AUDIO

JANUARY, 1960
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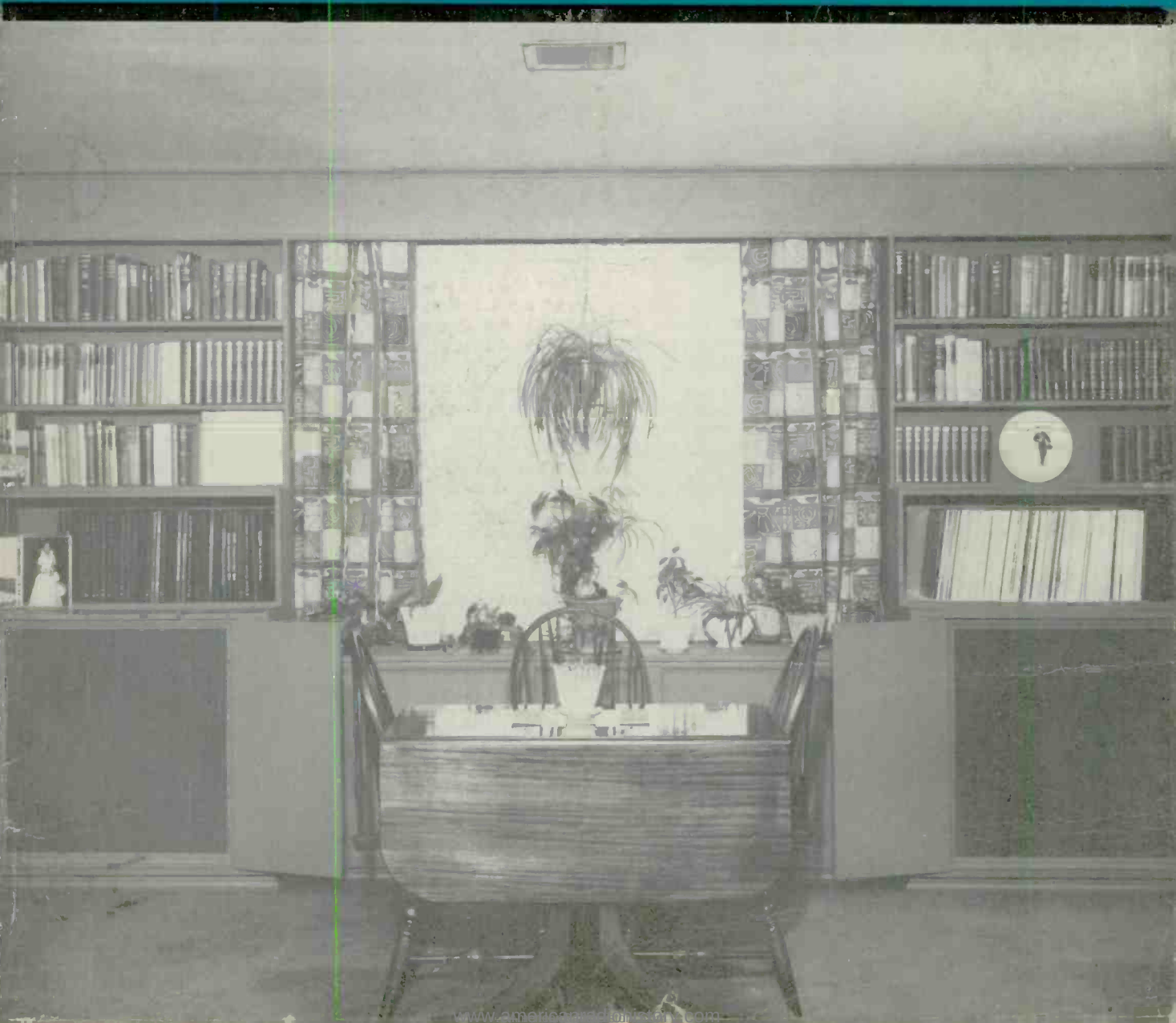

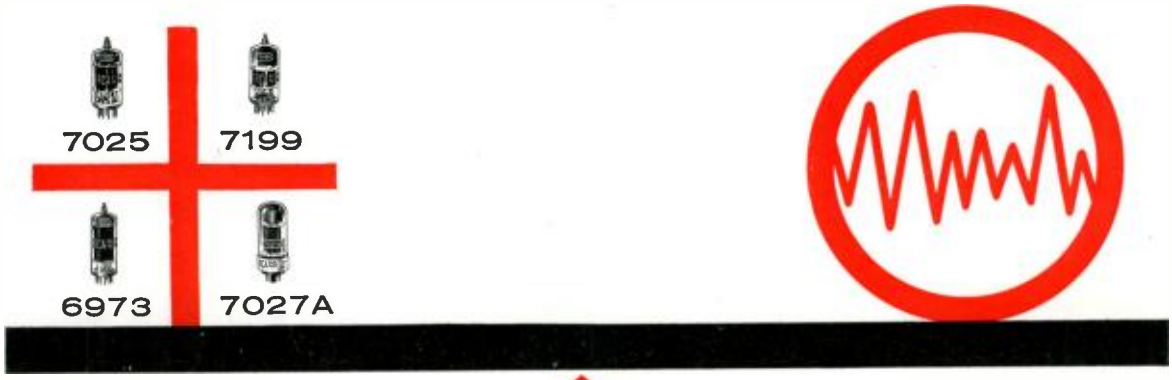

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JANUARY, 1960 VOL. 44, No. 1

Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

COVER PHOTO—Stereo loudspeakers in the Poughkeepsie, N. Y. home of Audioman No. 4, Charles R. Doty, who is a senior Engineer with IBM. For further description of his installation. turn to page 10.

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AUDIOclinic

JOSEPH GIOVANELLI*

About Capacitors and Resistors

Q. 1. There is no agreement concerning capacitors, either as to kind or polarity. According to the latest Allied Radio catalog there are three kinds: (1) plastic, molded tubulars (2) paper tubular-metalized (3) oil-filled paper capacitors. R. G. Chaplick, in the Oct. 1958 AUDIO, *uses mica capacitors. Hence, my question: What kind of coupling capacitors should I use for my building projects?*

Different writers and different magazines use different systems to indicate the polarity of coupling capacitors. I assume that the white or black band around one end of a tubular capacitor means the outside foil. I assume this means negative, in the sense that the banded end goes to ground, B-minus, or the side of lowest voltage. Referring to the article by C. G. McProud in the Aug., 1958 issue of AUDIO*—"The two-channel amplifier," I see, that, according to the drawing, the plates of the ECC83's are capacitance-coupled to the grids of the EL84's. The symbol for a capacitor is a bar paralleled by a curved line. I assume that the straight bar is positive, and the curved line is negative. According to this and most other diagrams in* AUDIO*—the positive end of the capacitor connects to the plate of the driver tube, and the negative fastens to the grid of the following, or driven, tubes. Hence, the question is:* How *do you hook up coupling capacitors—assuming that the capacitor is marked with a white or black band around one end?*

2. Now for resistors. Again the authorities vary in their opinions as to which type of resistors to use in a given situation. I give now as an example the McProud amplifier just mentioned in the previous question. I notice that only run-of-the-mill resistors were used in its construction. This really confuses me. My question is this: Why not use the best resistor all the way through? In what stage or stages of any amplifier, can you use run-of-the-mill wirewound or carbon resistors, in the range of two watt or higher? I assume it would depend, to some extent, upon the power rating of the amplifier. Frank Ferry, Seattle, Wash.

A. 1. There are at least three considerations which govern types of capacitors to be used. 1. When space is a factor and for low values, ceramic coupling capacitors should be used. 2. Oil-filled capacitors may be used as coupling agents provided that their metal sleeves are not grounded. Grounding a sleeve tends to bypass highs. 3. Paper capacitors, whether plastic-molded, paper tubulars, or metalized may be used but be sure that the negative, or outside-foil terminal is connected to a point nearest ground. The point nearest ground is not that of lowest d.c. voltage necessarily. It is the point of lowest impedance to ground. A grid is usually at a higher impedance than its preceding plate.

The manner of coupling these capacitors is well known and accepted. However, the confusion stems from the lack of agreement as to the meaning of the symbols denoting a capacitor.

In this magazine, it is assumed that the curved line represents the ground connection, outside foil, or black band of plastic-molded capacitors. Ceramic and mica capacitors are not polarized.

These considerations apply to audio-frequency work only. When the choice of a coupling capacitor to be used in a tuner must be made, things such as inductance and temperature stability must be considered.

2. Now for resistors. Your information about resistors is accurate. In some applications, however, the use of the more expensive metallic film resistor will give no better results than would be obtained from a cheaper component.

For instance, in a power amplifier, the noise produced by carbon resistors is of insufficient magnitude to be disturbing. I have recently completed a 100-watt amplifier in which all resistors used were two-watt carbon. Hiss level was barely audible, even with an ear right to the speaker. Even in most preamplifiers, I find that two-watt carbon resistors do an excellent job. The amount of power produced in the output of an amplifier does not govern the type of resistor used, except, of course, in the B supply where currents may be high, in which case the wattage of the resistor will be determined by the voltage drop across it and upon the current flowing through. It is, rather, the current in a circuit which bears upon the type of resistor used.

Preamplifiers and Crystal Pickups

Q. Somewhere, I saw a diagram for a network to follow an ordinary crystal phono cartridge. The device was to "look like" a magnetic cartridge to a preamplifier. In other words, this is to be a network which will allow a preamplifier to accept a junk-type crystal pickup. Can you give me the values of the components and the wiring scheme? Frank Ferry, Seattle, Wash.

A. The problem is complicated because each make of cartridge has at least slightly different characteristics. What you need to do is to roll-off the bass in the cartridge. This is done by using a resistor whose value is equal to that of the capacitive reactance of the cartridge at the frequency of 500 cps. The voltage output of the cartridge will however, be too high. Therefore, the shunt resistor should be

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

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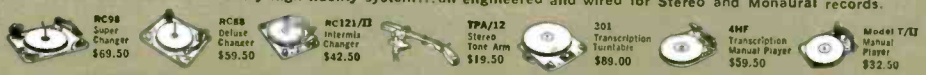

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made up of two resistors in the form of a voltage divider.

Values of these resistances for use with stereo cartridges would be approximately 250,000 ohms in series with 22,000 ohms. The signal is taken across the 22,000-ohm resistor. Since the preamplifier, however, is probably equipped with a 47,000-ohm input load, use another 47,000-ohm resistor instead of the 22,000 ohm resistor previously mentioned. The two 47,000-ohm resistors will be in parallel and, therefore, will be approximately equal to the 22,000 ohms specified above. If, for some reason, there is a great loss of highs, shunt the 250,000 ohm resistor with various sizes of capacitors until you find one which restores proper balance.

Pulling in the Weak Ones

Q. I wish to receive WFMT, Chicago, at 98.7 mc. A Rock Island station at 98.9 mc interferes with this reception considerably. I have a rotator, and I keep the antenna pointed between NE and ENE. If you will look at the map, you will see that Rock Island is north of here, and a little west. I can't figure out why my good antenna permits this interference. I am positive it is correctly installed. Would it be possible to obtain a booster that is tunable? I am using a broadband booster now and am wondering if I could get a tunable booster which will boost the 98.7 mc and not the 98.9. Maybe you can suggest something.

In the October, 1958, issue of AUDIO, *in the* EQUIPMENT REVIEW, *the Karg tuner was tested. Since each station operates on its own crystal do you think this would improve reception? John J. Haner, Galesburg, Ill.*

A. A quick check of my atlas shows that you are about one-fifth as far from Rock Island as from Chicago. Furthermore, the direction from which the two signals come is quite similar as far as beam antennas are concerned. No beam antenna, however efficient, is good enough to reject this strong, undesired, local Rock Island signal. Further, the frequency separation of these two stations is only 200 kc—which is within the bandpass of a good FM tuner. In addition, the Chicago station is at the outermost fringe of FM reception, complicating your problem even more.

I know that some radio amateurs have devised 36-element beam antennas. They are *not* commercially available. Perhaps you, or a ham operator friend of yours, can build one of them. After it is built, several days of trial and error adjustment are needed to make it work correctly—a case of "patience is a virtue." As you know, the more elements there are in a beam antenna, the sharper the directional characteristic becomes, together with a higher gain in the desired direction. When adjusting such a beam antenna, it is more important to get as high a front-to-back ratio as possible, rather than to achieve the greatest gain in the forward direction.

A tunable booster will help to improve the selectivity of an FM tuner since the selectivity curve of such a booster is quite broad, perhaps being as wide as one or two megacycles at 3 db down. All that the booster will do is to amplify both signals.

The crystal-controlled oscillator in the Kark tuner is valuable for eliminating annoying drift and for easy "tuning-in" of a station. The oscillator, though very stable, contributes nothing to selectivity. Selectivity is controlled mainly by the i.f. bandpass. Hence, the crystal tuning feature will be valueless in solving this problem. Æ

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"High Spirits" includes these bright selections:

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LETTERS

Gremlin Department

SIR:

It would seem that the "gremlins" were especially active in the "Low-Loading Self-biased Amplifier" article in the December issue. Here are the corrections, and I do hope you will publish an errata notice:

Figures 1 and 2 should have had the curves designated—A for the center curve, B for the upper curve, and C for the lower. Without these designations the punch is lost. (*The author is right—we omitted them.*)

Figure 2 has extra zeros on the upper cycle of the log scale for harmonic distortion. The top figure should be 10, not 100, and zeros should be removed from the others, leaving 5, 4, 3, and 2. (*Draftsman copied author's drawing, but we should have caught it.*)

Figure 3 has reversed designations on the voltage table. C_3 should read 325 and 450, while C_4 should read 275 and 350. (*Our error again.*)

In the parts table on page 21, R_3 and R_4 should be ½ watt, and the last tube referred to in the table for V_3 should be an ECC33, which my reference shows as the equivalent of the 6SN7. (*Ours too.*)

I am most pleased that you did include the voltage table on the schematic. I feel that this notation should be standard on all circuits you publish. It would be very helpful to others who might build the units.

L. B. DALZELL,
1162 Fleetridge Drive
San Diego 6, Calif.

Tuners and Turntables

SIR:

I have two questions you may be able to give me some help with.

Given the prospect of aligning an unfamiliar FM tuner on which no technical data are available—and not wishing to cut loose with a can opener—how do you tell which end is the primary and which the secondary of the ratio detector or discriminator transformer? (*Connect a VTVM to the detector test point ahead of the a.f. coupling capacitor and try one of the adjustments while a signal is fed to the i.f. amplifier. The secondary is the one which causes a wide shift from negative to positive voltage. The primary adjustment gives much less variation.*)

The second question relates to the rumble figure quoted for turntables and record changers tested for EQUIPMENT PROFILE. It is desirable, if only for relative comparisons, which is all that is claimed, of course. How is this test performed, and what is measured? I trust that it is total rumble content relative to not more than 7 cm/sec (in contrast to at least one manufacturer who quotes figures which turn out to be the 120-cps component, only relative to 20 cm/sec.) Could I have your measured figures for the two or three turntables and changers which you have found to have the lowest rumble of those so far tested?

CHARLES H. CHANDLER,
1, Marlborough St.,
Boston 16, Mass.

The test and procedure were outlined in the June, 1959, issue, from which we quote the following: "The NARTB standard of measurement . . . specifies that rumble shall be rated in db below 1.4 cm/sec stylus velocity at 100 cps, which corresponds to 7 cm/sec at 1000 cps with standard equalization. We made this measurement in a simplified manner, but the result approximates the NARTB standard. We used a D & R Flutter and Rumble test record, which has three bands—3000 cps with zero per cent flutter, 3000 cps with 1.5 per cent flutter, and an unmodulated band for the rumble test. The 3000-cps band is recorded at a level of 5.8 cm/sec, so by (observing) the output of this band, and then taking a second reading while playing the unmodulated band, the difference can be used to determine the NARTB figure. 5.8 cm/sec (at 3000 cps) is approximately 1.5 db below 1.4 cm/sec at 100 cps. . . . The acceptable rumble for a reproducing turntable is −35 db, in NARTB standards." Dual Model 1006 was measured at −36 db; Connoisseur Type B, −53.5 db; Collaro Constellation, −34 db; LESA, −32 db. These are all that have been tested in accordance with this method.)

Microphones

SIR:

We have just reviewed the article by Herman Burstein, "Microphones for Recording," in the October issue, and we have a couple of comments and a question.

On page 36, Mr. Burstein points out that many of the old disadvantages of ribbon microphones have been at least somewhat overcome, allowing more versatile units. This is certainly true. However, in fairness to your readers, we feel it should be pointed out that the ribbon microphones are still limited to indoor applications. This was not pointed out in the article and could lead to sad experience by a reader who might purchase a ribbon microphone and try to use it as an all-around unit.

In this same section, it is mentioned that manufacturers of ribbon microphones make it possible for the user to replace the ribbon in the field in case of failure. In substance, this may be true, but it is extremely doubtful that, despite the method by which the manufacturer furnishes the ribbon, an unskilled home technician could replace the ribbon and retain the original quality of the microphone. Presuming that this is possible, we are certain you will agree it would be much easier to replace a dynamic element in the field although this was not mentioned.

On page 40 in the Editor's note, you comment that the voice-coil impedance of typical dynamic microphones averages 30 to 50 ohms. This is universally true in the older dynamic microphones but the typical average dynamic today runs somewhere between 3 and 15 ohms. As a result, matching transformers are included even for 50-ohm input. This is a minor point and one which could hardly mislead your readers but for the sake of accuracy is worth mentioning.

The only remaining point is a question as to why Electro-Voice did not get a credit line for the cutaway drawing on page 36, which is obviously a cross section of the Model 664 microphone. Credits were given on all other photographs showing a specific type unit except on this one. Since this "Variable-D" type microphone is an original and exclusive Electro-Voice development, we would like to have it acknowledged as such. (*Now you have it.* ED.)

No doubt someone has already noticed that the description of patterns B and C in *Fig.* 15 on page 42 is inverted. However, this would not be difficult for even the reader to catch.

In general, this is one of the most accurate and informative articles we've seen on microphones for quite some time.

GEORGE R. RILEY,
Manager, Commercial Products,
Electro-Voice, Inc.,
Buchanan, Michigan

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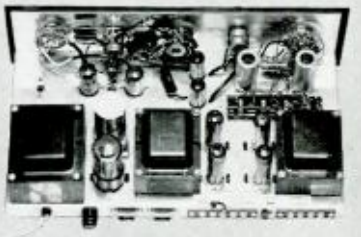
Other features include a speaker phasing switch, two AC outlets for accessory equipment and hum balance controls in each channel. As beautiful as it is functional, the SA-2 will be a proud addition to your stereo sound system. Shpg. Wt. 23 lbs.

SPECIFICATIONS—Power output: 14 watts per channel, "hi-fi"; 12 watts per channel, "professional"; 16 watts per channel, "utility". **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Controls:** dual clutched volume; ganged bass, ganged treble; 4-position selector; speaker phasing switch. **Inputs:** 4 stereo or 8 monophonic. **Outputs:** 4, 8 and 16 ohms. **Dimensions:** 4½" H. x 15" W. x 8" D.

New

HEATHKIT SA-2

$52.95



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This amazing performer delivers more than enough power for pure, undistorted room-filling stereophonic sound at the lowest possible cost. Featuring 3 watts per stereo channel and 6 watts as a monophonic amplifier, the SA-3 has been proven by exhaustive tests to be more than adequate in volume for every listening taste. A tremendous buy at this low Heathkit price. Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: 3 watts per channel. **Power response:** ±1 db from 50 cps, 20 kc at 3 watts out. **Total harmonic distortion:** less than 3%; 60 cps, 20 kc. **Intermodulation distortion:** less than 2% @ 3 watts output using 60 cycle & 6 kc signal mixed 4:1. **Hum and noise:** 65 db below full output. **Controls:** dual clutched volume; ganged treble, ganged bass; 7-position selector; speaker phasing switch; on-off switch. **Inputs (each channel):** tuner, crystal or ceramic phono. **Outputs (each channel):** 4, 8, 16 ohms. **Finish:** black with gold trim. **Dimensions:** 12½" W. x 6¾" D. x 3¼" H.

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This handsomely styled FM tuner features better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with on-off switch, and prewired, prealigned and pretested tuning unit. Clean chassis layout, prealigned intermediate stage transformers and assembled tuning unit makes construction simple—guarantees top performance. Flywheel tuning and new soft, evenly-lighted dial scale provide smooth, effortless operation. Vinyl-clad case has black, simulated-leather texture with gold design and trim. Multiplex adapter output also provided. Shpg. Wt. 8 lbs.

