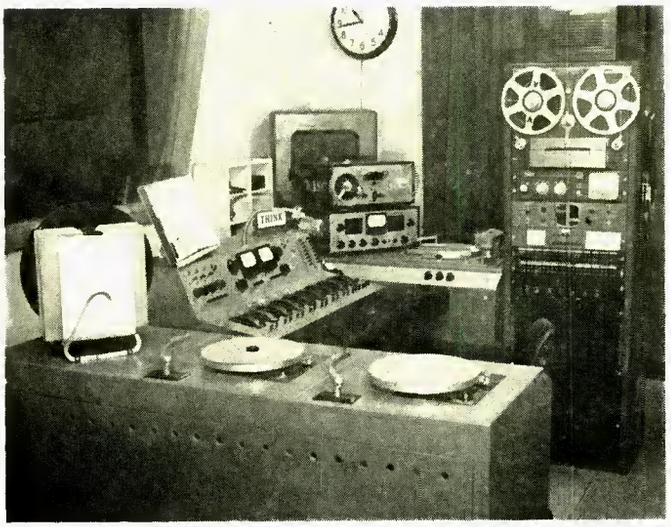

Fig. 6 (right). Control room of KASC—a wired-wireless station on the campus of Arizona State College at Tempe.

Figure 4 shows a close-up of the KTYL mixing bus. To keep shielding capacitance to a minimum the wire is run through one-inch aluminum tubing with low-capacitance shielded leads connecting to each channel control switch. The mixing circuit is the same as that following the preamp in *Fig.* 9. All of the preamps, and both program amplifiers are built on a single aluminum chassis immediately behind the front panel. This single chassis construction plus extreme care in layout and grounding is responsible for the exceptional performance of this custom-built con-

(*Continued on page 70*)

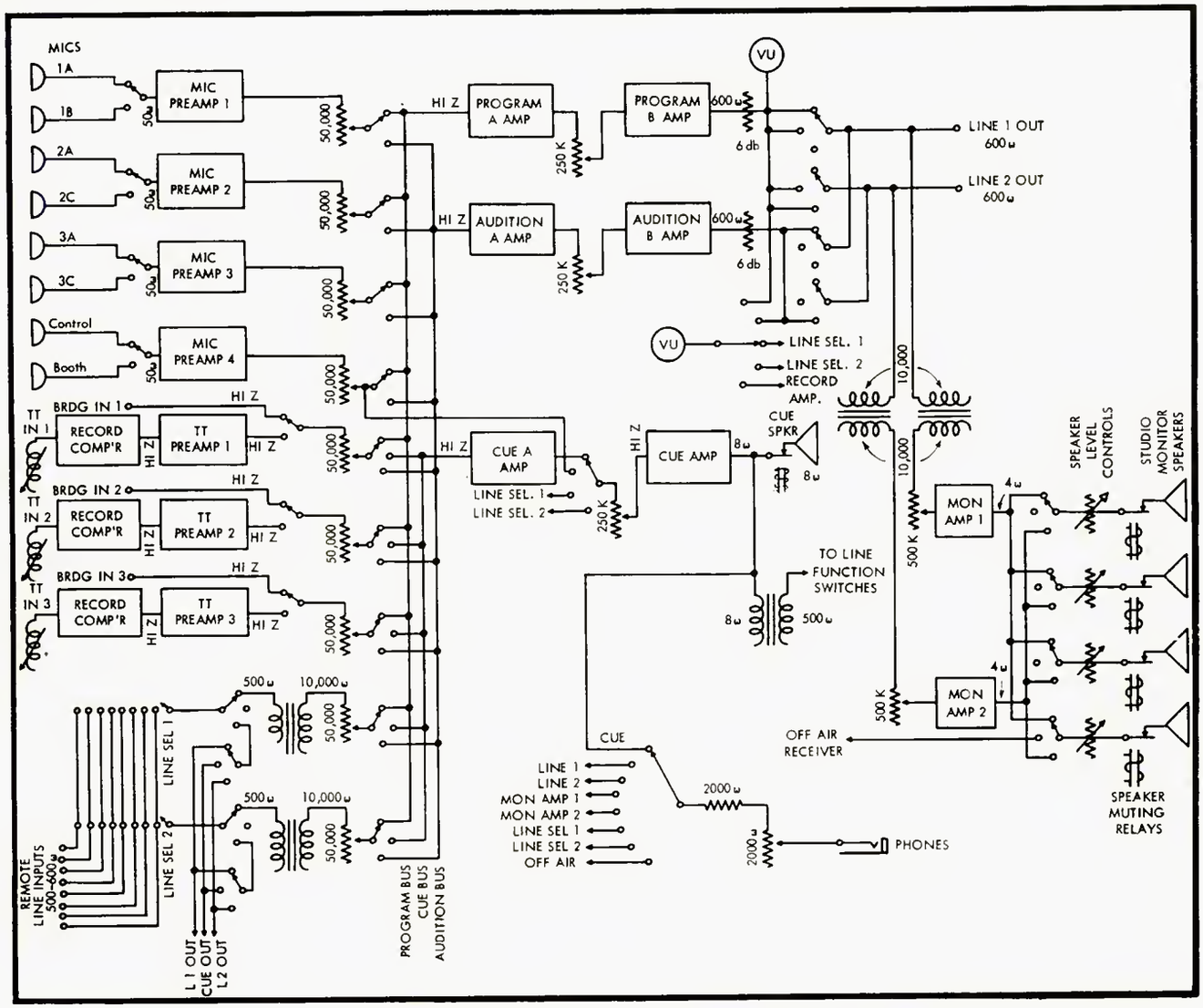

Fig. 7. Complete block schematic of the control equipment shown in Fig. 6.

Professional Equalizer-Preamp Suitable for Home Use

KENNETH W. BETSH*

Designed originally for broadcast-station use, this preamplifier can be adapted to any installation where it would be desirable to have the controls remote from the amplifier itself, making the mounting much more flexible for certain applications.

A combined equalizer and preamplifier designed especially for use with the phonograph record and transcription turntables used by an FM broadcast station that devotes most of its on-air time to recorded classical music can also be ideally suited to home use. This one is constructed in three units—control box, preamplifier, and power supply. The first two units are shown in *Fig.* 1 while the power supply is shown in *Fig.* 2.

The more important features of this equalizer-preamplifier are: (1) provision for two inputs so that separate pickups can be used for transcriptions or 78-rpm records and for microgroove records; (2) operation into a 250-ohm line at a level of –30 VU; (3) controls are housed in a small box to be mounted on the turntable motor-board while the preamplifier may be mounted in the base of the turntable cabinet; (4) a control panel with equalization switch positions indicated by manufacturer; and (5) use of the type 1620 non-microphonic pentodes in all amplifying stages. These tubes may be old "standby's," but they *are* quiet.

The control box provides the turntable operator with two controls. The left knob has six positions—three for each of the two inputs. Two degrees of "scratch" filtering plus a normal response position are allowed for each input. The right knob has nine positions for selecting equalization characteristics.

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Fig. 2. The power supply is built as a separate unit, but power may often be obtained from other equipment.

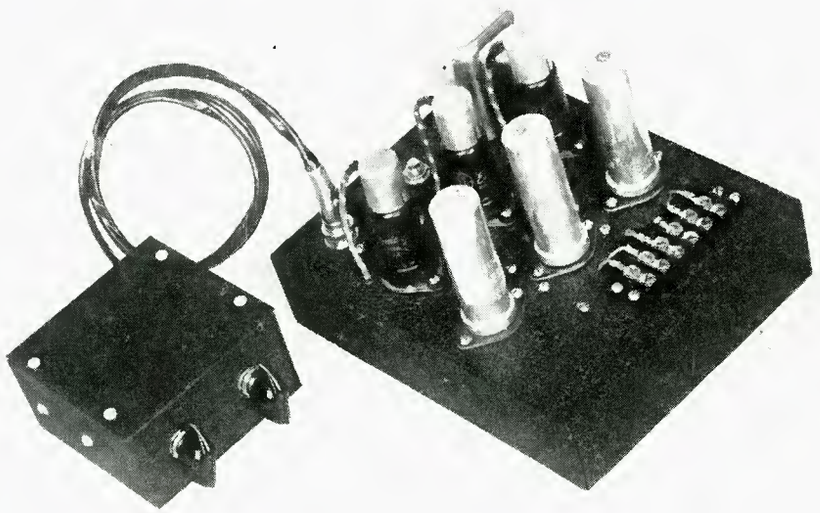

Fig. 1. External view of preamplifier and control box, the latter intended for mounting directly at the turntable.

Equalizing the differences in phonograph recording characteristics by exact calibrated preamplifier compensation or by the setting of variable bass and treble controls has been debated considerably. The former is an exacting method in that, providing the recording characteristic is known, the person playing the record can even be tone-deaf and have a fidelity of reproduction limited only by the other components in the reproducing system. With the latter method the fidelity depends largely on the hearing ability or particular desires of the person playing the record. In a situation where recordings are played for the enjoyment of others than just the person operating the equipment, the exact compensation method will assure the ultimate listener of a better and, just as important, a consistent quality of reproduction.

Anyone who has investigated various recording equalization circuits and equipment realizes to what extremes he can go. There can be separate bass turnovers, separate treble rolloffs, scratch and hiss filters, and other controls—each with many positions. The result is a very flexible unit that should match any of the seemingly infinite variety of recording characteristics that have been used. However, such a unit will be too confusing for anyone to use other than the designer or a user with long experience. While the results may be most gratifying in the hands of a qualified user, too often one soon finds the equalizer knobs left alone indefinitely in the hands of the average user.

At the other extreme is the preamplifier without variable equalization where new recordings may sound good but old ones sound completely "dead," or where old recordings sound fairly good but newer ones, with their high-frequency pre-emphasis, sound shrill and any distortion is magnified. This situation, however, can be no less satisfactory than the "can-handle-any-situation" equalizer if it is not properly used. Thus it can be seen that a compromise in the flexibility and simplicity of operation is a necessity, particularly, for radio-station use.

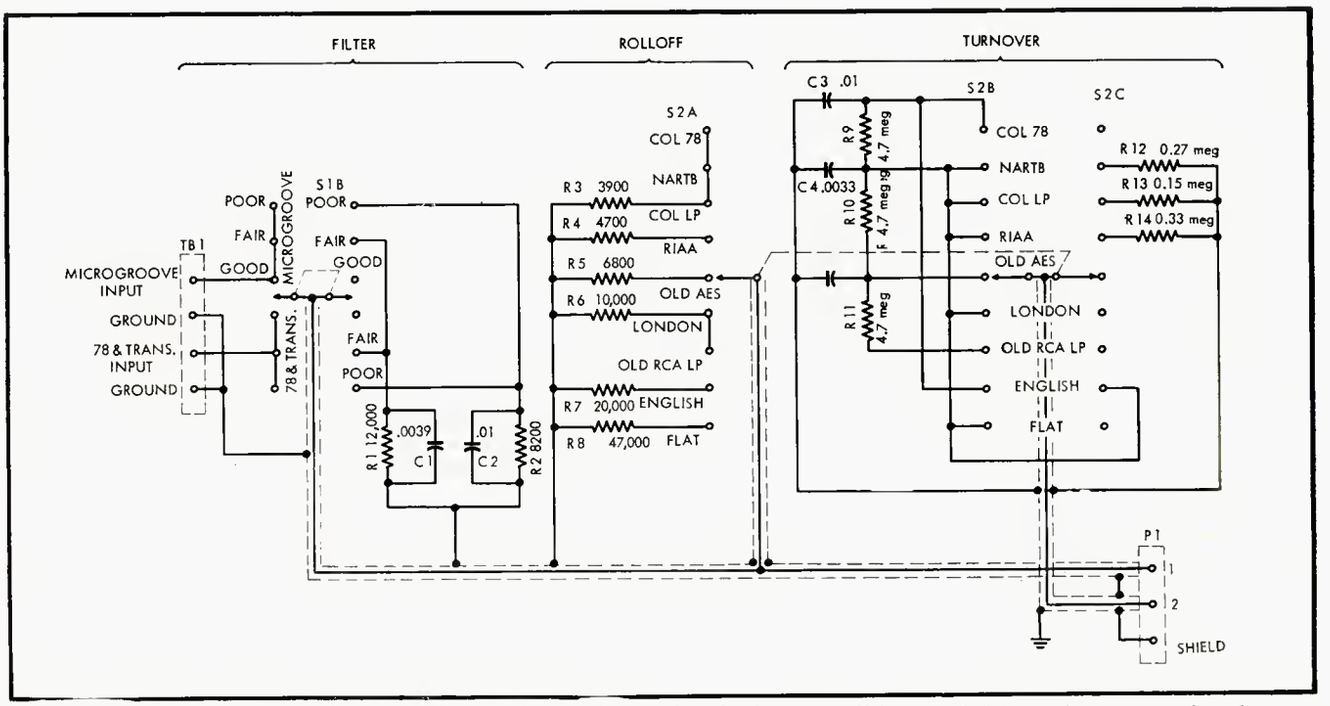

Fig. 3. Schematic of the control box. S1 selects pickup to be used and adjusts cutoff for good, fair, and poor record surface condition; S2 adjusts turnover frequency and amount of rolloff.

Nine Positions Adequate

From investigation and listening experience, the author has found that nine equalization characteristics will equalize accurately almost all records and transcriptions. These nine characteristics and their uses are listed in Table I.

The high-frequency rolloff is obtained by varying the terminating resistance of the cartridge. This method eliminates the need of either a filter with considerable insertion loss between the cartridge and the amplifier or of running a high-impedance grid or plate lead from the amplifier back to the control box for switching in capacitances for variable rolloff. The former method is undesirable in that it lowers the signal level to a point where noise is a severe problem. The latter method introduces shunt capacitances in cables causing undesirable high-frequency losses when flat response is desired. By terminating the cartridge with both resistance and capacitance in the proper ratio, it is possible to obtain a rolloff approaching 12 db per octave.

The disadvantage of this method is that the equipment is restricted to use with one make or model cartridge, since the inductance of the cartridge (upon which the rolloff characteristic of this equipment is dependent) varies with manufacturer and model. This is of no consequence in a permanent installation where changing to another model of cartridge is quite unlikely. Should this happen, however, it is only necessary to change a few resistors and capacitors, all located in the control box.

Component values given on the schematic of the control box, *Fig.* 3, are those for use with the regular G.E. home-type cartridge having an inductance of about 520 millihenries. Where different values are required for use with any other magnetic cartridge, they may be determined by experiment.

The Preamp Circuit

The first stage of the amplifier is a conventional pentode, as shown in *Fig.* 4. The cathode is bypassed with a large capacitance to prevent hum from heater-cathode leakage. The necessary low-frequency boost is achieved by the RC network of R_{20}, R_{21}, and C_{10} located between the first and second stages. This method is used rather than selective feedback for two reasons. First, the cathode of the first stage may be left at an a.c. ground; and, second, because it is necessary to run extension leads to the control box so that the turnover frequency may be changed. This circuit, with one side of the capacitors grounded and the capacitors relatively large in value, will not be affected in frequency response by the shunt capacitance of the remote cable.

The values of R_{21} and C_{10} in the low-frequency boost circuit create a turnover frequency of 800 cps, the highest

(*Continued on page 64*)

TABLE I

RECORD EQUALIZATION DATA

Position	Bass Turnover Frequency	Bass Boost Rolloff Frequency	Treble Rolloff at 10 KC	Use or Special Notes
COL 78	300 cps	None	16 db	Earliest Col. 78's lack pre-emphasis and, therefore, should be played with ENGLISH equalization.
NARTB (NAB)	500	60 cps	16	Older Westminster, Vox, & Remington LP's & American Transcriptions.
COL LP	500	100	16	Initial Col. LP's lack pre-emphasis—should use FLAT equalization for these.
RIAA* New AES Ortho	500	70	13.7	Adopted by most record manufacturers for LP's.
Old AES	400	None	12	Mercury and Decca Records.
LONDON RCA 78	500	100	10.5	For London FFRR's. A close match for earlier Victor 78.
OLD RCA LP	800	None	10.5	For RCA LP's with thin bass.
ENGLISH	250	None	4	English recordings including BBC transcriptions.
FLAT	500	None	None	Most European and early American records. Also, Capitol Telefunken, Musical Masterpieces, and Concert Hall Society LP's.

* Practically all modern LP records will play satisfactorily on this position which is about as near to a standard as the record industry will ever get.

How an Output Transformer Causes Distortion

NORMAN H. CROWHURST*

The operation of audio transformers has long been surrounded with an aura of mystery. This article distinguishes the different forms of distortion an output transformer can produce, and gives some simple measurement methods.

In Two Parts — Part 1

The use of audio transformers has long been deprecated on the grounds that they cause distortion. In fact the output transformer seems to be almost the sole survivor of the species and many attempts have been made to do without even this. A few amplifiers have been designed to dispense with the output transformer, apparently in the belief that the output transformer is the principal remaining cause of distortion.

Careful analysis will usually show that the tubes introduce more distortion than the output transformer would have and that a well-designed amplifier using the conventional output transformer can achieve a much lower order of distortion than is possible without one.

A few simple facts about transformers seem to get overlooked: when tube curvature causes distortion it distorts all frequencies; but the distortion a transformer causes due to nonlinearity of its magnetizing current is concentrated at the low-frequency end. The worst transformer made will not distort the middle frequencies and the way it distorts at both lower and higher frequencies is one of the things we shall clarify in this article.

But, surely, someone will say, a transformer *can* cause distortion at middle frequencies? "I remember replacing a transformer, and the replacement would not give so much power without distortion as the original did." Doesn't this prove that the transformer distorts at the middle frequency? To understand the cause of this experience, let's consider the effect of transformer efficiency on amplifier performance.

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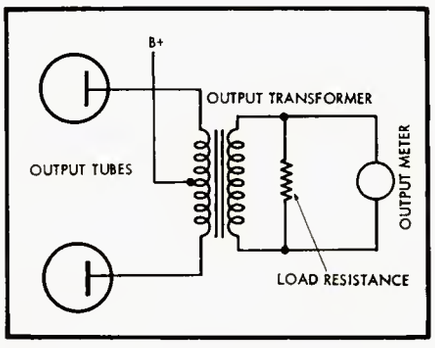


Fig. 1. Usual method of measuring output power consists of calculating the watts dissipated in a load resistor connected to the secondary of the output transformer. While this is the available power output, the output tubes actually deliver a little more than this.

The Importance of Efficiency

Amplifiers are rated to give a certain maximum output, determined by the performance of the output tubes. However, the output power is always measured on the secondary side of the output transformer, as shown at *Fig.* 1.

A good output transformer is probably about 95 per cent efficient. This means that, if the amplifier gives 50 watts output, measured on the secondary side of the transformer, there must be nearly 53 watts output *delivered to the primary side* from the output tubes. The output tubes are having to give nearly 53 watts output for us to measure a good 50 watts.

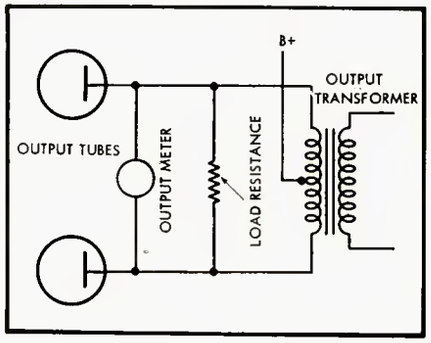


Fig. 2. Connecting a suitable load resistor on the primary of the output transformer to measure power avoids some of the loss in the output transformer, but the tubes still have to supply the core loss.

This is a little difficult to verify by actual measurement. The simplest step towards it is to remove the secondary resistance load and apply a plate-to-plate load on the primary, as at *Fig.* 2. If the secondary load was 16 ohms and the transformer refers this back to be, say, 6000 ohms plate-to-plate resistance, then a 6000 ohm resistor, of at least 50 watts dissipation, should be connected across the primary. The power is now delivered by the output tubes directly to the load, without passing through the output transformer, and can now be measured in the 6000-ohm resistor.

But all of the losses in the output transformer have not been removed by transferring the load from the secondary to the primary. The transformer core loss is still present. If, of the 3 watts lost in the transformer, 1 watt is due to core losses and 2 watts to losses in the winding resistances, we shall only measure 52 watts in the load connected to the primary, because the odd 1 watt will still be lost in the core.

This discussion is based on a transformer having an efficiency of 95 per cent. A 50-watt output transformer with an efficiency of 95 per cent, and a really good frequency response from 20 to 20,000 cps, is going to be fairly large and expensive. A 5 per cent power loss is only 0.2 db, so some will argue that we can accept a transformer of 90 per cent efficiency, which still represents a loss of less than 0.5 db, in order to achieve better quality in terms of frequency response, at a size and cost that is more reasonable. From some aspects the second transformer could be regarded as a better-quality job than the first, but . . .

Supposing we have made a substitution of a 90 per cent efficiency transformer into an amplifier that originally used a 95 per cent transformer: the tubes will still be capable of giving the same output—slightly less than 53 watts, which, with a 95 per cent efficient transformer *will* deliver 50 watts on the secondary; but with a 90 per cent efficient transformer, the same tubes will only deliver a little over 47 watts on the secondary.

At first glance, this may not seem to be a very serious loss. If you make the measurement at 47 watts on the secondary, you may correctly assess its true value. But unfortunately, output tubes to give 50 watts quickly run into distortion when they are pushed to a higher

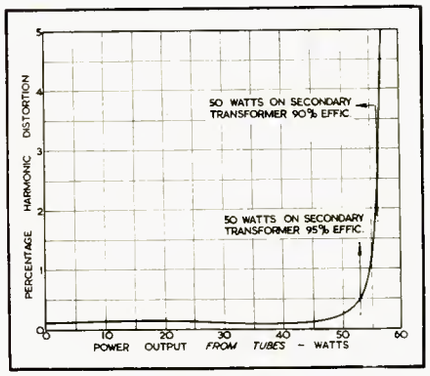


Fig. 3. Typical distortion characteristic of amplifier, plotted in terms of the power given by the tubes, to illustrate how use of transformers of differing efficiency can change the distortion at rated maximum output quite drastically, because the tubes also have to supply the transformer losses.

level. The distortion characteristic is similar to that shown at *Fig.* 3: the distortion at the 53 watts required to give 50 watts from a 95 per cent efficient transformer may be only 0.5 per cent; but to get the almost 56 watts needed for a 90 per cent efficient transformer, the distortion may rise to 2½ per cent, or even more. So, if the measurement is made only at the 50 watt level *measured on the secondary*, the impression can easily be obtained that the second output transformer is considerably increasing the distortion, as compared with the first one.

Unfortunately also, many people place considerable stress on getting the full value of wattage stated, within the rated distortion limit. If the output is stated to be 50 watts at 0.5 per cent distortion, then an amplifier is considered to be seriously lacking if it only delivers 48 watts with 0.5 per cent distortion, and runs up to 2 or 3 per cent distortion when the output is pushed to 50 watts. This viewpoint can be seriously detrimental to an assessment of transformer quality, when the only deficiency in the transformer is that it is slightly less efficient: it introduces a loss of 0.5 db, or maybe even less, instead of the original 0.2 db.

Low-Frequency Distortion

At the low-frequency end of the response, an output transformer causes distortion due to saturation of the core, which causes a nonlinear magnetizing current. This at one time was always true. But in recent years, with modern magnetic materials, and with some methods of operating tubes, the statement needs modifying, as we shall see. First let us see how we measure the low-frequency waveform of the transformer itself, and what kind of results we get.

Transformer Waveforms

In *Fig.* 4, (A) shows the arrangement for measuring the magnetizing current in a sample transformer by means of an oscilloscope pattern. Resistor R should be chosen so its voltage drop is a small fraction of that across the transformer winding, so the voltage on the winding is also close to sinusoidal. As full line voltage will probably be not enough to produce saturation in the primary of an output transformer the secondary winding should be used for the test, leaving the primary open-circuited and taking care not to get too near the open ends, which will produce a prohibitively large a.c. voltage.

It is important to take care which way round the Variac is connected to the line and also to see that the ground side of the scope does not return to the line ground, because, in these measurements, the scope ground is returned to a floating point between the resistor *R* and one side of the transformer winding. So take care to avoid having more than one ground point and also avoid metal-to-metal contact between the scope case and other grounded chassis.

The type of trace that the arrangement of (A) *Fig.* 4 gives when the core begins to go into saturation is shown at (A) in *Fig.* 5. The voltage applied to the vertical plates is approximately sinusoidal while the horizontal voltage follows the magnetizing current waveform, shown separately against a conventional time base at (D) in *Fig.* 5.

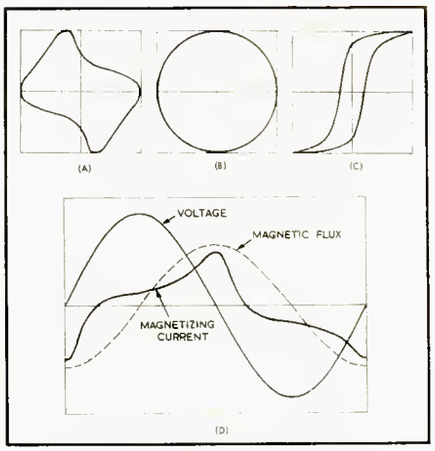


Fig. 5. Traces associated with core analysis: (A) magnetizing current horizontal with voltage vertical, using nearly sinusoidal voltage waveform; (B) circular pattern to check for 90-deg. phase shift in voltage display; (C) hysteresis loop obtained by 90-deg. shift on vertical plates; (D) waveforms displayed by normal time base, corresponding to the patterns of (A) and (C). Magnetic flux is shown dotted, because this cannot be displayed directly.

With a little adaptation, the circuit can be made to display the well-known hysteresis loop for the transformer core. The necessary changes are illustrated at

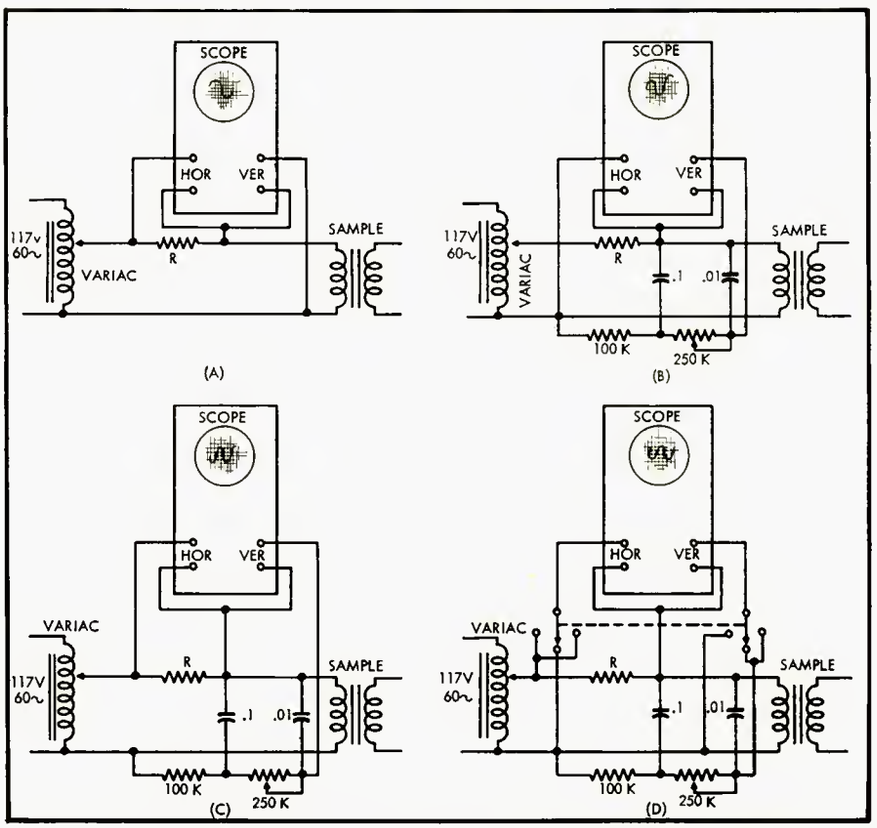


Fig. 4. Circuit arrangements for producing the oscilloscope traces: (A) the arrangement for the trace of (A) in Fig. 5; (B) connections for setting 90-deg. phase shift, by adjusting to get circle of (B) in Fig. 5; (C) connections to use with 90-deg. phase shift to give hysteresis loop at (C) in Fig. 5; (D) circuit with switching so that each display can be presented in quick sequence.

(B) and (C) in *Fig.* 4. When a sinusoidal voltage is used the magnetic flux in the core is also sinusoidal, but displaced 90 deg. from the voltage it induces. So, by introducing a 90 deg. phase shift in the vertical deflection, we can produce a hysteresis loop.

First we have to set up the 90-deg. phase shift. To do this, the components shown at (B) in *Fig.* 4 are added and the 0.25-megohm variable resistor and the scope gain controls are adjusted to obtain the circular trace of *Fig.* 5. Then, without altering the setting of the 0.25-meg. resistor, change the circuit to the arrangement of C in *Fig.* 4, when the hysteresis loop shown at (C) in *Fig.* 5 will be displayed.