SPECIFICATIONS—Tuning range: 88 to 108 mc. **Quieting sensitivity:** 2.5 uv for 20 db of quieting. **IF frequency:** 10.7 mc. **Image ratio:** 45 db. **AFC correction factor:** 75 kc per volt. **AM suppression:** 25 db. **Frequency response:** ±2 db 20 to 20,000 cps. **Harmonic distortion:** less than 1.5%, 1100 uv, 400 cycles 100% modulation. **Intermodulation distortion:** less than 1%, 60 cycles and 6 kc mixed 4:1 1100 uv, 30% modulation. **Antenna:** 300 ohms. **Output impedance:** 600 ohms (cathode follower). **Output voltage:** nominal .5 volt (with 30% modulation, 20 uv signal). **Overall dimensions:** 4¼" H. x 13¾" W. x 5½" D.

New

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New

HEATHKIT AS-2B (birch)
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A revolutionary principle in speaker design, the Acoustic Research speaker has been universally accepted as one of the most praiseworthy speaker systems in the world of high fidelity sound reproduction. Heathkit is proud to be the sole kit licensee of this Acoustic Suspension principle from AR, Inc., and now offers for the first time this remarkable speaker system in money-saving, easy-to-build kit form.

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SPECIFICATIONS—Frequency response (at 10 watts input)*: ±5 db, 40 to 14,000 cps; 10 db down at 30 and 16,000 cps; **Harmonic distortion:** below 2% down to 50 cps, below 3% down to 40 cps at 10 watts input in corner room location. **Impedance:** 8 ohms. **Suggested damping factor:** high (5:1 or greater). **Efficiency:** about 2%. **Distribution angle:** 90° in horizontal plane. **Dimensions:** 24" W. x 13½" H. x 11⅜" D.

*Power input required for average listening level will not exceed 10 watts.

New

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55 WATT HI-FI AMPLIFIER KIT (W-7A)

Utilizing advanced design in components and tubes to achieve unprecedented performance with fewer parts. Heathkit has produced the world's first and only "dollar-a-watt" genuine high fidelity amplifier. Meeting full 55 watt hi-fi rating and 55 watt professional standards, the new improved W-7A provides a comfortable margin of distortion-free power for any high fidelity application.

The sleek, modern styling of this unit allows unobtrusive installation anywhere in the home. The clean, open layout of chassis and precut, cabled wiring harness makes the W-7A extremely easy to assemble. Shpg. Wt. 28 lbs.

SPECIFICATIONS—Power output: Hi-fi rating, 55 watts; Professional rating, 55 watts. **Power response:** ±1 db from 20 cps to 20 kc at 55 watts output. **Total harmonic distortion:** less than 2% from 30 cps to 15 kc at 55 watts output. **Intermodulation distortion:** less than 1% at 62 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 80 db below 55 watts, unweighted. **Damping factor:** Switch on front panel for selecting either maximum (20:1) or unity (1:1). **Output impedances:** 4, 8 and 16 ohms and 70 volt line. **Power requirements:** 117 volts, 50/60 cycles, 90-160 watts. **Dimensions:** 8½" D. x 6⅝" H. x 15" W.

HEATHKIT EA-3
$29.95

A NEW AMPLIFIER AND PREAMP UNIT PRICED WELL WITHIN ANY BUDGET

14 WATT HI-FI AMPLIFIER KIT (EA-3)

Delivers a full 14 watts of hi-fi rated power and easily meets professional standards as a 12-watt amplifier.

Rich, full range sound reproduction and low noise and distortion are achieved through careful design using the latest audio developments. Miniature tubes are used throughout, including EL-84 output tubes in a push-pull output circuit with a special-design output transformer. The built-in preamplifier has three separate switch-selected inputs for magnetic phono, crystal phono or tape, and AM-FM tuner. RIAA equalization is featured on the magnetic phono input. Shpg. Wt. 15 lbs.

NOTE THESE OUTSTANDING SPECIFICATIONS—Power output: 14 watts. Hi-fi; 12 watts. Professional; 16 watts. Utility. **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms.

HEATHKIT UA-2
$22.95

"UNIVERSAL" 14 WATT HI-FI AMPLIFIER KIT (UA-2)

Meeting 14-watt "hi-fi" and 12-watt "professional" standards, the UA-2 lives up to its title "universal" performing with equal brilliance in the most demanding monophonic or stereophonic high fidelity systems. Its high quality, remarkable economy and ease of assembly make it one of the finest values in high fidelity equipment. Buy two for stereo. Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: Hi-fi rating, 14 watts; Professional rating, 12 watts. **Power response:** ±1 db from 20 cps to 20 kc at 17 watts output. **Total harmonic distortion:** less than 2% from 20 cps to 20 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 14 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 73 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms. **Damping factor:** switched for unity or maximum (15:1). **Input voltage for 14 watt output:** .7 volts. **Dimensions:** 10" W. x 6½" D. x 4¾" H.

HEATHKIT SP-2A
$56.95
(two-channel stereo).
Shpg. Wt. 15 lbs.

HEATHKIT SP-1A **$37.95**
(single-channel monophonic).
Shpg. Wt. 13 lbs.

HEATHKIT C-SP-1A **$21.95**
(converts SP-1A to SP-2A).
Shpg. Wt. 4 lbs.

STEREO-MONO PREAMP KIT (SP-2A, SP-1A)

Available in two outstanding versions! SP-2A (stereo) and SP-1A (monophonic). SP-1A convertible to stereo with conversion kit C-SP-1A. Use as the control center of your entire high fidelity system. Six inputs in each channel accommodate most any program source. Switch selection of NARTB or RIAA, LP and 78 rpm record compensation.

New HEATHKIT Tape Recorders

PROFESSIONAL QUALITY TAPE RECORDER KITS (TR-1 series)

These outstanding tape recorder kits offer a combination of features found only in higher priced professional equipment selling for $350 to $400. The precision tape mechanism is supplied completely assembled and tested. you build only the tape amplifiers. Two circuit boards are used for easy assembly and high stability. Separate record and playback heads and amplifiers allow monitoring while recording. Features include professional-type db sound level meter, counter, pause control, record interlock. 2 (switch-selected) speeds 3¾ and 7½ IPS. Frequency response: ±2.5 db 30 to 12,000 cps at 7½ IPS. NARTB equalization. Provision for mike or line inputs. Shpg. Wt. 30 lbs.

MODEL TR-1E: 4-track stereo playback, monophonic record & play. $17.00 DN., $14.00 MO. **$169.95**

MODEL TR-1D: 2-track stereo playback, monophonic record & play. $17.00 DN., $14.00 MO. **$169.95**

MODEL TR-1C: monophonic record & playback. $16.00 DN., $14.00 MO. **$159.95**

MODEL C-TR-1D: Converts TR-1D to TR-1E. 2 lbs. **$14.95**

MODEL C-TR-1C: Converts TR-1C to TR-1D. 2 lbs. **$19.95**

MODEL C-TR-1CQ: Converts TR-1C to TR-1E. 2 lbs. **$19.95**

STEREO-MONO TAPE RECORDER KIT (TR-1A series)

Our most versatile tape recorder kit, you can buy the new two-track (TR-1AH) or four-track (TR-1AQ) versions which record and playback both Stereo and Monophonic programming or the two-track Monophonic record-playback version (TR-1A). Precision bearings and close machining tolerances hold flutter and wow to less than 0.35%. NARTB equalization, separate record and playback gain controls and a safety interlock. Provision for mike or line inputs with 6E5 "magic eye" tube as sound level indicator. Two circuit boards for easy assembly.

MODEL TR-1A: Monophonic two-track record/playback with fast forward and rewind functions. Includes one TE-4 Tape Electronics kit. Shpg. Wt. 24 lbs.
$10.00 DN., $9.00 MO. **$99.95**

TR-1A Specifications—Frequency response: 7.5 IPS ±3 db 50 to 12,000 cps; 3.75 IPS ±3 db 50 to 7,000 cps. **Signal-to-noise ratio:** better than 45 db below full output of 1.25 volts / channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

MODEL TR-1AH: Two-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs.
$15.00 DN., $13.00 MO. **$149.95**

TR-1AH Specifications—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ±3 db 40 to 10,000 cps. **Signal-to-noise ratio:** 45 db below full output of 1 volt /channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc)push-pull oscillator.

MODEL TR-1AQ: Four-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs.
$15.00 DN., $13.00 MO. **$149.95**

TR-1AQ Specifications—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ±3 db 40 to 10,000 cps. **Signal-to-noise ratio:** 40 db below full output of .75 volts /channel. **Harmonic distortion:** less than 2% at full output. **Bias erase:** 60 kc (push-pull oscillator).

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Write today for free catalog describing over 100 easy-to-build kits in hi-fi—test—marine and amateur radio fields.

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Enclosed find $_____. Please enclose postage for parcel post—express orders are shipped delivery charges collect. All prices F.O.B. Benton Harbor, Mich. A 20% deposit is required on all C.O.D. orders. Prices subject to change without notice.

QUANTITY	ITEM	MODEL NO.	PRICE

AUDIOMAN NO. 4

Charles R. Doty, Senior Engineer at IBM, selected as the fourth Audioman—one who combines audio, music, and civic activities to make one multi-facet hobby.

WITH INTEREST IN RADIO extending 'way back to 1921 when he constructed a special receiving set to present the Dempsey-Carpentier fight to a capacity audience in a Peekskill, N. Y., theater and used people as "loudspeakers" to relay the broadcaster's comments to the listeners, Charles R. Doty has continued with sound reproduction as an important hobby. In 1950, he founded and was first president of the Poughkeepsie Audio Society, an organization which holds monthly meetings for its more than 400 members, at which prominent people in the industry and from musical circles talk on subjects ranging from technical problems to psychoacoustics and music. He has also served as program director for the society, as Director of the Dutchess County Philharmonic, as Treasurer of the Red Oaks Mill Fire Company, and as Deacon of the New Hackensack Reformed Church. He is a member of the AIEE, the IBM Country Club, IBM Study Club, and the IBM Quarter Century Club.

Mr. Doty is still using a Radio Craftsmen RC-8 tuner which, with a history of several modifications, he feels has no equal at this time. His stereo preamp was originally built for stereo as early as 1953, and it too has undergone several modifications (which is standard practice among dedicated audiofans, of course). Two husky power amplifiers using four 6550's each in push-pull parallel do double duty—in their 120-watt form they serve for concert use, and with two of the 6550's removed they provide 70 watts for home use, adequate for driving the speaker channels comprising AR-1W's with JansZen 1-30 electrostatic tweeters. He uses a Rek-O-Kut T-12H turntable with a 16-in. Fairchild arm and Fairchild 232 and Stereodyne II pickups. The equipment is all mounted in a modified rack, which includes the TV set, in a slight offset in the living room from which the cover photo was taken. Thus the control panel, shown here, permits proper adjustment of level and tone from a position where the average listener is likely to sit. The speakers shown on the cover are to the left and some 15 feet back of the rack position.

Control rack in Mr. Doty's living room, which was planned as an ideal listening center in his Poughkeepsie, N. Y., home.

One of Mr. Doty's most interesting audio activities was undoubtedly unique in concept and execution. On the afternoon of February 26, 1956, he presented a recorded stereo concert to an audience of about 500 people in the Poughkeepsie High School auditorium. The concert raised some $1500 and made it possible for the Dutchess County Philharmonic orchestra to "stay in business," and it still is. The program included excerpts from Saint-Saens A Minor Cello Concerto, Mozart's Eine Kleine Nachtmusic, excerpts from the Vassar Glee Club program at Skinner Recital Hall of December 3, 1955, and Brahms' Violin Concerto in D, Op. 77. In still another respect, Mr. Doty was way ahead of his time—he added a third speaker in the middle between the two end speakers, which were about 30 feet apart, in order to fill in the "hole in the middle." The middle channel was a combination of the two stereo channels and was played about 3 db higher in level than the end speakers. We have heard of other concerts where both live and recorded music was played to raise money, but this is the first one encountered where the musicians could sit in the audience and have the satisfaction of listening to recorded music saving their jobs.

With this strong interest in music and in the mechanics of its reproduction, Mr. Doty combines a high degree of craftsmanship and a generous personality which results in giving considerable time, advice, and actual physical help to others who are planning and installing their own systems. AUDIO is proud to number Mr. Doty as one of the select circle of Audiomen. Æ

Q: What's the only way to eliminate rumble?

A: Get rid of the motor and moving parts!

For those intent on elimination of turntable rumble, we offer the solution shown. For those who are still unwilling to take this simple (but drastic) step, we would like to address a few points.

All record players have *some* rumble. A well-engineered turntable will have so little rumble that it ceases to be a problem.

This rumble obsession has led to the use in some turntables of a lightweight motor which is primarily designed for constant load applications such as in clocks and timers. In turntable operation, however, a motor encounters constantly varying loads due to recording differences and modulations, changing tonearm position and variations in friction resulting from rotation and wear. When a lightweight motor is used in a turntable, performance and durability are sacrificed to eliminate a meaningless proportion of rumble—a truly false economy!

In the superb line of Rek-O-Kut STEREOTABLES, the hysteresis synchronous motor is precision-made and capacitor-operated to assure smoother multi-phase rotation for years of dependable performance. The motors are isolated from the turntable and deck. Drive mechanisms and other moving parts are machined to extremely close tolerances. Rek-O-Kut STEREOTABLES were used exclusively in the design and development of the 45/45 playback stereo cartridge, because *vertical rumble*, another serious factor in *stereo playback*, is at an absolute minimum in the Rek-O-Kut line of hysteresis STEREOTABLES. *All* these engineering features contribute to the exclusively accurate, silent operation of a STEREOTABLE.

Look to Rek-O-Kut for the utmost quality and dependability in turntable design. Newest models, L-34H and L-37H provide two speeds (33⅓-45 and 33⅓-78) and are powered by rugged hysteresis motors. Only $79.95. Eight other models are available for your individual needs... prices from $39.95. And, with your Rek-O-Kut StereoTable, be sure to specify the Rek-O-Kut Tonearm for the ultimate in precision-tracking. From $27.95. Write for a free brochure on the entire Rek-O-Kut line.

Looking for a new speaker system? See the incomparable Audax Paraflex—now at your dealer!

REK-O-KUT STEREOTABLES

Model L-34 illustrated

REK-O-KUT COMPANY, INC., 38-19 108th St., Corona 68, N. Y. Export: Morhan Exporting Corp., 458 Broadway, N. Y. 13. Canada: Atlas Radio Corp., 50 Wingold Ave., Toronto 19

RK-81

AUDIO ETC.

Edward Tatnall Canby

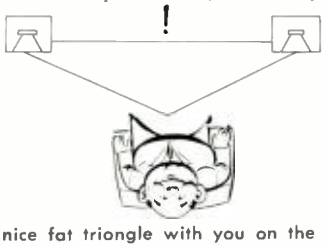
1. STEREO MYOPIA

BY TURNS I become resigned to, then peeved all over again at the short-sighted abuses of the stereo principle that are now prevalent in home phonograph products currently selling all over the place. Sometimes I wonder whether more than a relative handful of good Americans have any idea at all what stereo is, or sounds like. How *could* they, given these machines?

No—I'm not fuming about the calibre of the insides, from turntable and cartridge through to loudspeaker and enclosure (if any). That, in all its low- and high-priced munificence, is about the same as ever, allowing for a slow rise in costs and, maybe, a very slow but steady upping of relative sound values. (Yes, the sound is really better now than, say, ten years ago, or even five, level for level, price for price, and speaking in general terms.) There's no news story in this. What gets me down is the simplest aspect of all, stereo-channel separation. Oh no—not electrical separation, as of the cartridge. I mean straight separation of the two speakers or speaker systems, in space. Now you see it, now you don't, and that's something new, all right.

It does look as though stereo were a success now. Everybody sells machines to play it, everybody blows it up in glowing terms, and at least in theory, everybody is quite right. Stereo *is* good. It is definitely a worthwhile improvement, and on every plane of listening you can think of. It definitely is a bargain, considering its present cost and the extensive doubling-up of facilities that it requires. We should all be slapping each other's back and, in the ads anyhow, everybody is. Agreement, even if it is mostly expressed in those usual slick and meaningless phrases that greet every new audio development—the Ultimate in Tonal Realism, brings the Concert Hall right into your Living Room, a Thrill for the Entire Family (fam-ill-ee, it's pronounced by the admen) etcetc. OK, so we all agree.

Yet amid this monotonous flood of superlatives, we are seeing a strange growth, in the actual playing mechanisms, of true stereo and false stereo side by side under the very same publicity banners, in the selfsame lines and under the same brand names. It's a process that, shall I say, is screwily democratic—for the fact is that some of the cheapest and tinniest stereo offerings in some lines of these machines actually provide more true stereo potentiality than the cluttered behemoths of fancy furniture that fill up the higher sales levels in the very same lines.



A nice fat triangle with you on the fat side.

Fat Triangle

It's so simple. Stereo, the stereo effect, depends first of all and beyond all else on *separation*—physical, real, spatial channel separation in relation to the listener. Stereo, as we all should know by now, is a fat triangle. The listener makes one point on that triangle, the apparent source (I say that advisedly) of each of the two basic channels make the other two points. Granted that there are complications, that room acoustics, reflections, can aid or destroy or blur this triangle, that some systems are set up to make use of virtual images or reflected images. Even so—with all our ingenuity, we have not yet detached ourselves from the valid and basic stereo concept that is still the most useful approach to stereo listening. Speaker to the right, speaker to the left, listener in the middle, out front.

Some stereo phonographs provide for adequate separation, variably or inflexibly; others do not. And these last, judging by the goods now on display everywhere, are in the big majority. These handsome phonograph cabinets, you see, offer the greatest attraction imaginable—on paper and in the ads—they let you have your cake and eat it too. "One-cabinet stereo"! That's what some of them call it. Now you can have stereo in all its wonderful something-or-other without the inconvenience of those annoying two speaker boxes.

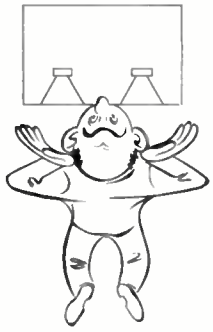
You can't always tell from the pictures, and my exploration of the department store and appliance outlets isn't at this point complete, but it's pretty clear that in many stereo phonographs the two separate channels are reproduced separately at a distance of from *a few inches* to several feet. Wow! What superb stereo *that* gives! Real close-up.

Scrowny triangle with you at the sharp point.

As I remarked once before, as far back as January, 1959, you can get an excellent and true stereo effect out of such a machine by resting your nose carefully on the bottom edge of the cabinet and opening both your ears wide. I mean it. I've tried it. It works.

Or you can achieve the proper spatial triangle by emulating the stereo ads, à la Japanese, squatting yourself on the floor about two feet in front of the cabinet, your tiny little feet crossed neatly beneath you, the torso in upright stance, the ears alert. . . . But if you are so utterly lazy as to move off and heave yourself into a sofa across the living room, you'll provide what might be called an infinitely acute triangle, so thin it borders upon a straight line with no width at all. That, my friends, has a name—it's called mono.

How many people who have bought stereo, or auditioned stereo, have in fact *heard* stereo? I honestly wonder. They say what you don't know won't hurt you. The modern parallel is that what you haven't heard you'll never want, and what you think you've heard you'll think you enjoy. People by the tens of thousands are now "enjoying" stereo on these happy terms.



. . . Resting your nose corefully on the bottom edge of the cabinet.

Zooming Curve

If you will look carefully at a few groups of our present stereo phonograph offerings I think you will find that a sort of stereo curve does exist, the curve of stereo potentiality. It has nothing to do with hi-fi and sound quality, which I maintain is almost completely beside the point here. Just separation.

(Sure, sound quality counts exactly as it has in the past. Yes, top hi-fi sound does perhaps convey somewhat more stereo message than low-fi sound, frequency-limited and full of distortion. But compared with the supreme importance—to stereo—of true spatial separation, not of vital account, though highly desirable. You will get far more stereo effect from two fifty-cent speakers six feet apart than from two hundred-dollar speaker systems two feet apart, and that is that.)

This curve that I mention is a funny one. At the very bottom of the price scale, the curve is high. Lots of stereo. In the middle, where we get to the fancy middle priced cabinetry from $100 up to perhaps $300 or so, the curve zooms down, down, almost to the rocky bottom of sheer monostyle stereo listening. Then, strangely, the curve at last starts upwards and at a thousand dollars or more you'll find some pretty

true stereo, worthy of professional attention.

It works this way. The cheapest stereo phonographs, most of them, are of several types that virtually require at least one speaker to be detachable. Space limitations. Often, both are detachable, or at least can swing out and away from the body of the machine. In a large number of these attractive beach-portable, collegiate-type phonographs it is indeed possible to place the two stereo sound-sources at any convenient and workable distance. That does it. (Also, you tend to sit closer to them.)