This setting will give the hysteresis loop at 60 cps, and its behavior at different levels can be observed by turning the Variac up and down. However, to arrange the setup so that this procedure can be repeated at different frequencies, the switching arrangement of (D) in *Fig.* 1 can be included, which provides for making the connections shown at (A), (B), and (C) of *Fig.* 4 in quick succession. The Variac should then be fed from a high-power amplifier that will deliver the necessary voltage without waveform distortion at the frequencies required.

If you switch the scope back to regular time base, which means the horizontal input is then disconnected and the vertical is displayed against time, the waveforms shown at (D) in *Fig.* 5 can be obtained (except the magnetic flux waveform, because there is no means of measuring this). Although these waveforms can be displayed there is no simple means of identifying the relative phase. This is the advantage of using the loop kind of display shown in *Fig.* 5 at (A), (B), and (C).

Transformers in Tube Circuits

All of these displays use at least an approximately sinusoidal voltage waveform. Distortion occurs because the *voltage* departs from the true sine wave. This happens because the distorted current waveform is drawn from a source resistance that produces a volt drop. In the arrangement of *Fig.* 4 we used the Variac and the low value of resistor R to maintain an approximate sinusoidal voltage by avoiding this voltage drop. But in practical amplifier circuits the plate resistance of the output tubes does not allow this condition.

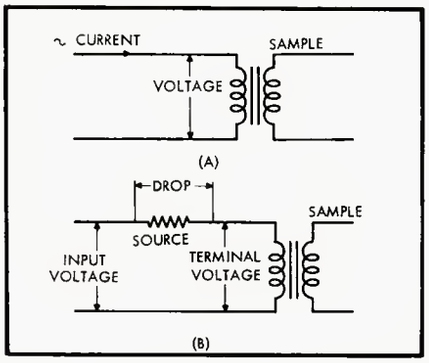


Fig. 6. Showing the quantities displayed in Fig. 7: (A) fed from a pentode, or high resistance source, the current is sinusoidal; (B) with a lower source resistance, neither the voltage or current is sinusoidal.

Pentode Outputs

A pentode is virtually a "current" source, so swinging to the other extreme for a moment, we could assume that the current is sinusoidal, as represented at (A) in *Fig.* 6. In this case the magnetic flux will be determined from the hysteresis loop and the voltage, in turn, is produced by the rate at which the flux varies at any instant. The waveforms produced are shown at (A) in *Fig.* 7. Current and voltage can of course be displayed on the scope, but the magnetic flux we can only deduce.

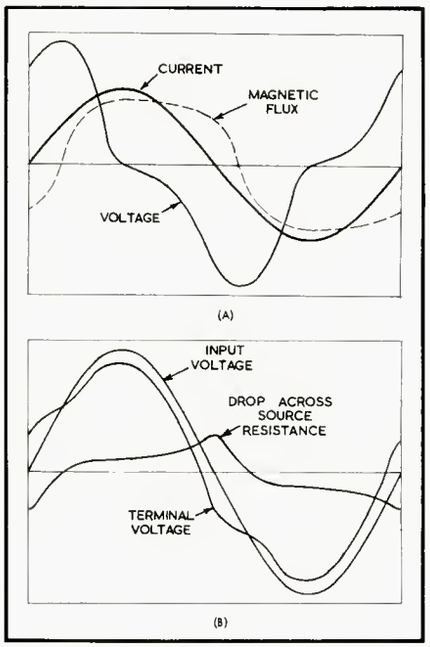


Fig. 7. Waveforms in different practical circuits: (A) with a pentode or high resistance source, the current is sinusoidal; (B) with a lower source resistance, these waveforms are typical.

These waveforms apply approximately to a pentode output stage without feedback. When feedback is used, the voltage waveform gets fed back over the whole amplifier so as to "correct" the current waveform, which then is no longer sinusoidal.

Triode Outputs

(B) in *Fig.* 6 shows how we can simulate the condition for triode amplifiers. The input voltage, which is sinusoidal, can be regarded as the open-circuit voltage at the plate. This input voltage is that applied to the grid multiplied by the amplification factor of the tube. The source resistance corresponds with the tube plate resistance and because of the drop in this source resistance, due to the current drawn by the transformer winding, the terminal voltage will differ from the output voltage, as shown at (B) in *Fig.* 7.

Notice that the terminal voltage comes much nearer to being in phase with the input voltage than the phase relationship between voltage and current at (A) in *Fig.* 7.

From this brief discussion it becomes evident that the magnetizing current and terminal voltage of a transformer cannot *both* be sinusoidal. In practice both of them depart from a true sine wave in shape and a certain amount of distortion results.

Another Kind of Low-Frequency Distortion

However, if the magnetizing current is a relatively small proportion of the total current in the transformer windings, the distortion may be a very small percentage. These curves were displayed with the transformer unloaded so that the magnetizing current is the only current in the windings. Had the transformer been terminated by its normal load resistance, the waveforms would probably have been indistinguishable from pure sine waves and distortion could only be detected by means of an analyzer.

Magnetizing current is invariably related to effective primary inductance and the way a transformer distorts at low frequencies depends upon the precise relationship between primary inductance and magnetizing current. Two numerical cases will illustrate this distinction.

First, suppose that the magnetizing current is 10 per cent of the load current. This means that the reactance due to primary inductance would be ten times the primary load resistance. This would cause an attenuation of less than .05 db. But if this magnetizing current was running into saturation so the magnetizing current waveform is as shown at (B) in *Fig.* 7, containing 20 per cent harmonic, this magnetizing current, being 1/10th of the total load current, could produce 1/10th this amount of distortion in the output waveform, or 2 per cent.

The second kind of distortion that can occur at low frequencies is not directly due to the waveform of the magnetizing current at all. The trans-

(*Continued on page 75*)

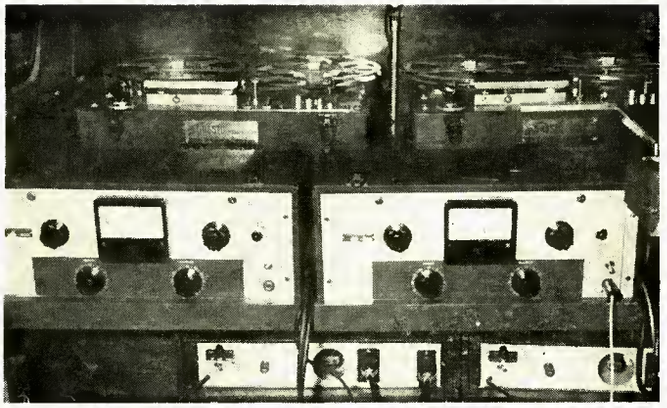


Fig. 1 (left). The term "portable" is often applied to any equipment which has a handle. The Tape-Mobile, not too much larger, has wheels. Fig. 2 (right). Aft from the operator's position are the two Presto tape recorders and their amplifiers.

Take Your Recording Room With You

By installing complete recording facilities in a Volkswagen bus, Crest Records is able to take the studio to the job.

ONE OF THE LIMITATIONS of flexible recording studio operation is that it is often difficult to bring the musicians to the studio—particularly when there are often as many as 200 people involved. Crest Records, of Huntington, on Long Island about 40 miles from New York city, is one of the first to solve this problem by constructing a completely portable recording plant within the confines—literally—of a Volkswagen Mikrobus. With this facility they are able to cover a recording date a hundred miles or so from their home studio and be sure that the results will be equivalent to those from the stationary plant.

Figure 1 shows the Tape-Mobile ready for the road. Within its relatively small interior are two Presto RC-10-14 recorders complete with their own amplifiers, as shown in *Fig.* 2. These are fed from a modified Presto console, *Fig.* 3, which serves as mixing panel, recording equalizer, monitor control, and disc recording amplifier. This unit is mounted lengthwise along the left side of the interior, with the two tape recorders side by side across the back. To the left of the console is a recording turntable, *Fig.* 4, which also serves for playback.

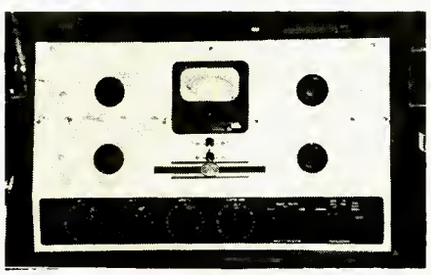


Fig. 3. Modifed Presto console also furnishes monitoring and drive for disc recorder.

Fig. 4. Disc recorder for location cutting of test discs. Note remote control buttons for the tape recorders in mounting just to left of console.

Monitoring in the Tape-Mobile is supplied by a Heathkit SS-1 speaker system mounted just above and behind the driver's seat, *Fig.* 5, and a spare speaker of the same type is carried for use as a studio monitor speaker, as well as for talkback. In the home studio the complete Heathkit system, comprising the SS-1 unit plus the SS-1a range extending speaker system is used.

Figure 6 shows the rear of the bus, with five cable reels mounted crosswise. These reels can be motor driven for rewinding, a clutch on each being engaged when needed. A simple boom arrangement attached to the back of the body holds microphone cables clear from the ground, avoiding damage to the cables as well as possibility of injury to bystanders who might trip over them.

Depending on the application, either Telefunken or Capps microphones are used for general coverage, with Altec 633's or 639's serving as additional units when necessary. At a recent New York State School Music Association concert in White Plains, both condensers were used—the Telefunken for general orchestra coverage, and the Capps for a more concentrated pickup from a group of 150 singers who augmented the orchestra of 125 on some of the numbers. Together the two groups occupied about one fourth of the entire auditorium space. This program was recorded by Crest "on speculation" largely, with records made from the tapes recorded at the concert being sold to the performers and their families.

One of the interesting sidelights on the Tape-Mobile operation is the use of Vocaline citizens' band transmitter-receiver units between the recording "truck" and the locale of the performers for communication.

Crest Records is one of the country's largest independent record pressing plants, and its versatility in providing subject material for its presses is greatly enhanced by the new Tape-Mobile.

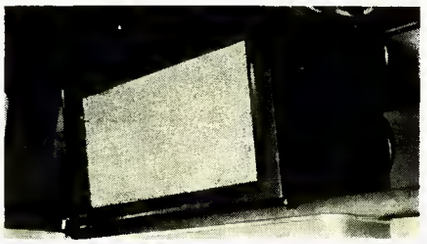


Fig. 5. Heathkit SS-1 speaker system serves as monitor, is mounted above and behind driver's seat.

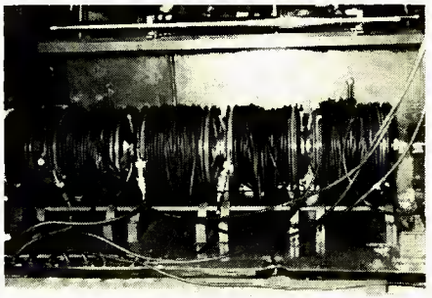
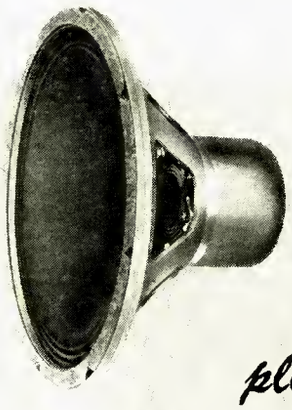


Fig. 6. Rear door gives access to power-driven cable reels—saving considerable time and effort when "striking" the set-up.

THIS GOODMANS 3-WAY SPEAKER SYSTEM FEATURES 20 TO 20,000-CYCLE REPRODUCTION ...AS WELL AS RESPONSE



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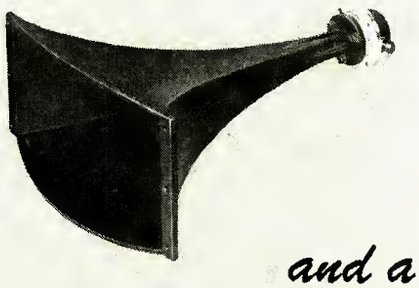

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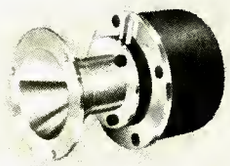


AUDIOM
15-inch or 18-inch Woofer

MIDAX
Mid-Range Reproducer

TREBAX
Tweeter

in an

ARU ENCLOSURE

Response and reproduction are not not necessarily the same thing. This is especially true at low frequencies. A speaker may respond to a 30-cycle signal, but may not *reproduce* it *audibly*. Therein lies one of the major advantages of this system. The cone area of a Goodmans 80 or 90, 15 and 18-inch woofers, is large enough to excite or move a sufficient mass of air so as to make its low *frequency response audible*. But, this does not mean that you can use any 15 or 18-inch woofer. The mere mass of the cone is itself likely to introduce 'hangover' distortion, unless very definite design measures are taken to counteract the inertia of the large cone.

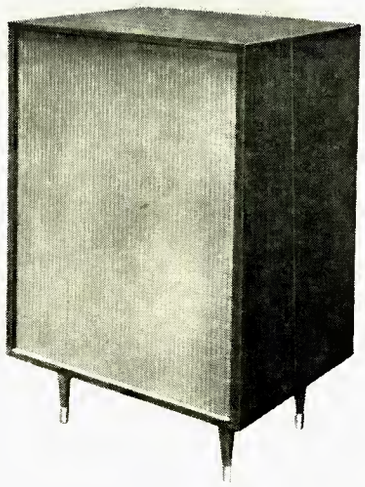
One of the most important of these design features is for the magnetic field concentrated around the voice coil to be so intense that it acts as a 'brake' upon the voice coil and prevents it (and the cone) from making any movement, except in response to the impulse of a signal. The superiority of the Goodmans 80 and 90 woofers, in this respect, is clearly expressed in their specifications:

	AUDIOM 80 15-in. Woofer	AUDIOM 90 18-in. Woofer
Fundamental Resonance	30 cycles	35 cycles
Flux Density	14,500 gauss	14,500 gauss
Total Flux	215,000 maxwells	267,000 maxwells
Power Handling Capacity (rms sine wave)	50 watts	100 watts

These figures may mean little to a non-technical reader. But they can serve as a basis for comparing different speakers of equal size. Naturally, the lower the resonance, the more desirable the speaker for low frequency applications. Flux Density and Total Flux define the intensity of the magnetic field. The higher the value, the better. Power Handling Capacity is self explanatory.

This system divides the audible spectrum as follows: the woofer reproduces from 20 to 750 cycles; two pressure-type reproducers take over, the Midax operating from 750 to 5000 cycles, and the Trebax, from 5000 to 20,000 cycles. The three speakers plus two crossover units are contained in an ARU 'friction loaded' Enclosure—Model 1500 for the 15" woofer and Model 1800 for the 18". These enclosures are available in kit form for easy home assembly.

The total result is one of smooth, wide-range reproduction . . . solid bass fundamentals to 20 cycles . . . crisp handling of transients without 'boominess' or hangover distortion . . . and without the stridency that is characteristic of many high frequency reproducers. The sound is clean, natural and satisfying.



Audiom 80 (15")	$95.50
Audiom 90 (18")	118.80
Midax with horn	58.80
Trebax with horn	27.00
Crossover XO-750/5000	30.00
ARU Enclosure Kits	
Model A-1500	71.85
Model A-1800	74.90

prices slightly higher west of Rockies

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MEMBER INSTITUTE OF HIGH FIDELITY MANUFACTURERS, INC.

Electrostatics, Watts, Realism, and Concert Halls

During the past few months, the Letters column has been the scene of a gentle controversy between readers and this author. His final word is of sufficient interest to appear as a complete article, we think, so here it is.

G. A. BRIGGS*

Judging by the letters appearing in the November issue of this journal, my comments on the above subjects have put the cat among the pigeons, and I welcome this opportunity to grab it by the tail and hold it down so that we can review the position in a calm and peaceful atmosphere. Not that I object to a fight! I believe that a fair exchange of blows on controversial questions often reveals more fundamental truth than any amount of ordinary lecturing and writing. I use the word "fair" deliberately, because I got the impression that one of your contributors was trying to hit below the belt. However, I will deal with him shortly. Let us take the subjects in order of importance.

Electrostatic Speakers

Mr. Janszen's letter is so well reasoned and informed that I find it difficult to disagree with him. There are, however, a few aspects of the problems involved which need further clarification. These are:

1. Plastic Diaphragms. I am prepared to accept Mr. Janszen's claim that they have evolved a material which can be stabilised in the climates mentioned, but in comparing such diaphragms with those used in moving-coil speakers I think his analogy is much wider of the mark than my comparison with the use of grease in pickups. (By the way, I hear that "tropical grease" is now a practical proposition.) A plastic diaphragm used in a moving-coil loudspeaker on a battleship must be robust and may be 1/16 in. thick, and has only to perform in the mechanical sense by vibrating. But the electrostatic diaphragm is only half a thou. thick and—in addition to vibrating—has to perform like the plate of a capacitor. I believe capacitors dislike excessive heat and humidity even more than I do.

2. Rigidity. I am glad that it is now admitted that the stationary electrodes must vibrate, but I would go further and say that the tone colour of the reproduction will be affected by the material used. The "tone" will never be perfect for all types of musical instruments. For instance, wood always suits violin tone. I recently heard unaccompanied violin reproduction (Bach/Milstein Capitol P8298) played in a large hall in Lisbon on two different loudspeaker systems:

(a) A brick assembly weighing about 1000 lbs;
(b) a sandfilled panel assembly weighing about 300 pounds.

To reproduce a violin (even in Carnegie Hall) you need less than one watt amplifier output, and I would have thought that both these structures would have been immune to any vibration from such input. But the difference in reproduction was remarkable and I much preferred the wooden assembly. (On brass, percussion, and chorus I preferred bricks.) The point about all this is that if you throw 10 to 15 watts of music at a full-range electrostatic speaker the sound output will be coloured by the make-up of the structure. It will not be "perfect," and tastes will still differ.

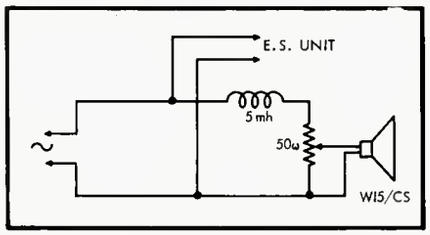

Fig. 1. Circuit giving gradual rolloff and volume control for woofer used with E/S tweeter of lower efficiency. Crossover between 500 and 1000 cps.

3. Directional effects. I entirely agree with Mr. Janszen's remarks. In fact, if I may say so, I think he has tackled the problem in his zig-zag tweeter set-up almost as successfully as we did in our horizontal mounting. (Excuse my modesty.)

4. Efficiency. Here I owe Mr. Janszen—and other makers of electrostatic speakers—an apology. Soon after writing about grossly inefficient bass speakers, I took delivery of a Janszen tweeter. (It cost me about £50, and being a Yorkshireman this nearly broke my heart.) We tested the speaker and found the sensitivity to be much higher than expected. I immediately wrote to New York to have the word "grossly" altered to "comparatively" but unfortunately this was not done. The difference between a good electrostatic speaker and a good moving coil is about 3 db. (*And newer e/s models are now on a par with or even more efficient than moving coil speakers.* Ed.)

But, and it is an important but, I do *not* rate the efficiency of a moving-coil speaker on resonant peaks. I rate it on total flux density in the magnet gap, and flux density is what you pay for in a magnet. We use a large magnet on our W15/CS woofer with a total flux of 180,000 lines. As Voigt proved the virtue of high flux density more than twenty years ago, I think we can take it as read.

With the circuit of *Fig.* 1 and slight use of the volume control we get an excellent match between the W15/CS and the Janszen electrostatic speaker.

5. High voltages. I do not doubt that due safety measures can and will be taken. In my opinion, the objection to use of polarising volts is not the possible risk, but the nuisance of having to plug into the mains before the speaker will work. The permanent magnet soon knocked the energised type out of the ring on this score alone, in spite of its early inefficiency. Nevertheless, I am sure that thousands of people on both sides of the Atlantic will plug into the mains with gusto if they can thereby get better reproduction. Thousands, nay, millions, (presumably all men) go to this trouble every day before shaving, and trouble it often is when travelling in various town and country districts.

6. Quality in General. As regards quality of reproduction, please, teacher, I have never said that electrostatics are not very good. In fact, after hearing P. J. Walker's full-range, free-standing, no-cabinet model at the first London Audio Fair I was so favourably im-

* *Wharfedale Wireless Works, Bradford Road, Idle, Bradford, Yorkshire, England.*

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Sensitivity and Distortion

Sensitivity and distortion are major considerations in determining tuner quality, and for comparing one with another. Yet, specifications rarely provide sufficient data to do either.

Distortion claims that fail to specify 'percentage of modulation' are meaningless. One doesn't even have to understand what 'percentage of modulation' means. It is enough to know that at 30% modulation, distortion may be quite low; whereas at 100% it may be intolerable. While most FM broadcasters operate with approximately 30 to 60% modulation, they go to 100% and beyond on peaks.

Similarly, the statement that a given tuner has 'X microvolt sensitivity for 20db quieting' is equally inadequate, unless the percentage of modulation is given. At 100% modulation, the sensitivity will 'look better' than at 30%. It is good engineering practice to measure sensitivity at 30% modulation, and the manufacturer who bases his sensitivity claims upon measurements made at 100%—without saying so—is introducing confusion.

Note these Pilot tuner specifications. They are clear and concise. And note too, that even the cathode follower impedances are given, for at higher impedances—2,000 or more ohms—the effectiveness of the cathode follower is sharply diminished.

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FM SENSITIVITY for 20db quieting with 30% modulation	less than 3.5 μv	less than 3.5 μv	less than 3.0 μv
DISTORTION at 5 μv input with 100% modulation	less than 1%	less than 1%	less than 1%
with 60% modulation	0.5%	0.5%	0.5%
CATHODE FOLLOWER Output impedance	500 ohms	500 ohms	500 ohms
PRICE *slightly higher west of Rockies*	$79.50	$109.50	$159.50

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pressed that I went home and started work immediately on a full range, free-standing, no-cabinet moving-coil model, which seems to work very well. Strange how one thing leads to another, isn't it? Baffles have been out of favour many years, but may well stage a come-back. As the French say, *reculer pour mieux sauter* is often a good plan. Even set-makers are showing signs of becoming tired of cabinet resonance. Only yesterday I visited a local dealer to buy a VHF set, as we are at last due to receive FM in my home town. A model with large frontal area and very shallow sides —virtually a flat baffle—astonished me by its high quality, resonance-free performance.

Watts

We now come to the letter from Mr. R. A. Greiner, to which I have already alluded. He seems to believe that an ounce of theory is worth a ton of practice. In the Festival Hall we have used four 15-watt amplifiers in front of nearly 9000 people—including leading engineers from B.B.C., E.M.I., and Decca, and many other knowledgeable people from universities, industry, and press. We had many and varied criticisms, but nobody ever complained of distortion. Mr. Greiner now says we ought to have used 130 amplifiers instead of four. This is nonsense. He ought to know that peaks are clipped during recording to avoid overloading in cutter head and groove. If the dynamic range is reduced by only 10 db—I believe it is often much more than this—the net result is to reduce a possible 2000 watts to 200 watts.

The only sensible way to decide how much power is required is to play an item at the desired volume level and measure the amplifier output, using an oscilloscope for optimum accuracy, or neon indicators for a fairly reliable answer. At home I use an amplifier which will give 15 watts at less than 1 per cent distortion over the full audio range. As I never *exceed* 10 watts output, I can assure Mr. Greiner that I do not run into distortion. If I change to speakers 3 db lower in efficiency, I shall need a a 30-watt amplifier; a drop of 6 db would call for 60 watts.

I will admit that more than 60 watts are required to reproduce the *full* organ in the R.F.H. with loudspeakers of the efficiency involved. I think 150 watts would be nearer the mark. But with a good man at the controls distortion is avoided by keeping the volume within bounds, and criticism is forestalled by never claiming to reproduce *full* organ.

As regards Mr. Greiner's claim (which your editor rightly questions) that more rigorous standards are now used in America than in England, I should have thought that distortion is understood and avoided with equal fervour in both countries. It is many years since H. J. Leak first advocated and produced domestic amplifiers with no more than 0.1 per cent distortion. The Williamson amplifier has also achieved world recognition. Furthermore, we got away with four Quad 15-watt amplifiers in the Royal Festival Hall because they are conservatively rated and can be pushed up to 80/100 watts without audible distortion.

Actually, it is a waste of time to talk about amplifier watts without specifying distortion and the frequencies at which the measurements are made. I think Paul Klipsch hits the nail on the head when he demands 10 watts clean at 12 cps. I am sure that his 10-watt amplifier would out-perform many a so-called 30 watter.

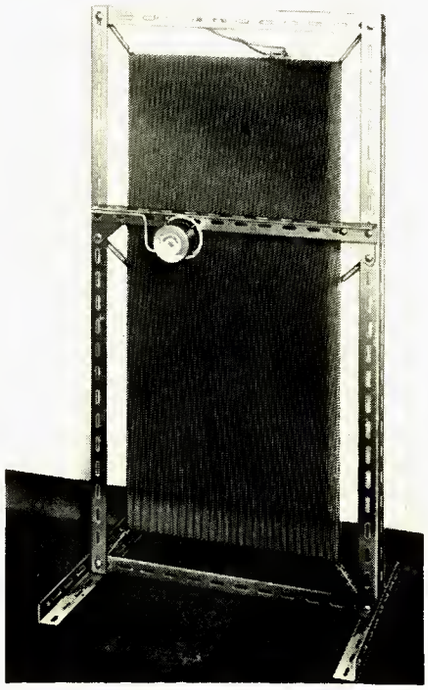

Fig. 2. Reverberation device designed by Dr. Kuhl. The driver is a normal 13,000-gauss loudspeaker magnet fitted with voice coil in mechanical contact with perforated plate. Crystal pickup rests on top edge of plate.

Realism

Mr. Greiner seems to think that life-like reproduction is obtained merely by avoiding distortion. The problem is not quite so simple. The success of the Wind Quartet in Carnegie Hall was the result of a good recording by Columbia and a bit of luck in placing loudspeakers and performers ideally on the platform for the replay, plus the skill and judgment of P. J. Walker at the controls. Distortion was no less than it was during 95 per cent of the actual playing time of all other items. We are of course referring to harmonic or intermodulation distortion.

German/Danish Development. The fundamental truth of the above view of the problem of realism in reproduction was brought home to me recently with considerable force when our technical manager, Mr. R. E. Cooke, returned from a visit to Copenhagen with details of a novel artificial reverberation device designed by Dr. Kuhl of Germany, and further developed by Mr. Lauridzen of Danish State Radio.

Basically, the device consists of a metal plate driven at one point by an electro-mechanical vibrator which is fed with the programme signal. Sound waves are set up in the sheet metal which suffer multiple reflection—in fact the plate behaves rather like a "thin" room having length and breadth but no height. Furthermore, because the velocity of sound in the metal is about 15 times that in air, a plate of modest dimensions will behave like a very large room. The reverberation signal is picked up at the edge of the plate by an amplitude sensitive device such as a crystal bimorph. Mr. Lauridzen has found that when the plate is in the same room as the loudspeakers, there is a tendency towards acoustic feedback, so he has produced a modified apparatus employing a perforated plate which is almost acoustically transparent, and this avoids the trouble from feedback. By routing part of the output from the main amplifier via this artificial reverberator and feeding the output to a second amplifier-loudspeaker combination, very interesting effects can be obtained. The acoustics of the listening room are masked and the listener has the sensation of being in a large hall, thus adding "life" to the music. The bass and middle registers take on a roundness which is very pleasing, and edginess in the treble is considerably reduced.

An illustration of an experimental device based on the above design and built in the laboratory of Wharfedale Wireless Works is shown in *Fig.* 2 The dimensions of the plate are 18 x 40 in. and the material is expanded aluminum. Heard alone (via loudspeaker), the vibrations from the plate sound like harmonic distortion *in excelsis,* and added to speech the result is ridiculous, but the improvement to choral, orchestral, and organ reproduction is acclaimed by all who have heard it. So the question remains: What is distortion?

Vibrating a sheet of metal with musical impulses, and feeding the distorted output to an amplifier and speaker system is calculated to make writers about "perfect" loudspeakers go berserk.