But—in the very same lines—when you raise your sights to higher prices you begin to run into cabinetry. And right there you smash straight into the critical area where the maker's conscience really must battle with sales appeal. Ouch—how it must hurt! A beautiful early-American or French Provincial cabinet and the designer is supposed to build *separation* into it! How? Aesthetically impossible—and who wants a second beautiful early-American cabinet, just as big? (Who wants a pint-size early-American half-cabinet, either, to house that second speaker in less space and at less cost?) There's your fine furniture product just crying for two neatly placed speakers at symmetrical points of vision, say two feet apart, and that's where you'll likely find them.

How hideous, to destroy the early-American or French Provincial style by forcing the speaker placements further apart! Yet many makers' consciences have gone that far; there are phonographs by the dozen with an ugly blank area in the middle and two grill-cloth or plastic-covered speaker vents at the far sides of the cabinet. Ugly as sin, but you do get maybe another foot of width out of your cabinetry. Three feet. The curve moves upwards a tiny bit. You can get real stereo out of these machines if you move your living room chair close. Blow smoke right into the stereo singers' mouths.

Then, you see, we proceed on upwards into the fancier ranges. "Fancier" means, of course, more gadgetry and (variably) better innards. But even more important, it means *bigger*.

Don't think I'm optimistic enough to think that the more expensive machines are bigger specifically in order to provide wider stereo separation. They are bigger for a more compelling reason—to look more impressive.

But it so happens that in this respect you can actually have your cake and eat it. The whopping, wall-filling stereo monsters, complete with built-in bar and TV, do in plain fact offer potentially excellent stereo (quite aside from their insides) merely by being big—i.e., wide. Their separation is adequate for most living rooms, though portability, flexibility of the speaker placement, is something else again. These big sets often give you six feet of separation, which is just about enough—barely.

There's only one flaw in this last rising section of the curve. It would rise higher if the size of living rooms didn't tend to increase right along with the size of the machines. A seven-foot stereo-bar-TV is as likely as not to land against one wall of a palatial fifty-foot living room, with couching facilities off thirty feet or so! Not much of a listening triangle there.

Now I will admit that a number of home machine makers have really tried to do something about the problem of speaker separation. Of course for most of us the only solution is also the most elementary and the simplest—components, plus *two*

(*Continued on page 48*)

EDITOR'S REVIEW

THREE-CHANNEL STEREO

MISLEADING ADVERTISING—to use a generous term—of "three-channel" stereo has crept into the papers these last few months, and finally the National Better Business Bureau has made an endeavor to secure agreement among phono manufacturers to discontinue the practice. Reports indicate that some of the manufacturers consider the "three-channel" gimmick to give them some edge over others in the same field, and these seem to be reluctant to conform to the NBBB's suggestions.

The misnomer has shown up in two separate forms, both wrong. No one who is technically familiar with stereo tapes and discs is going to be fooled for a minute, but then when one becomes familiar with the audio art he is not likely to become a customer of the products which are being described inaccurately anyhow. Three-channel tape is regularly used for master recordings—with both Ampex and Sony offering three-channel half-inch tape machines for that purpose; not priced for home use, however—but it is rare that such a tape is ever used outside the recording studio. To the best of our knowledge, no one has yet figured out a practical way of making a three-channel disc, although it should be theoretically possible to record three or four channels by a combination of the 45/45 groove geometry with the high-frequency carrier system developed by Jerry Minter. Obviously it would also be possible to broadcast three channels, with one on AM, one on FM, and one on either FM multiplex or TV. If four channels are necessary we could use all of them, and with the upcoming two-channel (for stereo) AM system it would be possible to have five or six altogether, depending on how many multiplex channels were to be employed.

However, none of these methods has yet been used for more-than-two-channel broadcasts, we believe—at least not commercially. And besides, we fail to see why three channels are needed, if we use the word *channel* in the stricter technical sense. The advertising in question has referred to two separate types of loudspeaker operation, and has degenerated into the three-channel designation for lack of a better name. All AUDIO readers are familiar with both of the loudspeaker arrangements described as "three-channel"—one simply mixes part of the signal from each normal channel and feeds the combination into a center loudspeaker, while the other employs a single woofer which is fed with the low frequencies from both channels, using two separate tweeters for the individual high-frequency outputs from the right and left channels.

The basic problem seems to be attributable to a lack of precise usage of the English language—in other words, what do you call the so-called "three channel" system? In this day of three, four, or even five separate loudspeakers in even the lower priced console phonographs for each channel of production, the simple term "three speaker" is not correct, either, even though we took that easy way out in Mr. Canby's AUDIO ETC. for this month. His original manuscript employed the term "three-channel" throughout whereas he actually meant three loudspeakers although each loudspeaker might be composed of two or more separate loudspeaker mechanisms. To avoid the incorrect use of "three-channel," we changed all of his nomenclature except the first few, which we put in quotes.

We feel that the term "three-channel" when applied to sets using three loudspeakers or three loudspeaker systems in whatever form is, to say the least, misleading; we hope that the manufacturers who use the term are themselves mislead and that they are not intentionally attempting to deceive the public. Fortunately, stereo gave manufacturers a new word to publicize, and now those who make what is legitimately called high fidelity can again put the stress where it belongs—on high fidelity. Sufficient proof of the misconception in the public mind is the fact that a customer will come in and say, "I don't want high fidelity, I want stereo." He *can* have both, of course, but he doesn't always get it.

MODEST ADVERTISING

One good sign we noticed last month portends a return to honesty in advertising, anyhow. In a New York newspaper we ran across an ad which offered a portable phonograph which wasn't called "high-fidelity" nor even "hi-fi." Of course, it sold for $9.77, which may be the reason. It seems there is an unwritten law about these things. You can't call it "hi-fi" unless the price is $9.95 or higher.

MORE!

FOR THE DIFFERENCE

Royal System Wall Cabinets designed by Poul Cadovius.

Here is more for the best of everything in quality record reproduction—the more that makes the difference! **more output!...more channel separation!... more response...more record life!** In short—more to enjoy because there's more quality for more listening pleasure. Without question, Pickering's Collectors' Series 380 is the finest—with more features and more flexibility than any other stereo pickup in the world.

COLLECTORS' SERIES 380. Totally new and unique to high fidelity is the "Collectors' Ensemble"...a complete quality "pick-up-package" for reproduction of all records—stereo, micro-groove, 78's.

OUTPUT: 15 mv per channel. CHANNEL SEPARATON: 30-35 db. FREQUENCY RESPONSE: + 2 db 20-20,000 cycles. SIGNAL TO NOISE RATIO: —65 db below reference. TRACKING FORCE: "A" type stylus—2-5 grams; "C" type stylus—3-7 grams.

Model 380E Collectors' Ensemble includes the Stanton Stereo FLUXVALVE with 3 "V-GUARD" styli for stereo, microgroove and 78 rpm records. $60.00
Model 380A includes Stanton Stereo FLUXVALVE with D3807A "V-GUARD" stylus for transcription arms. $34.50
Model 380C includes Stanton Stereo FLUXVALVE with D3807C "V-GUARD" stylus for auto-changer arms. $29.85

Only the Stanton Stereo FLUXVALVE features the safe, comfortable, easily replaceable stylus assembly.

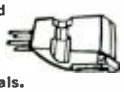
***PICKERING—for more than a decade—the world's most experienced manufacturer of high fidelity pickups...supplier to the recording industry.**

†PICKERING AUTOMATED CRAFTSMANSHIP

FLUXVALVE, "V-GUARD" "T-GUARD" UNIPOISE PAC (TM)

For example, the 380 is fully encapsulated in radiation-proof precious mu-metal for absolutely hum-free performance in any record player regardless of type—make—model. The only true way to judge a high fidelity component is to compare it with another... measure its performance with the most vital instrument of all...the ear. For—those who can hear the difference choose PICKERING*.

PRO-STANDARD SERIES 371. Now, the new and revolutionary PAC† technique developed by PICKERING has effected economies in manufacture which permit a reduction in the price of the Pro-Standard Series...an industry standard and the universal choice of professionals. Features four coil push-pull hum rejection circuit.



OUTPUT: 10 mv per channel. CHANNEL SEPARATION: 20-25 db. FREQUENCY RESPONSE: 20-15,000 cycles. TRACKING FORCE: "A" type stylus—2-5 grams; "C" type stylus—4-7 grams.

Model 371A Mk II Stanton Stereo FLUXVALVE Pickup now $26.40
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Pickering

PICKERING & CO., INC., PLAINVIEW, NEW YORK

SHIP WITHOUT AN OCEAN

How do you lay a cable on the ocean floor—a cable that is connected to scores of large, heavy amplifiers? How do you "overboard" such a system in a continuous operation, without once halting the cable ship?

Bell Telephone Laboratories engineers must answer these questions in order to lay a new deep-sea telephone system designed to carry many more simultaneous conversations. They're experimenting on dry land because it is easier and more economical than on a ship. Ideas that couldn't even be attempted at sea are safely tested and evaluated.

In one experiment, they use a mock-up of the storage tank area of a cable ship (above). Here, they learn how amplifiers (see photo right), too rigid and heavy to be stored with the cable coils *below* decks, must be positioned *on* deck for trouble-free handling and overboarding.

Elsewhere in the Laboratories, engineers learn how best to grip the cable and control its speed, what happens as the cable with its amplifiers falls through the sea, and how fast it must be payed out to snugly fit the ocean floor. Oceanographic studies reveal the hills and valleys which will be encountered. Studies with naval architects show how the findings can be best put to work in actual cable ships.

This work is typical of the research and development effort that goes on at Bell Laboratories to bring you more and better communications services.

Experimental amplifier about to be "launched" from "cable ship." Like a giant string of beads, amplifiers and connecting cable must be overboarded without stopping the ship.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

Universal Feedback Amplifier Circuit

ARNOLD J. KAUDER*

A simple amplifier of exceptional performance which should be adequate for practically any installation is the basis for this article, but its greatest value lies in the "universal" instructions for adjusting any feedback amplifier.

THE AMPLIFIER to be described has performed well with five different output transformers, which has led the writer to use the designation "universal." The amplifier has in each case been found completely stable with (a) no load, (b) 8-ohm resistive load, (c) 8 ohm loudspeaker load, and (d) a 0.1 μf capacitor load added to any of the load conditions of (a), (b), or (c) above. The feedback factor employed has been 20 db ±1 db.

Few of the "Williamson Type" and other amplifiers seen by the author have been capable of meeting such a stability test. Breathing of the loudspeaker cone, due to very-low-frequency oscillations, and supersonic oscillations readily seen on an oscilloscope are all too common. Either type of oscillation can produce negative charges on the grid sides of the output-tube coupling capacitors, with distortion and limited power output resulting. Marginally stable amplifiers have also been observed which do not normally oscillate, but are highly regenerative at extreme frequencies and do oscillate when audio signals with steep leading edges on the waveforms are fed to the input terminals.

A brief history of the development of the circuit is believed to be of interest and is as follows:

Development

The author was a "high fidelity" fan many years ago and is still not ashamed of the performance of a class-A push-pull 2A3 triode amplifier (power output of 7 watts) still on hand. After a lapse of 10 years, a reviewed interest in high fidelity led to a study of feedback and the present day amplifiers which have achieved recognition in the literature. The writer found to his annoyonce that it was not possible to duplicate a published amplifier circuit and employ a different output transformer and a more compact layout—unless extensive redesign of the coupling and feedback circuits was carried out.

The author then made an analysis of the problems in the design of feedback amplifiers and established the following principles for his own amplifier.

1. It should have as few stages as possible to achieve the required gain. Extra stages contribute phase shifts at low and high frequencies which reduce the inherent stability of the amplifier.

2. The simplest possible circuitry should be employed. Additional components which are not necessary simply add to the cost, complication, and potential for failure.

3. The output stage should be biased for Class A operation. It is not generally realized that plate current cutoff in a power output tube biased to AB operation can cause ringing and oscillation, as well as other forms of distortion due to the steep wavefronts in the output-transformer current waveform.

4. Multiple feedback paths should be employed, rather than a single path from output to the input, to achieve maximum stability.

5. Although the author is of the school which believes that a power output of 6 watts is adequate for the home, a power output between 15 and 20 watts should be employed to assure near-perfect linearity at the normal maximum 5-watt home listening level and to allow a reserve margin of power to compensate for tube aging, inefficient or mismatched speakers and other variables.

Circuitry

The schematic of the resulting amplifier is shown in *Fig.* 1, and its power supply in *Fig.* 2. It consists of a pentode voltage amplifier directly coupled to a split-load triode phase splitter, which is resistance coupled to the push-pull output pentodes. Actually, the amplifier may be thought of as the simplest two-stage pentode resistance-coupled type, with the phase splitter added to convert the design to push-pull operation. This simple straightforward design is neither startlingly new or even original, but fulfills admirably the requirement of the least possible number of stages and coupling networks. This is the initial key to stability in a feedback amplifier. The final key to the high level of stability lies in the three feedback paths, which will be discussed in a later paragraph.

To satisfy the Class A and power design requirements, the output tubes had

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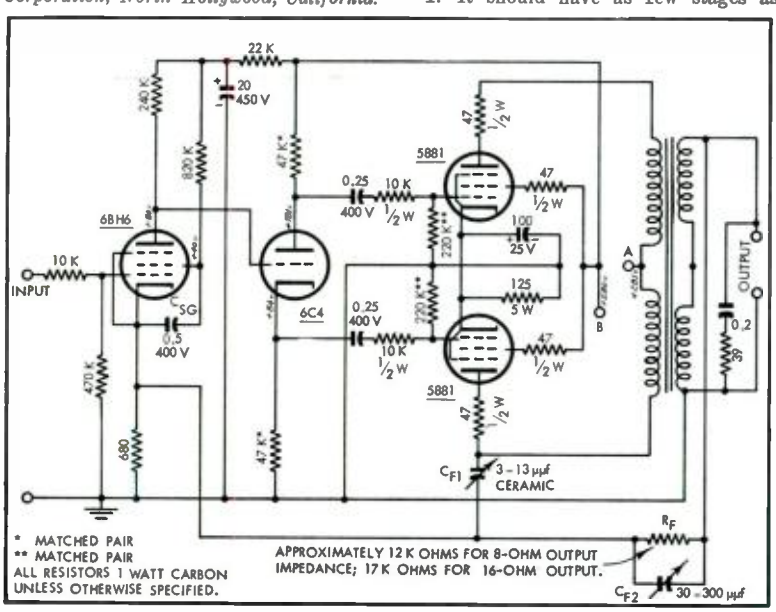


Fig. 1. Schematic of the author's "Universal" feedback amplifier.

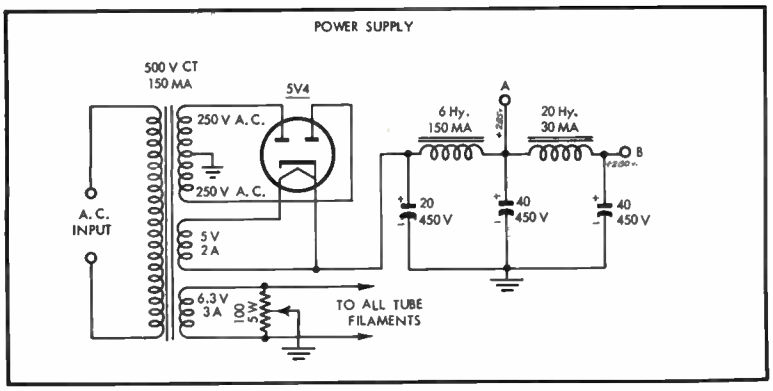


Fig. 2. Power supply for the "Universal" amplifier.

to be beam power tubes of the 6L6 type, with improved construction as exemplified in the type 5881 and 6L6GB. No available triodes are capable of providing either the high gain, or the power output in *Class A* operation which beam power tubes provide—and provide with modest power-supply and driver-stage requirements. Stabilizing resistors of suitable values are employed in the grid, screen grid, and plate circuits. The tubes are self-biased, since fixed bias does not appear to offer any advantage with beam-power tubes, while self bias permits the use of higher impedance in the grid circuits, with less loading of the driver stage.

The push-pull output stage is driven by a split-load or cathodyne phase splitter employing a type 6C4 miniature triode. After considerable study of phase splitters, this type is considered by the writer to be superior to all others, including the cathode-coupled inverter—actually the only other type deemed worthy of consideration. There has been much talk about unbalance of the cathodyne phase inverter at high frequencies, but after reference to the available literature, the author considers this to be much talk not based on adequate investigation.

Actually, the equivalent source impedance of either output channel is[1]

$$R_o = \frac{r_p R_L}{r_p + R_L (\mu + 2)} \qquad (1)$$

Substituting a value of 56,000 ohms for R_L, 10,000 ohms for r_p and 19.5 for μ as applicable for the 6C4 tube employed in this amplifier,

$$R_o = \frac{10{,}000 \times 56{,}000}{10{,}000 + 56{,}000\ (19.5 + 2)} = 460 \text{ ohms approximately.}$$

The output capacitances C_o for each channel are, respectively[1]
Plate Channel

$$C_o = 2C_{pk} + C_{gp}\left(1 + \frac{1}{A}\right) \qquad (2)$$

Cathode Channel

$$C_o = 2C_{pk} + C_{gk}\left(\frac{1}{A} - 1\right) + C_{hk} \qquad (3)$$

where A = the channel gain of approximately 0.9
and C_{pk} = plate-to-cathode tube capacitance
C_{gp} = grid-to-plate tube capacitance
C_{gk} = grid-to-cathode tube capacitance
C_{hk} = heater-to-cathode tube capacitance
For a 6C4 triode

$C_{pk} = 1.3$ µµf
$C_{gp} = 1.6$ µµf
$C_{gk} = 1.8$ µµf
$C_{hk} = 2.5$ µµf

Substituting these values in Eqs. (2) and (3):
Plate channel

$$C_o = 2(1.3) + 1.6\left(1 + \frac{1}{0.9}\right) = 5.96 \text{ µµf}$$

Cathode channel

$$C_o = 2(1.3) + 1.8\left(\frac{1}{0.9} - 1\right) + 2.5 + 5.28 \text{ µµf}$$

If these output capacitances are added to values of 10 µµf for wiring and 10 µµf for the input capacitance of the power output tubes, the total shunting capacitance of the two channels are 25.96 µµf and 25.28 µµf respectively, a difference of 0.68 µµf or approximately 1.5 per cent. Referring back to Eq. (1), the value of 460 ohms equivalent source impedance R_o with a shunting capacitance of 30 µµf will result in an output within 3 db of mid-frequency output beyond 10 mc, well outside the range of any audio amplifier this citizen ever wishes to possess. Any unbalance within the range up to a few hundred kilocycles is considered negligible.

As employed, the cathodyne splitter contributes little phase shift, is virtually free of distortion itself, is easily balanced with two matched load resistors and readily meets the driving requirements of 30 volts peak-to-peak output for the two power output tubes. The phase splitter is direct coupled to the input amplifier tube, a high transconductance type 6BH6 miniature pentode. The design of the first stage is conventional. However, the screen grid potential is chosen to permit operation with a relatively low value of bias resistor in the tube cathode circuit, to reduce the impedance of the main feedback network.

While it is believed that other triode and pentode tubes of similar characteristics may be employed in the first two stages, the 6B116 and 6C4 were chosen because they have low heater currents (150 ma), which have been found to minimize hum problems.

Reasons for Stability

The high degree of stability in this amplifier is achieved by means of three negative feedback paths of the simplest type as described below:

(*a*) The first stage has an unbypassed cathode resistor, which constitutes the first path providing negative feedback.

(*b*) A small adjustable capacitor C_{f_1} (3–12 µµf) connected between the plate of one output tube and the cathode of the input amplifier tube, provides the second negative feedback path. This path provides considerable feedback at the supersonic frequencies, eliminating the peak found in this region as the feedback factor is increased.

(*c*) The third feedback path is provided by a voltage divider connected across the output transformer, consisting of the feedback resistor R_f and the 680-ohm unbypassed cathode resistor of the input pentode amplifier tube.

An adjustable capacitor C_{f_2} (30–300 µµf) is connected across the feedback resistor to provide control of the feedback factor at the higher frequencies below the peak leveled by C_{f_1} discussed above.

Adjustment Procedure

The following procedure should be employed to adjust the feedback networks for stable operation of the Universal Amplifier.

1. With C_{f_1}, C_{f_2} and the main feedback resistor R_f, disconnected, run a response curve on the amplifier with a 4-, 8-, or 16-ohm resistor connected to the proper amplifier-output terminals. Depending on the quality of the output transformer, the response should be level within about 3 db (30 per cent approximately) of the midrange response (400 to 1000 cps) to about 10,000 cps or higher. Any reasonable audio oscillator covering from 20 to 100,000 cps is suitable.

2. Connect a 25,000-ohm variable resistor to maximum resistance as R_f and note whether the amplifier gain decreases. If it increases, reverse the out-

[1] "Radiotron Designer's Handbook." Edited by H. Langford-Smith, Fourth Edition, p. 330.

Fig. 3. Top view of the amplifier described.

put tube plate connections to the output transformer, or reverse the connections to the secondary winding of the output transformer.

3. Decrease the value of Rf slowly and look for a peak in the response of the amplifier in the high frequency ranges (usually found at about 40,000 eps or higher).

4. Connect Cf_1 and adjust as required to eliminate the high-frequency peak discussed above.

5. Continue to decrease Rf and readjust Cf_1 as required until the amplifier gain is reduced to one tenth of the value without feedback. This is a feedback factor of 20 db. With all but the highest quality output transformers a second response peak, in the frequency range somewhere between 17 and 30 kc will usually become evident. This peak will be considerably broader than the first response peak.

6. Connect Cf_2 and adjust as required to level the second peak.

7. Check the amplifier frequency response again and make slight readjustments of Cf_1 and Cf_2 as required to level any rises in the response curve. Connect the loudspeaker in place of the load resistor and repeat this step.

8. The amplifier may now be given the acid test of connecting capacitors across the output terminals. If the amplifier is not stable with at least a 0.02 μf capacitor across the output terminals further adjustments of Cf_1 and Cf_2 should be made as necessary. Rf and Cf_2 should now be measured and replaced with fixed value components.

If a peak in the low-frequency response of the amplifier becomes evident during the feedback adjustments, the value of the screen-to-cathode bypass capacitor C_{sg} of the input pentode amplifier may be reduced (in one case from 0.5 μf to 0.05 μf) to level the low-frequency response.

Feedback factors as high as 40 db (a reduction of 100:1 in gain) have been achieved with high-quality transformers. However, the amplifier then requires a 10-volt rms input signal for 15 watts output, whereas approximately one volt is sufficient for full output with 20 db of feedback. No difference in listening performance has been discernible with increase of the feedback factor beyond 20 db.

If any perfectionist (more power to such) does not accept the balance of the cathodyne phase splitter as being adequate, he may achieve theoretically perfect balance by adding a small adjustable capacitor across the cathode load resistor and check for perfect balance in the megacycle region. However, no test instruments should be connected to the cathodyne inverter itself, or the inherent added capacitance will invalidate the test results. The balance measurements must be made at the plate terminals of subsequent stages.

The author has tried the "ultra-linear" connection of the output tubes but has observed no advantage in performance to compensate for the reduction in gain. Those who prefer this method of output tube operation may change the bias resistor to a value approximating that for triode operation of the output tubes and follow otherwise the procedure outlined in this article.

This amplifier has been termed "Universal" since it is believed capable of

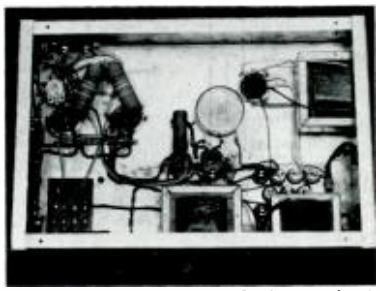


Fig. 4. Bottom view of the author's amplifier.

producing the optimum performance which is obtainable from any output transformer of suitable impedance ratios. There is no reason to believe that larger and smaller power tubes than the type 5881 cannot be used with equal success. However, the author takes a dim view of any type of operation of the output tubes except class A unless the output transformer is a top-grade unit and the screen grids of the output tubes are fed from a regulated power supply.

Additional Suggestions

The following notes are offered to prospective builders of the Universal Amplifier.

Note 1: The network across the transformer output terminals is intended to provide increased stability at high frequencies with no load. It is not needed with the best output transformers.

Note 2: It is recommended that all grounded leads be made to a common buss bar, which is isolated from the chassis except at the ground terminal of the input connector.

Note 3: No bias balancing control for the output tubes has been employed, since the 6L6GB and 5881 tubes seem to be quite uniform.

Note 4: The center tap of the 100-ohm balance potentiometer connected across the heater winding is grounded, since this connection makes hum inaudible with the ear at one foot from the loudspeaker. With different tubes or a different layout, it may be advisable to return the potentiometer center tap to a positive potential, which may be provided by a resistive voltage divider at the output of the power supply. Positive potentials up to about 55 volts may be investigated for minimum hum.

Note 5: The author's speaker system calls for an 8-ohm output impedance and this was provided on each output transformer used. Values of 16 or 4 ohms will require a different value of feedback resistor Rf. The primary impedance should be between 5000 and 7000 ohms for type 5881 and similar tubes.

Distortion and intermodulation measurements have been made, but will not be presented in this article. Suffice that the amplifier is essentially distortionless up to the overload point of the output tubes or transformer, whichever is reached first. The frequency response is flat from the low-frequency limit of the output transformer to somewhat higher than the resonant frequency of the output transformer, beyond which the response falls smoothly at a rate of 6 to 10 db per octave. The resonant frequencies of the transformers used have ranged from approximately 38 to 100 kc.

Figures 3 and 4 are top and bottom views of one version of the Universal Amplifier which provides plate and filament power for a large AM-FM radio phonograph console, and therefore uses two 5V4G rectifier tubes.

Figures 5 and 6 are views of a second version of the Universal Amplifier using silicon rectifiers in the power supply. Masking tape used to protect the paint finish of the transformers during construction is shown in *Fig.* 5 as a useful suggestion. Æ

Fig. 5. Another embodiment of the "Universal" amplifier—this one uses silicon rectifiers in the power supply section.

FROM THE ARCHIVES OF BELL TELEPHONE LABORATORIES

What's a Good Loudspeaker?*

Engineers have been concerned with loudspeaker response measurements for many years, as will be seen from this article which is over thirty years old. However, the principles of measurements remain the same today.

L. G. BOSTWICK**

WHAT CONSTITUTES a good loudspeaker? To answer this question there is needed a more precise method of ascertaining the capabilities of a loudspeaker than is provided through a mere listening test. While the ear is, of course, the final judge of the merits of a loudspeaker, it is quite unsatisfactory as a means of analysis. One loudspeaker may sound better or worse than another with which it is directly compared, but to describe or specify in a definite manner the peculiar characteristics which distinguish one from the other is usually exremely difficult unless the two are widely different. Furthermore, a direct comparison between two devices is necessary, and the magnitude of the difference is always a matter of opinion in comparisons of this sort.

On the other hand, acoustic measurements on loudspeakers are complicated by a wide variety of acoustic factors which must be properly considered in order that such measurements be indicative of the capabilities of these loudspeakers. Such factors as peculiarities in the distribution of the sound energy by the loudspeaker, and sound reflection, absorption and interference effects due to the measuring room enclosure, may cause large variations in the results obtained. When these factors are not taken into consideration, acoustic measurements may give entirely misleading information. The measurements and discussion which follow illustrate the magnitude and character of some of the more important acoustic considerations involved in determining what constitutes a good loudspeaker.

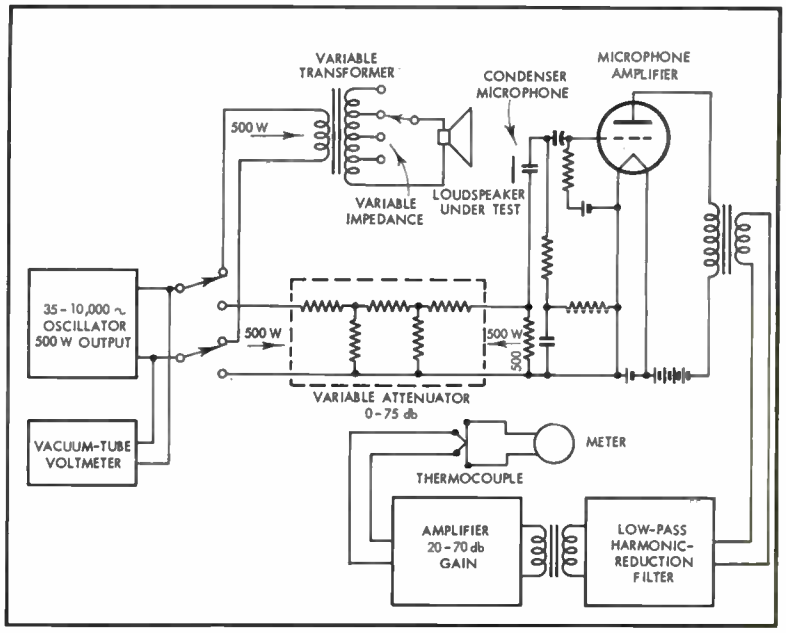


Fig. 1. Schematic circuit of loudspeaker response measuring system.

Methods of Measurement

The system used in making these measurements is shown diagrammatically in *Fig.* 1. The available power output of the oscillator is kept constant at all frequencies by means of a vacuum-tube voltmeter. With the oscillator connected to a loudspeaker, through the transformer, the gain of the amplifier associated with the thermocouple is adjusted at different frequencies until a mid-scale deflection of the meter is obtained as a result of the voltage generated by the condenser microphone. After each adjustment, the oscillator is switched

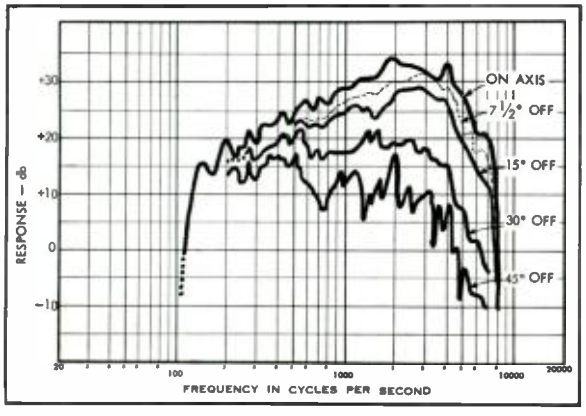


Fig. 2. Response-frequency characteristics of 115-cps cutoff exponential horn with moving-coil receiver. Measured outdoors 12 feet from horn mouth at specified angles to horn axis.

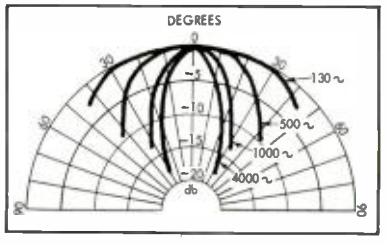
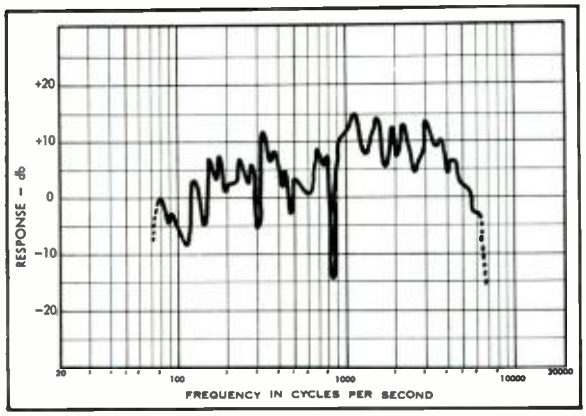


Fig. 3. Polar curves from data of Fig. 2.

* Reprinted by permission from *Bell Laboratories Record*, May, 1929.

** *Research Department, Bell Telephone Laboratories.*



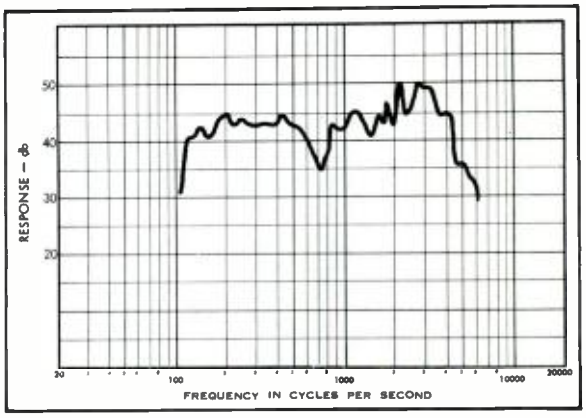


Fig. 4 (left). Response-frequency characteristic of 115-cps cutoff exponential horn. Measured outdoors on horn axis two inches from mouth. Fig. 5 (right). Response-frequency characteristic of 3½-inch piston-diaphragm loudspeaker. Measured 12 feet from diaphragm, in highly absorbing room.

from the loudspeaker to the input terminals of the attenuator, and the attenuator is adjusted to give the same meter deflection. Variations in the attenuator settings with frequency show the variations in the performance of the loudspeaker in decibels.[1]

Performance curves obtained for the same loudspeaker by such a procedure may differ widely, due primarily to three causes. These are: variations with frequency in the energy distribution of the sound field of the loudspeaker; wave interference at the condenser-microphone position due to sound reflections from the walls of the measuring room or to a difference in distance from the microphone to different points on the radiating surface; and variations with frequency in the energy-absorbing power of the measuring room.

The magnitude of variations in the sound field distribution can be shown from measurements obtained outdoors in an open field where the effects of any room enclosures are absent. Such measurements appear in *Figs.* 2, 3 and 4, for a 115-cps cut-off exponential horn with a loud-speaking receiver of the moving-coil type. *Figure* 2 shows response curves obtained when the condenser microphone is placed twelve feet from the center of the horn mouth and at different angles from the axis. As the microphone is moved away from the horn axis, the response at the higher frequencies becomes less, while at low frequencies the change is slight. This is because the angle subtended by the sound field becomes smaller the higher the frequency, and the sound energy is increasingly concentrated along the horn axis. Thus a response-frequency characteristic of almost any desired trend may be obtained by suitably locating the condenser microphone. *Figure* 3 is a polar coordinate curve plotted from the data of *Fig.* 2, showing the sound-field angles for four frequencies.

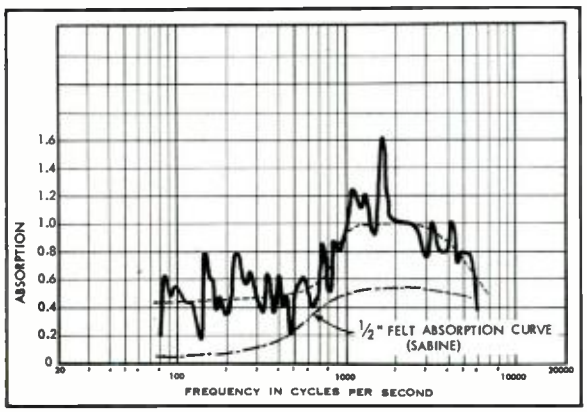
Figure 4 shows a curve obtained for the same loudspeaker, but with the condenser microphone on the axis only two inches from the mouth. This curve is considerably more irregular than the axis curve of *Fig.* 2. These irregularities can be attributed to interference between sounds reaching the condenser microphone from different points of the horn mouth. After a distance of about twelve feet has been reached, the sound paths from these points to the condenser microphone become substantially equal, and therefore, the interference disappears. Thus, the two axial curves in *Figs.* 2 and 4 are quite different.

Standing-Wave Effect

The effect, on the indoor response measurements, of interference or standing waves due to reflections from the walls of the measuring room is illustrated in *Fig.* 5. These measurements are of a loudspeaker with a three-and-one-half-inch diaphragm of the piston type, with the condenser microphone located about twelve feet away on a line perpendicular to the center of the diaphragm. The loudspeaker and microphone were located equally distant from and on opposite sides of the center of

(*Continued on page 68*)

[1] This is now the official name of the transmission unit. See *Bell Laboratories Record*, December, 1928, page 137.



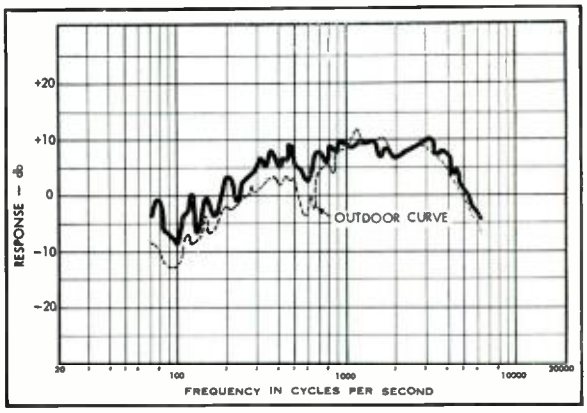


Fig. 6. Response-frequency characteristic of 3½-inch piston-diaphragm loudspeaker. Measured in highly absorbing room and averaged in small region 12 feet from diaphragm.

Fig. 7. Absorption-frequency characteristic of felt-lined room with respect to a region relatively near its center and the sound source. Calculated from data of Fig. 6.

Another Look at Acoustic Suspension

EDGAR M. VILLCHUR*

In order to clarify some apparent misunderstandings about the functioning of the acoustic suspension principle, its originator reiterates some of the basic philosophy and adds some supporting information.

DURING THE PAST YEAR an increasing number of articles about the type of speaker system known as "acoustic suspension" or "air suspension" have appeared, whether or not these terms were actually used.

An article[1] in the March, 1959, issue of this magazine attacks almost every point which the writer has used as a theoretical basis for explaining the acoustic suspension design. At the same time the authors describe another high-compliance-speaker/sealed-enclosure combination whose design they apparently justify on other grounds. Without taking up each point in turn, the writer felt that this would be a good opportunity to review some of the basic principles of the acoustic suspension system, and perhaps prevent some misconceptions from getting started.

* *Acoustic Research, Inc., 24 Thorndike St., Cambridge 41, Mass.*

[1]Robert C. Avedon, Wayne Kooy, and Jack E. Burchfield, "Design of the wide-range ultra-compact Regal speaker system," AUDIO, March, 1959, pg. 22.

One statement in particular is made in the above-mentioned article which, if true, destroys as invalid the entire basis of the acoustic suspension speaker system. This is the statement that the air in the cabinet of an acoustic suspension system is significantly non-linear.

The first aim of the acoustic suspension design, over and above uniformity of frequency response, compactness, and extension of response into the low-bass range, is to reduce significantly the level of bass distortion that had previously been tolerated in loudspeakers. This is accomplished by substituting an air-spring for a mechanical one. If, as claimed by Messrs. Avedon, Kooy, and Burchfield, the sealed cushion of air in the small cabinet is in actuality less linear than a good mechanical suspension, the writer has been barking up the wrong tree. Replacing a non-linear element—the elastic restoring force of the mechanical suspensions of a speaker—with another element even more non-linear certainly does not put us ahead. Here is the first published theoretical objection to the acoustic suspension system, that the writer is aware of, which is really germaine to the subject and which, if correct, invalidates the whole idea.

Linearity of the Acoustic Suspension System

There are three basic types of speaker mounting for bass reproduction—the horn, the resonant enclosure (bass reflex, acoustical labyrinth, and so on) and the direct-radiator baffle.

Once a baffled direct-radiator system is chosen, it should be clearly understood that bass performance depends exclusively upon cone excursion, assuming a rigid cone. Knowledge of the distance, damping characteristics, and linearity of the motion of a given speaker cone—in short, knowledge of the position of the cone at every instant of time—will enable us to describe bass performance without knowing the size of the cabinet. This is like saying that knowledge of the diameter and r.p.m. of the wheels of a

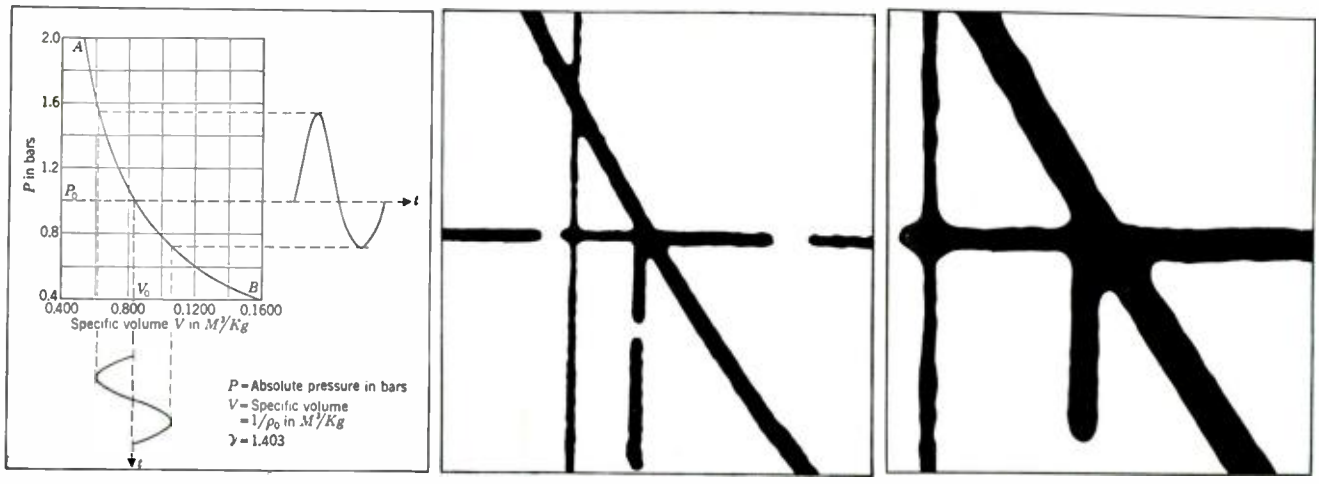


Fig. 1. (A), left. Graph showing non-linearity of air when volume is compressed and expanded by a large amount—in this case approximately ± 25 per cent. (P_o = normal atmospheric pressure.) The curvature of the transfer characteristic produces the wave distortion shown. (B), center. Enlarged center portion of the same graph. Note that the curvature of the transfer characteristic is all but undetectable. (C), right. Further enlargement of the center portion. Although this section of the transfer characteristic (the heavy diagonal line) still represents a volume change of ± 5 per cent, the curvature for such a small change is not apparent. The actual maximum air volume change in an AR-1 speaker cabinet is ± 0.75 per cent, one-sixth of the section shown.
(By permission from "Acoustics," by Beranek. Copyright 1954, McGraw-Hill Book Co. Inc.)

vehicle will enable us to predict road speed, without knowing the horsepower of the engine, the number of cylinders, or other side matters.