Extra Speaker. Of course it is often possible to obtain quite noticeable improvements to single-channel reproduction by adding an extra speaker or speakers and placing it/them a few feet apart to overcome room coloration and mask the individual characteristics of the single speaker system. It is worth while

(*Continued on page 58*)

New highs in value

Model H-F 206 Super-Tweeter

High-frequency far beyond audibility. For 5000 cps crossover or above. "Reciprocating Flare", die-cast aluminum wide-angle horn. 120° horizontal x 50° vertical dispersion. *New* super-efficient driver housed in die-cast aluminum casting. Power capacity: 25-50 watts*, 8 ohms. N-1 or N-2B network recommended. 6"x3¼"x6⁹⁄₁₆". Shpg. wt. 3 lbs. **$27.00 Net.**

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Great value. Suitable for 2500 cps crossover. Response to 15,000 cps. Sturdy one-piece die-cast "Reciprocating Flare" horn. 120° horizontal x 50° vertical dispersion. High conversion efficiency. 8 ohms. 25 watts*. N-1 or N-2B dividing network recommended. 9½"x2⅜"x5⁵⁄₁₆". Shpg. wt. 2 lbs. **$16.50 Net.**

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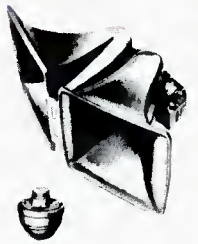


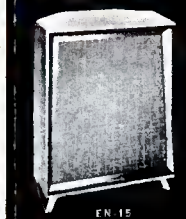
Model Cobreflex-2

Perfect as top end of 2-way systems, or mid-range of 3-way systems. 27" exponentially-flared air column permits crossover as low as 350 cps. Use with Model T-30 driver. Design produces uniform dispersion 120°x50° from 250 to 15,000 cps. Unique die-cast construction of extra heavy aluminum. 10¼"x 18½"x9¼". Shpg. wt. 11 lbs. **$23.00 Net.** T-30 Driver: **$20.00 Net.**

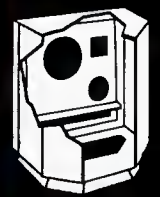
**Integrated Program*

A treat to the eye — a delight to the ear . . . Decor-Coustic Enclosures

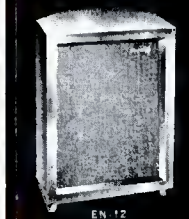
Designed with P.S.E. in mind... *"Decor-Coustic"* speaker enclosure design, a University exclusive, achieves a perfect union of the finest principles of acoustic baffling and interior decoration. University speaker enclosures are built by master craftsmen of the finest selected hardwoods and choice veneers, which are finished to accent their rich, natural beauty. University's traditional use of fully-braced ¾" wood throughout, ensures rigid vibrationless joints to provide buzz-free performance.



EN-15



INTERIOR VIEW SHOWING BAFFLE



EN-12

INTERIOR VIEW SHOWING BAFFLE

The EN-Series — Cornerless-corner enclosures embrace best features of rear horn loading, phase inversion and direct radiation. Designed for most popular P.S.E. combinations, the EN-Series will accomodate multi-speaker systems as well as wide-range speakers. Versatile speaker mounting board has pre-cut speaker openings. Unique adapter boards permit wide selection of components. Full ¾" wood used throughout. No mechanical resonance, rigidly braced. Use in corner or against wall. Mahogany, blond and unfinished.

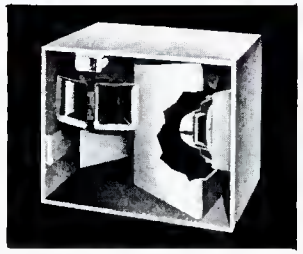
Model EN-15 — Speaker mounting board pre-cut for: 15" speaker; factory fitted with removable adapter for 12" speaker; 8" mid-range speaker with adapter for mounting "Reciprocating Flare" horn speaker; tweeter opening for HF-206, UXT-5, 4401, 4409. Tweeter and mid-range adapters serve as blocking plates when used with 12" or 15" wide range speakers. 37"x28"x19¼". Shpg. wt. 80 lbs. **EN-15M, $125.00; EN-15B, $130.50; EN-15U, $102.00** ***All Net.***

Model EN-12 — Speaker mounting board pre-cut for: 12" speaker; mid-range opening for 4408 or 4409; tweeter opening for HF-206, UXT-5, or 4401. Tweeter and mid-range adapters serve as blocking plates when used with 12" wide-range speakers 30"x21½"x15¾". Shpg. wt. 48 lbs. **EN-12M, $75.00; EN-12B, $78.50; EN-12U, $64.50.** ***All Net.***

KEN Series KwiKits — Do-it-yourself version of EN Series enclosures. Similar in every respect except that KwiKits employ a simplified front frame design. Finest grade ¾" Birch hardwood cabinet plywood. Almost all of assembly done with screwdriver. Kit contains: all pre-machined and pre-shaped wood sections; glue; hardware; plastic wood; sandpaper; easy to follow instructions.

KEN-15 — 37"x28"x19¼"; shpg. wt. 70 lbs. **$49.75 Net. KEN-12** — 30"x21½"x 15¾"; shpg. wt. 45 lbs. **$39.75 Net.**

Model EN-CB Unfinished-Utility Enclosure



A *true* folded *self-contained* exponential horn, operates with highest quality wherever placed, independently of walls or floors. Complete in itself with all acoustically correct elements always in place, EN-CB is identical in design to the enclosure used in the famous "Classic" *"Decor-Coustic"* system. Ideal for the do-it-yourself home decorator . . . the many ways to finish the EN-CB is limited only by the imagination. Can be used horizontally or vertically. Fully assembled, constructed of Grade 1 Birch plywood with locked and mitred joints and braced with heavy glue blocks. Supplied unfinished, less base and frame, but with necessary hardware for mounting speaker. Recommended components are: Model C15W Woofer, Model HF-206 Super-Tweeter, Model Cobreflex-2 Mid-range Horn with T-30 Driver, Model N-3 Crossover Network. 40" x 30" x 24". Shpg. wt. 150 lbs. **$120.00 Net.**

Model TM-812 "Tiny-Mite" Enclosure — The only cornerless-corner enclosure for both 12" or 8" extended range speakers. Versatile enclosure is supplied with mounting board cut out for 12" speaker; adapter for 8" speaker with ample space for tweeter opening is available. Performance can be favorably compared to much larger enclosures. Highly efficient University horn-loaded phase inversion principle is employed in this extra-sturdy cabinet which matches the high power handling capacity of University speakers. Versatile design and shape permits use in room and ceiling corners, or along a flat wall. Mahogany or blond, also unfinished birch. Measures only 21" h. x 15½" w. x 12½" d. Shpg. wt. 22 lbs.

TM-812M Mahogany-$39.75 Net.
TM-812B Blond-$42.25 Net.
TM-812U Unfinished-$34.00 Net.

PRICES SHOWN ARE FOR EAST OF THE ROCKY MTS.
PRICES, TRIM AND SPECIFICATIONS SUBJECT TO CHANGE

"I have a speaker I'd like to keep."

"I'd like to start from scratch."

"I want to start a simple system and build on it."

"I have a system I'd like to improve."

"I custom build systems for resale."

WHICH ONE ARE YOU?

TEAR HERE AND TAKE WITH YOU WHEN SHOPPING AT YOUR FAVORITE HI-FI CENTER

The answer to all is P·S·E

Progressive Speaker Expansion, University's "Master Blueprint" for developing a speaker system to its fullest potential, is the most practical answer to your speaker problems.

Think of it!—now, you can buy a speaker and never worry about it becoming obsolete, because *you can improve tomorrow what you buy today.* Now, you can *improve your present speaker or system without discarding what you have.*

Here's how P.S.E. works:

University speaker components, networks, and enclosures have been so uniquely designed that it is possible for you to start with an excellent speaker or basic system, at *low cost,* and add to it later—*while enjoying immediate* listening satisfaction.

P.S.E. makes it possible to build up to a great variety of magnificent sounding systems in successive, relatively inexpensive stages regardless of budget or space limitations... until what you have meets *your* listening requirements.

P.S.E. makes it possible for *you* to buy a speaker *today* in the terms of the deluxe speaker system you want *tomorrow!* You are thus able to devote most of your budget primarily to the initial selection of quality amplifying and program source equipment which cannot be economically altered or substituted at a later date.

P.S.E. is the *best* way because...

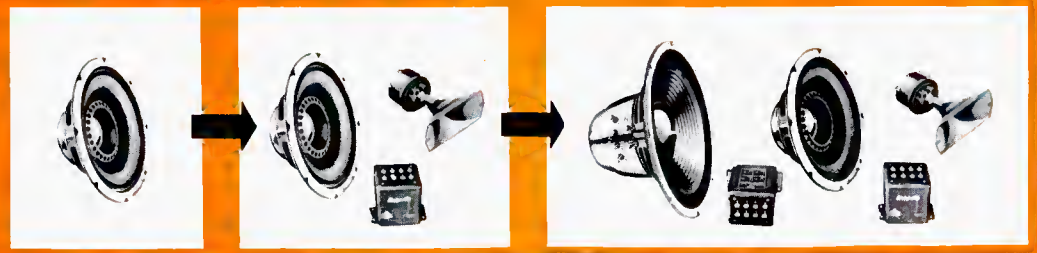
University speaker components are flexible. Dual impedance and adjustable response woofers guard against obsolescence, a wide selection of tweeters makes possible crossover points to suit most requirements...*exclusive* design features enable a tweeter to become a mid-range and vice versa.

University L/C dividing networks and high-pass filters are *adjustable,* making possible a variety of crossover frequencies and impedances to *custom build* your system around the speaker components you now own or plan to buy.

University components are designed so that speaker and network can be easily integrated for improved sound reproduction...you may advance progressively until you reach the highest standards of all—YOUR OWN!

Plan today—the University way with P.S.E.—Start with one of the versatile top quality speakers or systems shown in charts A-B-C-D. Only University products offer such flexibility of application combined with magnificent performance.

HOW P.S.E. WORKS, *A typical example:*



STEP 1 Start with the University Diffusicone-8 — realize immediate listening satisfaction with this top quality reproducer.

STEP 2 Now improve the high end. Realize brilliant, wide-angle high frequency reproduction to inaudibility by adding the Model HF-206 Super-Tweeter and N-2B L/C crossover network.

STEP 3 Build up the low end. Reinforce bass response by adding the Model C12W Adjustable Response 12" woofer with the N-2A L/C network. Diffusicone-8 now functions as a mid-range speaker. The result...a deluxe multi-speaker system...the system you want tomorrow but started today...the **P.S.E. way!**

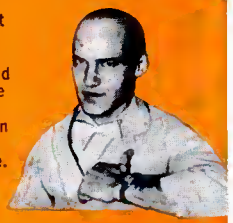
If you have a speaker you'd like to keep...
P.S.E. enables you to develop **your present speaker** into a deluxe speaker system. And, you can do it in successive, relatively inexpensive stages. For instance: If you have an 8" extended range speaker use **Group A.** For 12" or 15" speakers use **Group B.** For a coaxial or diffaxial speaker use **Group C.**

If you'd like to start from scratch...
there is no limit to the possibilities offered with P.S.E., for instance: Start with an extended range speaker and build to a deluxe multi-speaker system. See **Groups A** and **B.** Or, start with a coaxial or diffaxial speaker and build by adding tweeter or woofer. See **Group C.** Or, start with a simple 2-way system...and build to the multi-speaker system of your choice. See **Group D.**

If you want to start simple system & build on it...
P.S.E. is designed so that you can develop from a basic 2-way to a deluxe 3 or 4-way speaker system. For instance: Start with a basic 8" woofer and tweeter. See **Group A.** Or start with a basic 12" or 15" woofer and tweeter. See **Group D.** Or start with a coaxial or diffaxial and further improve performance. See **Group C.**

If you have a system you'd like to improve...
University's versatile speaker and network components make it easy. You can improve **your system** to a deluxe system **without discarding what you have.** For instance: If your system has an 8" woofer, see **Group A.** Or if you have a coaxial or diffaxial see **Group C.** Or if your system has a 12" or 15" woofer, see **Group D.**

If you custom build systems for resale...
P.S.E. is ideal for **custom planning** a deluxe or simple speaker system to suit your customers requirements. No matter what your plans, you can do it better with University's P.S.E. In **Groups A, B, C, D** you will find combinations of speaker and network components that will satisfy the most discriminating music lover. Make your work easier...follow the P.S.E. Plan for the **ultimate in speaker systems...** and give your customers **top dollar value.**



GROUP A

SYSTEMS STARTING WITH 8" SPEAKERS

The University line of 8" speakers is ideal for **space saver** and **budget** installations. Depending upon individual requirements, you can start with the Model 308 Diffaxial speaker...the Diffusicone-8 Diffaxial speaker...or, a small 2-way system employing the C8W 8" woofer and tweeter with network. Shown in the chart below, are high-quality deluxe multi-speaker systems which can be developed from the "initial" speaker or speaker system. The performance capabilities of these systems are equal to the finest in this price range, and higher!

KEY NO.	WOOFER	Low Crossover NETWORK	MID-RANGE	High Crossover NETWORK	TWEETER
A1	6200	N-2A	C8W	N-1 or N-2B	4401
A2	C12W	N-2A	C8W	N-1 or N-2B	HF-206 or UXT-5
A3	6200	N-2A	Diffusicone-8	N-1 or N-2B	4401
A4	C12W	N-2A	Diffusicone-8	N-1 or N-2B	HF-206 or UXT-5
A5	C15W or C63W	N-2A	Diffusicone-8	N-1 or N-2B	HF-206 or UXT-5
A6	C12W	N-2A	308	Built-in	Built-in
A7	C15W or C63W	N-2A	308	N-1 or N-2B	HF-206 or UXT-5

PLEASE NOTE:
Instructions for proper use of these charts appear on page following Chart "D" (at right).

3-way Diffaxials for triple pleasure

Model 315 15 3-way Diffaxial Speaker

Heavy-Duty "Reciprocating Flare" horn tweeter is projected *thru-axially* through center of woofer. Ultra highs are distributed by acoustic screen of tweeter horn. Full-bodied mid-range reproduced by *patented* Diffusicone* element. Woofer performance is equivalent to Model C15W. Crosses over mechanically at 1000 cps and electrically at 5000 cps through built-in L/C network with "Brilliance" control. 6½ lbs. of all-Alnico 5 Gold Dot magnet. Response from 30 cps to inaudibility. 50 watts of integrated program; 8-16 ohms; 12" deep; Shpg. wt. 34 lbs. **$132.00 Net.**

Model 6303 15" 3-way Diffaxial Speaker

Medium power version of the Model 315. Sonorous bass with full bodied mid-range provided by *patented* Diffusicone element crossing over mechanically at 1000 cps. High efficiency tweeter, with "Reciprocating Flare" horn, is projected *thru axially* through the center of the woofer. Built-in L/C network crossing over at 5000 cps. "Brilliance" control. 2 lbs. of all-Alnico 5 Gold Dot magnet. Response from 30 cps. to inaudibility; Handles 30 watts of integrated program; 8-16 ohms; 10" D. Shpg. wt. 15 lbs. **$80.10 Net.**

Model 312 12" 3-way Diffaxial Speaker

A completely engineered package ... University's HF-206 super tweeter is *thru-axially* projected through the center of the 12" woofer. Full-bodied mid-range reproduction is handled by *patented* Diffusicone principle. Built-in L/C network and variable "Brilliance" control. Crossover is mechanical at 1000 cps. and electrical at 5000 cps. Contains 2 lbs. of all-Alnico 5 Gold Dot Magnet. Response from 40 cps. to inaudibility. Handles 25 watts of integrated program; 8-16 ohms; 8" D.; Shpg. wt. 12 lbs. **$64.50 Net.**

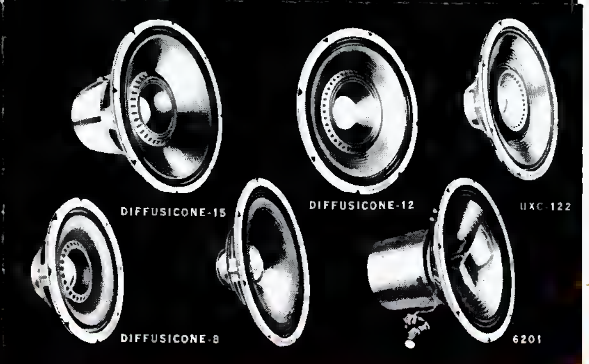
Model UXC-123 12" 3-way Diffaxial Speaker

New integrated 3-way speaker assembly wired with built-in L/C network and "Brilliance" control. *Exclusive* uni-sectional Diffusicone element. New UXT-5 super-tweeter with "Reciprocating Flare" horn mounted *through* the center axis of woofer. Highest efficiency, lowest distortion and true uniform wide-angle dispersion. Super-sensitive all-Alnico 5 magnet. Crosses over mechanically at 1000 cps, and electrically at 5000 cps. Response from 45 to 17,500 cps; 25 watts of integrated program. 8-16 ohms; 8¼" deep; Shpg. wt. 6½ lbs. **$59.50 Net.**

Model 308 8" 3-way Diffaxial Speaker

Undistorted response from 50 to 15,000 cps. Features University's *exclusive* true *thru-axial* construction with compression tweeter projected through the center of the woofer. Tweeter horn employs University's "Reciprocating Flare" principle crossing over electrically at 5000 cps.... mid-range is reproduced from patented Diffusicone element through a 1000 cycle mechanical crossover. Woofer has extra large voice coil for enhanced bass response. 1¼ lbs. of all-Alnico 5 Gold Dot magnet. 25 watts of integrated program; 8-16 ohms; 6¼" deep; Shpg. wt. 5 lbs. **$37.50 Net.**

*PATENT NO. 2,641,329



Extend the range of enjoyment

Exclusive University 2-way Diffaxials

University's *patented* 2-way diffaxial speakers now in all 3 sizes! This unique design with 1000 cycle mechanical crossover, results in full fidelity anywhere in the room ... full undistorted response without loss of highs at listening points progressively off speaker axis. Exclusive *bi-sectional* construction and one-piece moulded diaphragm provide long trouble-free life. All models contain *super-sensitive* all-Alnico 5 Gold Dot magnet for high efficiency. All connections made to binding posts.

Diffusicone-15—Response from 30 to 13,000 cycles; Handles 30 watts*; 8-16 ohms; 1½ lbs. all-Alnico Gold Dot magnet; 10" deep. Shpg. wt. 12½ lbs. **$45.00 Net.**

Diffusicone-12—Response from 40 to 13,000 cycles; Handles 30 watts*; 8-16 ohms; 1½ lb. all Alnico Gold Dot magnet; 4¼" deep. Shpg. wt. 6 lbs. **$33.00 Net.**

Model UXC-122—Response from 45 to 13,000 cps; 25 watts*; 8-16 ohms; 4" D. Shpg. wt. 5½ lbs. **$29.75 Net.**

Diffusicone-8—Response from 70 to 13,000 cycles; Handles 25 watts*; 8-16 ohms; 1 lb. all-Alnico Gold Dot magnet; 3⅝" deep. Shpg. wt. 5 lbs. **$23.50 Net.**

Model 6200 12" Extended Range Speaker

Shallow design perfect for wall, flush ceiling, and limited space installations. Contains full pound of all-Alnico 5 magnet. *One-piece* molded cone of special pulp content for long, trouble-free life. High efficiency, requires a fraction of power needed for ordinary 12" speakers. Response from 45 to 10,000 cps; 30 watts*; 8-16 ohms; 4" deep; Shpg. wt. 5 lbs. **$23.50 Net.**

Model 6201 Dual Range Coaxial Speaker

A *true* dual range coaxial system. The tweeter, *thru-axially* projected through the center of woofer, is a complete high efficiency driver with University's *exclusive* "Reciprocating Flare" horn. Contains 1¾ lbs. of all-Alnico 5 Gold Dot magnet. Response from 45 to 15,000 cps. Handles 25 watts*; 8-16 ohms; 8¼" deep; Built-in L/C network with balance control wired to 36" cable. Shpg. wt. 7 lbs. **$49.50 Net.**

**Integrated Program*

Crossover the bridge

Model N-1 Adjustable Filter

Adjustable high pass filter with built-in "Brilliance" Control. Crossover and impedance combinations: 2500, 5000, 10,000 cps. at 8 ohms; 1250, 2500, 5000 cps. at 16 ohms; 5000, 10,000 cps. at 4 ohms. Can be used with N-2A L/C network in 3-way system. 3⅝" x 3¼" x 3". Shpg. wt. 3 lbs. **$10.50 Net.**

Model N-3 *Acoustic Baton* Network

An *adjustable* L/C network for 3-way systems. Connections for either 350 or 700 cps. crossover between mid-range and woofer. Tweeter crossover is 5000 cps. Built-in "Presence" and "Brilliance" controls. Adjustable for vertical or horizontal mounting. Fits panels up to 1" thick. 8 ohms. 7"x5"x3". Shpg. Wt. 5 lbs. **$28.00 Net.**

Models N-2A and N-2B Adjustable L/C Dividing Network

With either or both these units, any combinations of speakers can be used in a great variety of voice coil impedances and popular crossover points. N-2A and N-2B can be used in combination for 3-way speaker systems. 3⅝"x3¼"x3". Shpg. wt., each, 3 lbs.

N-2A ADJUSTABLE CROSSOVER. 6 db/oct. 2-way L/C network. May be used in pairs as 12 db/oct. network, or singly as 12 db/oct. low or high-pass filter. Crossover—350 or 700 cps. at 8, 16 ohms; 700 cps. at 4 ohms. **$18.00 Net.**

N-2B ADJUSTABLE CROSSOVER. 6 db/oct. 2-way L/C network. May be used in pairs as 12 db/oct. network, or singly as 12 db/oct. low or high-pass filter. Crossover—1250, 2500 or 5000 cps. at 8 ohms; 2500 or 5000 cps. at 16 ohms; 2500 at 4 ohms. **$14.00 Net.**

Model AP-8 "Balance" Control

Effective and efficient attenuator pad for balancing sound according to room acoustics and personal taste. Ideal for use with N-2A and N-2B networks. Complete with polished brass escutcheon and knob, etched on both sides plate is marked "PRESENCE" for use in mid-range circuits, and "BRILLIANCE" for use with tweeters. Suits 8-16 ohms systems. Fits panels up to 1" thick. Shpg. wt.: 7 oz. **$3.75 Net.**

Woofers that really go down

Model C15W Dual Impedance Range Woofer

Maximum conversion is maintained by a new type voice coil with greatest axial depth and excursion ever attained. Exclusive twin spider arrangement and 6 lb. all-Alnico 5 Gold Dot magnet reduces distortion to virtually broadcast level. Response from below 30 to 3000 cps. Up to 50 watts integrated program. *Exclusive* dual impedance voice coil assembly enables use in any system of 4 to 20 ohms, facilitating altering or expanding systems. 10½" deep; Shpg. wt., 24 lbs. **$75.00 Net.**

Model C63W Adjustable Response 15" Woofer

The same highly efficient unit as used in *woofer* section of the 6303 diffaxial, incorporates the *exclusive* built-in response limiter. Response adjustments are set at the popular crossover frequencies of 700, 2500 and 5000 cps., for compatible roll-off characteristics. 1½ lbs. of super-sensitive all-Alnico 5 Gold Dot magnet. Response from 30 to 6000 cps.; handles 30 watts of integrated program; 8 ohms; 10" D. Shpg. wt. 13½ lbs. **$47.70 Net.**

Model C12W 12" Adjustable Response Woofer

Built-in facilities enable high-end adjustment response to 700, 2500 or 5000 cps. suiting requirements of most tweeters. Crossover points can be changed to achieve best tonal balance. When used with N-1 adjustable high-pass filter, combination forms a complete L/C network. 1½ lbs. super-sensitive all-Alnico 5 Gold Dot magnet. Response: 40 to 6000 cps. (overall). 8 ohms. Up to 30 watts integrated program. 6½" deep. Shpg. wt.: 8 lbs. **$33.00 Net.**

Model C8W 8" Woofer

Ideal for assembling a compact, high quality speaker system. Perfect also as a mid-range in low cost 3-way systems and is suitable for crossover up to 5000 cps. Heavy super-sensitive all-Alnico 5 Gold Dot magnet. Response to 50 cps. is achieved when properly baffled. Up to 25 watts of integrated program. 8 ohms. 4¼" deep. Shpg. wt.: 4 lbs. **$13.50 Net.**

GROUP B

SYSTEMS STARTING WITH 12" OR 15" EXTENDED RANGE SPEAKERS

University 12" or 15" Extended Range speakers provide immediate listening satisfaction... at **modest initial cost**... and serve as a basis for a deluxe multi-speaker system. Expansion is accomplished progressively, by adding a speaker and network component with each step. Thus, an "extended range" speaker may serve as the woofer in a 2-way system or a mid-range speaker in a 3-way system, while in some systems, such as B5 thru B7, it functions as a woofer in 2 and 3-way systems.

KEY NO.	WOOFER	Low Crossover NETWORK	MID-RANGE	High Crossover NETWORK	TWEETER
B1	C12W	N-2A	6200	N-1 or N-2B	4401 HF-206 or UXT-5
B2*	C15W or C63W	N-2A	6200, Diff-12 or UXC-122	N-2B	4409
B3	C15W or C63W	N-2A	Diff-12 or UXC-122	N-1 or N-2B	HF-206 or UXT-5
B4	6200, Diff-12 or UXC-122	N-2A	4409	N-1 or N-2B	HF-206 or UXT-5
B5	C15W	N-2A	Diffusicone-15	N-1 or N-2B	HF-206 or UXT-5
B6	Diffusicone-15	N-2A	4409	N-1 or N-2B	HF-206 or UXT-5
B7	Diffusicone-15	N-2A	Cobreflex-2/T-30	N-1 or N-2B	HF-206 or UXT-5
B8	Diffusicone-15	N-2A	Diff-8, 12 or UXC-122	N-1 or N-2B	HF-206 or UXT-5

*NOTE: When this system is used complete as a three-way arrangement, use the N-2A as a 350-cycle crossover between woofer and mid-range, and a 1250-cycle crossover with the N-2B between mid-range and tweeter speakers.

GROUP C

SYSTEMS STARTING WITH COAXIAL OR DIFFAXIAL SPEAKERS

University Coaxial and Diffaxial speaker systems are self-contained ... easy to install and provide excellent wide range performance. However, coaxial and diffaxial speakers can be further developed to one of the deluxe multi-speaker systems shown in the chart below. The use of a 4409 "Reciprocating Flare" horn speaker in combination with a coaxial or diffaxial speaker increases the output and dispersion of the mid-range, thereby adding still further to the sensation of "presence" Bass and treble ranges can also be extended or reinforced, as indicated by the suggested systems.

KEY NO.	WOOFER	Low Crossover NETWORK	MID-RANGE	High Crossover NETWORK	TWEETER
C1	C12W	N-2A	308	Built-in	Built-in
C2	C15W or C63W	N-2A	308	N-1 or N-2B	HF-206 or UXT-5
C3	C15W or C63W	N-2A	6201	Built-in	Built-in
C4	C15W or C63W	N-2A	6201	N-1 or N-2B	HF-206 or UXT-5
C5	C15W or C63W	N-2A	312 or UXC-123	Built-in	Built-in
C6	C15W	N-2A	6303	Built-in	Built-in
C7	6201	N-2A	4409	Built-in	Built-in
C8	312 or UXC-123	N-2A	4409	Built-in	Built-in
C9	6303	N-2A	4409	Built-in	Built-in
C10	315	N-2A	4409	Built-in	Built-in

GROUP D

MULTI-SPEAKER SYSTEMS USING 12" OR 15" WOOFERS TO START

University speaker and network components are **designed** for expansion. Dual impedance and adjustable response woofers... adjustable L/C dividing networks and high pass filters... and a large selection of tweeters that make possible varying crossover points, enable you to "tailor" your speaker system to suit your listening requirements. Most important is the fact that you can do it in easy stages. Start with any of the 2-way systems shown in the chart below... in time build to a deluxe 3-way system.

KEY No.	WOOFER	Low Crossover NETWORK	MID-RANGE	High Crossover NETWORK	TWEETER
D1	C12W	N-2A	4409	N-1	4401 HF-206 or UXT-5
D2	C12W	N-2A	4409	N-1 or N-2B	HF-206 or UXT-5
D3	C15W or C63W	N-2A	4409	N-1 or N-2B	HF-206 or UXT-5
D4	C15W or C63W	N-2A	C12W	N-1	4401 HF-206 or UXT-5
D5*	C15W or C63W	N-2A	C12W	N-2B	4409
D6	C15W or C63W	N-2A	Cobreflex-2/T-30	N-1 or N-2B	HF-206 or UXT-5

*NOTE: When this system is used complete as a three-way arrangement, use the N-2A as a 350-cycle crossover between woofer and mid-range, and a 1250-cycle crossover with the N-2B between mid-range and tweeter speakers.

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

LISTEN *University sounds better*

Its easy to follow the charts

Indicates the speaker (and associated components, if any) with which a particular system is *started*.

These are the components which are added to improve the initial speaker, thus resulting in the *first expansion* of the system.

Represents speaker and components added in the *final expansion* of the system. Now you possess the best there is, tailor-made to *your* specific requirements.

EXAMPLE: The system shown under Group A as A-4:

A4	C12W	N-2A	Diffusicone-8	N-1 or N-2B	HF-206

Diffusicone-8, in orange block, is the first speaker used. By itself, it's an excellent extended range speaker providing response from 70-13,000 cps. When the HF-206 Super-Tweeter and either of networks shown in gray blocks are added, the Diffusicone-8 then functions as a "woofer" and the combination performs as a "2-way" system. Later, by adding C12W woofer and N-2A network shown in white blocks, the Diffusicone-8 serves as a mid-range of the now fully developed "3-way" speaker system.

SPECIAL NOTES

(1) Models N-1, N-2A, N-2B crossover networks are adjustable for crossover frequency and impedance match. The N-1 is a high-pass filter with built-in high frequency control. The AP-8 Balance Control can be used with N-2A and N-2B for variable control of PRESENCE and BRILLIANCE. The N-1 filter works only with the speaker it feeds; N-2A and N-2B are L/C networks which aid in the segregation of the audio spectrum into those portions feeding both speaker preceding and speaker following network, resulting in smoother crossover characteristics.

(2) The following crossover frequencies are recommended with speakers indicated:

Cobreflex-2/T-30	350 cps.	C15W or C63W	350 or 700 cps. (when feeding into a cone speaker for mid-range)
4409	700 cps.		
4401	2500 cps.	C12W	700 cps.
HF-206	5000 cps.		(when feeding into a cone speaker for mid-range)

(3) In speaker combinations using the Cobreflex-2/T-30 or Model 4409 horn (or cone speaker) as mid-range, and the HF-206 as tweeter, the N-3 "ACOUSTIC BATON" 3-way network with built-in PRESENCE and BRILLIANCE controls may be used instead of the combination of N-2A and N-2B networks shown in charts. However, using N-2A and N-2B permits progressive, *step-by-step* expansion of these systems.

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how far the meter should be allowed to swing during a recording session. Inasmuch as distortion increases rapidly with slight increases beyond the maximum permissible recording level, it is best to err on the side of under-recording.

Figure 4 shows that the recording-level meter is driven in the playback mode as well as the record mode. As things turned out, a steady 400-cps tone recorded at a level producing 2 per cent harmonic distortion produces in playback a meter reading about 5 db below the 100 mark. Allowing for a 6 db lag on transients, this means that a properly recorded tape should hit peaks that do not exceed about 11 db below 100 per cent. Thus the meter, as shown connected in *Fig.* 4, is useful in evaluating within a few db whether a recorded tape, regardless where made, was recorded at too low or too high a value. It will be found that some commercial recorded tapes contain levels 10 db or higher than permissible for truly clean sound.

The fact that V_5 is connected so as to produce a meter indication in the playback mode has one possible disadvantage. When a signal is fed into J_2 or J_3 for recording, the meter produces an indication even though the play-record switch S_1 is in the play position. Thus an absent-minded recordist may forget to throw the switch and get nothing for his efforts. However, it is very easy to remedy this situation by disconnecting the plate of V_5 from the direct lead to B_1+ and connecting the plate instead to B_1+ via the record terminal of S_1d. Consequently V_5 will receive power only in the record position and the meter will remain inactive when S_1 is in play position.

Play-Record Switching

The four sections of S_1 perform the following switching functions:

S_1a switches the grid of V_1 to microphone input in record and to the record-playback head in playback. The playback signal arrives by a circuitous route via S_1–C_1, which determines whether the head is to serve in the play or record mode.

S_1b introduces bass boost in playback by connecting the R_5–C_3 losser circuit to ground. In record, it grounds out a number of switch terminals, thus providing the shielding effect previously mentioned in the section dealing with the bias oscillator. As may be seen in *Fig.* 4, bias current is present at the R terminal of S_1a in the record mode. By leakage and/or radiation, some bias energy would be picked up by the P terminal of S_1c, transferred to the P terminal of S_1a, again picked up by the R terminal of S_1a, and amplified by V_1 when this tube is in use for microphone recording; ultimately this bias pickup would not only affect the indication of the record-level meter but would also cause the bias current applied to the record head to exceed the correct amount. However, this undesirable chain of events is prevented by S_1b, which in the record mode shunts the P terminals of S_1a and S_1c to ground.

S_1c, as already stated, determines in which mode the play-record head shall perform.

S_1d in the record mode supplies B_1+ to V_4, which drives the record head, and to V_6, the oscillator. As previously stated, it may also be used so that V_5 and the meter only function in the record mode.

The amplifier's play-record switching arrangement lacks a feature which, although not essential in the writers' opinion, would be desirable from the viewpoint of convenience and could be had if S_1 contained a fifth set of contacts. This feature would permit leaving the input signal plug in J_2 (but not in J_3)

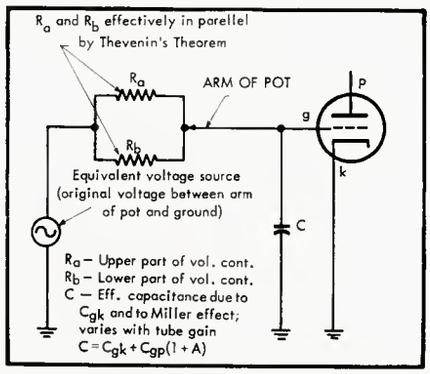


Fig. 12. High-frequency attenuation due to the Miller Effect.

when switching from play mode to record mode. Assuming that a fifth set of contacts, S_1e, were available (as could be done by using a double-deck switch), *Fig.* 11 shows the essential features of the improved switching arrangement. It may be seen that in the record mode the signal from V_1 would still be interrupted by a plug inserted into J_2. However, in the play mode the volume control would be disconnected from the high side of J_2 and connected instead to the shorting arm of J_2, which carries the signal from V_1.

Low-Noise Resistors

Low-noise resistors—which may be of the precision, deposited-carbon type—are specifically called for only at the plate (R_1) and the cathode (R_4) of V_1. Even R_4 could be a conventional type; however, two conventional cathode resistors were tried and although one behaved satisfactorily the other did not. To play safe, *Fig.* 4 calls for a low-noise cathode resistor.

Although V_1 is the critical stage so far as resistor noise is concerned, it was considered desirable, at little extra expense, to minimize the risk of such noise in later stages by using 2-watt resistors at the plates of V_2 and V_4 and at the cathode of V_3.

Volume Control

It will be noted that the volume control is 0.25 megohms instead of the more usual 0.5 megohms. However, due to the amount of Miller effect which occurs when using a high-gain triode such as the 12AX7, it is necessary to use the smaller resistance, although this may have some disadvantages, such as requiring a larger coupling capacitor or failing to present to the input signal a load having quite as large an impedance as desired. There is a maximum loss of 1 db at 15,000 cps at mid-setting of the 0.25 megohm control, whereas mid-setting loss would be as great as 3 db at 10,000 cps if a 0.5 megohm control were used.

Miller Effect denotes the increase in a tube's effective input capacitance resulting from plate to grid capacitance, C_{gp}. This increase is equal to $C_{gp}(1+A)$, where A is tube gain. Triodes have a relatively large value of C_{gp}, so that Miller Effect is much more severe for them than for pentodes. And the effect is greater for a high-mu triode such as the 12AX7 than for a low-mu tube such as the 12AU7.

Figure 12 illustrates how grid-to-cathode capacitance due to Miller Effect causes high-frequency attenuation at mid-settings of the volume control. R_a is the resistance between arm and high side of the control; R_b is the lower resistance leg. By Thevenin's Theorem, the two resistances are effectively in parallel with each other and in series with the equivalent voltage source, which is the original voltage between the arm of the pot and ground. The larger the parallel resistance of R_a and R_b, the larger the time constant formed by this resistance and the capacitance due to Miller Effect, and the lower the frequency at which losses begin to occur. Maximum parallel resistance occurs when R_a and R_b are equal, that is, at mid-setting of the pot.

In order to keep mid-setting losses at a minimum, the shielded lead from J_1 to the volume control should be as short as possible and of minimum capacitance; microphone cable having a capacitance of 25 μμf per foot is suitable. If lead dress is carefully arranged to avoid hum pickup, an unshielded connection can be used between J_2 and the volume control.

Direct Coupling

One of the criticisms that might be leveled at the amplifier, especially since economy is an important consideration, concerns the absence of direct coupling between V_2 and V_3. This would permit C_4, R_{10}, and R_{11} to be eliminated and would also provide better low-frequency response.

(*Continued on page 67*)

Equipment Report

Pickering "Fluxvalve" phono cartridges and the Unipose arm—Connoisseur three-speed turntable—"Steel Slides" for equipment cabinets

THE APPARENT—and unattainable—goal of phonograph pickup manufacturers might well be a massless stylus with infinite compliance, and a resonance at least an octave above the audio spectrum, although if the unit were to comply with the first two specifications there would be no resonant frequency. Furthermore, and much more important, the stylus would not center itself between pole pieces and would undoubtedly generate considerable distortion. Actually, the Fluxvalve has the lowest effective mass of any of the pickups for which figures are published, and while there is considerable *theoretical* advantage to high compliance, it must be remembered that the stylus must be acted upon by some restoring force if it is going to work properly in actual use. That the choice of mass and compliance has been made judiciously by the manufacturer is attested by the fact that the Fluxvalve will track perfectly in a Rek-O-Kut 120 arm at two grams, and this does not mean only that the stylus will stay in the groove at that force but that intermodulation distortion remains satisfactorily low, which is a better measure of proper tracking force.

The Fluxvalve, shown in *Fig.* 1, consists of a plastic housing which contains the magnet and the coil structure, and which is grooved on the top and bottom to accommodate the two stylus fittings. These are readily interchangeable, and with four types available—2.7 mil radius in either sapphire or diamond, and 1.0-mil and ½-mil radii in diamond only—the user can make his choice depending on his own special requirements. The 2.7-mil radius is used for standard-groove records, and the 1.0-mil radius is normally used for LP's. However, with those records which are cut with V grooves, and *with a top-quality turntable* the advantages of the ½-mil stylus can easily be heard by the ear, particularly with respect to the extremely high frequencies. The effect is similar to the sound obtained from 78-rpm microgroove records—which is comparable to live FM on a good tuner.

Pickering advertising has often referred to the Fluxvalve as "the pickup you can use to calibrate records." The curve shown in *Fig.* 2 shows this to be practically true, since there is a peak of only 2 db in the vicinity of 13,000 cps, and a droop at 20,000 of 0.4 db, using a Cook series 10 (78 rpm) test record. The rolloff at the low end is due to the customary low-frequency turnover, and the curve represents an actual measurement with 0 db corresponding to 15.5 mv at a stylus velocity of 9 cm/sec, which is the velocity of the 1000-cps level-setting band at the beginning of the record. These measurements were made with a record which had been played only about four times previously. Using an older record that had been played dozens of times showed a loss of 4.5 db at 20,000 cps.

Under typical conditions in two different makes of changers, the Fluxvalve was found to track reliably and operate the trip at a stylus force of 5 grams, and in both instances the hum pick-up—often a problem with changers—was below audibility at any position of the arm with the volume control set to produce a listening level of somewhat higher than normal (actually approximately 90 db, with normal for the average listener in the vicinity of 75 db). The Fluxvalve is capable of giving excellent quality with a satisfactorily low stylus force and does live up to its claims as a "tool" for measuring records.

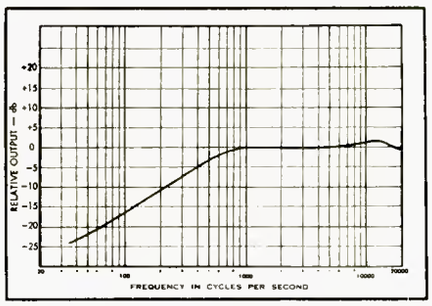
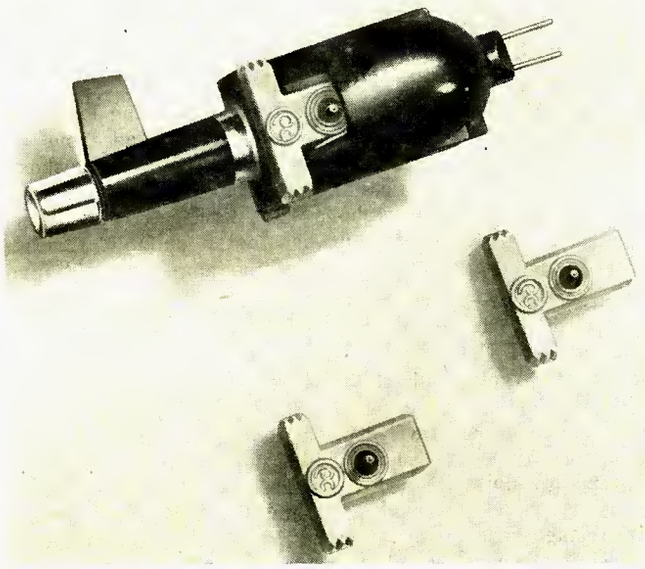


Fig. 2. Performance curve for the standard model of Fluxvalve, using Cook Series 10 (78 rpm) test record.

From the technical standpoint, the Pickering Fluxvalve exhibits a measured inductance of 350 millihenries and a d.c. resistance of approximately 3750 ohms, resulting in an impedance at 1000 cps of approximately 5950 ohms. With this inductance, the performance should not be adversely affected up to 25,000 cps with a total capacitance of 150 μμf for connecting cables and associated circuitry. As with any magnetic cartridge, the inductance can be resonated to a chosen frequency by the use of external capacitors and a suitably chosen terminating resistor to effect a sharp cutoff at practically any desired frequency—the droop above cutoff being at the rate of 12 db per octave. Most users of high quality equipment are already sufficiently conscious of the possible effect on frequency response of high-capacitance cables, and will therefore scrupulously avoid them.

The Unipoise Arm and Fluxvalve Assembly

Employing the same basic design for the pickup, the new Unipoise arm and Fluxvalve pickup assembly has just been introduced, and we have had an opportunity of observing it in action and listening to its performance. Useable only with professional-type turntables, the new arm, shown in *Fig.* 3, is of modern design, and integrates the arm with the pickup in an interesting form. The arm has extremely low mass and low friction for precision, nonwearing reproduction of current and future microgroove recordings. It has a single needle-point bearing to allow both vertical and horizontal motion, and has an integral cartridge which takes the same stylus inserts as the standard Fluxvalve. The low inertia of the arm makes it possible to take full advantage of the very high compliance and low dynamic mass of the Fluxvalve design, and completely minimizes forces which can impair the finer details impressed on



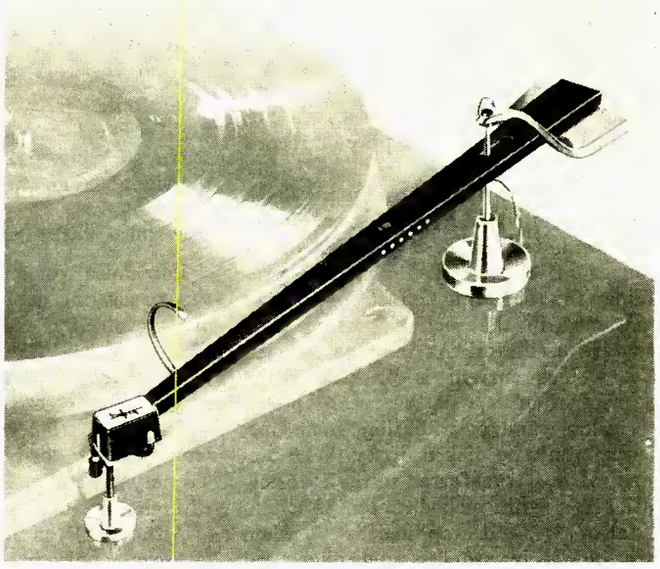


Fig. 1 (left). The Pickering Fluxvalve with two of the stylus inserts shown separately. Fig. 3 (right). The new Unipoise arm and Fluxvalve assembly, which offers modern design and superlative performance in a completely integrated unit.

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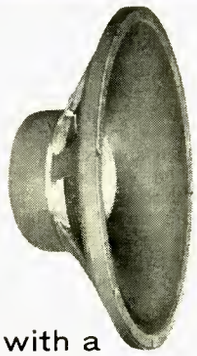

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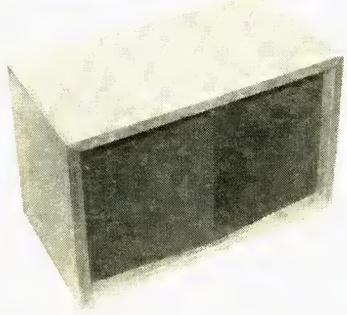


put your D130 in a JBL signature "HARKNESS" enclosure

Otherwise known as the Model C40 Lowboy Console Back-Loaded Folded Horn, the Harkness is the newest acoustical enclosure made by James B. Lansing Sound, Inc. An exponentially-tapered horn with a six-foot path and four-square-foot mouth is driven by the back of the speaker cone from 175 cps on down. Above this frequency the D130 acts as a direct radiator. Styling and dimensions make this unit most welcome in any living room.

add a JBL signature 175DLH high frequency assembly

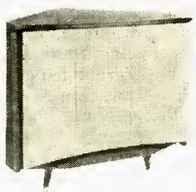
and dividing network to make the greatest single improvement possible in your high fidelity sound system. The 175DLH includes a high efficiency driver with complex phasing plug machined from a solid billet of pure iron, an exponentially tapered horn machined from a casting, and a true acoustical lens. The lens, found only on JBL Signature units, disperses highs smoothly over a solid 90° angle with equal intensity regardless of frequency.

the JBL signature D123

is a twelve-inch extended range loudspeaker that is only 3⅝" deep. This shallow shape permits it to be mounted between studding, flush with the surface of a standard wall or partition. With three-inch voice coil and cast frame it is the outstanding precision loudspeaker in its class.

the JBL signature D208

is an eight-inch extended range loudspeaker which, in spite of its small size, is in every respect a true precision transducer. Made with an edge-wound, aluminum ribbon, two inch voice coil, the D208 is widely used by professional sound systems engineers as an extension speaker in multiple outlet or stereophonic installations.



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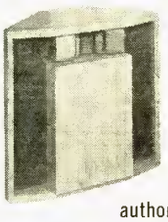

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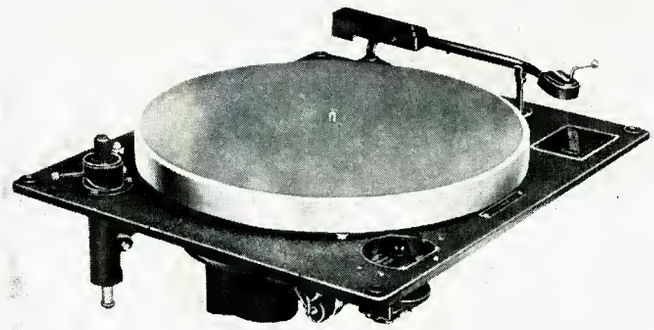


Fig. 4. Connoisseur three-speed-with-vernier turntable which employs a hysteresis-synchronous motor.

modern microgroove recordings.

The complete assembly consists of a molded head and lightweight arm riding on the upright needle pivot, and the cartridge is an integral part of the assembly and permanently sealed into the housing. The upright bearing member passes through a slot in the arm and damping is effected at this point. The entire assembly mounts in a single hole and may be adjusted to match the height of the turntable surface. A directly calibrated sliding weight allows for adjustment of the stylus force between one and six grams.

The measured output of the assembly is 13.8 mv for a stylus velocity of 9 cm/sec, and the frequency response is claimed to be flat from 20 to 30,000 cps, although our own measurements were not carried to that extent with any degree of accuracy. To obtain 30,000 cps from a test record requires that an LP record be operated at 78 speed, and one can not be certain of calibration. However, we have seen perfect sine waves at 28,000 cps (from a 12,000-cps band on an LP test record) which is sufficient for our own curiosity. For those who have turntables of sufficiently high quality to work with very light tracking force, this unit will certainly give outstanding performance. **B-16**

CONNOISSEUR TURNTABLE

There is a wide choice available to the audiofan in practically all of the components required for high-quality reproduction, but the addition of one or two more certainly will not glut the market, and it may offer some features not heretofore found.

The Connoisseur three-speed turntable, British-made and imported by Ercona Corporation, is an example of craftsmanship and electrical and mechanical design that may well attract interest. Shown in *Fig.* 4, this turntable is mounted on a cast aluminum plate, and features a hyteresis-synchronous motor, a variable-speed feature, a mechanical brake coupled to the on-off switch, and a cast and turned aluminum platter which is fitted to a heavy shaft. Because of the separation of the speed-change and on-off controls, the Connoisseur eliminates the possibility of being started in a wrong speed by mistake, which would be a definite advantage in professional or broadcast studio operation. The speed control turret is located at the left rear of the mounting plate and consists of a lever which moves the idler up and down in steps for the three speeds and a fluted knob which serves as a vernier to provide a speed change of approximately ±4 per cent around the three standard speeds.

The off-on control is located at the front of the mounting plate and to turn the unit on performs three separate operations—it releases the brake, moves the idler into contact with the inside of the turntable rim, and turns on the a.c. switch. Turning the unit off reverses the operations. The mechanical brake consists of a cork pad which is lifted by the starting lever to contact the lower edge of the turntable rim.

The hyteresis motor has a tapered and stepped shaft to provide for the speed variation, and is attached with very soft rubber vibration mounts. The idler has needle bearings, and is also isolated with soft rubber mountings. Mechanically the unit is well built and should be capable of long and trouble-free life.

In the performance department, the Connoisseur shows a noise and rumble 48 db below full modulation, measured as previously described in these columns and in a practical installation. By way of comparison, measurements by the same means have indicated a signal-to-noise ratio of only 51db in the quietest turntable we have measured. With the vernier speed control set for exactly 33⅓ rpm at the LP position, the lever was moved to the 45-rpm position and then to the 78-rpm position, checking the stroboscope a small one is furnished with the turntable) at each speed in order to check the accuracy of the three positions. It was found that there was a variation of less than 1 per cent from *exact* speeds in each of the other positions.

Normally intended for use with the Connoisseur arm and pickup, the base plate is already drilled. However, for much of our test work we find it necessary to employ an arm which will mount different types of cartridges, so we drilled and tapped the plate to accommodate a Rek-O-Kut 120 arm. (Because of the rubber mounts between base plate and the cabinet it is necessary that the arm be mounted on the base plate.) With this combination, our experience to date has been one of complete satisfaction with the Connoisseur turntable. **B-17**

"STEEL SLIDES" FOR EQUIPMENT CABINETS

Aside from the difficulty in mounting the two slides required heretofore with record player or turntable bases, there has always been the problem of eliminating rumble and acoustic feedback. Popular demand for hi-fi equipment has stimulated many manufacturers to bring out cabinets which mount both speaker and phono equipment. This allows a compact set-up, but has the drawback that some of the vibration produced by the speaker is coupled through the cabinet to the pickup stylus, causing a high-gain feedback path to exist at some low frequency. This frequently gives rise to distortion of low tones, and more often causes a rumble or even a continuous roar.

Steel Slides, Inc., of Yonkers, N. Y., has developed a means of mounting a phono base which is not only simple to install but which also eliminates the problem of coupling between speaker and turntable. This unit may be employed with equipment which is separate from the loudspeaker just as well as for those installations in a single sabinet. The Steel Slide consists of a single center member of formed steel which is affixed to the cabinet and another of identical size and shape which is affixed to the record player base. The two parts simply slide on each other. Elimination of any coupling between speaker and stylus is effected by mounting the "fixed" slide in rubber, and adding two spring-mounted nylon rollers which bear on a sponge rubber insert on the bottom of the record player base when it is in the playing position. Additional sponge rubber bumpers isolate the front of the panel from the cabinet.

Aside from the advantage of simple mounting (did you ever try to mount two conventional slides and keep them perfectly parallel and properly spaced?), this device is most effective in eliminating acoustical feedback. Looking at the slides would almost be enough to convince the observer that they wouldn't work and that since only one was used it would be likely to bind. Such is not the case however. The precision with which the slides themselves are rolled, together with a wax coating, makes them work quite smoothly, even with extensions which couldn't be obtained with conventional slides.

We find that these units are of exceptional convenience in use and that they are most effective in eliminating interference between loudspeaker and phonograph—even when both are mounted in the same cabinet—when employing the rubber and roller mounting. And we have no hesitation in recommending them to manufacture or home constructor alike. **B-18**

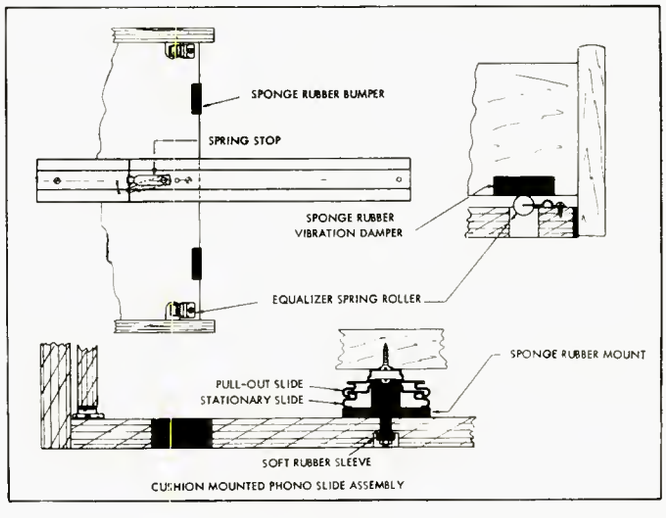
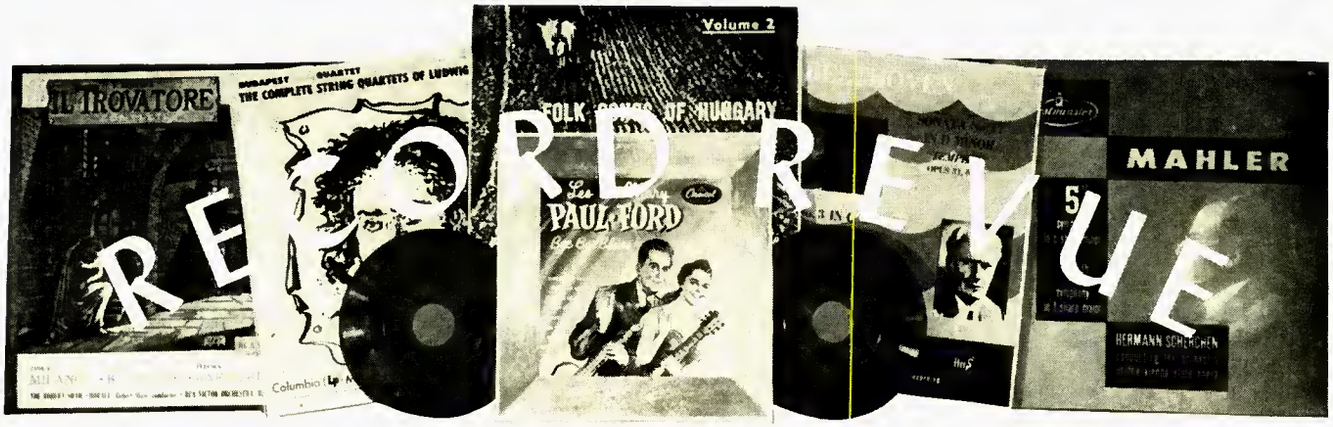


Fig. 5. Method of mounting Steel Slides to eliminate acoustical coupling.



EDWARD TATNALL CANBY*

Scouts' Report

MY TWO SCOUTS have been industriously listening to records these many months, but my own output has filled all our space without giving them a chance to be heard. From their reports of recent months, here are items that you shouldn't have missed hearing about—good or bad.

Brahms: Double Concerto for Violin and Cello; Vars. on a Theme of Haydn; Tragic Overture. Isaac Stern, Leonard Rose; N.Y. Philh., Bruno Walter. **Col. ML 5076**

"Biggest, bestest Double Concerto I've ever heard," spouts Scout #2, and then, "supreme!" and much more of the same. That's enough to make me put this disc in the top spot here and to wish I'd been able to play it five or six times myself; I have that much respect for these eminent performers. The other items, note, also appear in the Bruno Walter Brahms album along with the four symphonies. Scout #2 really went overboard and thinks this is one of the greatest Brahms discs ever. "Hi-fi all over the place . . ."

Brahms: Complete String Quartets. Haydn: Quartet in E Flat, Op. 33, #2. Budapest Str. Quartet. **Col. SL 225**

—Similarly with these, on a smaller scale; Scout #2 is nuts about the performance, thinks they are beautifully played, that they positively melt, yet have the clean, definite Brahms lines underneath. That accords with my ideas of the Budapest. Top recommendation.

Mozart: Quintet for Piano and Winds in E Flat, K. 452. Beethoven: Quintet (same), Op. 16. Walter Gieseking; Philharmonia Wind Quintet. **Angel 35303**

Another very high recommendation from Scout #2, and with good reason, for here is a group of winds from the top-notch British Orchestra playing with the late and great pianist, Gieseking. "The performance is great," he says, uncompromisingly. "Glowing and rich and so deeply understood." He'd buy it, even, for the Mozart alone.

Mozart: Serenades #12 and #15. Boston Pops Orchestra, Fiedler. **RCA Victor LM 1936**

Interesting reaction here and I could have predicted it: Scout #2 says "I must admit having been prejudiced—I saw the Boston Pops name and curled my lips. But I was quite wrong. They're lovely." These are the more familiar items among the Mozart Serenades and Fiedler plays them "with no fuss and feathers, just clean and sunny and quite gorgeous."