Cone amplitude is dependent (assuming that the speaker is capable of sufficient excursion) on the bass resonant frequency of the woofer as mounted; response drops 12 db per octave below the resonant frequency. Linearity, or absence of distortion, depends primarily on the nature of the elastic restraint seen by the cone, and on the homogeneity of magnetic flux over the voice-coil path, the latter normally taken care of by voice-coil overhang.

The current commercial speakers employing the acoustic suspension system —in which the overwhelming part of cone restoring force is due to the air-spring—have resonant frequencies representative of the lowest in the field (the AR-1, for example, has a mounted resonant frequency of 43 cps). There are no published technical arguments, to the writer's knowledge, which could lead anyone to expect any less excursion capability from a speaker in a 2-cubic-foot enclosure, with a given resonant frequency as mounted, than from a speaker in a 15-cubic-foot cabinet, where the two systems exhibit the same final resonant frequency. The speaker cone is obviously not able to sense the difference between mechanical suspension stiffness and air-pillow stiffness, ignoring questions of linearity, when it is deciding how far to move in response to a given applied force.

Until the appearance of the above-mentioned article, there has also been nothing in the literature which would lead one to expect less linearity from a speaker utilizing an air-spring. On the contrary, both theory and practice clearly point to a significant increase in linearity and reduction in bass distortion. Now, however, we have on record an argument that does predict higher rather than lower bass distortion. The argument is stated as follows:

> "It has been contended that the mechanical suspension non-linearity is much greater than the extreme linearity of the air-spring or sealed air volume of the cabinet. This is not true.
>
> ". . . It is extremely difficult to make this process [*air compression and rarefaction at an audio rate*] anything other than adiabatic. The physics text will also show that adiabatic compression is inherently non-linear . . . so when it is said air suspensions are inherently more linear than mechanical suspensions a misstatement has been made, for mechanical suspensions are often made that are more linear than these compact air springs.
>
> ". . . the non-linearity of the air suspension overshadows any reduction in distortion derived from a throw longer than ⅜-in."

Fig. 2. Fiberglass, in weighed-out amounts, being used to fill an AR speaker cabinet.

Linearity of the Air Spring in the Speaker Enclosure

The interior volume of the enclosure of an AR-1 or AR-3 speaker system, making approximate allowance for the space taken up by the speaker itself and by the nine reinforcing braces, is 1.5 ft.^{3}. The effective cone area for a 12-inch speaker may be calculated on the basis of a 10-inch diameter flat piston, as 78.5 sq. in.^{2}. Therefore, when the cone is undergoing peak-to-peak excursions of ½ inch, the enclosure volume is alternately decreased and increased by 19.6 cu. in., the volume taken up by a center-to-peak excursion of the cone. This is readily calculable, in relation to the 2592 cu. in. of the enclosure, as representing a volume change of 0.75 per cent. Such a volume change, in turn, can be converted to terms of linearity, either by the well known gas equation[2] or by a chart[3] relating pressure and volume of air above and below atmospheric pressure.

The gas equation tells us that the pressure of our enclosed body of air will be inversely proportional to its volume raised to the 1.4 power. If we halve the volume, the pressure will not be merely doubled, but will be increased by $2^{1.4}$, or 2.64. The non-linearity indicated is significant. On the other hand, when the volume is changed by a very small amount (in this particular case 0.75 per cent) the variation of pressure change from the inverse of volume change will be insignificantly small.

When the speaker cone moves back half an inch and decreases the air volume to 0.9925 of its former value, the air pressure would, in the perfectly linear case, increase by a factor of 1.00755. Instead, in the non-linear case, it increases by a factor of $(1.00755)^{1.4}$, or 1.01. Raising the former number to the 1.4 power hardly changes it. The non-linear aberration involved—the difference between 1.00755 and 1.01—is of the order of one-fourth of one per cent. a totally insignificant figure in the field of loudspeakers.

One may achieve a better intuitive understanding of the mathematical principle illustrated above by an exercise in which different numbers are raised to a given power. For example, 10^2 equals 100; the ratio between the base number and its square is ten to one. 2^2 equals 4, and the ratio has decreased to only two to one. As the number being squared approaches one the ratio between it and its square also decreases, until, when the number is one, it is *equal to* its own square. This is why the number 1.00755, when raised to the 1.4 power, is increased by only 0.24 per cent.

The preceding analysis can also be represented graphically, as in (A), (B), and (C) of *Fig.* 1.

Adiabatic and Isothermal Pressure Changes

The non-linearity described is characteristic of a volume of air subjected to pressure changes when there is no chance for the heat generated to flow out of the system. When a volume of air is compressed and heated, the accompanying rise in heat and hence in molecular activity increases the number of molecular collisions, and the air is effectively stiffened. Such a pressure change, accompanied by a change of temperature, is called *adiabatic*. Pressure changes associated with sound in free atmosphere are adiabatic, and sound pressure changes in an unlined speaker cabinet are also adiabatic, because the walls of the cabinet are unable to conduct the heat generated by these pressure changes quickly enough to the outside atmosphere.

If the speaker cabinet is filled with the proper kind and amount of material such as fiberglass, the air of the cabinet is exposed to a very large area of material, provided by the interstices and convolutions of the fiberglass. The generated heat of the compressed air can flow very quickly—this means within the period of the audio frequency pressure change—into the fiberglass, and back again. Thus the temperature of the air itself, and the corresponding molecular activity, remains constant. Such pressure changes are called *isothermal*. The isothermal behavior of air in a cavity filled with the proper absorbent material has been known for years, and is described in the literature.[4]

(*Continued on page 75*)

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[2] $P = \frac{K \text{ (a constant)}}{V^{1.4}}$ (For certain gases, including air).

[3] Leo L. Beranek, "*Acoustics*," pg. 274, McGraw-Hill Book Co., 1954.

[4] Ibid., pg. 4, 220.

Audio Designer's Handbook

An up-to-date collection of amplifier circuits and design information chosen as being representative of current and possibly future trends. Here in one collection will be found circuits which should fill practically every need of the hobbyist.

Prepared by

AMPEREX APPLICATIONS ENGINEERING LABORATORY

Edited by DAVID SASLAW

In Two Parts—Part I

IN RECENT YEARS tremendous strides have been made in the audio field, not only in technology, but in consumer demands as well. The ever-increasing quality of recordings has in turn created the need for ever-increasing quality in reproducing equipment. In addition to more demanding quality standards, modern audio equipment also has to cope with a variety of different signal sources; several kinds of phonograph pickups, tuners, tape (either preamplified or direct from the head), and microphones. The recent emergence of stereophonic recordings, both disc and tape, has added the need for two-channel playback without eliminating any of the previous requirements. It is indeed a tribute to the audio designer that he has not only kept up with the demands but in many cases has exceeded them.

A problem of great importance faced by the audio designer is cost. How can all the technical and consumer demands be satisfied without making the cost prohibitive? It was with the proper quality-cost balance in mind that this handbook was prepared. The design information and schematics in this handbook are meant to provide the audio designer with a collection of useful ideas and circuits. There are designs ranging from the simplest to the most elaborate; from the least expensive to the quality-at-any-price category. In essence, this is a collection of various methods for solving the same design problems. Naturally there are many more methods which are not presented, some of which are being developed in our laboratories at this very moment. Information about these is yours for the asking.[1]

Before plunging into the technical aspects of amplifier design it might be helpful to review some of the over-all requirements of monophonic and stereophonic systems.

[1] Write your problem to Amperex Applications Engineering Laboratory, 230 Duffy Ave., Hicksville, N. Y.

AUDIO SYSTEMS

Monophonic

In general a monophonic system consists of a phonograph pickup, a preamplifier, a power amplifier, and one or more loudspeakers. In addition, many systems include an AM/FM tuner and a tape recorder. No matter how good these components are, however, they can do no better than reproduce the signal supplied them from the record, tape, or broadcast. The signal will certainly contain some distortion. In the case of records and tapes a part of the distortion is deliberate.[2] As far as the deliberate distortion (recording characteristics) is concerned, compensation is easily effected by means of an equalization network. There is no cure, however, for any other type of distortion in the signal. Fortunately, the recording and broadcast engineers have done an excellent job in producing signal sources with minimum undesired distortion.

Obviously, one of the criteria for selecting components must be the amount of distortion they will add to the signal. It would be incongruous to couple a low-distortion amplifier with a high-distortion speaker since the system would sound the same if a lower quality amplifier were used. Therefore, when components are selected their effect upon the over-all distortion of the entire amplifying system should be kept in mind.

Monophonic systems may be constructed with the preamplifier, power amplifier, and/or tuner all on the same chassis or each on a separate chassis. Usually the separate chassis systems are somewhat more flexible and can be easily adapted to a variety of signal sources. For example, if all the signal sources used in a particular system are high level, say about 500 mv, an additional voltage amplifier is not necessary. On the other hand if a preamplifier is necessary, then there is considerable freedom in the choice of power amplifier. Also the separate chassis construction prevents harmful interaction between the components and simplifies heat dissipation. An additional advantage of this type of system is the possibility of retaining some of the components when converting to a stereophonic system.

On the other hand, a combination system undoubtedly makes more efficient use of parts and thus effects cost reduction. The efficiency of this type of unit is the natural result of specific knowledge about the pickup or tuner characteristics which permit design of the optimum circuit for these known quantities. Clearly then, either method may be "the best" depending upon the specific circumstances.

[2] Any departure from flat frequency response is a "distortion;" it is properly called "amplitude distortion" and when intentionally introduced in one part of a system all the way from studio microphone to your loudspeaker, it is usually compensated by introducing a complementary amplitude distortion in another part of the system. ED.

Stereophonic

Perhaps the easiest way to describe stereophonic reproducing systems is that they have *more than double* the problems inherent in the monophonic systems. Not only are there two channels, but there must of necessity be some method for relating these channels to each other to preserve the original balance. In addition, the stereophonic signal in many cases is lower in level than the monophonic signal. This calls for extra gain and less distortion in the system.

The comments in the monophonic section concerning the advantages and disadvantages of single- and separate-chassis systems apply equally to stereophonic equipment. Each system has its strong points which are directly related to the needs of the particular group of consumers concerned.

AMPLIFIER DESIGN

The Ideal Amplifier

The principal features of the ideal amplifier are:

1. The distortion produced by the amplifier should be negligible up to maximum output. By distortion we mean the presence in the output of frequency components and phase relationships which were not present in the input. The frequency components consist of harmonics of the signal frequencies and of sum and difference frequencies resulting from intermodulation between different frequencies in the signal. In addition, parasitic oscillations give rise to undesired frequencies commonly called "ringing." The phase distortion is caused by phase shift of different frequencies.

2. The response of the amplifier should be uniform throughout the audible frequency range. The average ear will respond to frequencies in the range of 30 to 15,000 cps. The upper limit of this range may extend to 20,000 cps. To make realistic reproduction possible, therefore, the amplifier should handle frequencies between at least one octave above and one octave below the audible range.

3. The amplifier must have excellent transient response. Many sounds, particularly those from musical instruments, rise very rapidly, to a high intensity and decay relatively slowly. Such sounds are spoken of as "transients." The steeply rising wave fronts of transients can be shown to consist of a wide range of component frequencies. The ability of an amplifier to reproduce them faithfully will therefore depend on a wide frequency response and little phase shift over the whole frequency range. Variations in the relative phasing of the component frequencies of a transient would result in a change in its aural character.

4. An adequate reserve of power should be available. For faithful reproduction, the sound level should be comparable with that of "live" conditions. The amplifier should thus be capable of handling peak powers considerably above the average level to allow peak sounds to be reproduced without overloading and audible distortion.

5. The output impedance of the amplifier should be low. This will improve the performance of the loudspeaker and ensure clean reproduction, particularly of transients. Air loading of the loudspeaker tends to limit the low-frequency resonance of the cone and suspension. The electromagnetic damping of a low output impedance in the amplifier is, however, effective in maintaining adequate control of the cone movement over the entire frequency range. The output impedance should preferably be much less than the impedance of the loudspeaker voice coil, the ratio of the two being termed the "damping factor." In practice, a damping factor above 10 is desirable.

6. Hum and noise in the amplifier should be below an audible level.

Amplifier Performance Criteria

The performance of an amplifier is normally specified with reference to some or all of the points listed in the previous section. However, these points define the ideal amplifier characteristics. The following definitions provide background for the amplifier performance measurements given in subsequent sections.

1. Power. The audio power available at the output of an amplifier is defined as V_{load}^2/R_{load}, where V_{load} is the voltage developed across a load resistance R_{load} connected to the output terminals of the amplifier when driven with sinusoidal input. The rated output power of the amplifier is the maximum audio power which can be obtained without exceeding either the maximum ratings of the tubes or the distortion level permitted for the system.

2. Distortion. The principal form of distortion which occurs in amplifiers is non-linear distortion which is normally divided into harmonic and intermodulation distortion. Each of these contributes some voltage to the output at frequencies which differ from those occurring in the input signal.

(*a*) *Harmonic Distortion.* Voltage which occurs in the output at second, third, fourth, and so on, harmonics of the fundamental signal frequency comprises harmonic distortion. It is expressed as a percentage ratio of the voltage associated with the particular harmonic to the total output voltage of the amplifier. Total harmonic distortion is the ratio of the voltage associated with all the harmonics to the total output voltage. The total harmonic distortion D_{tot} is the rms value of the individual distortion D_2, D_3, D_4, and so on—that is:

$$D_{tot} = \sqrt{(D_2^2 + D_3^2 + D_4^2 + \ldots\ldots)}$$

(*b*) *Intermodulation* Distortion. If an input signal contains several different frequencies, any nonlinearity in the amplifier will give rise to modulated waveforms having frequencies which are the sums and differences of the interacting waveforms. The extent of this distortion is measured by the degree of interaction between two pairs of test signals. The interaction between signals of very different frequencies is called intermodulation distortion.

Intermodulation distortion in amplifiers is measured with a test signal consisting of a low frequency—usually 60 cps, but can be anywhere from 40 to 100 cps—mixed with (but not modulating) a high frequency which is usually 7000 cps, though some methods use 3000 cps.[3] The ratio of the peak-to-peak amplitudes of the low- and high-frequency test signals is 4:1. The output obtained with the two signals is assumed to be equivalent to the output obtained with a single sine-wave signal with a peak-to-peak amplitude of the combined waveform. The distortion is quoted as the rms value of the amplitudes of the sum and difference waveforms expressed as a percentage of the amplitude of the high-frequency signal.

(*c*) *Hum and Noise.* Contributions to the output from various stray signals picked up at points in the amplifier are normally lumped together and measured at the output with a load across the input to stimulate the pickup impedance. The fraction of the rated output voltage measured across the load resistance is then expressed in decibels below rated output, so that:

$$\textit{Hum and Noise (in db)} = 20 \log_{10} \frac{\textit{voltage with input loaded}}{\textit{rated output voltage}}$$

A level of hum and noise of −60 db means that the rated output voltage is 1000 times the voltage developed when the input is loaded as described.

(*d*) *Negative Feedback.* Negative feedback is used to improve amplifier performance. Part of the output is re-injected in an earlier stage 180 deg. out of phase with the input signal, thus reducing sensitivity and distortion. It is usual to refer to the amount of feedback in decibels, determined from the ratio of voltage gain of the amplifier without feedback to the voltage gain with feedback. Thus, a feedback of 26 db would mean that the gain without feedback is 20 times the gain with feedback.

The gain of an amplifier without feedback must therefore be high enough to allow for the loss in gain resulting from feedback. This disadvantage of using feedback is far outweighed by the advantages which are:

(1) reduced distortion
(2) improved frequency response
(3) lower output impedance
(4) less phase shift
(5) less dependence of gain upon changes in supply voltage

Circuit Design

Although the power-handling capacity of an audio amplifier is not the property which is most important to the listener

[3] Other frequency combinations are used for specific types of measurements. The CCIF system, for example, uses a pair of frequencies differing by a specific amount (usually 400 cps), with both being varied simultaneously throughout the audio spectrum. ED.

(a low level of distortion is usually considered to be so); it is nevertheless the prime concern of the circuit designer. The peak power required for realistic reproduction of music depends mainly upon the size and acoustical nature of the room and upon the taste of the listener. In the home it is generally considered that an output power of 12 to 17 watts will be adequate with efficient loudspeakers. If simplicity and economy are the primary considerations, an output of 8 watts can give a generally acceptable standard of performance. In large rooms, however, a maximum output power of at least 50 watts will be necessary. The type of output stage used will depend upon the maximum power required of the amplifier. Consequently, the design of the amplifier usually proceeds from output to input stages, the requirements of the output stage dictating to a large extent the design of preceding stages.

Output Stage

Not many years ago triodes were considered to be the only useful output tubes. There was good reason for this attitude. The pentode and beam tetrodes available at that time had extremely high distortion. In recent years, however, with the development of low-distortion power pentodes such as the 6CA7/EL34, 6CW5/EL86, and the 6BQ5/EL84, this trend has been more than reversed.

For example, when the low-distortion characteristic of triode operation is desired, it is not at all uncommon to use a pentode in triode connection; or for a distortion level somewhere between the triode and the pentode a type of distributed loading popularly called "Ultra-Linear" operation is used.

Recently there has been increased interest in the use of power pentodes such as the 6CW5/EL86 which can operate at low voltage and high current. With this type of tube the low voltage and high current swing (low plate-to-plate load impedance) reduces the stringent primary inductance requirements of the output transformer. Thus fewer turns are necessary and both the leakage inductance and stray capacitance are also reduced. The result is improved transient response and increased stability.

The ability of the push-pull stage to reduce harmonic distortion has made it the standard for high-quality amplifiers. However, because of the higher distortion tolerated in low cost amplifiers, the single-ended pentode output stage is more economical than the push-pull output stage.

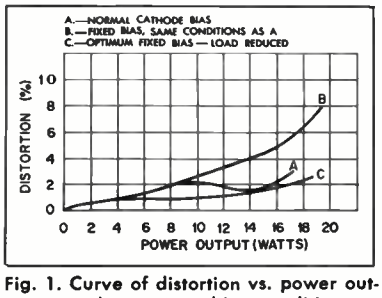

Fig. 1. Curve of distortion vs. power output under various bias conditions.

Let us now examine more closely the three types of output stages previously mentioned—pentode, triode connected pentode, and distributed load.

1. Pentode Output Stage. The pentode output stage is usually in push-pull Class AB. The over-all efficiency of these stages is fairly high being of the order of 40 to 50 per cent and the harmonic distortion varies up to 4 per cent at full output. Consequently, negative feedback is necessary to reduce distortion.

The recommended operating conditions for Class AB are usually based on measurements with continuous sinusoidal drive. The cathode resistor is chosen so that with zero-signal input, the tubes are operated near Class A and at full drive near Class B. The plate-to-plate load resistance is chosen for optimum performance at full drive. Shifting of the operating point is due to the effect of the increased plate and screen currents on the cathode bias resistor. With a typical output stage using two 6BQ5/EL84 pentodes with a plate supply of 310 volts, the increase in cathode current and consequently in grid bias is about 40 per cent with sinusoidal input voltage.

However, when speech and music are used to drive the stage instead of sinusoidal input, the situation is entirely different. The average amplitude of the signal compared with the occasional peaks is now very small and consequently the average variation in cathode current is also very small. Because of the relatively long time constant of the bias network, the operating point even under peak signal conditions shifts so little that the stage can be considered as operating with virtually fixed bias.

Therefore, to approximate speech and music conditions, full sinusoidal drive and fixed bias should be used for measurements.

When a Class AB stage is designed using measurements based upon sinusoidal drive and cathode instead of fixed bias, increased distortion during peak passages of speech and music will result. (See *Fig.* 1). To compensate for this, the quiescent operating point can be adjusted from Class-AB_1 operation to a point nearer to Class-B operation by increasing the cathode bias resistor. This involves a smaller zero-signal cathode current and plate-to-plate load resistance. As a result there are larger variations in the instantaneous plate and screen currents when the stage is driven. However, this effect is compensated for by the increased time constant in the cathode circuit which keeps shifting of the operating point to a minimum.

It should be noted that this low loading form of operation is suitable only for use in speech or music reproduction and produces excessive distortion when driven by a sine-wave signal. For this reason it is difficult to measure directly the distortion levels which occur under practical conditions unless fixed bias is substituted for the cathode bias during test conditions.

Another method for improving performance is to use distributed loading in the output stage. Depending upon the precise loading used, the variation in plate and screen currents can be reduced to such a level that almost identical performance is obtained under cathode and fixed bias. This type of operation will be described in the section entitled Distributed Load Output Stage.

2. Triode Output Stage. A low level of distortion can be obtained in a push-pull triode stage operating Class AB. It has been found that power pentodes such as the 6CA7/EL34, triode connected, easily deliver 12 to 15 watts at harmonic distortion levels below 1 per cent using a supply voltage of about 425 volts.

Maximum power output and the corresponding distortion vary somewhat with the value of the load impedance. This is illustrated in *Fig.* 2 where the performance of the 6CA7/EL34 power pentode is shown in triode connection.

For plate-to-plate-load impedance below 7000 ohms, either a common or separate cathode resistors (bypassed) can be used; above 7000 ohms improved operation is obtained with an unbypassed common cathode resistor. Operating conditions approach Class A as the load impedance is raised and optimum performance for high-quality operation is obtained with a load impedance of about 10,000 ohms.

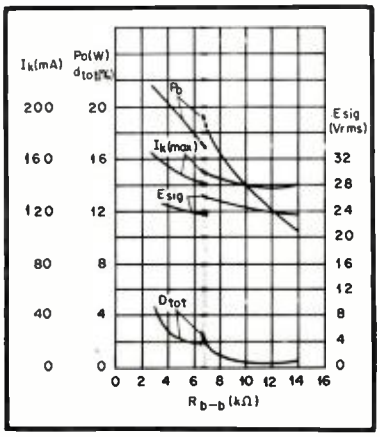

Fig. 2. Performance curves of the 6CA7/EL34 in triode connection.

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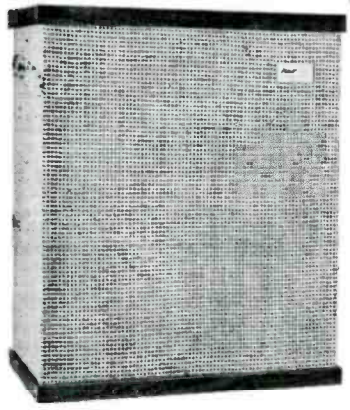

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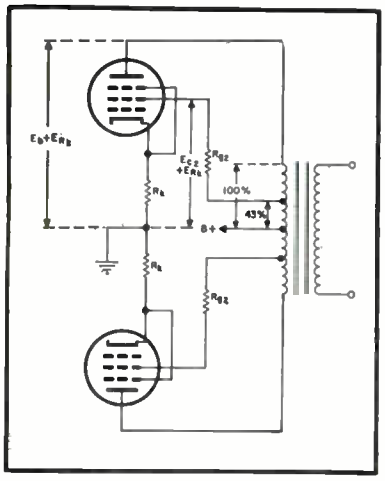


Fig. 3 Basic configuration of distributed-load (Ultra-Linear) output stage.

This type of output stage (Williamson) has been used for a number of years in high-quality amplifiers. Because of the low inherent distortion, less negative feedback is necessary to give acceptable linearity as compared with the amount of feedback required in pentode or tetrode output stages of similar power outputs. Furthermore in three- or four-stage amplifiers with most of the feedback applied over the whole amplifier (including the output transformer) it is possible to obtain increased stability for a given distortion level.

3. Distributed-Load Output Stage. Although the triode push-pull output stage has great value (if distortion is a primary consideration) its low efficiency and limited power output are usually serious disadvantages. The distributed-load output stage seems to have overcome these disadvantages while retaining the lower distortion of the triode stage. This type of operation involves the application of negative feedback in a non-linear manner through the screens. The screens of the output tubes are supplied through taps on the primary of the output transformer (see *Fig.* 3). Distributed-load characteristics are intermediate between pentode and triode operation and approaches triode operation as the percentage of primary turns to the plate and screen circuits increases.

Under optimum conditions, the distributed-load circuit delivers about 65 per cent of the power of the equivalent pentode stage, but with considerably lower distortion. With the output at the level of the equivalent triode output stage, the distortion is reduced to triode magnitude. At the same time the output impedance is reduced to a level comparable with that of the conventional push-pull triode stage.

Laboratory experiments have indicated that with a common winding ratio of 0.2 (that is 20 per cent of the winding common to plate and screen circuits), the distortion level is comparable to triode connection. Also it has been found that at higher outputs appreciable improvement is obtained if the common winding ratio is increased further. The best over-all performance has been obtained with a percentage of about 40 to 45. Approximately 60 watts can be obtained from a pair of 6CA7/EL34 with only about 2.5 per cent distortion at the start of grid circuit.

Figure 4 shows the typical performance of a 6CA7/EL34 when operated with the primary windings tapped at 43 per cent of the turns. The power output shown is into the load.

From the distortion figures in Table 1, it appears that little advantage would be gained by further approaching triode operation. There are, however, several advantages in operating at about 40 per cent of the primary turns. In the first place, almost identical performance is obtained under cathode bias and fixed bias because the closer we approach Class A triode operation the less variation we get in plate and screen currents as the stage is driven. Secondly, in common with normal triode operation, power output and distortion are less dependent on the value of the load impedance. With the tap at about 40 per cent of the turns little change in performance is observed by a change in plate-to-plate load impedance of 6000 to 9000 ohms.

Phase-Splitter and/or Driver Stage

The phase splitter delivers signals of opposite phase and appropriate ampli-

(*Continued on page 72*)

TABLE I—PERFORMANCE DATA

TUBE TYPE	MODE OF OPERATION	OPERATING CONDITIONS					TOTAL DISTORTION (%)					
		E_b (volts)	E_{g_2} (volts)	R_k (ohms)	R_{p-p} (k-ohms)	R_{c_2} (ohms)	10 w	14 w	20 w	30 w	40 w	60 w
6CA7/EL34	Triode Connection	400	*	470 (each tube)	10	*	0.5	0.7	—	—	—	—
	Distributed Load 20% common winding	400	400	470 (each tube)	7.0	1000 (each tube)	0.7	0.8	1.0	1.5	5.0	—
	Distributed Load 43% common winding	400	400	470 (each tube)	6.6	1000 (each tube)	0.6	0.7	0.8	1.0	—	—
	Pentode Connection	330	330	130 (common)	3.4	470 (common)	1.5	2.0	2.5	4.0	6.0	—
							5 w		10 w		15 w	
6BQ5/EL84	Triode Connection	300	*	150 (common)	10	*	1.0		—		—	
	Distributed Load 20% common winding	300	300	270 (each tube)	6.6	—	0.8		1.0		1.5	
	Distributed Load 43% common winding	300	300	270 (each tube)	8.0	—	0.7		0.9		—	
	Pentode Connection	300	300	270 (each tube)	8.0	—	1.5		2.0		2.0	

* Screen connected to plate

TABLE II

	FIGURE 5		FIGURE 6		
Plate Supply Voltage	250	350	250	350	volts
Cathode Resistor	1200	820	68,000	82,000	ohms
Plate Resistors	0.22	0.22	0.1	0.15	megs
Output Voltage	35	45	20	35	rms volts
Gain	58	62	25	27	—
Total Distortion	5.5	3.5	1.8	1.8	per cent

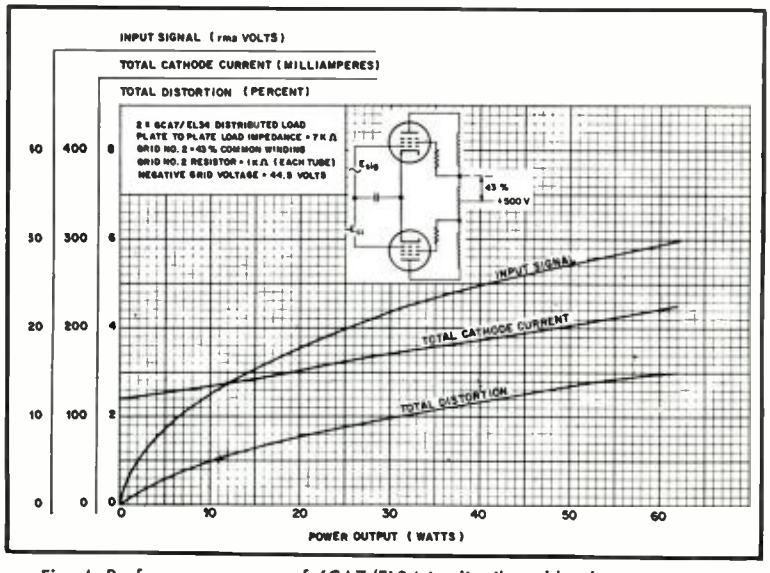
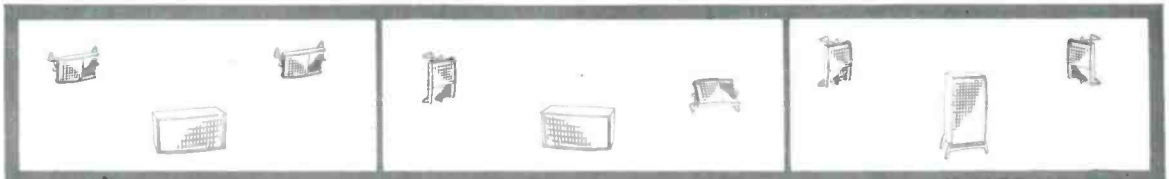


Fig. 4. Performance curves of 6CA7/EL34 in distributed-load output stage.



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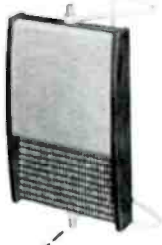

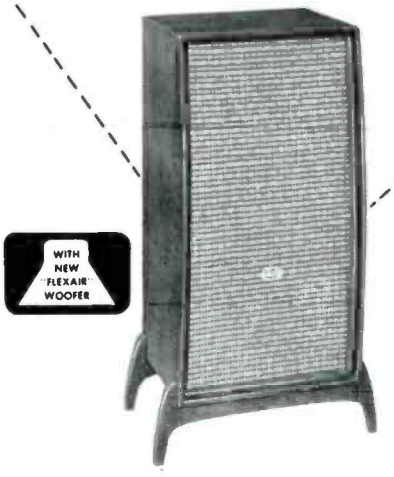

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"Unclean Hands" Forfeit Patent Protection

ALBERT WOODRUFF GRAY*

While lying, deceit, thievery, and other forms of hanky panky may succeed in some circles, they seem to be statutorially ruled out of patent infringement cases.

REFUSAL by a Federal District Court in New Orleans to extend protection against infringement to the owner of a patent on the ground that, "The robber baron morality of another day is no longer acceptable," and that "Any patent obtained through fraud and dishonest dealings is unenforceable," was sustained on October 17th, 1958, by the United States Court of Appeals.[1]

In this litigation the invention involved, the heterodyne phase-comparison principle, relates to radio navigation in which the object, whether on land, sea or air, is accurately determined by an arrangement of transmitters and receivers of high-frequency radio waves.

During World War II an employee of the National Advisory Committee on Aeronautics, Charles E. Hastings, designed such a system for radio navigation which was called "Raydist." Later, in January, 1947, the commercial aspects of this subject became the the subject of a discussion by this inventor before the Institute of Aeronautical Science.

At this time interest of the petroleum industry in oil exploration in the offshore areas of the Gulf of Mexico had become demanding. Given areas were explored in small vessels by underwater explosions and the recording of effects.

When the exact geographical location of these explosions or of the vessel could be determined, then by a comparison of the recorded effects a complete oil field could be plotted. The difficulty lay in the lack of accuracy when the ship was beyond sight of the shore.

Information came to the head of the geophysical research department of one of the petroleum companies that this design, "Raydist," was the simplest and most accurate system then available for radio navigation and surveying.

In a little office in Virginia a few weeks later the designer of this system was visited by the research head of this petroleum company. At that time this designer gave a demonstration of a Raydist two-dimensional system—two fixed transmitters with a receiving set in a moving automobile.

The experiment proved a complete success and the automobile accurately located with but a few feet variation. From these results the petroleum research head was convinced that this system was the answer to the problem of off-shore oil exploration. Within a few days two department heads of the company were discussing appropriation of this Raydist system with the Seismograph Service Corporation.

Earlier Patent Granted

At this time the patent counsel of the inventor of this system became convinced that the system infringed a patent that had been issued for this same principle to a Frenchman, Etienne Augustin Honore, in 1939, and undertook to locate the patentee and secure either an assigument or license of the patent.

Not more than a week later sketches and specifications of this system were sent to the patent counsel of the Seismograph Corporation at Chicago with a letter of the Vice-President of the company, T. A. Manhart, that, "I am enclosing five disclosures relative to position determination by means of the heterodyne principle. If you will, as you suggested, study them we will get together as to what we will do with them after our visit to the Hastings people in Washington." Three days later the writer of this letter called at Hastings' office at Norfolk, Virginia.

This visit has been described by the United States Court of Appeals. "Pursuant to their plans Manhart visited Hastings the next day, May 15th, at Norfolk and represented to Hastings that he was not technically competent. Whether or not Manhart's degree in geological engineering and his prior experience with Seismograph refutes his claim of lack of technical qualification to understand the subject matter is purely speculative.

"During this meeting Manhart proposed a business deal, to use Raydist for electronic survey on the Gulf coast, which would give S. S. C. the exclusive right to exploit the seismic field in the industry."

In the meantime feverish efforts were being made by the officers of the company to identify and locate the French patent which Hastings had intimated would be infringed. Negotiations with Hastings dragged until September but assured of the French patent and equipped with information from Hastings the company, according to the Federal Court, "never contacted Hastings again nor did it ever drop so much as a subtle hint to Hastings that their bargainings had terminated."

On the 25th of October the final contract of the company with the French inventor was signed. Four months later Hastings' counsel, attempting to negotiate with the French inventor, learned for the first time that this inventor "had licensed his interest to others."

The Reckoning

In its decision of the suit subsequently brought for infringement of the Raydist patent, which unbeknown to Hastings it had secured, by the Seismograph Service Corporation, the Federal District Court in Louisiana said,

"The importance of the equitable issues in this case transcends the interest of the parties. The far reaching social and economic consequences of a patent give the public a permanent interest in seeing that patent monopolies spring from backgrounds free from fraud or other inequitable conduct.

"Courts are insisting on increasingly higher standards of commercial integity. It has long been recognized that any patent obtained through fraud and dishonest dealings is unenforceable in a court of equity.

"No single test can be applied in all cases where improper acqquisition of business information is charged. The in-

(*Continued on page 71*)

* *112-20 Seventy-second Dr., Forest Hills, N.Y.*

[1] Seismograph Service Corp. v. Offshore Raydist, Inc., 135 F.S.342, Sept. 29, 1955; aff'd 119 U.S.P.Q.146, October 17, 1958.

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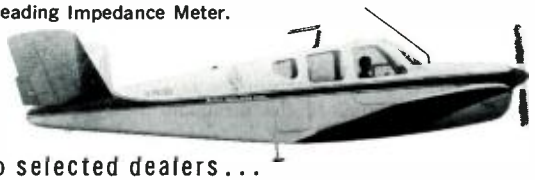

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Improving the Signal-to-Noise Ratio

HERMAN BURSTEIN*

If the performance you are getting from your tape recorder does not come up to the standards you would like, one or more of the suggestions offered may improve your lot. Most of the ideas are fairly simple, but collectively they could make even a poor machine satisfactory.

In Two Parts—Part I

THE CRITERIA of a tape recorder's quality may be placed on two broad categories: (1) mechanical motion (wow, flutter, timing accuracy); and (2) electrical performance. The latter comprises three basic criteria: frequency response, distortion, and signal-to-noise ratio. Of these three, signal-to-noise ratio is at least as important as the other two and is probably the characteristic most noticeable to the average user. It takes no particular skill and very little time to ascertain whether a given tape machine is excellent, average, or mediocre with respect to keeping noise and hum at a suitably low level with respect to the audio signal.

The problem of obtaining a high signal-to-noise ratio is generally greatest in playback, because the playback head delivers a very tiny audio signal. Hence it is difficult to keep noise and hum produced by the playback amplifier sufficiently below the signal as to be inaudible. In recording, one generally deals with a higher order of audio signal, unless using a microphone of quite low sensitivity, so that maintaining a high signal-to-noise ratio is less of a problem.

Obviously, one should pay careful attention to what a tape machine's specifications have to say about signal-to-noise ratio. Based on a recording level that produces 3 per cent harmonic distortion, a high-quality machine will provide a signal-to-noise ratio of at least 55 db in playback. If the rating is on the basis of 2 per cent harmonic distortion, one can subtract about 3 db, so that a ratio of at least 52 db is called for. If the reference level is 1 per cent harmonic distortion, one can subtract another 3 db.

Since specifications and actual performance can differ, one should, if possible, check the performance of the machine one intends to buy. A quick way to check is to play a commercially recorded tape recorded at a level low enough to result in clear sound. The noise and hum produced by the tape machine should be of about the same order, relative to the audio signal, as encountered in the case of an FM tuner or when playing a phonograph record; at least this is so for a high-quality machine. At the worst, the noise from the tape machine should be only slightly greater relative to the audio signal than in the case of a tuner or phonograph.

Another way to check the playback noise of a tape recorder is to play a blank tape. If the dominant noise is tape hiss—as can be determined by listening to the tape amplifier with the tape still and with the tape in motion—it is safe to say that the tape machine has a very good signal-to-noise ratio in playback.

It is also advisable to check the noise in recording. One should record from a high-level source, as from an FM tuner, and, more important, from a microphone. Of course, the greater the sensitivity of the microphone (the higher its output for a given sound level), the higher will be the ratio of audio signal to noise produced by the record amplifier. One should attempt to use a microphone of average sensitivity, about – 55 db/microbar, at fairly close range. In playback, the signal-to-noise ratio should be roughly comparable with that from a tuner or phonograph.

A tape machine that originally had a very good signal-to-noise ratio may fail in this respect with age. Or the ratio may not have been as good as desired to begin with. In either case, there are various factors to be considered and measures that may be taken by the person wishing to improve the signal-to-noise ratio of his tape machine. Some of the measures to be discussed require a slight amount of technical ability, about the same order of ability acquired by those who have assembled an amplifier kit, which many thousands with no knowledge of electronics have done. Hence it does not seem amiss in these pages, intended especially for the layman, to deal with a few simple procedures requiring one to go inside the tape amplifier. Moreover, many readers probably can count among their friends at least one with sufficient knowledge of electronics to assist them.

Tube Selection

Tubes of a given type tend to vary from one to another because of manufacturing tolerances. Two of the respects in which they vary is the amount of noise and hum produced. In these respects, the most important tube is that in the first stage, because its noise and hum are amplified in all successive stages. Hence, to assure minimum noise and hum one should obtain three or four of the tube type employed in the first stage and try these successively. Since

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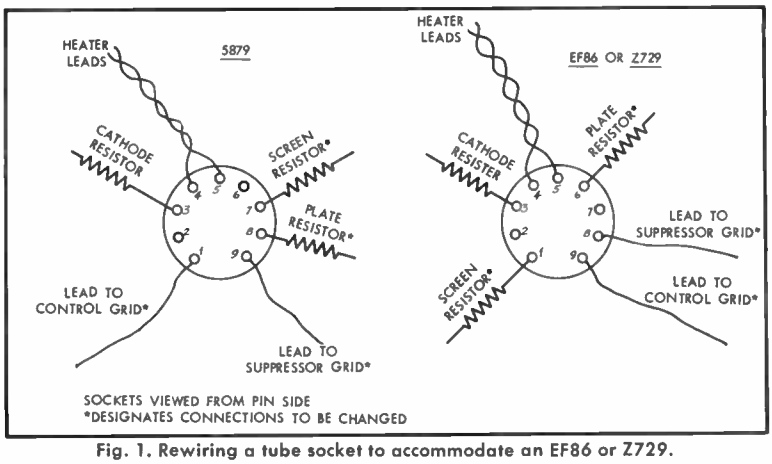


Fig. 1. Rewiring a tube socket to accommodate an EF86 or Z729.

tape amplifiers frequently employ the same tube for more than one stage, the extra tubes generally are not wasted.