I always did think that the Boston Pops had, and has, a special beauty, a way of performing "great" music so that it really can pass for "light" in the best listening sense, and a touch with light music that almost makes it great. That's Arthur Fiedler, who has a really superb sense of style in his interpretations, and the superb ensemble of the Pops men, alias the Boston Symphony.

Beethoven: Piano Concerto #5 ("Emperor"). Wilhelm Kempff; Berlin Philh., van Kempen. **Decca DL 9741**

Scout #2 has essentially my own reaction to this pianist. Kempff is not the big-time, dramatic player that most people want; but he has a tremendous reserve of Beethoven emotion on tap in spite of a seemingly mild and rather dry approach; his sense of structure and his feeling for the phrases, ideas, lines in Beethoven is fantastic. So—his versions tend to be anticlimactic at first, but to grow upon you, as the Beethoven thunderers do not. Kempff simply has more to say.

Thus, Scout #2 warms up gradually to this one—"a nicely controlled performance, not terribly exciting"—and then begins to hedge, ending up with considerable enthusiasm. You will, too.

Schubert: Piano Sonatas in A (posth.), A Minor, Op. 164. Friedrich Wührer. **Vox PL 9130**

This continues the Wührer series of Schubert piano works. He is a big pianist, a bit on the severe side but very powerful and, shall I say, fundamental.

Scout #2 is thoroughly happy with this recording—thinks the big posthumous A major sonata is both superb listening and wonderfully turned out by this pianist. The A Major, Op. 164, an early Schubert, is lovely if less interesting. (Note that Schubert's early works were the first published, running up to high opus numbers; his later works mostly disappeared in manuscript until after his death—and so have no opus numbers, just that ominous designation, "posth." indicating that somebody dug them up out of an old attic after Schubert was dead. Often a long while after, too. Like the Unfinished Symphony and the Great C Major Symphony.)

Schumann: Dichterliebe; Songs from Myrthen and Liederkreis. Anton Dermota, tenor, H. Dermota, pf. **Telefunken LGX 66023**

Scout #2 is a *lieder* fan and knows his stuff. He thoroughly approves of Dermota's Schumann, says he does a "sweet, sensitive job—he really listens to the music, listens to Schumann" and really understands him. Very romantically sung, but not too much for the music, the Scout thinks.

"There's nothing Dermota with this recording." Ugh—but try it just the same, I suggest, puns or no. (Let 'em quote *that* in their advertising.)

Schubert: Die Winterreise. Schumann: Liederkreis. Fischer-Dieskau; Gerald Moore, pf. **RCA Victor LM 6036**

Schumann and Beethoven Lieder. Max Lichtegg, tenor, H-W. Haussemein, pf. **London LD 9183**

While I'm at it, here are some less happy reactions on the part of the same Scout #2, who is nothing if not positive. "Dieskau and Moore do well by Schubert but there is, for me, a sameness about the songs (in the singing of them, that is). The songs . . . do tend to sound a little alike—it takes a really expert interpreter to handle each one carefully and delicately, so that the whole cycle has shape and pace . . . this is where Dieskau fails." He adds that when he heard Lotte Lehmann do these Schuberts he "nearly done himself in," and I practically died on the spot m'self when I heard her do the series in person, in Town Hall. People wept all over the place. *She* knew how, even if her voice wasn't much by then.

I should say that Fischer-Dieskau has made a big name as a lieder singer and you may feel differently than Scout #2 about him. But, judging from what I've heard before, I think maybe I'd go along with this opinion.

Oof! As to Max Lichtegg on the London disc, I dare not quote the Scout's all-too-positive reaction. Quite unprintable and I'll mention merely his final word, in large capitals: GAD! He didn't like it. Not one little bit.

Might add that if you don't trust Scout #2 you're welcome to go right out and try this one for yourself. I don't think I will.

Schubert: "Wanderer" Fantasy; Moments Musicaux. Istvan Nadas, pf. **Period SPL 719**

Well, I'll quote Scout #2 on this one—he's a bit more temperate, merely calls it "ghastly." (Don't ever get into record reviewing! You're not supposed to use words like that, you know.) I quote it merely because I've heard this pianist elsewhere and find that, for my ear, he is a highly proficient, tough-fingered mechanism with about as much soul, for 19th century music of the poetic sort, as Univac itself. And the "Wanderer" Fantasy, from ultra-poetic Schubert, is a very long and very wandering piece that can only be brought to life via the utmost in warm, human sympathy translated into keyboard playing—not at all a simple task. So, you see, maybe Scout #2's reaction was a healthy one, if a bit intemperate.

Debussy: Childrens Corner; La Boite à Joujoux. Orch. Nat. de la Radiodiffusion Fr., Cluytens. **Angel 35172**

Scout #1 took on this disc and thinks it represents the best of French-style orchestral playing by an all-French orchestra, recorded with excellent sound. These are orchestral versions of music that you may know in the piano form.

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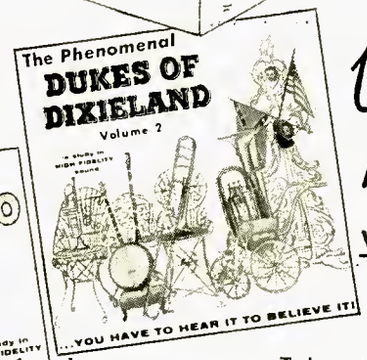

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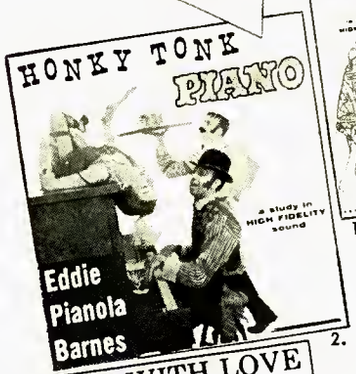

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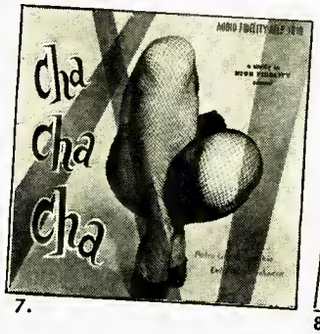

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WRITE FOR FREE CATALOG

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Berlioz: Overtures (The Corsair, Les Francs-Juges, Roman Carnival, King Lear). Paris Conservatory, Albert Wolff.
London LL 1297

. . . And here's another good French-style recording of French music, says Scout #1, who thinks the veteran French conductor, Wolff, is the most successful of the many conductors who work with this somewhat overworked orchestra; he does best in "coaxing from it a precision of ensemble, orchestral sheen, and a pastel transparency of sound . . . that is all too rare these days in the playing of French orchestras." Agreed. They do tend to be inexcusably sloppy in their off moments as I've too often noticed myself, but they still have a special and wonderful sound at best. Here it is.

Fine performances of music that is a typical Berlioz collection of magnificent stuff and magnificent bombast; he's mostly that way in his overtures. I'd place a bet on this one as a good hi-fi item.

Mozart Anniversary Album. (Reissues).
RCA Camden CFL 105 (6)

This was one of RCA's early sendoffs for the Mozart year and it makes an unparalleled high-class grab-bag of notable old RCA Victor performances from 78 days, some of them outstanding, now as then.

Don't forget that in the more leisurely and edit-less 78 period people spent a long time on every record. By today's standards, the care and finish of musical performance was often remarkable. I notice this again and again in listening to old 78's, originals or in reissues. They were done *con amore!*

Scout #2, never phazed, shoots me a vast account of each and every item in this huge album—I'd have to take a whole column to get it to you. That's a reviewer's life, these days. Best I can do is to say he is enthusiastic about numerous pieces notably Symphonies #26 and #29 (Boston, Koussevitsky—I remember these well) and #34 (same outfit) and #38 (Bruno Walter), as well as the Sinfonia Concertante with Stokowsky, which I remember as superb, if rather juicy in the over-all. Also Symphony #39 with Beecham. He says "Eine Kleine Nachtmusik" "bumbles along like a buffalo," which exactly describes my memory of the old version! Mixed bag, mostly very good. But no hi-fi—far from it.

Look out for some zany mixed-up labeling. In our copy the Mozart Requiem turned out to be another "Prague" Symphony. We got only the end, which Scout #2 didn't much like anyhow.

Giovalli Martinelli Sings by Request.
Camden CAL 274
Rose Bampton In Opera.
Camden CAL 293
Gladys Swarthout in Opera.
CAL 273
Maria Jeritza in Opera.
CAL 275

Just four of a continuing series, part of the immense and systematic re-exploration of the old Victor catalogues that is now going on under the name Camden. Very little in the way of hi-fi, but lots for the memory here and plenty of musical value according to taste. Somehow I don't think it's much use giving opinions as to which of these discs is "best" nor which singer is supreme. Scout #1 has his ideas, in detail, but your own are more important, for you.

These, after all, are the big voices of our recent past and their records are good to have.

40 Years of Singing with Martinelli.
Allegro-Royale 1635

Scout #1 reacts with a Hmmm to the question—howcome these older recordings of Martinelli appear on this label, he a Victor artist, I wouldn't know.

I react with incredulity to the fine subtitle of this disc—*forty years,* mind you, of Signor M.'s singing. It says, in plain letters, HIGH FIDELITY.

So *that's* when hi-fi began! Always did wonder. (But there are three new items on the record, 1 year old. Maybe that makes the whole thing hi.)

Gigli at Carnegie Hall.
RCA Victor LM 1972
Jussi Bjoerling Sings at Carnegie Hall.
RCA Victor LM 2003

Another series that complements the reissues, these are ostensibly made at actual concerts though, I suspect, there is a modicum of editing here and there after the fact. The programs are typical mixed-recital and there's much applause. (There has to be, for audiences at this sort of affair invariably begin to clap three notes before the end of every song.) There are also fierce bravos, bravissimi, shrieks and yells, to give plenty of atmosphere. Those who like such concerts will be happy enough; those who want merely to hear the voices and the music, like me, will be slightly annoyed at all the hoopla. We'll make up our own minds, thank you.

Gigli, "Giggly," still shows a great voice even at an advanced age, allowing for reasonable physical decline. Bjoerling, whose audiences are just as fanatically steamed up about him as Gigli's (I heard Bjoerling in the flesh last summer) is in his prime and RCA is getting him in early on the series—which may well go on until old Carnegie gets torn down, a few years from now.

Musicquiz—vol. 11. (Opera).
Period SPL 1601

(with game material, instructions.)

Period has been more circumspect in this second issue of the great game of guess what's what in music, this time devoted to opera. The first volume, generally symphonic, quoted samples of dozens of works, from sources that, shall we say, seemed debatable. So debatable, perhaps, that this volume is innocuously played on an organ! Well, if you like opera on an organ and like to guess, it's all yours. A Party Game, and Scout #1 was the guy who played it for me.

Balakirev: Thamar. Islamey; Russia. Philharmonia Orch. von Matacic.
Angel 35291
Delius: Sea Drift; Paris. Royal Philh., Beecham. BBC Chorus, Bruce Boyce, ten.
Col. ML 5079

Two shiny, glittering LP's in gahgeous sound for those as likes the glittering shininess of the Russian school of orchestration or the . . . uh, well, the glittering shininess of Delius at his most expansive. I can't think of anything else to say right now, since I'm not a fan of either one to the extent of a whole diseful. But don't let me stop you.

Scouting More Operas

Massenet: Manon. Los Angeles, Henri Legay, Michel Dens, Cho. & Orch. Theatre Nat. de L'Opera-Comique, Monteux.
RCA Victor LM 6402 (4)

This is, according to Scout #2, a really noble and wonderful performance—marred solely by one singer—the heroine herself, de los Angeles. All the others are French, including orchestra and conductor. In that very, very special *milieu,* so utterly stylized and precise in its own special, wonderful way, the different voice of de los Angeles, as he says, "sticks out like a sore thumb."

This is inevitable, and RCA Victor surely asks for it—for this is the sort of thing that, for the highest of artistic reasons, you just don't do. Not in a unified, all-French performance, anyhow. Nothing at all wrong with the great star—don't misunderstand. She simply is a singer out of another tradition, of another vocal color, with a different training-up. She does not blend with the French.

Indeed, Scout #2 says "her interpretation is deep and sensitive" and in an American performance, usually with a mixture of unlike singers, she doubtless would stand out far ahead of the others. She's superb—but different. It's the stylistic difference that is so agonizingly objectionable to Scout #2 here, and I'll back him up on my own experience. It seems to be a frequent RCA policy to place RCA stars in the middle of an outside performance and I don't think this is the first

time it has led to stylistic inconsistency in the ensemble. Artistically, you see, the heroine *must* be a French singer in this sort of performance, one who has the same background as the rest. Nothing else will do—no matter how great the chosen lady may be.

All else here is absolutely tops—Monteux (French), the lead tenor, Legay (French) and all the rest. Surely for those who rightly worship de los A. as a great singer (I do, too) and who will not be disturbed by the style, this is bound to be a fine investment.

Moussorgsky: The Marriage. Soloists and State Radio Orch. of the USSR, Kovalev. Westm. **OPW 1202 (2)**

You wouldn't recognize the Russian soloists' names if I listed them, but Scout #2 enjoyed this plenty—in fact I'll quote his comment.

"I was surprised at how musical—how tuneful—this sounded; then I looked and saw that Ippolitov-Ivanov had finished the opera (Moussorgsky had only completed the first act), even though he had stayed within M.'s experimental intention that this music should be set to everyday language rather than formalized poetry.

"I don't make much sense out of Moussorgsky's first act., It has the intended 'speech-music' sound, blunt and obviously experimental; the people talk rather than sing and it's interesting mainly because it is Moussorgsky and it was a new sort of thing. Ippolitov-Ivanov cheers it up, takes most of the experiment out of it—but it's easier to hear, his part, and very enjoyable! It's real opera.

"Singers are superb—brassy, black-bready and loud." That's Scout #2.

Mozart: Cosi fan Tutte. Lisa della Casa, Christa Ludwig, Emmy Loose, Dermota, Schoeffler, Kunz, Vienna State Opera Cho., Philharmonic Orch., Boehm. **London XLLA 32 (3)**

Scout #2 thinks this is a really wonderful performance—it comes alive and no doubt about it, is a happy, spirited affair—and it can so easily be heavyweight, or just vocally acrobatic. He likes it better than the version with Schwarzkopf and Merriman on Angel. It ought to be the ultimate choice, then, unless you want the English version with the Metropolitan Opera, from New York. Highly recommended as the highest sort of Mozart comic froth.

Donizetti: Don Pasquale. Renato Capecchi, Bruna Rizzoli et al, Choir, Orch. Teatro di San Carlo di Napoli, Molinari-Pradelli. **Epic SC 6016 (2)**

As is clear from the listing, this is a real all-Italian job, from an opera house in Naples. Scout #2 thinks this is the best of Donizetti, that this performance is fine but maybe not as spritely, as "buffa" as a performance he heard on Westminster. (WAL 206, listed in Schwann but not in the Long Player.) This one "doesn't sizzle" for him—but perhaps it shouldn't and this one is to the Italian taste, sizzle or no. Better try both if you're interested.

Verdi: Falstaff. Gobbi, Paneri, Alva, Spataro, Schwarzkopf, Merriman; Philharmonia Opera Co., von Karajan. **Angel 3552 C/L (3)**

This indeed offers a fine mixture of talent, from all sorts of places, and I was interested to see what Scout #2 might think.

No objections at all from him on the matter of style. Verdi, done well, can accommodate a surprising variety of singers from nominally different backgrounds. That's the beauty of the Italian style. Not so with the French.

But the Scout likes the older Toscanini version better. A lightness in that one, a humor and warmth, that this recording doesn't quite hit. I'll add that I heard the Toscanini and was charmed, too, for this was the Maestro's home territory and he had a dedicated, excited cast and orchestra to deal with. This one, however, would seem to be only slightly behind, and if, possibly, you found the high-tension whirlwind of Toscanini's performance a bit too much for you, this version will certainly treat you more gently and sweetly.

AUDIO ETC.

Edward Tatnall Canby

"LIVE" STEREO

HAVE YOU EVER tried "live" stereo—that is, stereo reproduction of a performance actually occurring at the same moment, elsewhere? I was in on an interesting experiment of this sort recently. Part of it was recorded, on an Ampex stereo 350, but the main event was the simultaneous show, and it came off very nicely.

The problem was a familiar one, if the stereo solution was relatively a new idea. A series of invitation concerts, presented by The B. de Rothschild Foundation of New York for a medium-sized audience, say somewhat over a hundred, the artists a world-famous violinist and a pianist to match, Joseph Szigeti and Carlo Bussotti. There wasn't room in the small "hall," the concert room, and so somebody had the inevitable idea of running a line upstairs to another public room and reproducing the music there for the overflow part of the audience.

Of course it would have to be done right, with real "hi-fi" equipment, so the people in charge turned to an engineer who, being an enterprising soul, immediately went them one better—let's make it stereo. After due explanations and assurances, the idea carried, and the project was on.

Now this sort of overflow transmission to an extra audience seated in another room is a common enough thing these days in other areas—it's done with speeches, annual meetings for the stockholders, political rallies, medical conventions, and so on, not to mention fairs and carnivals, where the proceedings inside the paying area are piped outside, to entice the customers in. Closed-circuit TV is now used for many such purposes, when and where practical.

Music is not so easily taken care of in this manner. It's tricky to reproduce well, as we all know. Listening acoustics are all-important. But also, people don't like the idea a bit. They object to being made to listen to "live" music off in a side room somewhere, via loudspeakers. Most people are still convinced, anyhow, that the sound will be a travesty of the original. They think immediately of some such dreadful noise as the public address systems used for political outdoor rallies, music at a skating rink (not always the equipment's fault, just the skating rink acoustics) or maybe those same terrible squawks heard outside night clubs or midway carnival shows or auction rooms. No doubt about it, most average concert-goers will instantly quail at the thought of a concert reproduced in another room for their benefit.

And so our audiences, for three concerts, huffed and puffed up two flights of stairs, leaving the "real" concert behind them on the ground floor, and entered the gym-like upstairs room with something less than enthusiasm on their faces. They were mostly just plain disgruntled, though to be sure, they'd been warned (their applications being last in the mail) that this would happen. All right in the home . . . but to go to a live concert and then have to listen to *loudspeakers!* Definitely not cricket, said their faces.

But though many of them went downstairs at intermission to fill empty seats here and there, a very considerable number stayed right on with us, and a few were actually heard to observe, after a trial of the real thing downstairs, that they actually thought it sounded better over the speakers—and it certainly was more comfortable, more relaxed.

And so you begin to see what we had. A rather unique test of character between an actual live performance and a public reproduction of the same, simultaneously, with the same audience for both—that is, people from the same list of invitees, channeled to the one or the other quite arbitrarily according to the order of their application for admission. Fun. We not only were able to hold our own in the reproduced version, but we had the pleasure of a private playing of the test tapes, afterwards for the distinguished violinist himself—Joseph Szigeti.

Stereo?

The special features of the reproduction were of two sorts. (a) High-quality equipment throughout, namely Altec mikes, McIntosh amplifiers (the big ones) and preamps, AR-1 woofer systems and JansZen tweeters. And (b) two of each—two complete systems. Nominally speaking, one system was set up for the violinist and the other for the piano. The violin played close into his mike, right over the tall music desk (he stood up, of course) and the piano played into the other mike, set up near its tail end. The piano was open at half-stick, the top lifted about six inches.

Upstairs, the violin speaker stood up on a bench, the woofer on end, the tweeter on top of it and about man-high. The position was relatively the same as the mike downstairs. The piano speaker system sat on the floor, long-side down—underneath a real

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

piano. There was even a piano bench (empty) to aid the illusion, though it had to be taken away to put the stereo recorder on when the final concert came. The setup, then, was as closely as possible the same as the living arrangement downstairs in the concert room, with the violin to the left, "standing up," the piano to the right, lower down (and so with better bass reinforcement) and near the tail end of the "dummy" piano.

And so you are all jumping to conclusions, I am sure: this was a two-channel, two-point transmission *par excellence*, with a channel and a speaker for each of the two instruments.

Ah now, but it wasn't. It was a stereo reproduction, *par excellence*, which is something else again, decidedly.

Stereo reproduction depends on interaction or, perhaps I should say, overlapping, of two or more channels, and the stereo effect is, as the ear hears it, the filling-in of the space behind and around the reproducing speakers. Just how that happens is a matter that isn't at all easy to put into safe words. Imagination? Partly. Phase differences between the direct sounds from the two sources? Yes. But I prefer to think that, practically, the biggest effect in our two-channel stereo comes from the differing reverberation pattern, the echo, as heard in the two speakers. The direct sound of a piano and a violin may well be separated more or less, to right or left, but what brings the music alive is the simulated space around and behind them, and this is created mainly by the liveness—heard from two locations.

The fact that our violin was noticeably on the left of us was useful information, but that was only part of the good effect we had. Never forget that in most concert situations you really can't tell where a given sound comes from, if you close your eyes. You know where it is by sight, and so you tend to "hear" it there—but this is thanks to the power of suggestion as much as anything else. In our "3-D" excitement of these last few years we've greatly exaggerated the importance of what I might call "point-your-finger-at-it" literalism.

In real musical life, separation is wonderful, satisfying, musically useful to hear, *provided* that it occurs within a good overall liveness, in one single space, *provided* that all the sounds—left, right or middle are immersed in the same surroundings. This applies, you see, to both the original living music and to any stereo reproduction you may try. One space, with various sounds distributed inside it, sharing in it.

Now this is normally the case in stereo reproduction, for the simplest of reasons. The sounds are shared between the speakers. Some of each comes out of each speaker. The end-effect for you, the listener, is a blending of sounds from both speakers. If you are at a proper distance from the two, this blending is highly satisfactory. (But if something is wrong, somewhere, you hear two separate images. Or if you are too close to either speaker, you hear a double image.) It is the combined sound of the two speakers that blends—or rather, you blend the two sound sources yourself, to make one complete image of the whole, including the right-and-left elements of separation within the whole.

But this blending, in turn, is due to the two stereo mikes, which "hear" the very same sounds, though from different vantage points. Unless you seal up your sound makers in soundproof boxes, or record them in different studios, both mikes will pick up some of all the sound.

Not, of course, if you place your mikes so hideously close that virtually no outside sound gets into them. Some "pops" stereos are done this way: in an ultra-dead studio, plenty big, a crooner-singer and, maybe, an accordion, are spaced 'way apart, each miked very close so that each goes 99 per cent into his own mike and the two are recorded to all intents and purposes separately but simultaneously. That's real two-point, two-channel recording, and it isn't stereo at all.

Well, we couldn't do that. How could we? How would you persuade a famous violinist—especially in front of an audience—to play in such a way that his mike would pick up none of his accompanying piano? How could the piano be miked so that its channel would have no violin at all on it? Obviously impossible, short of soundproof booths and ear-phones!

So the normal situation, as in all stereo recording, is that both (all) instruments are picked up on both (all) channels of your system. The overlap is very large, maybe 80 per cent in volume terms. Play either channel alone and you get all the music, though out of balance. Some is too close and/or too loud, other parts are too distant and/or too soft. Play both (all) your channels together and, with proper speaker placement and room acoustics and proper listening location (phew!), you get a stereo realism. That's what we were after.

So, you see, our reproduced concert was definitely stereo, two separate channels overlapping on the same music. Our two speakers produced one combined sound and they overlapped in content, both reproducing the piano, both reproducing the violin. There was, indeed, a certain separation—about as definite as that of the live concert itself and no more. Our violinist was more or less "at" the left-hand speaker, standing up on its bench, though the sound of the fiddle also came loudly from the other speaker. At the proper distance the two blended, leftwards. (If you stood close, you heard two violins, one in each speaker—but we kept our audience well back.)

A peculiar effect and a tricky one and it wouldn't have worked if we hadn't been able to place our audience members exactly where we wanted them, and keep them there. So much depends, in stereo reproduction, on the right listening place, the strictly limited area outside of which things go completely haywire. For, never forget, those two speakers represent merely two samplings of the infinite variety of living sound spreading out into the three-dimensional space of the original. A fine effect but a delicate one.

Which brings me to a point. Can such stereo reproduction ever, then, be a literal realism, as of the original sound? Was the concert heard upstairs through speakers identical to the same heard alive downstairs? The answer, of course, is no. Stereo "realism" is, like ordinary, one-channel realism, an effect, an illusion, an imaginative re-creation of the original. Stereo, like standard sound reproduction, has its own

ways of acting on you. Yes, stereo does come a bit closer to a literal realism in certain respects. A tiny bit closer, but even that slight increment of realism is enough to feed the listening imagination and add new listening values galore. Nevertheless—stereo sound is still reproduced sound, and that is that. Not literal.

Matter of Liveness

Take liveness, for instance. Same problems, basically, as in "monaural" pickup. You still have two spaces to deal with, you still combine the two in your listening. Double liveness. And in stereo you end up, as in "monaural," with a sound essentially unlike the original though useful and beautiful in its own terms. So with our concert.

The live concert had its own typical values of sound—and sight as well, with the presence of famous performers. The concert upstairs, via two-channel reproduction, before a live audience seated in rows just as those downstairs, had comparable but quite different values. The sound was not even remotely the same, except that the same notes were played.

I tried out listening in both places. I stood in the concert room during rehearsal while somebody played the piano, people talked, shuffled chairs around. Then I listened upstairs while the same thing went on down below. You would never recognize the transmitted sounds as coming from the same room.

Downstairs, as you listened, the acoustics were dead—too dead. Sound-tiled ceiling over which shiny paper had been placed in an effort to liven things up a bit. Very heavy drapes to the sides (covering mirrored walls). It was one of those places where you want to whisper to your coworkers, setting up mikes and so on, where a clap is instantly swallowed up, where the huge concert grand piano rumbled beautifully inside itself, but stopped dead when the fingers were lifted from the keys. No echo.

Upstairs, we were in a long, low ballet-practice gym, hard and live, one wall a continuous mirror, not draped. All plaster, metal, hard floor, undraped windows with shiny venetian blinds. Our only sound-damping was furnished by the audience and the folding chairs. We set the venetian blinds half-open, to help break up reflections.

The quite dead sound of the room downstairs came straight out of our two speakers into this rather potent liveness—and that is what you heard, a hard, brilliant, live sound not in the least like that downstairs.

What else? Isn't this the standard phenomenon in reproduced music—it takes on the liveness of the listening room, added to that of the original space? True of stereo sound as well as the usual one-channel sound. In most homes, you hear mainly the original recording hall, as the bigger and more reverberant of the two spaces. But when the listening room, as in our case, is no home parlor but a biggish and very live public place with a reverberation of its own—and when the originating room is acoustically on the dead side—then common sense tells you that you'll hear mainly the listening room, as the dominating apparent

reverberation, and this is what happened. Our reproduced musicians were in *our* liveness, not theirs.

Not 100 percent. There was enough sense of space downstairs so that a feeling of distance and extra space was added to the live sound of our room. Thus our musicians seemed to play not exactly at the speakers but behind them. The violin, being very close to its mike (about two feet from Szigeti's nose) seemed scarcely back of its left-hand speaker. But the piano, a more diffuse sound-source and most of it well away from either mike, appeared distinctly behind the speaker, in a synthetic space just noticeably off to the right, in the rear. Rather nice ensemble. Both together, in sum, were apparently playing for us in an excellent small concert hall, quite live and reverberant. That was the combined product of the two rooms, the stereo double liveness.

All of which, you can understand, is the kind of liveness effect to be expected of *any* loudspeaker reproduction from a deadish original into a very live listening space. A one-channel transmission would have been basically the same. Why, then, did we bother with stereo? What if the speakers had simply been connected to one common transmission channel, using the two mikes in the same position? What, in other words, *was* the stereo increment, the extra value imparted by the two-channel pickup?

Stereo in Action

Well, I can best describe that stereo increment in subjective listening terms. Let me go over the set-up again from the audience viewpoint.

When you first entered our listening room upstairs, if you had been down below at the actual concert (people came up after the intermissions to try us out), you would probably have been shocked—so utterly different was the effect. It took a good five or ten minutes of listening to get used to that astonishing change. Especially since, if you were like most people there, you had expected some sort of literal reproduction, sounding "the same" as the original.

It didn't sound the same, and not even remotely the same. And so, for a while, you floundered. Here was a big, live violin sound, a huge piano, in a long, low, very live room partly darkened, with only a couple of lamps, one in back and one against the wall directly behind the "violin" speaker. (It was deliberately placed there to camouflage the speaker itself, distract attention from its square face, and thus help the imagination hear a violinist in that spot.)

Downstairs all was oyster-white and fluorescent light, a square space with a high ceiling and a projecting balcony cutting the room in half. Downstairs the sound was close, dry, the atmosphere warm and crowded. One of those pin-drop atmospheres. Upstairs you could shuffle around and nobody noticed, in the low light, and there was lots of air (and plenty of street noises) from an open window.

But if you stayed on upstairs, if you listened quietly for ten minutes or so, you began to forget the concert sound downstairs, where the mikes were, and you began to hear the music itself directly, in its own terms. Stereo terms.

Indeed, for the first few minutes I doubt if you would have noticed the stereo aspect of the sound, especially if you hadn't been told, or didn't know about stereo. You did *not* hear the violin dramatically off in one front corner and the piano 'way over in the other, yards apart! Quite correctly, the two were together in the middle, their combined sound-source only about ten feet wide (i.e., the speakers were about that far apart). The two instruments played together and you heard them together, as you should.

It was only gradually, if you were a newcomer to these things, that you became conscious of the fact that when the violin made an entrance in the music you tended to turn your ears just a bit towards the left . . . yes, the fiddle sound was perceptibly on that side, now that you put your mind to it. In fact it did seem to come more or less from the black shape that was the stand-up speaker on the bench, to the left. (Because of the lamp behind it you couldn't see much and so you could almost imagine the black speaker blob as a man standing up—playing.)

But most people, I think, didn't consciously notice this at all. They simply heard music and thought that it sounded remarkably good and life-like, but didn't bother to analyze just why. That's as it should be.

Less definitely, you might have come to feel that the big piano was rather vaguely to the right of center, or at least to the right of the violin. It was such a big instrument (in sound and in fact) that you heard it mainly as filling the front of the room—but even so, it was, slightly, on the right, especially when the violin played with it.

I think the best sign of our success was the tell-tale fact that the more you listened, the more satisfactory did the sound become. You began to sense the personality of that violin, up front left. You looked at "him" as he began a phrase, you heard the tiny crackles, up there, as he reached out and turned a page, you heard breathing sounds, creaks from bow and fiddle; you "watched" him tune up a string, to the piano's A, between movements. A highly natural illusion of presence, that was best in that it was wholly unexaggerated.

This, then, was the stereo increment, a continued and increasing ease of listening (where the standard monaural reproduction would have tended to become increasingly wearisome). These effects describe stereo in action, as a serious and legitimate aid to solid music listening.

We felt a considerable sense of triumph merely in the fact that some people, knowing nothing about stereo, stayed with us for as long as an hour and a half, sitting in silence as at a real concert. We had put on our own show using the base material of the concert going on downstairs, and our show was a success in its own terms.

Concert Psychology

The oddest thing about this experiment was just that—it's quasi-concert status. Was it, or wasn't it? Should people listen as to a hi-fi program of music, or as to a concert? Specifically, should they act like people at a concert, or like people listening to hi-fi or to phonograph records? There's a whale of a difference!

(*Continued on page 64*)

CHARLES A. ROBERTSON*

How Choice the Critic?

RECORD COLLECTORS who depend on critical reviews to aid them in making their selections eventually learn from hard experience how to evaluate the opinions of each critic. This reviewer hopes he will not confound readers by providing a maximum of factual information with a minimum of opinion. There are many facets of jazz and it is not his intention to show a prejudice against any of them. Each record will be judged against the highest standards of sound reproduction, placed in its historical niche, and weighed therein. An attempt will be made to pass along the essence of the feeling or mood generated by the artists. It is believed that readers of AUDIO are intelligent enough to choose the records they want to buy with these aids alone.

The reproduction of jazz has lagged behind that of classical music and only recently has it been afforded some of the care lavished on its big brother. Though the finest equipment may be used, engineers capable of recording the latest juke-box favorite cannot always achieve the balance necessary to a finely integrated jazz unit. Too few companies have followed the lead of Vanguard and Columbia in attempting to escape the confines of cramped studio sound. In the main, this column will be devoted to improving the sound of recorded jazz. Discs deemed good or superior by most reviewers may not pass muster here, but an effort will always be made to tell why.

Somehow jazz critics seem to find it necessary to pretend to a certain amount of sophistication. But this reviewer, who began collecting in the early 30's, can remember when many of the recorded performances now treated casually would be regarded as an oasis in a desert. He will try to temper his enthusiasm and at the same time stay out of the controversies revolving around the assorted styles of jazz. Two discs of the moment are brought to mind to serve as examples.

Audio Fidelity's *The Dukes of Dixieland,* has been rightly acclaimed for its technical distinction while dismissed musically as just another dixieland group. This may be, but it would be an unimaginative listener who cannot feel the humid heat of the Crescent City and see the lights of Bourbon Street. An atmosphere is created in which the wholly personal styles of the Dukes emerge with a happy beat and youthful vitality. But it is up to the reader to decide whether his collection warrants another dixieland package.

Verve's *Louis and Ella* has been welcomed beacuse it represents the enhanced sound now afforded Norman Granz subsidiaries, formerly among the worst offenders in the way of distortion. There is still room for improvement. The balance between the voices is unequal and Oscar Peterson and his trio are too much in the background. As a result the session rarely jells. There is the impression of a talented group of performers struggling along in their highly individual ways, trying to achieve a relaxed feeling in a small studio, without sufficient rehearsal. But admirers of any one of the artists will want the record, if only as a memento of what might have resulted with more preparation by all concerned.

Collectors of classical records are usually able to read several reviews and hear the selection on FM radio, in some areas, before making a purchase. Jazz lovers are not so fortunate. FM radio has few programs (Skip Weshner's "Accent on Sound," on Manhattan's WBAI being one) which feature new jazz releases, and AM radio duplicates the juke-box. Conflicting reviews often confront them because of bias shown a particular school by some critics. When a purchase is ventured, they often find they did not receive the value expected. This column will endeavor to chart the maze of new releases so that the growing displays of long

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Editor's Note:
In the continuing search for a guide to the music available on LP's, we again offer a column on the "lighter" side—including Jazz as the principal subject, augmented by those novelty recordings which do not fit into the category covered so capably by Canby. We trust 1) that Mr. Robertson's efforts will be as well received by our readers as they are by ourselves, and 2) that we will have a column on *Jazz and all That* every month. In the meantime, we commend these comments to you with our compliments and believe they will complement AUDIO's record coverage.

playing jazz will seem less vast and bewildering. It will also include a few items of audio and miscellaneous interest not touched by Mr. Canby.

Finally, this reviewer has no connection with the record industry or music business. He believes that a critic who accepts such employment, even to the extent of formulating record liners, should leave current reviewing behind and confine his attentions to publicity blurbs and writings in which his position is clearly defined.

Symphonic Horizons

The past year has seen the record factories turn out a growing flood of jazz. This has placed an increasing pressure on the musician and composer to come up with something new. It has afforded the talented artist an opportunity to try extended forms and fresh instrumentation. It has resulted in the haphazard addition of string sections to jazz groups. The arranger has acquired an exaggerated importance. This all points to broader horizons for jazz, unfortunately not all healthy.

So far, there has been only one symphonic effort by an authentic jazz performer on long playing records. It is Sidney Bechet's *La Nuit est une Sorciere,* London International, made memorable mostly by the composer's soprano-sax, partly because of the staid playing of the French orchestra, which is reproduced too dimly. A better performance and recording might improve the effect, but it would still remain a concerto for jazz instrument and orchestra.

Most jazz composers who attempt a symphonic work are inclined to try to impress jazz effects on classical forms. This is the main fault with Rolf Liebermann's *Concerto for Jazz Band and Symphony Orchestra,* RCA Victor. It has some exciting dynamics and comprehensive ideas, but is essentially an arrangement on an arrangement.

Modern classical composers who have used jazz influences have absorbed them into the classical framework, resulting in more integrated compositions. They have been successful within these limits and their work belongs in the collection of every jazz lover. New recordings worthy of attention are Leonard Bernstein's presentation of his *Fancy Free,* coupled on Columbia with a re-pressing of the 1923 ballet, *La Creation du Monde,* by Darius Milhaud and Aaron Copland's *El Salon Mexico.* The Orchestra de la Suisse Romande, conducted by Alberto Erede, has also favored the Milhaud on a London disc, due for early release. New to the long playing catalogue is the rollicking *Impressions of Paris,* by Jacques Ibert on MGM, performed by Arthur Winograd and the MGM chamber orchestra. This makes satirical use of some rickey-tick effects of the 20's, always in good taste, and is filled with Gallic wit and charm.

However, these compositions fail as an extension of jazz as they allow no room for improvisation or the personality and tonal qualities of the accomplished instrumentalist. Modern jazz composers are more apt to study and utilize the works of composers noted for their exploration of new

forms—Bartok, Berg, Schonberg and Stravinsky, not to forget Debussy and Delius. In this they have been most successful as individual performers or in works for groups no larger than a sextet. Efforts for full band have become bogged down in arrangements which soon sound dated. Ellington's extended compositions have stood the test of time because of the freedom he has allowed soloists.

Jazzmen have not received enough encouragement for their serious works. Income from recordings and concert performances are not guaranteed unless a connection has been made with a big band or orchestra. Paul Whiteman, Woody Herman, Stan Kenton and Sauter-Finnegan have all made their contributions in this respect. But the outlets have never been plentiful or all-inclusive, and the returns have often been small.

Some farseeing record company or musical trust should sponsor a competition for the serious jazz composer. ASCAP or BMI could promise publication. The AFM music performance trust could provide sufficient rehearsal time. The recording company could return any excessive profits for future awards. The results should be exciting. And some interesting collaborations might be forthcoming. Imagine Bechet with one of the modern French composers.

Leon Berry: The Giant Wurlitzer Pipe Organ, Vol. One
Audio Fidelity AFLP 1828

Leon Berry, who has a particular affinity for the large theater organ, is heard exploring the stops of the three-manual Wurlitzer housed in the Hub Rink, Chicago. The brilliance of this instrument, constructed in 1931, has been extended by remodeling which doubled its wind pressure and placed the percussion pipes outside the pipe chamber for a more vibrant voicing. This has enabled the engineers to capture a variety of unusual effects with a harmonic purity not always attained in organ recordings.

The repertoire is made up of that type of theater piece best able to aid this tonal excursion, from the ponderous *Blacksmith Blues* to the airy *Third Man* theme.

This is what is familiarly known in hi-fi circles as a demonstration record, often put to the use of determining the response of a sound system. One method is to gradually increase the volume setting until either the record or some component shows distortion. If it is the record, it immediately becomes dated. Should the system not measure up, the conscientious fan begins a tour of audio outlets in search of something to tame that wild disc.

Considering the amount of sound in these grooves, an unclipped sixteen cycles, I would strongly advise against such a test as something is likely to give and it will not be the record. A more perceptive test is to determine how softly the music can be played without loss in bass or tonal brilliance. This is one record that will also hold up at low level. It is so clean that the rushing of the wind through pipes can be clearly heard and the soundwaves decay in all naturalness.

La Fiesta Brava, Vol. 2: Plaza de Toros
Audio Fidelity 1817

The continuing relation of the story of the bull ring on this label, by way of the music which signals much of the action, is as thoroughly annotated as the first volume and even more fetchingly packaged with five sizeable color plates. When a projected third volume is issued, an afternoon on the shady side of the arena can be enjoyed at will.

The Banda Taurina of the Plaza Mexico, under Genaro Nunez, is recorded in a large auditorium which lends it a spacious, out-of-doors sound: deep bass drum, full brass, and crashing cymbals in superior reproduc-

tion. It plays with the authority of long experience, majestic at times and at others seemingly carried away by the excitement of the occasion.

If a trip south of the border is in your plans, as it may well be at this time of year, these volumes are standard equipment. A familiarity with them will add greatly to a visit to the ring. The twelve selections relate to episodes in the action, or interludes between, all explained in the notes which provide a concise introduction to the sport. But they can be enjoyed by persons who never intend to see a matador in all his glory.

Mundell Lowe: New Music of Alec Wilder
Riverside RLP 12-219

When Alex Wilder first presented his new music in the 1930's, it defied classification. It still does, though annotator Frank Sinatra calls it jazz. It is too set and constrained for that definition, too vital for mood music and too full of ideas to be called popular. His records have remained fresh over the years mainly because they have not been overly imitated. Modern jazz has not followed the course charted by this composer.

Anyone who liked Wilder's little sketches in the past will like the dozen found here. He has always entrusted them to accomplished musicians and in this case Lowe's guitar and Joe Wilder's impeccable trumpet are allowed to emerge from the ensemble more than is customary in his writings. Better sound than Wilder has had awarded him before, with more to be supervised by him promised on this label, unless he runs out of trick titles to match his portraits.

Jo Basile: Rendezvous à Paris
Audio Fidelity AFLP 1821

Here the phonograph can claim superiority over most live performances. In an age when the accordion rarely can be heard in concert without the intervention of a catch-as-catch-can public address system, it is an instrument, along with the harmonica, that is best enjoyed on record. And the acoustics of most halls and clubs are seldom perfect, so that effects such as the tremolo or bellows shake gives most pleasure in the living room through the controlled amplification of a good reproducer.

Jo Basile displays the enormous range of the complex instrument that the modern piano accordion has become in traditional ballads and contemporary pieces close to the romantic character of the French people, who have contributed so much to its development. He is well equipped to encompass its virtuoso aspects. Its organlike tones are especially adapted to wide-range reproduction with uncompressed dynamics, such as is afforded in this attractive package.

Alberto Calderon; Mike Pacheco: Con Sabor Latino **Tropicana 1201**
Danzonera Tropicana; Alberto Calderon: Tropical Heatwave **Tropicana 1202**

A new label brings something new to the Latin-American music scene and returns a historic name to the record industry. Oliver Berliner, grandson of Emile Berliner, who invented the disc record, is responsible for the company credited with these releases. They are the work of musicians who have served a long apprenticeship as sidemen with the large commercial Latin-American orchestras, many of them attaining a featured status.

Now they are allowed to display their artistry in selections arranged to their own tastes, and of their own composition in several instances. It is parallel to the work done in jazz by the small groups seeking a release from the treadmill of the big bands—musician's music, highly polished, with purity of line and a rhythm not too far removed from its folk origins.

Alberto Calderon, who spent fifteen years with Xavier Cugat before joining Desi Arnaz, directs his orchestra on one side of each disc, from the timbales. The cojunto instrumentation is designed to display the dexterity of the timbalero. The restrained brass is limited to two trumpets, but the rhythm has only the restraint of good taste and no grunts.

Mike Pacheco has seen service with Perez Prado and West Coast studio groups. His

sextet is built around his bongo drums and the arrangements of modern pianist Bob Gil. Effective absorption of modern jazz influences provides a startling contrast to more publicized units guilty of tacking Latin-American rhythm willy-nilly onto screaming brass and raucous reeds and dubbing this hodgepodge a new Afro-American music.

George Hernandez directs the Danzonera Tropicana in the more formal rhythms of the danzon to fill out the second disc. Once the only socially acceptable dance of Cuba, it is rarely heard on records since the mambo and cha cha cha supplanted it in public favor. A cello and viola augment the usual four violins and two flutes. A first choice will depend upon a preference for this dreamy, exotic music, or the more brassy Calderon side.

Percussion fans and students of Caribbean rhythms are advised to forego neither. With the battery gathered here, engineers Stan Ross and Larry Levine could have produced some sensational hi-fi effects. They have been content to capture the drums in all clarity and crispness, with a fine over-all sound not often afforded this type of music. A model recording, doing justice to the name Berliner.

Oscar Brand: Bawdy Songs and Backroom Ballads, Vol. 3 **Audio Fidelity 1824**

Oscar Brand has a virile, masculine voice well suited to this ribald material. This folksinger extraordinary goes back as far as the 17th century for English and Scots ballads to complete the fourteen numbers in this third volume.

By means of careful re-recording, he occasionally joins himself in a duet. I wish that in at least one of the American songs he could have been helped out by Jack Teagarden, also a notable admirer of the Indian maid *Red Wing*.

Ben Lucien Burman: Steamboat 'Round the Bend **Folkways FP 74**

An antidote for the pangs of wanderlust is to be had in B. L. Burman's guided tour of his beloved river. Those who have dreamed of floating down to Cotton Town on a shanty boat or one of the few remaining steamboats will find a vicarious satisfaction in this album, as the author tells his stories, anecdotes and sings his songs of the Mississippi with a homely simplicity suited to the pilot house.

Eddy Manson helps out with harmonica interludes in a score of his own fashioning. Folkways has gone far afield for some of its documentaries, to the detriment of the sound. This is not the case with this clear hour-long recital of lore gathered during a lifetime of affection for the mighty river. A pamphlet on the material is included.

Turk Murphy: New Orleans Shuffle **Columbia CL 927**

This date finds the rambunctious Mr. Murphy back in San Francisco, that stamping ground of the jazz revivalists, after a country-wide jaunt during most of 1955. It is somewhat of a disappointment when compared to his preceding Columbia release *New Orleans Jazz Festival* (CL 793), one of the best of the on-the-spot recordings yet made by that company. Personnel changes brought about by the end of the tour, as well as the choice of material, make it impossible to match that performance.

Revivalist bands, such as the one sparked by this accomplished trombonist and composer, are dedicated to the early heritage of jazz and the original basic style of playing it. At their best, they can make three bids for the attention of the collector. First, through the preservation and recreating of traditional tunes in acceptable sound. Second, by the addition of variations on the original theme, with improvised solos projecting the personality of individual performers, warranting a listening curiosity equal to that earned by earlier versions. Third, by composition and group development of new works to freshen the mainstream of jazz.

Turk has come through with a grand slam frequently in the past. In this instance he forgoes originals for numbers mostly famil-

iar to collectors in superior versions, some available on LP, others still begging for a chance to be heard again. Six are associated with Louis Armstrong: *Of All the Wrongs You Done to Me; Mandy, Make Up Your Mind; Kansas City Man; Irish Black Bottom; Drop That Sack; Come Back Sweet Papa.* Two are King Oliver classics: *Chattanooga Stomp* and *New Orleans Stomp.*

This is fast company. Much too much for the new trumpet, Birch Smith, at his present stage of development. The redoubtable Doc Evans, who guested in this chair on the tour, might have been able to cope. Bob Helm plays beautiful low-register clarinet, but still thins out to the point of Boyd Senter squawks on high, fast passages. Turk fails to scale the heights reached in *Festival,* when spurred on by the veteran Santo Pecora. Don Ewell, pianist, and Dick Lammi, are on top of proceedings with memorable choruses.

Added for tour purposes, drums have again been dropped from the band. It is Turk's contention that he cannot find a drummer capable of keeping the beat he desires. Instead, he depends upon a tuba. This may be suitable for a large restaurant or club, but its virtues have eluded Columbia engineers. Equalization which brings the tuba into focus must be made at the expense of the remaining brass. One can only concentrate on the lead instruments and let the tuba thump along its leaden way. Otherwise the sound is adequate and undistorted.

Anyone who has missed the *Festival* disc should remedy that error from the standpoint of both performance and audio interest. Columbia engineers Harold Chapman and Ad Theroux arrived in New Orleans in October, 1955, with the equipment they had used the week before to record The Philadelphia Orchestra. They had one short weekend to set up in three widely different acoustical locations— the Municipal Auditorium, the Streckfus Lines' S.S. President (complete with resounding steamboat whistle), and the marble halls of the Delgado Museum of Art.

That they did their work well is evident in the way the sound comes off the grooves. It is plain that there is more on the tapes than the mass-produced pressing, which Columbia allots its pop department, allows to come through. This is not the highest fidelity. But it is an improvement on previous efforts where the sound has not filled the grooves. It does capture the zest of the performers and the enthusiasm of the audience. Even the applause seems sweeter on the Delta.

No better justification is needed for the program of on-the-spot recordings arranged for Columbia by George Avakian. The idea originated from the sales chalked up by the Benny Goodman Carnegie Hall concerts, as well as the financial returns of Decca's Louis Armstrong concerts and the poorly recorded Jazz at the Philharmonic.

One reason advanced was that jazz artists need the incentive of an audience and thrive best in an atmosphere of excitement not always present in a studio. Jazz purists, who prefer a relaxed after-hours session, know this to be something dreamed up by blurb writers. Still these performances are frequently better than some stiff, strained studio dates. And they preserve something that might otherwise be lost in the economics of the industry.

On-the-spot excursions have been made to catch the work of Louis Armstrong, Dave Brubeck, Erroll Garner, Lionel Hampton, and the groups at the Newport Jazz Festival, where the engineers encountered mist and rain along with all the usual difficulties of capturing a continuous live concert. Some of them have been saved by skillful patching of tapes under Avakian's supervision. With his permission, I hope to give you an accounting of the engineering problems met in future releases. They promise to be of increasing audio interest.

Horace Silver and The Jazz Messengers
Blue Note 1518

Blue Note is the oldest of the continuously active independents in the business and has maintained its position by being a step ahead of everyone else. It enters its eighteenth year with a reputation for introducing performers virtually unknown to the public. As they win

recognition, many of them are snatched up by bigger companies. The latest to move on are the Jazz Messengers who, along with the Modern Jazz Quartet, take laurels as the most satisfying of the modern groups on the East Coast.

Horace Silver has written seven of the eight originals heard on this session and is responsible for getting it together. I had almost given up hope of ever hearing a young pianist approach a blues theme with the true feeling he shows on such tracks as *Creepin' In, The Preacher,* and *Doodlin'.*

The JM's are a hard-driving bunch with little of the suavity of the MJQ, and are apt to attempt more than they can safely accomplish, something John Lewis would never permit. But it adds up to more varied listening for the jazz fan.

Kenny Dorham, trumpet, and Hank Mobley, tenor, play with an exciting fluency on fast passages and never descend to exhibitionistic blowing. Art Blakely, drums, and Doug Watkins, bass, provide the moving, break-it-up type of rhythm suited to this style. Horace Silver is the one to listen for, and he comes through nicely in this Van Gelder recording.

ELECTROSTATICS

(*from page 28*)

moving the extra speaker(s) about until the best position is found, and also reversing the leads to try different phasing. On organ, piano, choral and orchestral works I consider this to be a step nearly half way towards stereo.

It is only fair to add that I was converted to this view by a remarkable demonstration of the Philips Novasonic system which I heard at Century House, London, using a bass enclosure up to 300 cps with two small cabinet speakers for the treble. All room resonance was virtually killed. It seems to me that the very fine results so often obtained with two channels are to some extent—although not mainly—due to overcoming listening room resonances by using two loudspeakers suitably spaced and placed, and similar room control is quite feasible with single-channel working. In a concert hall the subduing of hall resonance achieved by switching on extra speakers suitably spaced on the platform is often quite fantastic to hear.

Carnegie Hall

To refer briefly to our demonstration of October 3, 1956, I agree with your editor's November criticisms. For reasons which would not interest the reader, we were using only three large speaker systems, instead of four used at our previous demonstration. This left us a bit short of peak reserve when reproducing the organ and Hallelujah Chorus, for which I am to blame. But it does not mean that we needed 130 large speaker systems instead of four, nor should it completely invalidate the demonstration, which was never intended to do more than show what results are possible with specified power and equipment.

An unforeseen and far more serious

cause of trouble was vibration of the percussion instruments arrayed on the platform. On some items, I could actually recognise the music on loud passages by listening to sympathetic vibrations of these instruments transmitted to them through the platform and by air. The net result was an effect rather like distortion from faulty pickup tracing.

This event was my ninth public demonstration, and I feel sure that readers will believe me when I say that this distortion was something quite unprecedented and unusual. Although it did not affect the reproduction of every record, the repercussions have been unfortunate. Playing a programme of records is rather like painting a picture; distortion on three or four out of twelve items forms a blot on the landscape and spoils the effect, especially in a sophisticated city like New York.

On the other hand, the recording and reproduction of the Morton Gould Percussion piece with Tap Dancer were quite equal in every way to the Wind Quartet already referred to. Listening to the tapes recorded during the concerts, it is impossible to detect many of the switches from live to speaker source of sound, or vice versa, and this is a gruelling test.

Conclusion

To end on a harmonious note, I agree with every word written by Mr. Tom G. Smith. A martini in the U.S.A. seems to contain about 95 per cent gin. Here many people like them 50/50 [known as Gin and It (*short for Italian, meaning Vermouth.* ED.), or Gin and French]. But in Belgium an order for a martini brings you vermouth with no gin (*Perish forbid.* ED.). In Portugal they prefer vermouth diluted with soda water. So we all please ourselves, and I certainly think that similar freedom must apply to sound in the home.

Soon after our Carnegie affair, I visited the flat—sorry, I should say apartment—of my old friend M. David Kramer, and I listened half an hour to his outfit: 100-watt amplifier feeding a bank of about 14 loudspeakers in a room rather smaller than my own music room at home. (Modesty forbids any mention of the make of loudspeaker.) I was so favourably impressed that I admitted to M.D.K. that in the unlikely event of another expensive flutter in Carnegie Hall, I would expand to 150 watts with six or eight large speaker assemblies; so perhaps the differences between us are not so wide after all! (Mr. Nunn—please note.)

Your country is bigger than ours, your income level is higher, you use bigger motor cars and your steaks are bigger. It is clear that many Americans like to use bigger amplifiers. Why not?

ABOUT MUSIC

HAROLD LAWRENCE*

Colossal Concerts

THE CONCERTI GROSSI of Corelli are generally performed by less than a score of musicians. Even with augmented forces, as when played by the string complement of a symphony orchestra, the number is seldom more than doubled, but it is large enough to arouse the ire of certain critics who maintain that in such repertoire, bigness is the enemy of authenticity. What would these same critics say if they heard one of the Corelli concerti grossi executed by 150 instrumentalists, or a group totalling in size the combined membership of the Corelli Society, the Stuttgart Chamber Orchestra, I Musici, the Virtuosi di Roma, the London Baroque Ensemble, the Boyd Neel String Orchestra and the Berlin Chamber Orchestra? The baroque specialist might recall that Corelli himself directed such an orchestra in a special concert organized by Queen Christina of Sweden in 1687, one of many interesting facts reported in Marc Pincherle's authoritative book on *Corelli: His Life, His Music*, recently published by W. W. Norton & Co.

Queen Christina's gala orchestra, however, was an intimate chamber ensemble compared to the many examples of musical "spectaculars" that have hurled decibels at audiences in concert halls, parks, arenas, and exhibition palaces over the years. The love of grandiosity has been an enduring characteristic of the human race from the Druid's menhirs and megalithic stones, the Egyptian pyramids, the Roman Colosseum, the Eiffel Tower, the statue of Christ atop Rio de Janeiro's Corcovado Peak, to the gigantic cinematic productions of Cecil B. De Mille. One of the earliest examples of musical colossi may be found in the Old Testament which tells of the 4000-voice Levite choir employed to sing hymns in King Solomon's temple. Hector Berlioz longingly referred to these ceremonies, declaring that his native France was deaf to the "sublimities of monumental music."

England, on the other hand, thrived on monumental music making. In an amphitheatre especially constructed under the dome of St. Paul's Cathedral, 6500 children of the London charity schools sang hymns to the accompaniment of trumpets, kettledrums, and organ. Berlioz, attending one of these annual performances in June, 1851, disguised as a clergyman, wept unashamedly under the "shattering effect" of the sound and the spectacle. Despite the tremendous sonic volume produced by these little singers, aural confusion did not result. "The amazing effect of the unison (in one of the hymns) is due," wrote Berlioz in *Les Soirées de l'Orchestre*, "to two causes: to the enormous number and good quality of the voices in the first instance, and secondly to the disposition of the singers in very high tiers. The reflectors and producers of sound are thus nicely balanced. The air within the church is struck from so many points at once, in surface and in depth, that it vibrates as a whole and its disturbance develops a power and majesty of action on the human nervous system which the most learned efforts of musical art have so far not given us any notion of."

Berlioz dreamed of duplicating St. Paul's "vocal volcano" by having his *Requiem* performed in the Pantheon by a "small orchestra of three or four hundred instrumentalists" and a chorus of 4000.

Some two centuries before Berlioz wrote those words, Orazio Benevoli composed a 53-Part Festival Mass for the Consecration of the Salzburg Cathedral in 1628. The number 53 represents the total amount of vocal and instrumental parts in the score. This included two eight-voice choruses, solo singers, a pair of continuos, and six separate instrumental ensembles—two for strings, one for winds, and three for brass. The score is supposed to have measured two feet, nine inches long and one foot, ten inches wide. This was an instance of a little known aspect of 17th century music described by historians as the "colossal baroque" style. The designation applies not merely to physical dimensions but to complexity of scoring as well. The antiphonal effects in Benevoli's massive work deserve one day to be recorded on 12-channel stereophonic tape (one-and-a-half-inch tape, that is).

Such Baroque contrapuntal extravaganzas are a far cry from the scoring used by Johann Strauss the Younger at the 1872 Boston Music Festival. Before an audience of 100,000, the Waltz King directed 20,000 singers—the task of controlling this sea of mouths was assigned to one hundred assistant conductors—and an orchestra of 1000 players in a program beginning with the *Blue Danube Waltz*. To inform the audience that the concert was about to start, and to alert the conductors, a cannon was shot off in the hall. The experience unnerved the Viennese composer and he vowed never to return to the U. S. A.

Other conductors thrived on a Gargantuan musical diet. Of these, the most celebrated 19th century figure was Louis Antoine Jullien (1812–1860), a fiery director with a decided flair for the sensational. Unlike Strauss, Jullien reveled in 1000-strong orchestras. And the bigger the instruments he used the better. In 1849 he added twenty Roman trumpets, each about three yards long, to a performance of Bender's *Roman March* for a touch of authenticity. To heighten the effect of one of the pieces on an orchestral program at the Surrey Gardens, he imported a troupe of Zouave trumpeters who "dashed into" the orchestra blowing furious fanfares to the delight of the audience.