The differences among tubes of a given type can be fairly profound—as much as 10 db in the case of hum if the heater is operated on a.c. The ear will generally serve as an adequate instrument for rejecting a tube that is poor so far as hum is concerned. Similarly, the ear can enable one to detect tubes that are outright hissy. However, if one is trying to select among tubes that differ by only a few decibels in their hum and noise characteristics, it is probably necessary to measure the output of the tape amplifier with a sensitive vacuum tube voltmeter to be sure which is the best tube. Moreover, when one does find the tube that is best, there is a possible pitfall: be sure that this tube provides as much amplification as the others, because sometimes a tube apparently has less noise and hum only because it provides less amplification. The amplification of a tube can be determined on a suitable tube tester; or, using a test tape with a constant signal, one can measure the output of the tape amplifier when various tubes are used in the first stage.

Tube Substitution

A significant reduction of noise and/or hum often can be achieved by substituting a similar type of tube for the one originally used in the first stage. Perhaps the best example is the use of an ECC83 in place of a 12AX7, which is frequently the first stage tube. The ECC83, basically a European tube (although some are made in America), is electrically identical to the 12AX7 but on the average has superior hum and noise characteristics. Recently, American manufacturers have brought out the 7025, also intended to be a superior replacement for the 12AX7. Other high-quality replacements include the American 12AY7 and the Telefunken 12AX7.

Sometimes a pentode is employed in the first stage. Here the European EF86 has won a position of very high esteem. If the tape amplifier presently has a 5879 (American) or Z729 (European) in the first stage, these can be replaced by the EF86. No rewiring of the tube socket is required, if the original tube was a Z729, whereas rewiring is necessary if it was a 5879. *Figure* 1 shows the pin locations of the 5879 and EF86. If the latter is substituted, it is necessary to rewire the resistors, capacitors and other elements of the first stage so that they are connected to the proper tube pins; this task requires probably no more than 10 to 15 minutes.

Reversing the Power Plug

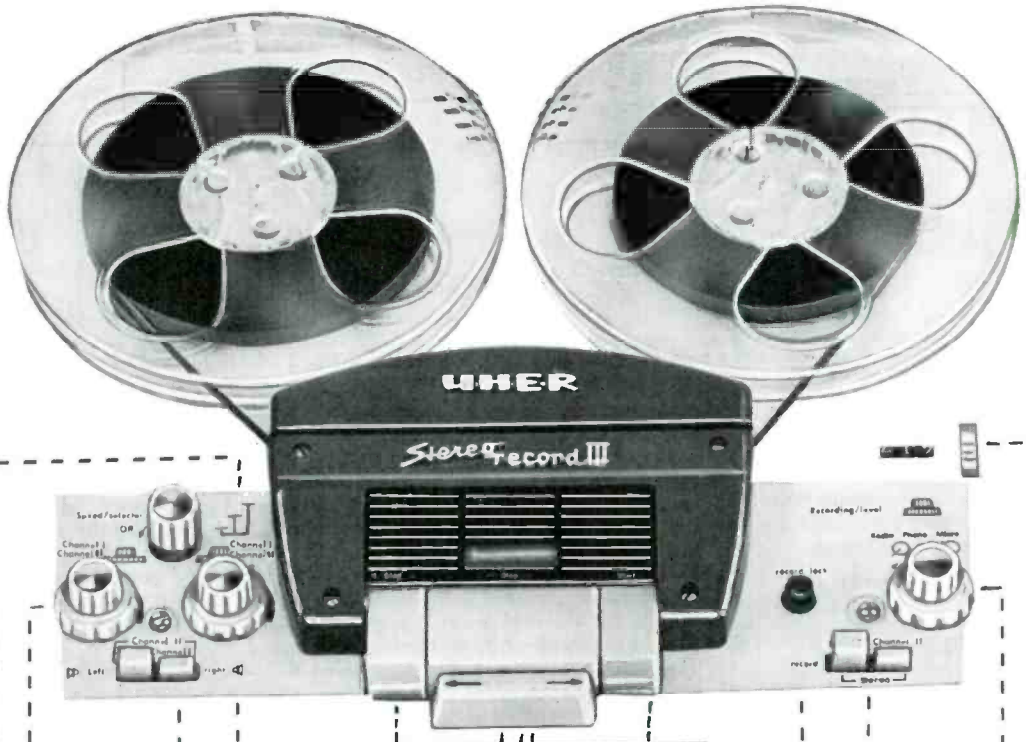
As simple a measure as reversing the power plug in the house outlet can sometimes reduce hum by a significant amount. If the tape machine has a potentiometer for canceling hum, this should be readjusted for each position of the power plug.

Tube Shields

The first stage tube is, or at least should be, shielded against hum pickup. The shield should make firm contact with ground through the socket mounting or through other means. If the shield has worked loose, it may be ineffective; in fact, the loose shield may serve to increase hum above the level produced by an unshielded tube. For maximum protection against hum pickup, shields are available that are made of special material, such as the "Co-Netic" shields made by Perfection Mica Co. If one has access to Mumetal, it is possible to fashion a tube shield out of this material.

Demagnetization of Tubes and Shields

A magnetized tube, particularly in the first stage of the tape amplifier, can be a source of hum. While tube selection can eliminate this difficulty, another technique is to demagnetize the offending tube by means of a bulk eraser, being careful not to bring the tube too close to the eraser lest the powerful pull of



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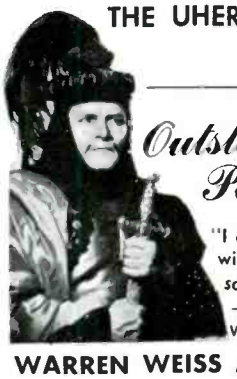

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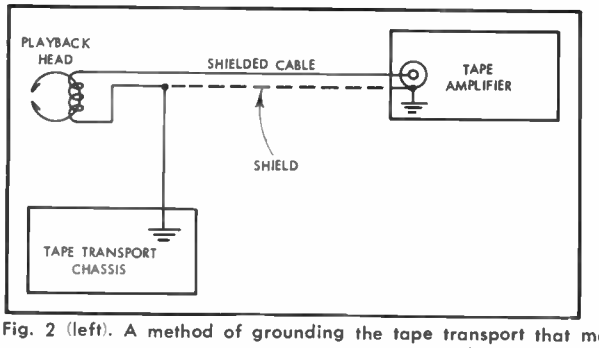


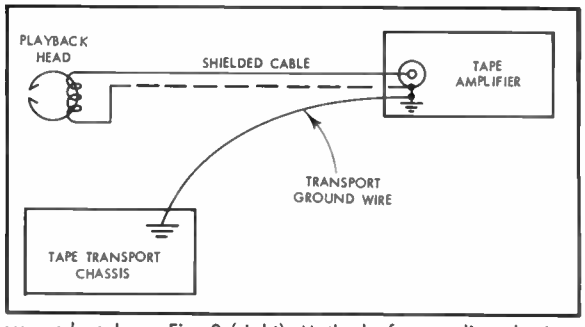


Fig. 2 (left). A method of grounding the tape transport that may produce hum. Fig. 3 (right). Method of grounding the tape transport that generally results in the least hum.

the latter dislodge any of the tube elements.

Similarly, a magnetized tube shield can be an unsuspected source of hum. Here tube substitution would probably do no good. However, the shield can be demagnetized by a bulk eraser.

Routing of the Cable from the Playback Head

If one employs only a tape transport, using the control amplifier instead of a tape amplifier to provide the necessary amplification and equalization of the signal produced by the playback head, careful attention must be paid to the routing of the cable between the head and the control amplifier. If the cable passes close to leads carrying a.c., or close to a power transformer, motor rectifier tube, or other component where a.c. is present. it may pick up enough hum to become audible; keep in mind that the signal presented by the cable to the amplifier undergoes tremendous amplification, which is greatest in the vicinity of the hum frequencies, namely 60 and 120 cps.

Sometimes one may run into a crosstalk problem if the cable from the playback head runs close to another cable carrying a high-level signal, for example from a tuner. Should the tuner be on, then one might hear a radio program along with the signal from the tape machine.

Grounding of the Tape Transport

Whether an integral tape amplifier or one's control amplifier is used in conjunction with the tape transport mechanism, there should be a good ground connection between the transport chassis and the amplifier. An increased hum level may result if one depends upon the cable shield for a ground between the transport and the amplifier, as in *Fig.* 2. Instead, a separate, heavy ground connection is generally preferable, as in *Fig.* 3. In this case the playback head should not be grounded to the transport chassis, for this will provide a second path to the amplifier ground point; the dual paths, as shown in *Fig.* 4, constitute a ground loop, which picks up hum.

Lead Dress

Sometimes excessive hum is due to improper routing of the hot lead from the playback head to the grid of the first tube in the playback amplifier; the reference here is not to the routing of the cable between the head and the amplifier but to the path followed by the hot lead of the cable *inside* the amplifier. If the lead comes too close to a.c. heater wiring, other wires containing a.c., a power transformer, or the like, it may pick up enough hum to be audible. Moving the lead by a slight amount, perhaps a small fraction of an inch, can sometimes result in appreciable improvement. Of course this is a trial-and-error procedure, but the results on occasion justify the effort expended. It may be preferable to leave the lead from the playback head in its original position and try moving other leads, such as a.c. heater wiring.

Installing a Hum-Bucking Pot

To cancel hum due to operation of the tube filaments on a.c. instead of d.c., a number of inexpensive tape machines connect a tap at the center of the heater winding on the power transformer to ground, as in *Fig.* 5. While this does greatly reduce hum, seldom does it minimize hum as fully as possible. A superior procedure, illustrated in *Fig.* 6, is to place a potentiometer across the heater winding, with the arm of the pot connected to ground, and adjust the arm for minimum hum. Usually it is not difficult to find room to install a pot. Drilling a hole takes a few moments, and the necessary connections are few and very simple. Note in *Fig.* 6 that the center lead of the heater winding is removed from ground.

Construction of a D.C. Heater Supply

The more ambitious home constructor may wish to install a source of d.c. for the heaters of the tubes in his tape amplifier, replacing the original a.c. supply. *Figure* 7 shows a suitable d.c. supply, which can be used for the first stage or first two stages of the tape amplifier. It will do no harm to continue operating the remaining stages on a.c.

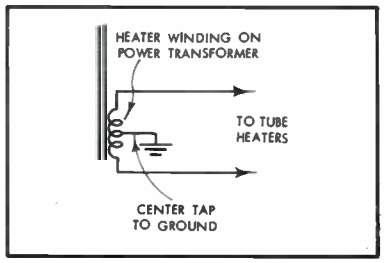


Fig. 5. Method of hum cancellation often used in moderate-priced tape recorders.

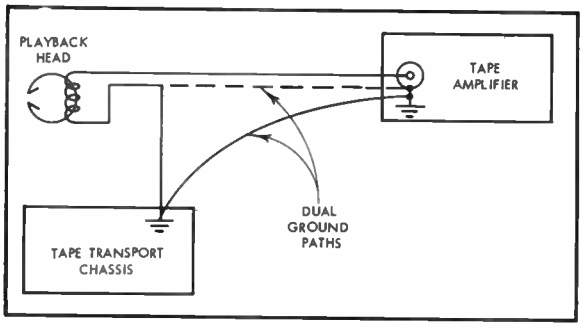


Fig. 4. Formation of a ground loop.

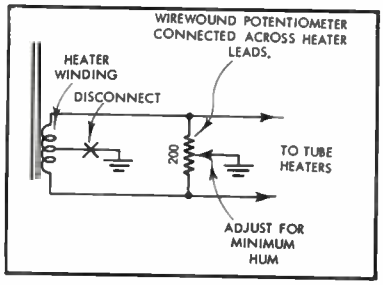
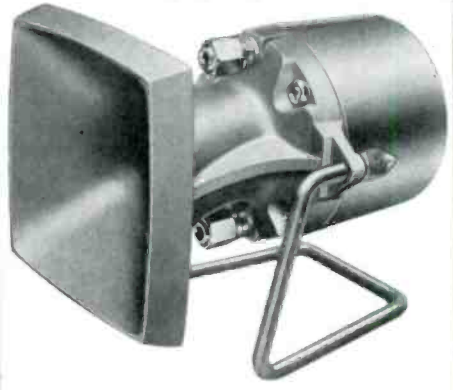


Fig. 6. Installation of a hum-bucking potentiometer.

FOR BETTER HIGH FREQUENCY REPRODUCTION . . . A HORN TYPE TWEETER

The model PT-4 is offered to the public at the price heretofore unthought of for a horn type speaker, the drastic price reduction being effected by eliminating all inessential parts as much as possible and also by facilitating mass production by employing conveyer systems, and moreover from the standpoint of efficiency, it is just as good as a conventional horn type speaker, and in addition improvements made in vibrating elements have brought about a superior high frequency characteristic, successfully solving a difficult problem considered inherent to such a speaker. If used in conjunction with the PIONEER 8″, 10″ or 12″ woofer, it will give a highly satisfactory performance, repraducing high frequency saund of vialin and trumpet in their pleasing natural tones.

PT-4



- Ideal for home high fidelity systems
- Despite its low price, the PT-4 provides identical performance as costly horn tweeters manufactured heretofore.
- Incorporating PIONEER's unique diaphragm and powerful magnetic field, the PT-4 provides clean undistorted high frequency reproduction.
- With its handsome appearance, the PT-4 horn tweeter will serve as a decorative accessory that will enhance the atmosphere of the listening room.

SPECIFICATIONS

Voice coil impedance	16 ohms
Cutoff frequency	1,500 cps
Frequency response	1,500—16,000 cps
Maximum power input	20 watts
Sensitivity	105 db/watt
Crossover frequency	over 3,000 cps
Total flux	22,500 maxwell
Flux density	14,400 gauss
Weight	694 g (24.5 oz.)

FUKUIN ELECTRIC, TOKYO, JAPAN

5 OTOWACHO 6-CHOME, BUNKYOKU, TOKYO, JAPAN

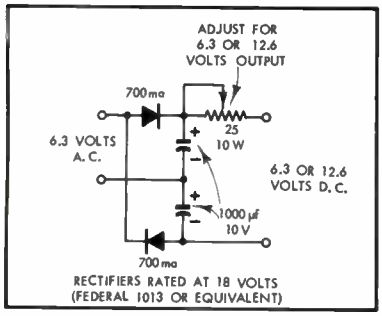


Fig. 7. Construction of a d.c. heater supply.

Re-Orienting the Motor

The transport motor is a major potential source of hum picked up by the playback head. Sometimes hum can be significantly reduced by re-orienting the motor, namely rotating it a number of degrees about its axis. If the motor is suspended by three bolts, as is frequently the case, one can then turn the motor 120 deg. in either direction.

Relocation of the On-Off Switch

It is common practice for the on-off switch to be located on the gain control of the tape amplifier. However, the 60-cps current at the switch creates a minute hum field which may be picked up in significant quantity by the gain control, particularly if the control is situated at an early stage of the amplifier so that there is a great deal of subsequent amplification. Installation of a separate toggle switch, as in *Fig.* 8, for turning the tape machine on and off can sometimes effect a worthwhile reduction in hum.

Adding Filter Capacitance

If hum is of the 120-cps variety—that is, pitched an octave higher than the 60-cps hum encountered when bringing a screwdriver or similar metal object close to the playback head—it may be possible to reduce it by adding filter capacitance, as in *Fig.* 9. Additional capacitance of about 30 to 60 μf will usually prove effective, particularly when added to the filtering stage closest to the rectifier stage. Of course, it is possible that a filter capacitor has opened or greatly decreased in value, so that one is really replacing rather than adding capacitance.

Shielding the Playback Head

Normally the playback head is partly encased in Mumetal or other special material designed to prevent hum pickup. In addition, the better tape machines surround the heads with a heavy shield with an aperture just wide enough to permit the tape to pass through. In other machines, a piece of Mumetal or other shielding material is sometimes mounted on the pressure pad holder so that when the pad is brought against the playback head the shield guards the face of the head against hum. As illustrated in *Fig.* 10, it may be possible for the handy audiofan to rig up something of this kind himself. In addition to Mumetal, one can use Co-Netic for shielding purposes, or even a piece of silicon steel, fashioned from a transformer lamination. Co-Netic is very easily cut and bent to the desired shape.

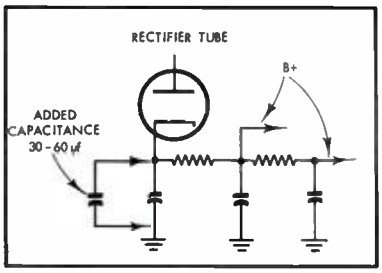


Fig. 9. Adding filter capacitance to reduce hum.

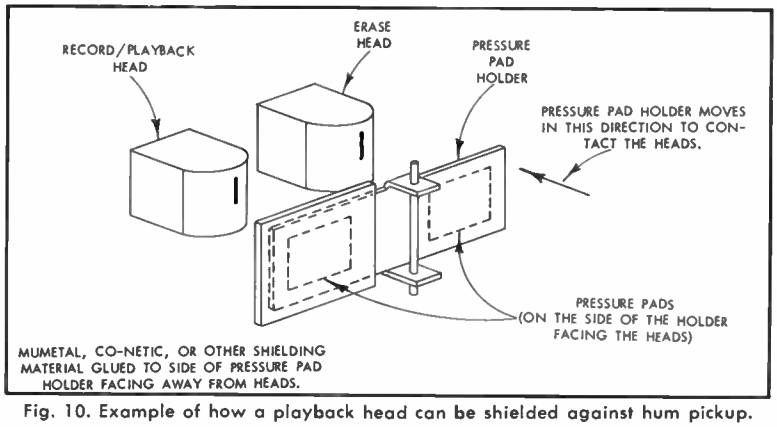


Fig. 10. Example of how a playback head can be shielded against hum pickup.

Shielding Other Components

If hum is picked up by the playback head from the motor or power transformer, it may be possible to remedy this situation by placing a shield around the offending component. The shield may consist of Mumetal, Co-Netic, silicon steel laminations, or copper.

Defective Playback Head

Most playback heads have two windings which, when properly connected, serve to cancel hum picked up by the head. However, if for any reason the windings are electrically unequal, cancellation will be imperfect, resulting in an increase in hum. Shorted turns in one of the windings could produce such a situation. Replacement of the head is then called for.

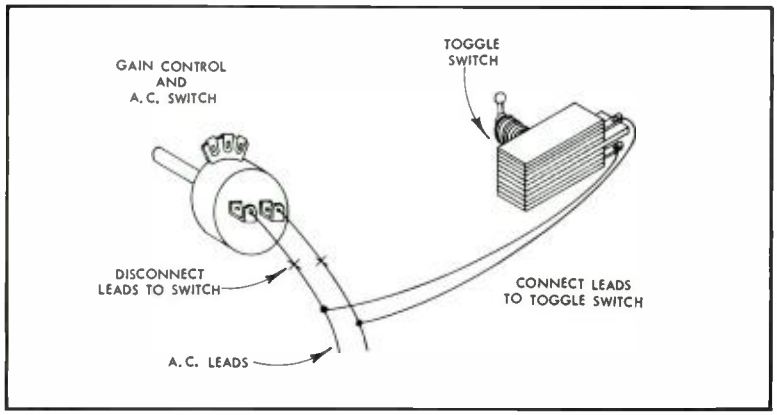


Fig. 8. Installing a separate on-off switch to reduce hum pickup.

Substitution of Resistors

One of the principal sources of noise—high-pitched rushing or hissy sounds as contrasted with hum—is the garden-variety resistor. Imperfect contact of the particles within the ordinary molded carbon resistor results in internal arcing and consequent noise voltages. It is generally possible to obtain a substantial reduction in noise by substituting resistors with low-noise properties in the first stage or perhaps in the first two stages of the tape amplifier. Such resistors are called for in the plate, cathode, and grid circuits.

Wire-wound resistors have the best noise characteristics, but they are also quite expensive, as much as $2 or $3 apiece. Moreover, since they consist of a number of turns of wire, they may be-

(*Continued on page 74*)

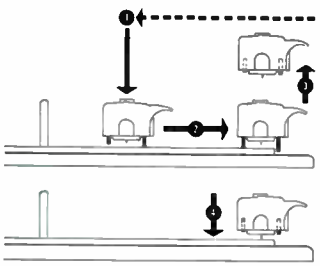
because you get authentic high fidelity stereo and monophonic reproduction *plus all these extraordinary features*

SINGLE PLAY TURNTABLE — For unrestricted *manual* play, you can place the tonearm anywhere on the record while turntable is either motionless *or* rotating. For fully *automatic* play, just press START button. In both cases, the tonearm can be moved about at will, returns to rest after play... and the motor shuts off.