Conductors like Jullien and Costa were fond of introducing instruments of Brobdingnagian proportions into their orchestras. Some of these were the ophicleide—a monster key bugle—a huge double-bass which required two players, a monster bass drum, a double-bass saxophone and a monster bass gong-drum measuring some seven feet in diameter and ten feet in height.

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

It is not known whether Tchaikovsky's *Overture 1812* was actually given its première as planned by the composer. It was scheduled to have been performed by a vast orchestra at the consecration of the Cathedral of the Redeemer in the Kremlin. A battery of field artillery and the cathedral bells were supposed to have joined in at the climactic moments of the score. Nothing definite has been reported about this concert, although Mercury has reconstructed the original scoring using the bells of the Harkness Memorial Tower at Yale University (the cathedral was blown up during the Revolution), a bronze cannon made in Strasbourg in 1761 and of the type used by Napoleon in his ill-fated Russian expedition, and a supplementary brass band—not to mention, of course, the nucleus of the score: the symphony orchestra itself.

Orchestral colossi are no longer a part of the musical scene. However, the urge to splurge on a large musical scale is still expressed in the British Isles where massed pipes and drums and titanic choirs still reverberate in churches, halls, and over the countryside. ●

RECORD REVUE

(*from page 45*)

Moussorgsky: Boris Godunov. The National Opera, Belgrade.
London XLLA 31 (3)

"This is a super-long reviewing," writes Scout #2, "but it is such a stupendous opera!"

And one of his favorites too. I can't begin to quote all of his analysis, but it'll have to suffice to say that he is fascinated, feels it is a good and truthful performance, sincere, without phoniness, with some especially lovely singing and careful orchestral playing—but it somehow lacks shape; it seems to miss the massive "panoramic wholeness" of the really top versions of the opera.

He isn't able to say how one holds together such a vast, intricate, complex work and this puts him (and me) out on a critical limb—yet these things *are* apparent, even if they can't be explained in a few lines of print, and so must be said, for better or worse. Scout #2 feels, specifically, that a number of cuts here, perhaps made in an effort to pull the sprawling opera together, are actually important scenes whose absence makes for a loss in characterization (and this is a character opera) and so, a further loss of shape.

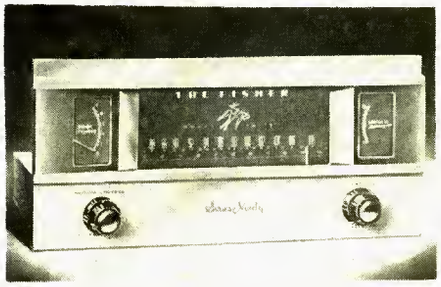
Somehow, he thinks, there just isn't quite that taut, broad, huge, "Mother Russia" feeling, the "War-and-Peace" sense, that goes with "Boris" at its very best. In other Russian operas by this excellent group I have felt myself a certain heady lightness of weight that would fit in this category, I think. It's as though the Belgrade singers were somehow lighter on their feet, less ponderously impressive, than their Russian counterparts. So with the Boris here (Changalovitch) who is "earnest and sympathetic but not subtle; you don't feel his pain enough." There is no pain more profound and massive than that of this immensely powerful, pathetic character, on the "Boris" stage.

Glinka: Russlan and Ludmilla. Soloists, Cho., Orch. Bolshoi Theatre, Kondrashin.
Westm. OPW 1401

Well, this performance is pure Russian and by the top group of them all—but the opera is no deep tragedy. Scout #2 says he thinks its plot is the silliest he'd waded through yet and it took several hearings before he got to make sense of the whole; but he really came to like it and thinks the music has a wonderful purity and simplicity with a fine "happy" feeling and much good comedy in musical terms. An excellent performance in all its aspects. ●

NEW PRODUCTS

● **Fisher Professional FM Tuner.** Entirely new in both circuit design and in appearance, the new Fisher Model FM-90 tuner makes use of a full wide-band detector as well as an exclusive Fisher circuit known as Dual Dynamic Limiters, designed to give complete AM noise rejection. The dynamic limiters are in full operation at all times, regardless of signal strength, and completely reject noise and

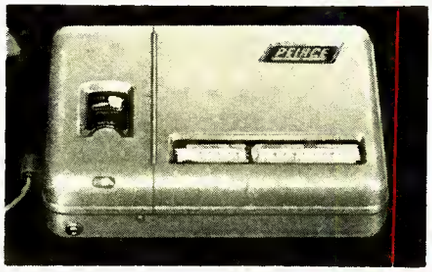


interference caused by automobile and oil-burner ignition systems and by household appliances. Two panel meters are incorporated for accurate tuning, one to indicate signal strength and the other to indicate center-of-channel. Further information is available from Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y. **B-1**

● **Transistor Tester.** A tool of equal value in the laboratory or on the service bench, the TT-2 is a precision tester which measures the basic characteristics of transistors. Operating procedure consists of first measuring the transistor for shorts, opens, and leakage. A reference bias is then established, using 1-per-cent calibration components. A small precisely-known signal is then applied automatically to the input terminals of the transistor under test, and the current gain is read on the Beta-300 scale. If beta is less than 100,

a second signal is applied and the gain is read on the Beta-100 scale. The alpha range of interest, 0.9 to 0.990, is displayed over most of the meter scale using a logarithmic calibration. In the sense that it measures basic characteristics of the transistor under test rather than simply a good-?-bad factor, the TT-2 is comparable to a mutual conductance tube tester. Available as a complete instrument or in kit form. Further information may be obtained from Kit-Tronics, 2315 Hendola Drive, NE, Albuquerque, N. M. **B-2**

● **Portable Magnetic-Belt Dictation Machine.** Although it weighs but 4½ lbs. and is no larger than an average book in size, the Peirce Secretary is a complete dictation machine which operates on two self-contained batteries, as well as on car current or standard 117-volt a.c. lines. It is an all-transistor unit which is completely compatible with Peirce office transcribing machines. Unlike miniature recorders, the Secretary is designed essentially for dictation purposes, and incorporates instant playback and review at any dictation point as often as desired. The Peirce magnetic belt holds 15 minutes



of recording, and can be mailed in ordinary envelopes, filed, and reused thousands of times. A press-to-talk and press-to-listen microphone control actuates the motor, and an indicator light shows when the machine is running and when batteries are due for replacement. For further information write Peirce Dictation Systems, 5900 Northeast Highway, Chicago, Ill. **B-3**

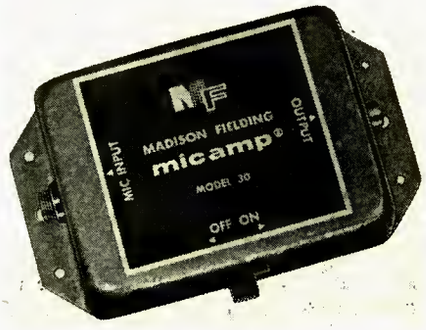
● **Sherwood 20-Watt Amplifier.** Surpassing earlier models in a number of respects, the new Sherwood Model S-1000 II incorporates a number of features which are normally associated only with amplifiers considerably higher in price. Among these features are: Six inputs (two with preamp) selectable from the front panel; presence rise control; tape-head equalization; microphone equalization; tape mon-

itor switch; EF-86 low-noise preamp tube; damping factor selection; 1 per cent intermodulation at 20 watts; feedback tone controls; cathode-follower recording output; 3-millivolt phono sensitivity; all unused inputs are shorted to prevent cross-talk. Frequency response of this Williamson-type amplifier is 20 to 20,000 cps ± 0.5 db at 20 watts. Complete data, specifications and curves may be obtained by writing to Sherwood Electronic Laboratories, Inc., 2802 W. Cullom Ave., Chicago 18, Ill. **B-4**

● **Browning Crystal-Controlled FM Receiver.** Designed primarily for professional application, this new FM receiver is especially well suited for relay use in high-fidelity "wireless" networks. Crystal controlled oscillator assures exceptional

stability. Sensitivity is 2 microvolts for 20 db quieting, and output is 6 milliwatts into 600 or 150 ohms. Audio response is within ± 2 db from 30 to 15,000 cps. Audio distortion is 1 per cent or less from 50 to 15,000 cps, 1.5 per cent at 30 cps. Hum is down more than 60 db at full output. Tuning range is 80–108 mc. Panel-mounted Simplex-Multiplex switch and signal strength meter are among the tuner's features. Complete technical information will be supplied upon request to Browning Laboratories, Inc., 752 Main St., Winchester, Mass. **B-5**

● **Transistorized Impedance-Matching Preamplifier.** The "Micamp," an all-transistor impedance-matching preamplifier, permits the direct use of low-impedance low-level cartridges and microphones with tape recorders, amplifiers, and p.a. systems



equipped only with high-impedance input. It provides 30 db gain, is free from hum pickup, and has a frequency response of 20 to 20,000 cps within 1.5 db. Distortion is under 0.75 per cent at full output. Manufactured by Madison Fielding Corporation, 863 Madison St., Brooklyn, N. Y. **B-6**

● **Cook Chromatic Scale Test Record.** This is the newest in the series of test records manufactured by Cook Laboratories, Inc., 101 Second St., Stamford, Conn. It is the first record of its type to employ true musical pitches based on chromatic intervals of the tempered scale as opposed to mathematical frequencies which have prevailed in the past. The entire musical range of eight octaves is contained on the record. Tone bursts are also included on the record to permit detection of cabinet resonances and cone break-up in speakers. The record is equipped with a pressed-in "strobolable" and is supplied with an 8-page informative booklet written by Emory Cook. **B-7**

● **All-Transistor P.A. System.** The Lustraphone p.a. system incorporates a 10-watt amplifier, rechargeable batteries and an 8-in. speaker in a single portable carrying case. Storage space is included for a press-to-talk microphone which is also included with the system. Tone and volume controls are provided, as well as terminals for additional speakers. The fully-transistorized amplifier is capable of

delivering 10 watts and incorporates preamplification sufficient to permit full output from a microphone or phono pickup. Frequency response is flat from 100 to 10,000 cps. Harmonic distortion is below 5 per cent. The system is powered by rechargeable 12-volt 7-ampere-hour dry batteries. Current drain averages 0.5 amp, permitting the amplifier to be used for a period of 14 hours before recharging is required. The system can also be furnished with standard replaceable batteries when desired. Complete details on the Lustraphone can be obtained by writing John Ould USA Ltd., 519 S. Fifth Ave., Mt. Vernon, N. Y. **B-8** ●

Invest once — buy a REK-O-KUT precision turntable. Your purchase of a Rondine turntable is an investment in *the best* in sound and record care! Because Rondine is "quiet for keeps! . . . it will remain your one abiding component even when you improve on other equipment in your system. For those first venturing into "high fidelity" . . . Rondine will be your *first* and *last* investment in a turntable! Rondine precision turntables suit every budget — Rondine Jr., 2-speed — $59.95 . . . Rondine Standard, 3-speed — $84.95 . . . Rondine DeLuxe (hysteresis motor), $129.95.

write for colorful booklet — "Turntable or Record Changer — Which Shall I Buy?"

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AUDIO ETC.

(*from page 51*)

Well, our people acted 100 per cent as though they were at a concert, and at first this had me rather surprised. After all, there was nothing but a batch of loudspeakers in the room.

No matter. The people took one look through the door, stole in on tiptoe, took their seats soundlessly and sat rigid and still. When a lady dropped her purse everybody jumped. (When some small thing snapped downstairs near one of the mikes, they jumped too.) Not a sound and hardly a motion! And when the downstairs audience clapped, our audience burst into clapping right along with them, just as though the soloists were right in front of us. Very odd, I assure you, when you think how people usually act in front of loudspeakers—talking, moving around, asking questions, maybe doing their knitting or reading magazines or writing letters. No, this audience with one accord decided it *was* a concert and acted that way. Why?

Well, figure it for yourself. I can only say that if the reproduction had been punk the concert "spell" couldn't have endured ten minutes.

* * * *

Well, I gotta be going . . . space is used up. There are some interesting general conclusions to be drawn here and I'll sum them up next month, when our space budget will be resumed. Meanwhile, try "live" stereo for yourselves if you have a chance. It's a fine thing to play around with and I'd like to see somebody try it with, say, four channels. Not super-symphonic (like the pre-war Philadelphia orchestra experiments) but on a simple, practical, every day scale such as is possible with standard present-day hi-fi equipment. Good luck to you.

EQUALIZER PREAMP

(*from page 19*)

turnover frequency desired. The control box contains other capacitors that are paralleled with C_{10} to reduce the turnover frequency.

The gain control is located between the first two stages of the amplifier. This will add about one-half megohm to the source resistance of the RC boost network. It is the function of R_{20} to establish this source resistance. The larger it is, the closer the bass boost will approach the 6 db/octave function necessary for accurate record equalization. Under these conditions this circuit has less than 1 db error in 30 cps response due to not meeting the 6 db/octave function. Grid-to-ground capacitance of the second-stage grid circuit and other shunt capacitances are compensated by C_9, a 5-μμf capacitor across R_{21}.

If a low-impedance output is not necessary, the output transformer primary may be replaced by a 0.47 megohm re-

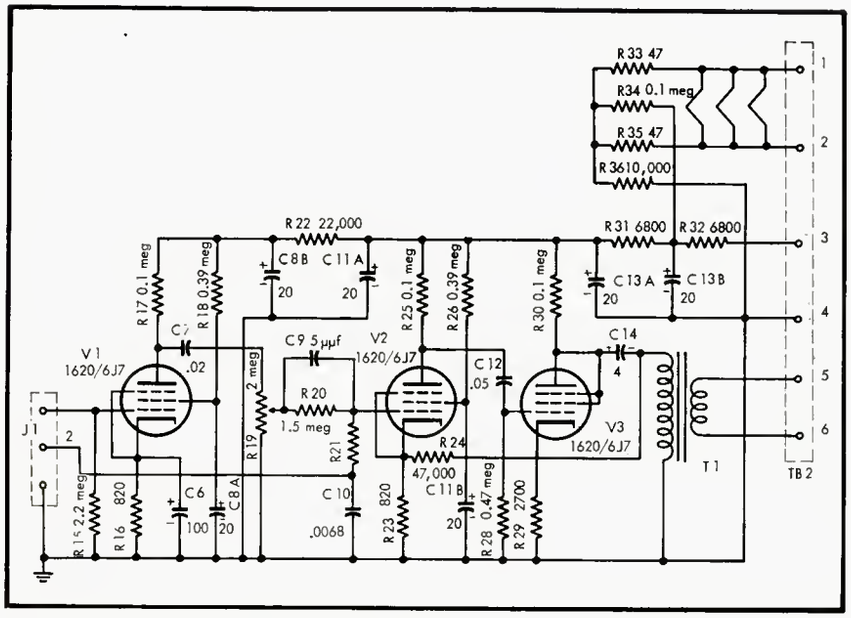

Fig. 4. Schematic of the amplifier. When used to feed a high-impedance amplifier following the preamp, the transformer may be eliminated, as shown in Fig. 5.

sistor and a .05-μf capacitor as shown in *Fig.* 5. The value of C_{14} may be reduced to 0.25 μfd. To increase the output, the feedback resistor, R_{24} may be increased to 0.1 or 0.22 megohms.

The use of a.c. power for the heaters is possible by the use of type 1620 tubes or selected type 6J7's. The d.c. level of the heater supply is determined by R_{33}, R_{34}, R_{35}, and R_{36}. By having a difference of about 20 v. d.c. between heaters and cathodes, considerably less hum is introduced into the amplifier. R_{34} and R_{36} also form a bleeder for the power supply.

As shown by the schematic in *Fig.* 6, the power supply is quite conventional using resistance-capacitance filtering. Because current drain is low, the series resistance may be as large as the reactance of a filter choke and still not reduce the voltage excessively.

Measurements

To insure proper design of the equalization circuits and the amplifier, several tests were made. First the signal-to-noise ratio was determined. An input of 10 mv was fed into the control box, with the controls set to NARTB and NORMAL positions. The gain control was set to provide a −20 dbm output which, in the case of a 250-ohm load, is .05 volts. The difference in levels as read at the plate of the third stage between signal and no-signal input is slightly over 50 db. The measurement is here because the noise voltage at the secondary of the output transformer is insufficient to be read on an a.c. vacuum-tube voltmeter.

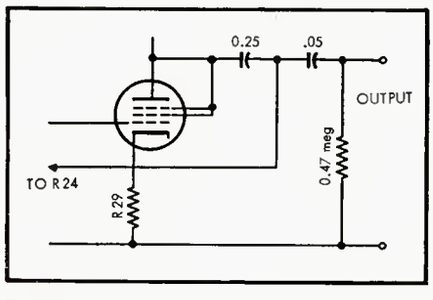

Fig. 5. Arrangement of output stage when used for feeding an amplifier with a high-impedance input.

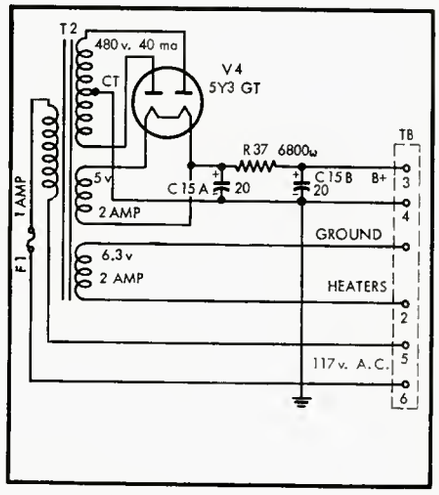

Fig. 6. Schematic of the power supply.

The frequency response of the amplifier without the equalization circuit was determined with C_{10} shorted. The controls were set to FLAT and NORMAL positions. A constant input of 10 mv at all frequencies was used, and the output was read across a 240-ohm carbon resistor placed across the output of the amplifier. Results show the amplifier with equalization networks removed to be ±0.3 db between 30 and 20,000 cps.

The characteristics of the equalization networks were measured by feeding an audio oscillator through a low-impedance attenuator and in series with a cartridge of the type to be used into the control box as shown in *Fig.* 7. Again,

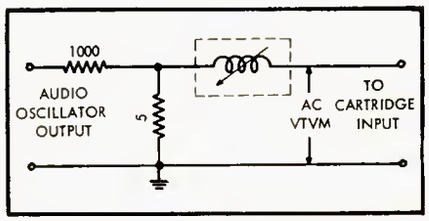

Fig. 7. Circuit used for feeding output of oscillator into the unit to provide accurate indication of cutoff, which depends on inductance of cartridge.

the signal was read across a 240-ohm resistor across the output. Curves for five of the characteristics are shown in *Figs.* 8 and 9.

Considerable care should be given to the selection of parts for equipment of this type where trouble-free performance is necessary. The use of high-quality components and considerable voltage and power derating of usually available parts is highly recommended. Resistors and capacitors in the equalization circuits should be individually measured or else should be parts with no more than 5 per cent tolerance. Mica capacitors are recommended in these circuits. The output transformer should be essentially flat between 30 and 15,000 cps. The primary impedance should be about 20,000 ohms. With the feedback loop employed, a small impedance mismatch is permissible. The particular transformer noted in the parts list is only one of several suitable units.

Float-mounted tube sockets should be used. These may be purchased items or made by enlarging the mounting holes of conventional saddle-type sockets, inserting a grommet, and mounting on the chassis with another grommet in the mounting hole of the chassis.

Construction

The preamplifier is built on a $7 \times 9 \times 2$ chassis, the control box is $4 \times 4 \times 2$, and the power supply is on a $5 \times 7 \times 2$ chassis. In each unit the circuit ground is connected to the chassis at one point only. If either the control box or power supply is mounted on metal so as to have a chassis ground to the amplifier, the circuit ground to the chassis of the particular unit should be omitted. Heater leads should be twisted and should not run parallel to audio leads.

Two models of this equalizer-preamplifier have been in use several months at a combined educational and volunteer-operated FM station. Both the student and non-technical volunteer operators learned in a very short while to use the equalizers to their fullest advantage. Many compliments have been received as to the fidelity of reproduction of records over the air.

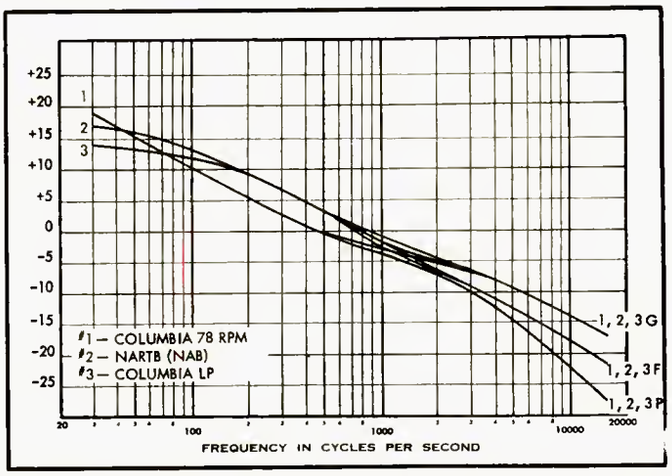

Fig. 8. (right). Response of equalizer-amplifier in Columbia 78, NARTB, and Columbia LP positions of S2.

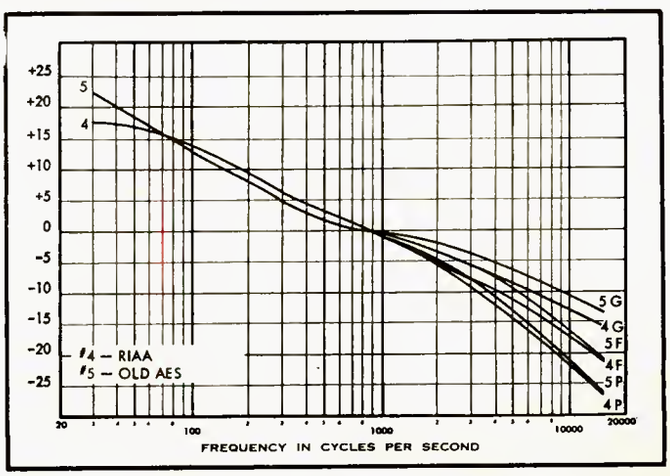

Fig. 9 (right). Response in RIAA and Old AES positions.

RECORDER AMPLIFIER

(*From page 37*)

As a matter of fact, direct coupling was tried. The values of R_7 and R_{11} were juggled to make the grid of V_3 a few volts negative with respect to cathode. Although the circuit worked satisfactorily with one 12AX7, substitution of another 12AX7 caused the grid to go positive with respect to cathode. Both tubes checked good on a tube tester. Although this may have been the result of one chance in a thousand, it was felt that this was one chance too many, and orthodox *RC* coupling was therefore used.

V. COMBATTING HUM

The principal obstacle to a satisfactory signal-to-noise ratio in a tape amplifier is hum. It may consist of the 60-cps fundamental, the 120-cps second harmonic originating in the B+ supply, or the 180-cps third harmonic emanating from the power transformer or transport motor. The battle against hum is of sufficient importance to justify a separate section on this subject.

The following steps were employed to reduce hum to a minimum. Some of these measures produce several db improvement and others only a fraction of a db. Added all together, however, they make possible an inexpensive tape recorder having an impressive signal to noise ratio of 50 db for half-track recording at 7.5 ips, at the same time maintaining low distortion, wide frequency response, and conformance to NARTB equalization.

1. *Common Ground.* All grounds for V_1, V_2, V_3, the shield of the cable leading to the record-playback head, and the arm of S_{1b} were connected to a common lug well-soldered to the chassis at a point near V_1. This common ground is identified as Point A in *Fig.* 4.

2. *Hum-Bucking Pot.* A 100-ohm 2-watt wirewound pot (R_{29}) was placed across the 6.3 volt heater supply, with the arm returned to the common ground (Point A). Use of a d.c. heater supply would not render the pot needless inasmuch as the pot helps cancel 60-cps hum introduced at the head and other points as well as hum attributable to use of a.c. on the heaters.

3. *Selected 6AU6.* For best results in playback, as well as when recording from microphone, V_1 must have superior characteristics with respect to hum, noise, and microphones. Although preferred (and relatively expensive) audio pentodes, namely the domestic 5879 and foreign Z729 and EF86, were considered for V_1, the writers decided instead to use a *selected* 6AU6, which can be fully as good. The problem of selection is facilitated by the fact that the 6AU6 is

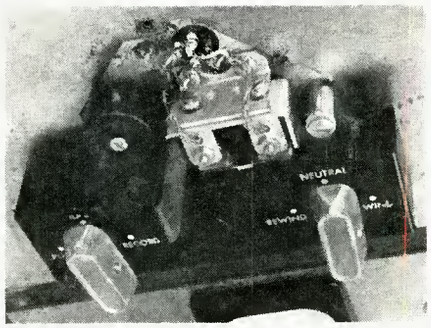

Fig. 13. Silicon-steel shield warps hum field near record-play head sufficiently to account for a hum reduction of approximately 6 db.

frequently encountered in FM tuners, TV sets, commercial radio-phono combinations, etc. Consequently, in many a household enough 6AU6's can be turned up to provide at least one superior tube. If it is necessary to purchase several 6AU6's in order to obtain one having superior characteristics, these tubes are relatively cheap and the leftovers can be used as replacements for other purposes.

The writers, partially exploring their resources, came up with nine 6AU6's and found three suitable for use as V_1. The variation from best to worst among the nine with respect to hum was about 15 db. The writers also had available seven 5879's, only two of which would have been suitable. The hum variation from best to worst was again about 15 db, although average performance of the 5879's was somewhat better than that of the 6AU6's. Previous experience with Z729's indicated the need for selection here, too. The writers had no experience with the EF86.

4. *Demagnetization.* As further measures against hum originating in V_1, the tube shield and the tube itself were demagnetized by bringing them into and out of the magnetic field produced by the a.c. bulk eraser used for tapes. Care should be taken not to carry the tube too close to the powerful pull of the electromagnet lest the tube elements be injured.

5. *Grid Shield.* Although the grid of V_1 has fairly low impedance to ground when connected to the playback head or to a dynamic microphone, yet there is appreciable opportunity for hum pickup. To minimize such pickup, the V_1 socket is oriented so that the grid pin faces a corner of the chassis, and a metal shield physically isolates the grid from the remaining pins, other wiring, heater leads, etc. The shield, shown in *Fig.* 3 is fashioned from a piece of tin can and is held in place by soldering it to the shield-pin in the center of the socket (miniature ceramic sockets generally have such a shield-pin). Height of the shield is slightly less than chassis depth, and it is about 3½ in. long before being formed into the shape shown.

6. *Power-Supply Filtering.* Generous amounts of filter capacitance were used to insure no hum in the B+ supply as well as adequate decoupling of stages. It may be noted that two stages of filtering precede the earliest B+ connection.

7. *Location of Power Transformer.* The power transformer if not properly located may introduce third harmonic hum (180 cps) by way of the playback head or amplifier components. In the original Pentron HFP-1 amplifier, the transformer was situated approximately in the center of the chassis, which made for considerable hum pickup. The writers removed it from the chassis, extended the leads, and relocated it in the far right corner of the box which houses both transport mechanism and amplifier. Before the transformer was permanently mounted, it was turned in all possible directions to determine the position resulting in least hum pickup. A very substantial reduction in hum was effected by these measures.

8. *Lead Dress.* Heater leads were made as short as possible and run flat against the chassis. Twisted leads were used only for runs over two inches. The 117-volt leads to the power switch (mounted in the volume control) were twisted and run along a corner of the chassis. Care was exercised to keep circuit components, especially grid leads, as far away as possible from a.c. wiring.

9. *Orientation of Power Plug.* As much as 3 db or more reduction in hum can be obtained by proper orientation of the power plug, that goes to the 117 volt line. Correct setting of the hum-bucking pot varies with position of the plug.

10. *Shielding the Playback Head.* As previously stated, the higher-priced transport mechanisms enclose the playback head in a heavy mu-metal cover during operation. But such a shield is expensive and difficult to make, so the writers instead resorted to the device of using a piece of metal to "warp" the hum field surrounding the head. The most effective position for this shield, as might be expected, was directly in front of the head, but this was impracticable because of the pressure pad and other mechanical considerations. However, experimentation revealed an alternative position, shown in *Figs.* 2 and 13 yielding results not too far from opti-

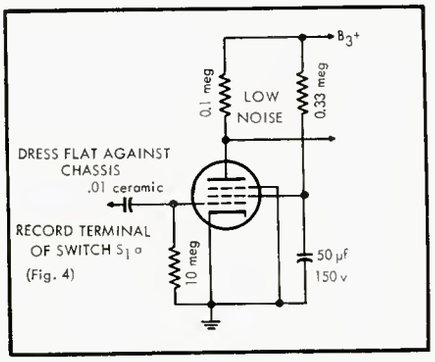

Fig. 14. Alternative input circuit—abandoned because of increased distortion.

mum. *Figure* 13 is a closeup of the shield employed. It consists of a thin piece of silicon steel about ¾ in. wide and 2 in. long after being bent double. The shield is alongside the playback head and clamps like a hairpin onto the bracket that holds the heads and guides the tape. The silicon steel is an I-plate from a power transformer—the same transformer that was converted into a bulk eraser by removing the I-plates and facing the E plates one way.

The head shield is somewhat ungainly-looking. However, it accounts for something like 6 db hum reduction, which is a fair exchange of appearance for performance.

11. *Miscellaneous Measures.* As further precautions against hum, the transport and motor (insulated from the transport) were grounded to the amplifier chassis, and the amplifier was equipped with a bottom plate (part of the original Pentron).

12. *Input Grid Circuit.* The V_1 input grid circuit shown in *Fig.* 4 is different from the one originally contemplated which is shown in *Fig.* 14. The advantage of using the circuit in *Fig.* 14 is that the hum-bucking pot has greater effect, permitting another 2 or 3 db of hum reduction. The disadvantage which led to its rejection, however, is that it produces considerably more distortion On the other hand, this difference in distortion may be considered academic by some, wherefore it is felt that the discarded circuit merits mention.

As pointed out in the section on specifications, the circuit of *Fig.* 4 can accommodate as much as 50 mv input with less than 1 per cent IM distortion and as much as 100 mv with only 1.5 per cent IM. However, the circuit of *Fig.* 13 produces 2 per cent IM at only 12 mv input, 3 per cent at 15 mv, 4 per cent at 20 mv, 8 per cent at 40 mv, and so on up. On the other hand, this circuit produces but 1.4 per cent IM at 10 mv, and at 5 mv distortion is down to 0.3 per cent. Thus, within the normal range of voltage output from a playback head, which is usually below 5 mv, the circuit of *Fig.* 14 would produce imperceptible distortion. Even on peaks, where amplifier IM distortion might reach 1.5 or 2 per cent, this amount would be relatively small compared with 8 per cent or more IM from the tape itself.

Yet, despite its potentialities for less hum, the circuit of *Fig.* 14 was abandoned because it crowds the margin of safety too much with respect to distortion. Although it can doubtless provide satisfactory results with regular tape, trouble may arise when using high-output tape, which results in greater voltage output from the head. Moreover, it is quite possible that continued advances in the art of tape manufacture will produce tapes with substantially higher output than now available.

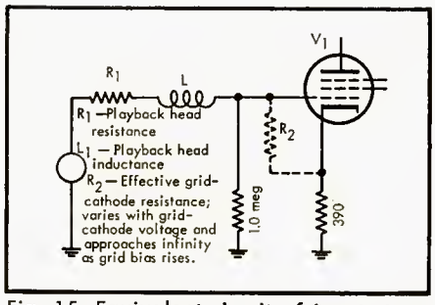

Fig. 15. Equivalent circuit of input stage to show how effective grid-cathode resistance attenuates high frequencies.

In going to the input circuit of V_1, careful consideration had to be given to the value of the cathode resistor, R_4. Too high a value not only reduces gain but, more important, lessens the effect of the hum-bucking pot. As already indicated in the discussion concerning *Fig.* 14, hum-bucking effect was greatest when cathode resistance was smallest; i.e., zero.

On the other hand, too small a cathode resistor at V_1 results in high-frequency attenuation; this may be explained with the aid of *Fig.* 15. Grid voltage relative to the cathode controls the electron stream that passes the grid in moving from cathode to plate. The limiting effect of the voltage differential between cathode and grid has the same effect as a resistance between the two. *Figure* 15 shows the equivalent circuit when the playback head is directly connected to the grid. The head consists largely of an inductance L, which is in series with the equivalent grid-cathode resistance R_2 just described. L and R_2 thus form a low-pass network, the frequency at which attenuation becomes significant varying directly with R_2. If R_2 is low enough, attenuation can be appreciable within the audio range.

A 390-ohm resistor was found sufficiently large to limit attenuation at 15,000 cps to a fraction of 1 db, with a margin of safety. No attempt should be made to increase gain of V_1 by installing a bypass capacitor across R_3, because this reduces the effectiveness of the hum-bucking pot.

VI. CARE OF THE RECORDER

To insure top-quality recording and reproduction of tapes, it is important to observe maintenance and check procedures at regular intervals. These measures, of course, vary from one machine to another, yet there are several basic steps that should be taken with respect to all recorders from which maximum performance is sought:

1. *Azimuth Alignment.* Using one of the test tapes available on the market, azimuth alignment should be checked, and corrected if necessary, every two or three months in order to insure good high-frequency response. Furthermore, by keeping a record of maximum output level when playing the azimuth alignment

tone, it is possible to ascertain whether playback head wear has reached the point where high-frequency response is impaired.

2. *Frequency Response Check.* Record-playback response of the entire machine should be checked occasionally. Besides deterioration of the playback head, changes in component values or faulty tubes can cause poor frequency response.

3. *Bias Current Check.* Bias current through the record head should be checked every few months or oftener inasmuch as the correct value is fairly critical when top-notch results are desired at 7.5 ips. As previously pointed out, too much bias reduces high-frequency response, while too little increases distortion.

4. *Cleaning the Heads.* The heads accumulate tape oxide and other matter, forming a film that, although extremely thin, reduces response of the playback head, particularly at high frequencies. It is therefore necessary to clean the heads quite frequently, perhaps after every 10 or 20 hours. Alcohol should be used, applied by means of absorbent cotton on a toothpick. Cleaning requires only seconds.

5. *De-magnetization of Heads.* When signals are abnormally high, the iron core of the head may behave non-linearly, resulting in a net d.c. component that goes through the record and playback heads. Over a period of time this d.c. gradually magnetizes them. A magnetized head both records noise onto the tape and adds it to the signal in playback. It is therefore advisable to demagnetize the heads every few weeks by means of an a.c. electromagnet purchased or constructed for this purpose.

6. *Tape Lift.* Most home tape recorders contain no mechanical provision for lifting the tape away from the heads during rapid rewind or forward wind, although such contact considerably accelerates head wear. It is therefore advisable to remove the tape from the heads and rewind or wind it directly between reels. If this cannot be done, it is possible to fashion from celluloid or similar smooth material a shim which can be inserted between the tape and the heads during rapid transit.

IMPEDANCE MIXING

(*from page 17*)

sole. *Figure* 5 shows KTYL's FM control board. Although much less complicated than its big brother, the physical layout and circuitry is much the same.

Rebuilt "Intercom" into Console

There is one more example of existing high-impedance audio consoles which may point up the idiosyncrasies of this circuitry. When Arizona State College at Tempe decided to inaugurate a wired-

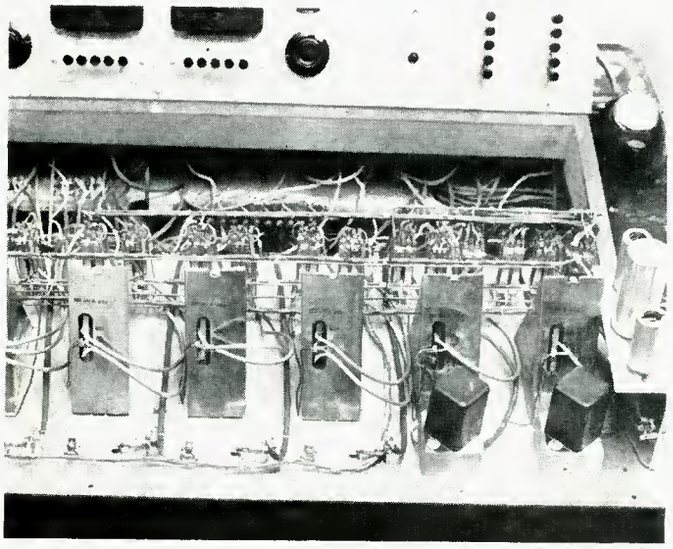

Fig. 8. Mixer bus construction of equipment at KASC.

wireless radio station serving the campus area some rather vague specifications were drawn up and the equipment selected was furnished by a manufacturer who makes excellent intercoms. Unfortunately, the technicians who wired the audio console obviously had no experience with intercoms or any other sort of electronic equipment. There was hum, distortion, noise, crosstalk . . . even the ground loops had ground loops! After about four months of continual rewiring it became obvious that the unit as it stood simply did not meet the increasingly diversified needs of the school radio department. A new console was designed using most of the original components and the college approved the construction of this new control board.

One important advantage of a custom-built system is the ability to suit physical design to the particular application. *Figure* 6 shows the present control room of KASC. The arrangement of the console and associated equipment was carefully planned for maximum operating efficiency. *Figure* 7 is a functional diagram of the electronic circuit. Notice that the mixing system is the same high-impedance circuit employed in our other two examples. One of the biggest difficulties in building such a unit is devising a satisfactory method of switching high-impedance circuits. For long life under continual operation telephone switches are required, but unless precautions are taken the capacitance between adjacent leaves of these switches will generate horrible amounts of crosstalk. A comparison between the simple switches shown in the functional diagram and the actual circuits of *Figs.* 9, 10, and 11

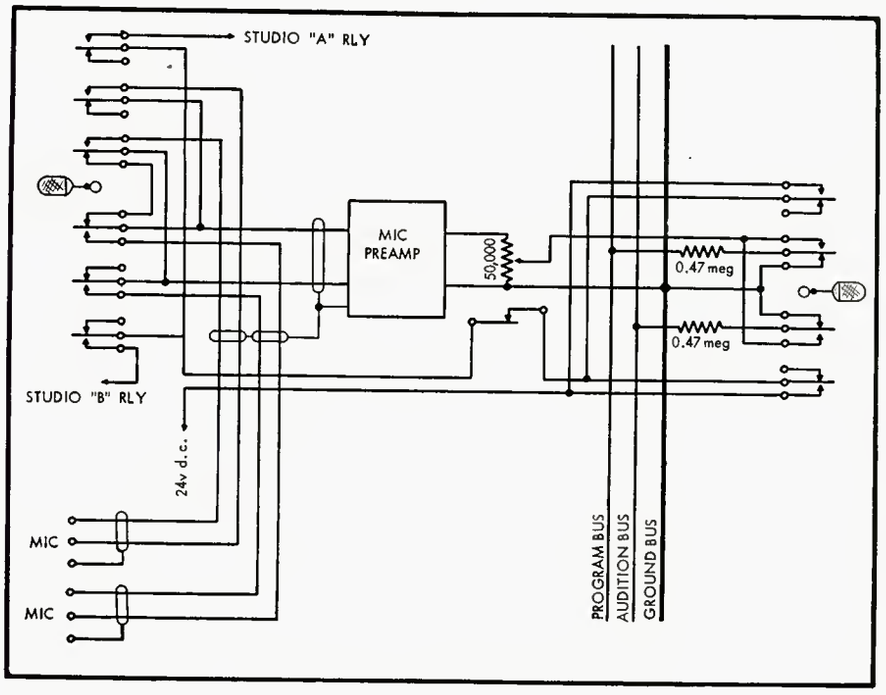

Fig. 9. Microphone input and mixing circuits showing switching in detail.

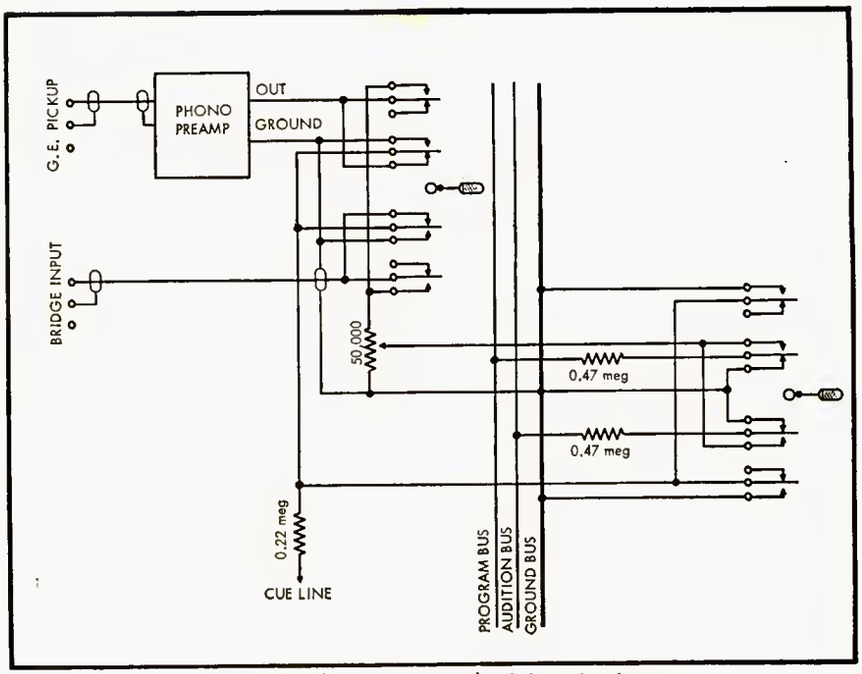

Fig. 10. Phono input and mixing circuits.

show the amount of forethought necessary to achieve satisfactory performance.[2]

The complicated line switching system deserves explanation because it performs a useful function found on no commercial broadcast consoles. The reason for this special circuit is that KASC's remote lines often serve a double purpose. For example, the school station has a telephone line connected to KTYL–FM. During school hours KASC picks up the FM audio from the line and broadcasts it over the school's

[2] Further expansion since this article was written has made even the equipment described inadequate. In 1957 the studios will move into new enlarged quarters completely installed with professional broadcast equipment.

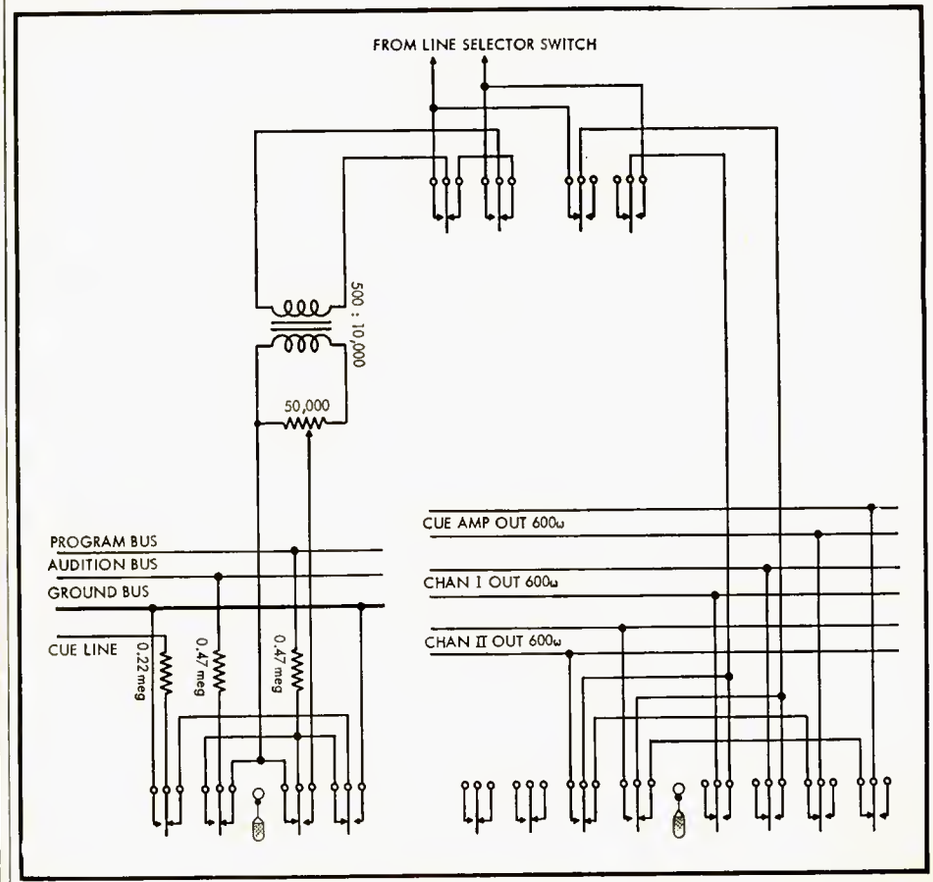

Fig. 11. Line input and mixing circuits of KASC console.

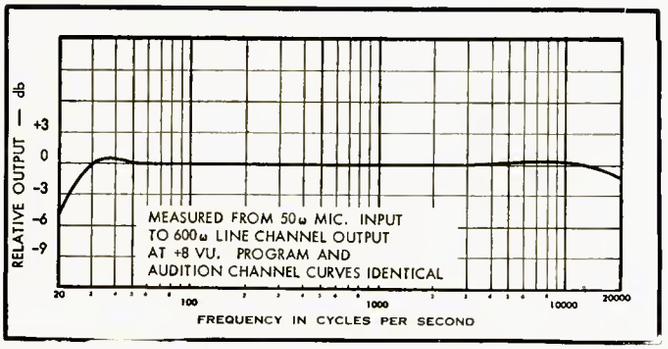

Fig. 12. Over-all frequency response curve of KASC console measured from 50-ohm mike input to 600-ohm line output at +8 dbm level.

wired-wireless AM transmitter. Later on the situation is just reversed and KTYL–FM carries some of the programs originating from KASC and the switch has to be made in the space of a ten-second station break. KASC has similar arrangements on campus. In order to facilitate these switchovers of remote lines, the console is wired so that the required connections can be made by flipping one switch from "receive" to "send."

Two of the channels in the audio board have pushbutton switches enabling them to be connected to any of three tape recorders or five remote lines. Below each attenuator are three telephone switches. The first is a "send-receive" switch which connects the line either to the mixer or to the console output. The second switch is operative only when the line is used in its normal "receive" capacity. It can then be switched to either program amplifier or to the cue amplifier. The third switch is active only when the line is used to "send" program material. It can then be connected to the *output* of either program channel or the cue amplifier. This last position is also used to carry on a two-way conversation over a line when setting up a remote broadcast. The console operator switches the line to "send-cue." He connects his headset to the line and the input of the cue amplifier to the console mike preamp. Relays automatically cut out the cue speaker to prevent acoustic feed-back. The console operator can now talk to the technician setting up the remote at the other end of the line without tying up either program circuit.

Figure 8 shows the program and ground busses run directly behind the attenuators. At the end of these busses is located a single-stage amplifier for both circuits to make up the loss in the mixing system. Each preamp, together with its input source and mixing attenuator, is separately grounded to the copper bus which runs parallel to the two program busses. Since only one side of the audio circuit is switched the grounding system must be kept as short and heavy as possible to prevent crosstalk due to a common ground impedance in the two program circuits. Although the wiring looks sloppy in the photo leads were dressed and cabled after all the troubleshooting was completed.

The final console design has performance specifications well within broadcast ratings. The over-all frequency response is indicated in *Fig.* 12. Mr. Tom Voss, who worked with the KASC control equipment for over a year, states that except for occasional trouble with the original components, the console performs as well as a commercial broadcast installation. However any equipment is useless if the person responsible for its maintenance doesn't understand it. The college has occasionally had trou-

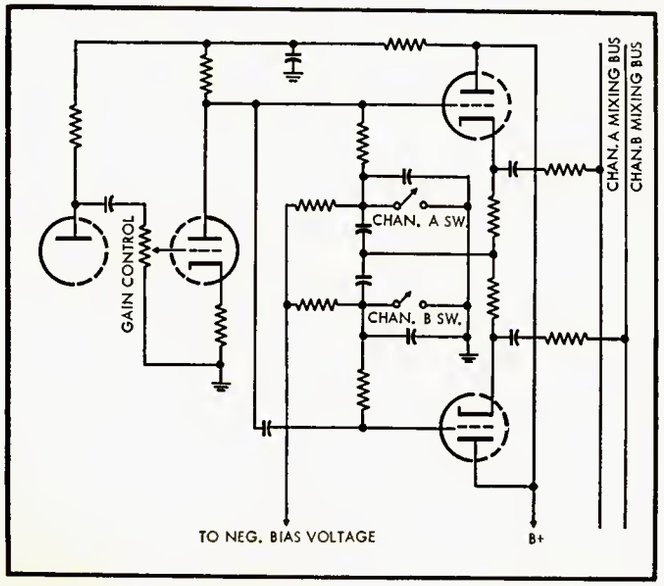

Fig. 13. Simplified schematic of cathode-follower mixing circuit with grid bias control.

ble because would-be audio engineers are eager to change something here and ground something else at another point and in about two hours have the whole system working about the same as the original factory-built unit.

This sensitivity to screwdriver mechanics is another drawback to high-impedance circuits although it is just a matter of degree . . . some "technicians" could disassemble a crowbar and never get it back together. But in spite of the trickiness of high-impedance dual program consoles, the idea is easy enough to use in single program applications.[3] The fact that the commercial Australian product meets such rigid professional demands is indication that a properly designed circuit is satisfactory for quality installations.

Possible Modifications

There *is* a modification which enables the transformerless mixer to give trouble-free service in dual program consoles. Suppose that instead of a transformer for each channel, we substitute a cathode follower. With a suitable choice of circuit values we can hold the impedance in our mixing circuit to 600 ohms and the addition of a cathode-follower stage is considerably less expensive than a transformer. While we still lack the ground loop security that transformer isolation gives, normal careful grounding procedure will result in a mixer that is not much more expensive than the high impedance configuration, yet gives the stable operation of low-impedance design.

A further trick which can be employed in dual program consoles is shown in *Fig.* 13. Switching the output of a cathode follower is apt to generate clicks and thumps so we have moved the switching to control the grid bias instead. This means much simpler and cheaper telephone switches as well as allowing us to regulate the d.c. time constant in such a way as to eliminate acoustic pick-up of switch clicks from the console. If you listen closely to almost any radio station you'll hear clicks and clacks every time the console microphone is switched on. The short reverberation of the noise made by the operation of the telephone switch and the speaker muting relays is picked up by the mike. But if the mike is not "live" until a fraction of a second after the switch has been thrown and the relays have closed, the switching will be effectively noiseless. The RC time constant of the grid-bias voltage filter can be designed to give such an effect.

Notice also that attenuators have been made an integral part of the preampli-

[3] An inexpensive single-channel consolette designed for recording and remote pickup operations will be marketed by the author's firm early in 1957.

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fiers. Plug-in preamps can be so designed that any trouble in the amplifying stages, attenuator, or program switch can be cured by simply plugging in a replacement preamp while the defective unit is being repaired. This trick is used to some extent in the more elaborate Stromberg-Carlson sound distribution systems.

After experimenting with various types of audio mixing systems I feel that either the high-impedance or cathode-follower design can be used for perfectly stable high-quality consoles if the following points are kept in mind:

1. Keep all components as compact and close together as possible. High-impedance audio circuits should be separated from output lines and a.c. power leads.
2. Design as little switching as possible in high-impedance circuits.
3. Be *sure* that no possible switching combinations will result in capacitive crosstalk between adjacent leaves of telephone switches.
4. Grounding is *extremely* critical.

Naturally, if you aren't familiar with the design and wiring of low-noise microphone amplifiers and high-fidelity circuits you'll have trouble if you attempt anything so ambitious as an eight-channel audio console. But anyone who has had experience with good grounding procedure and low-capacitance wiring layout can build a custom designed console that will meet the specifications of factory built broadcast equipment at about one-half the cost.

•

OUTPUT TRANSFORMER

(*from page 22*)

former may operate well within the saturation limit, but the inductance only represents a reactance of, say, twice that of the load resistance. This will result in about 1 db loss at this frequency and also will cause the load line on the tube characteristics to open out into an ellipse. In this case the distortion present will be due to the elliptical load line rather than to the nonlinearity of the transformer magnetizing current.

Another variation of this condition occurs in amplifiers with large amounts of feedback. This produces a low effective source resistance, so the distortion component of magnetizing *current* does not appreciably distort *voltage*. With a damping factor of 30, a magnetizing current 25 per cent of load current, and containing 30 per cent harmonic, will only cause 0.25 per cent distortion in the output. But the 25 per cent reactive magnetizing current may cause the tubes to clip, producing a much bigger distortion than this.

(*to be concluded*)

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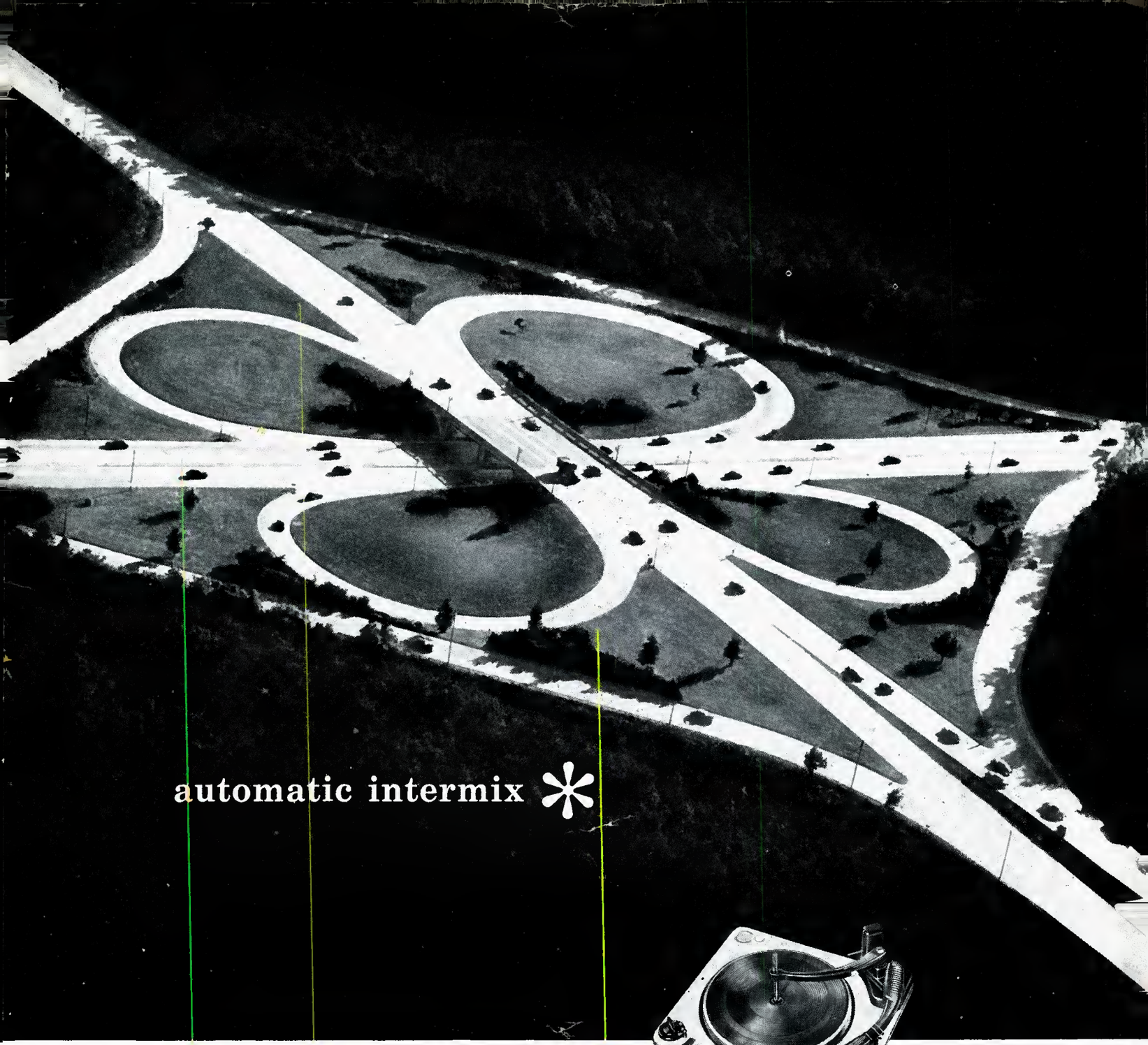

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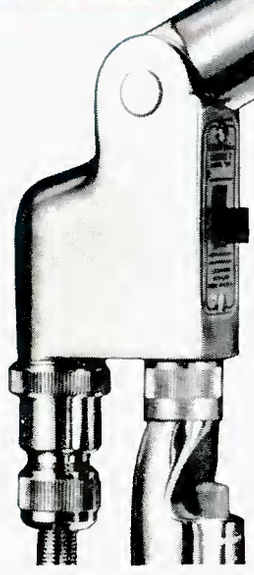

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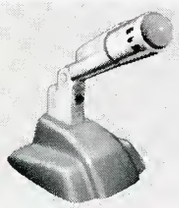

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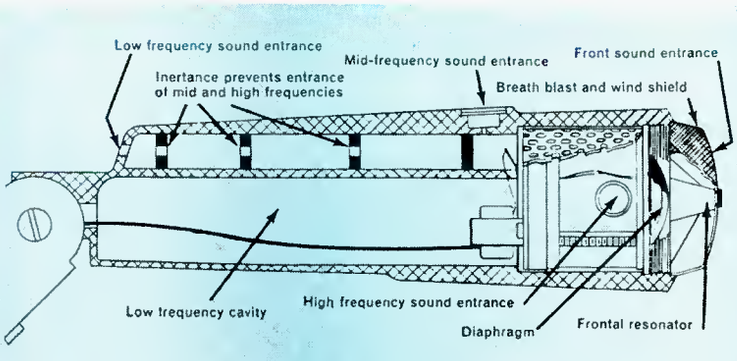

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