AUTOMATIC RECORD CHANGER — Simply change spindles — nothing else to do. Only three buttons let you start, stop, reject, or repeat. Further, you can always rearrange a stack of records even while a record is playing!

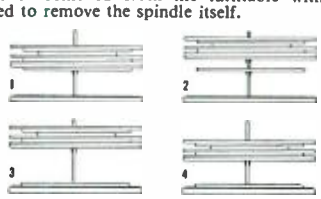
TRACKS AND TRIPS AT AS LOW AS 1½ GRAMS — That's why you can use the most sensitive *turntable* cartridges with high compliance styli not ordinarily recommended for automatic equipment. This ensures extra long life for *all* your records.

FOOLPROOF RECORD INDEXING — The roller-feeler guides in the tonearm *measure each record individually*, letting you intermix *any* size record (even under and oversized "standard" records) in *any* sequence. Eliminates need for troublesome mechanical linkages and arbitrary set-screw adjustments. Can't miss!



1. When START button is pressed, tone arm moves toward center. 2. With wheels down, arm glides lightly over top unused surface until outer wheel locates exact outer edge. 3. Arm rises and wheels retract. 4. Arm gently descends to play.

ELEVATOR ACTION CHANGER SPINDLE — There's no pusher arm to chip record edges, no spindle offsets to enlarge center holes. The entire stack is lifted off the bottom record to let it descend gently to the turntable. Records can be removed from the turntable without need to remove the spindle itself.



1. Record stack ready to play. 2. Stack separates from bottom record. 3. Bottom record descends. 4. Stack gently lowers for next play.

POWERFUL RUMBLE-FREE MOTOR— So powerful, in fact, that the Dual's heavy turntable can reach full RPM in less than ¼ turn from a dead start! And, because of its exceptionally high quality and exclusive rigid-equipoise suspension, rumble is eliminated at the *source*.

LAMINATED AND CONCENTRICALLY GIRDED TURNTABLE — Can't go out of round, can't warp, can't wobble. Dynamically balanced and rotates on heavy duty ballbearing. Result: professional performance.

CHOICE OF REPEAT — Now you can either repeat the same record *indefinitely*, or just once with the *self-cancelling* REPEAT button.

THE DUAL 1006

combination turntable/changer

IS YOUR ONE LOGICAL CHOICE

Tested and acclaimed by technical and consumer reporting organizations, the United Audio Dual-1006 is unquestionably your best value at only $69.95

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PRODUCTS OF DISTINCTION

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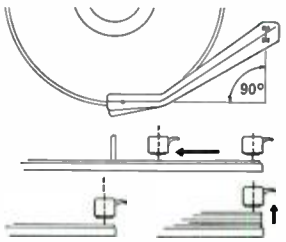
CONSTANT SPEED CHANGE CYCLE — You get fast record change regardless of playback speed, because the Dual has an independent auxiliary transmission used only for cycling.

ONE-PIECE PROFESSIONAL TONEARM— Avoids distortion of cartridge output and multiple resonances common to two-piece arms. A double set of ballbearings in *each* axis provides the perfect arm motion — lateral *and* vertical — vital for stereo tracking.

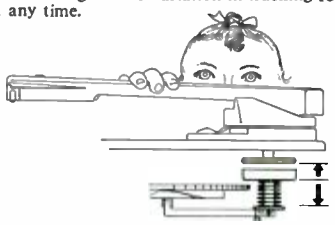
PERFECT TRACKING



Always perfect vertical and lateral stereo tracking because arm pivot axis remains 90° to cartridge axis.

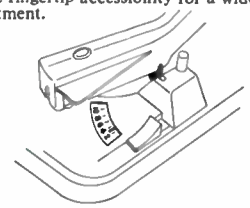
AUTOMATIC GEAR DISENGAGEMENT—No need to remember "neutral," no worry about flat spot thump... because *all* of the individual speed gears and the idler disengage after every play.

JAMPROOF TONEARM SLIP-CLUTCH — Even if the tonearm is restrained while cycling, no damage will result, because it's engaged only by an ingenious slip-clutch which provides the further advantage of totally disengaging the arm during play. This allows the arm to track freely, with no drag and no variation in tracking force at any time.



INTERRUPT PLAY AT ANY TIME — You can stop and start again, any record exactly where you want—even during automatic changer operation —without affecting the cycling action.

BUILT-IN STYLUS FORCE MEASURING GAUGE Direct reading, easy to use, and conveniently located for instant check. No guesswork. And you have fingertip accessibility for a wide-range of adjustment.



LOCK-IN CARTRIDGE HOLDER — Lets you interchange cartridges instantly, effortlessly; takes all standard-size cartridges.

MULTI-PURPOSE STEREO/MONO SWITCH — Adapts your stereo cartridge for mono output, at the same time completely eliminating random noises from unused groove. Very convenient too for balancing stereo speaker systems.

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At last, from Electro-Voice — the makers of the incomparable Patrician — a new concept of high-performance, low-resonance speaker systems. Listen to the new sound, note the naturalness . . . especially in vocal renditions. Relax, listen for hours without fatigue. Enjoy full range . . . from the soft sound of background music to the full dynamic response of orchestral climaxes. Whether your taste runs toward the economical Leyton or all the way to the "Patrician" of small speaker systems — E-V's new Royal 400 — you can't buy a better speaker system. Ask your dealer for a demonstration.

**All systems are illustrated with E-V's new Stereons for true 3-channel stereo. Esquire, Regal and Royal use Stereon 300 at $49.50 each. Leyton matches Stereon 100 at $34.50 each.*

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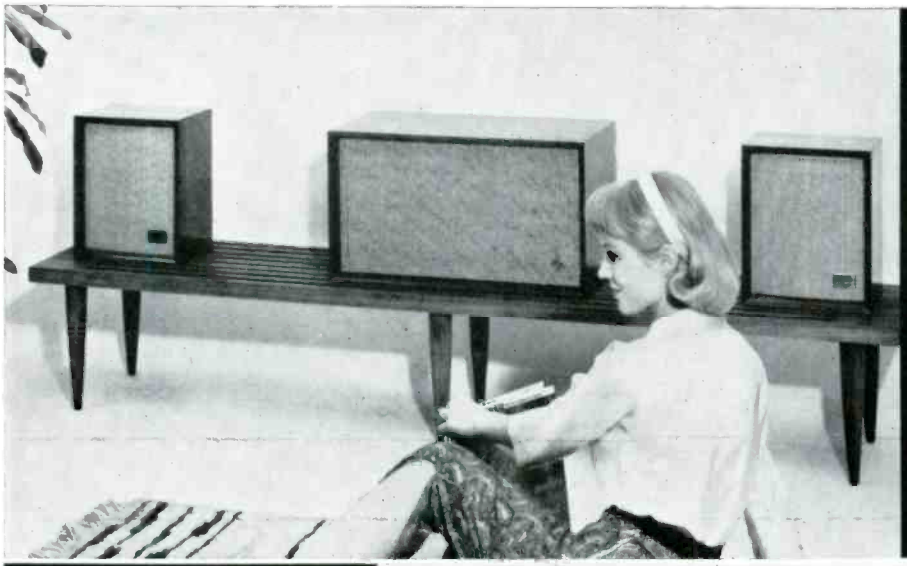

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3-way economy system
12" woofer
8" midrange
compression HF tweeter
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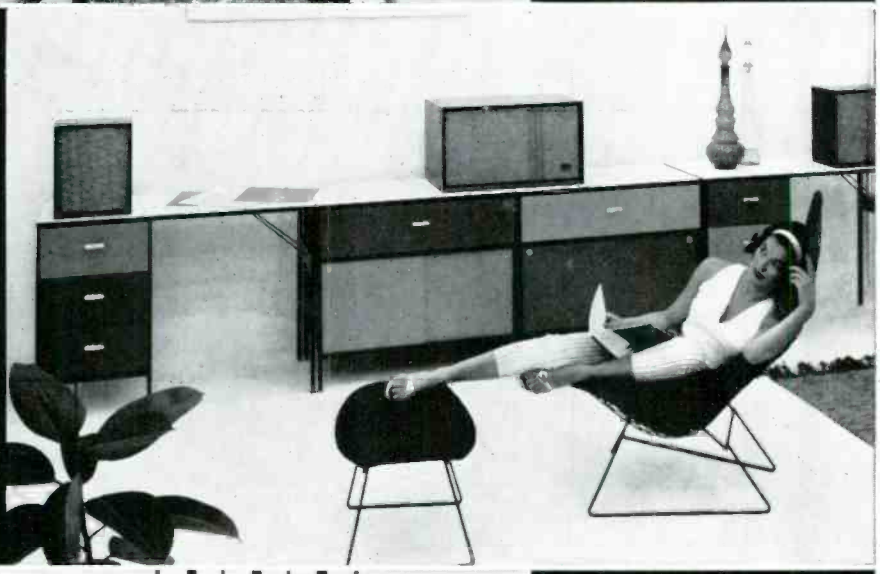

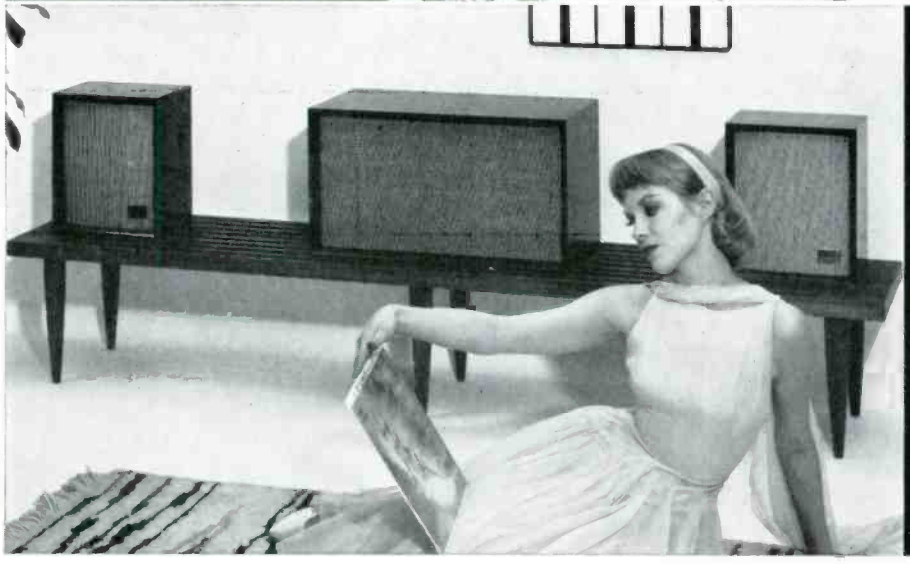

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12" woofer
8" midrange
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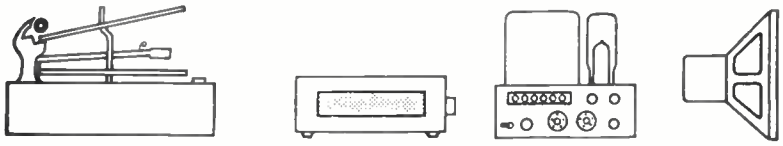


HARMAN-KARDON CITATION II STEREO BASIC AMPLIFIER KIT

Ever since the first announcement of Harman-Kardon's two Citation kits, the audio fraternity has been anxiously awaiting the actual appearance of these units on dealers' shelves. Since they are priced rather higher than most kits, there were some who felt that when the audiofan *could* afford to spend that much money he would probably prefer to buy a factory-built amplifier. On the other hand, there were many who felt that while they could afford that amount of money, they wanted better quality than it would buy ready-made, and that therefore they could get top-quality merchandise at quite a saving.

When we first heard the Citations—I is a stereo preamp, II the power amplifier—at a press showing, our immediate reaction was that one listened *through* the amplifier system clear back to the original performance, and that the finer nuances of tone shading stood out clearly and distinctly for the first time. Now that we have assembled the Citation II for ourselves and have had an opportunity of "living with" the completed unit for a couple of weeks, we reiterate the same opinion, and add to our original impression some further comments.

The quality of reproduction reminds us of the solidity of Western Electric theatre amplifiers of some years ago—the 50-watt units using a pair of 284-D triodes with 1250 volts on the plates. The bass is clean and firm, and for the first time we noted that the low-frequency end appeared to be present even at low volumes without the need for the usual bass boost. This is, we are told, due to the elimination of phase shift in the low-frequency range, and in the words of the amplifier's operation manual, "an amplifier having a wide frequency response at usable power levels below 5 cps has a tight and clearly defined low end, particularly in the 40 to 100 cps region." Whatever the reason, there is no denying that the performance is really outstanding.

The operation manual also tells us that "a similar condition applies to the performance of an amplifier in the high-frequency spectrum. If an amplifier limits its high-frequency response to slightly above the limit of audibility, it may have a tendency toward strident reproduction and poor differentiation of instruments in the high overtones. Conversely, an amplifier which has a frequency response beyond 100,000 cps without evidence of ringing or instability with reactive loads will offer clean, transparent tone qualities in the higher frequencies with excellent instrument separation." Most high-quality amplifiers today have good response in the high-frequency region, but some have been observed to become unstable under varying loads, and it must be admitted that the impedance presented to the amplifier by a loudspeaker varies constantly throughout the audio spectrum. We could find no evidence of instability in the Citation II with capacitive loads from .001 up to 15 μf, although the response began to fall off, as observed on a 1000-cps square wave, with loads above 6 μf. Inductive loads ranging from 1 to 10 mh showed no effect on the output wave whatsoever.

Circuitry

The Citation II, engineered by Stewart Hegeman, consists of two identical amplifiers powered by a low-resistance doubler circuit employing silicon rectifiers with more than adequate capacitance and a choke for filtering. The output stage of each amplifier uses a pair of KT88's, driven by a long-tailed pair of 12BY7 video pentodes as a phase-splitter, which is in turn preceded by another 12BY7 as the input stage. Relatively low plate loads are employed throughout, and feedback is applied in three separate loops—one from each driver plate to its own grid, one from each output-tube plate to the opposite driver grid, and one from the secondary of the output transformer to the cathode of the input stage. Each feedback loop is compensated for phase shift, with the result that the equivalent of 30 db of over-all feedback is reached.

Output-tube bias is separately controllable for each of the four tubes, with a built-in meter indicating the normal plate current. In addition, an a.c. balance is provided to compensate for different values of gain in the two halves of each amplifier which might result as tubes age, with the optimum setting also indicated by the meter. The two output transformers and the power transformer together weigh 50 pounds in their shipping box—cardboard, and of little weight—which is, in itself, an indication of the quality of transformers. It is almost an axiom with amplifiers that the quality of the output transformer is proportional to its weight.

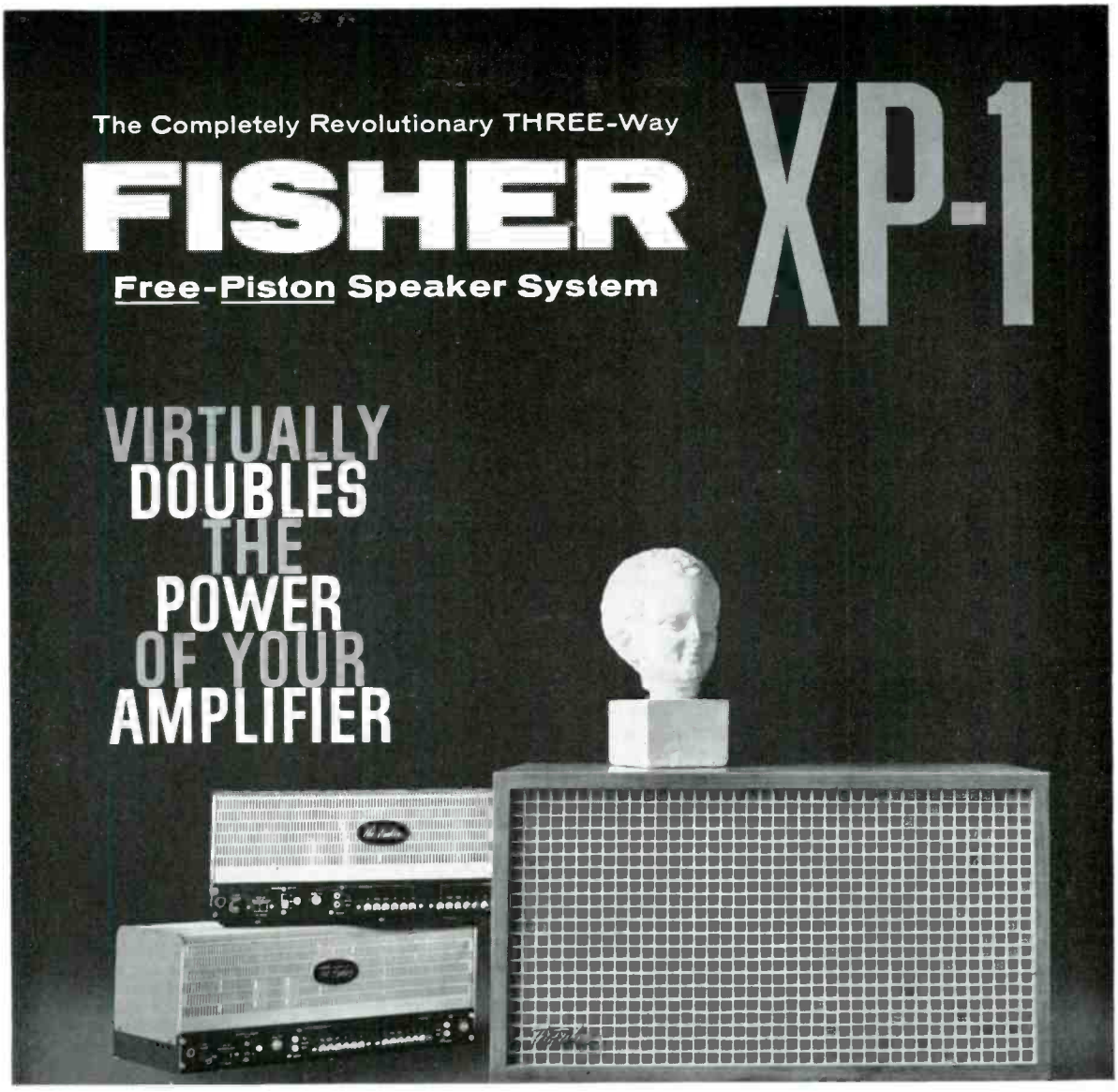
The Citation II is not small—measuring 16⅜ in. wide, 11½ in. deep, and 9 in. high—and completed it weighs a total of 60 pounds. The unit, shown in *Fig.* 1, is finished in charcoal brown and gold, and a protective screen is available when the unit is to be installed where the tubes should not be exposed. Over-all power consumption is 350 watts, and no power switch is provided on the chassis, since it is likely that the user would control power from the preamplifier position.

Performance

Specifications for the Citation II call for an output rating of 60 watts per channel, with a peak power output of 130 watts per channel. IM distortion is rated at less than 0.5 per cent at 60 watts, less than 0.2 per cent at 20 watts, and unmeasurable at normal listening level. Harmonic distortion is rated at less than 0.5 per cent at 60 watts from 20 to 20,000 cps, less than 0.1 per cent at 20 watts, and unmeasurable at normal listening level. Frequency response is rated at 18–40,000 cps +0, −1 db, at 60 watts; 12–60,000 cps +0, −1 db at 20 watts, and 2–80,000 cps +0, −1 db at one watt.

Our own measurements gave IM figures of 0.35 per cent at 60 watts, .08 per cent

Fig. 1. Harman-Kardon's new Citation II basic stereo amplifier constructed from a kit —or available completely wired.



A magnet assembly *92% more efficient* than that employed by conventional bookshelf speaker systems, plus free-piston cone action for distortion-free response—these are but a few of the reasons behind the unparalleled performance of the XP-1. Its superiority can be discerned subjectively, in the quality of its sound—and *objectively*, by means of this simple comparison test:

■ Visit your dealer. Ask him to connect the XP-1 to any power and program source. Then, *without* changing the volume control setting, replace the XP-1 with a similar speaker, containing an identical degree of damping and with comparable magnet size. To attain the same level of sound reproduced by the XP-1, *the competitive speaker must be driven by almost twice the power!*

■ For that reason, the XP-1 can even be used with modest ten-watt amplifiers. Frequency response—*uniform* from 30 cps to well beyond the range of audibility. Hermetically-sealed enclosure, free of nails and screws. Finished on all sides. Available in Mahogany, Walnut or Cherry. **$129.50**

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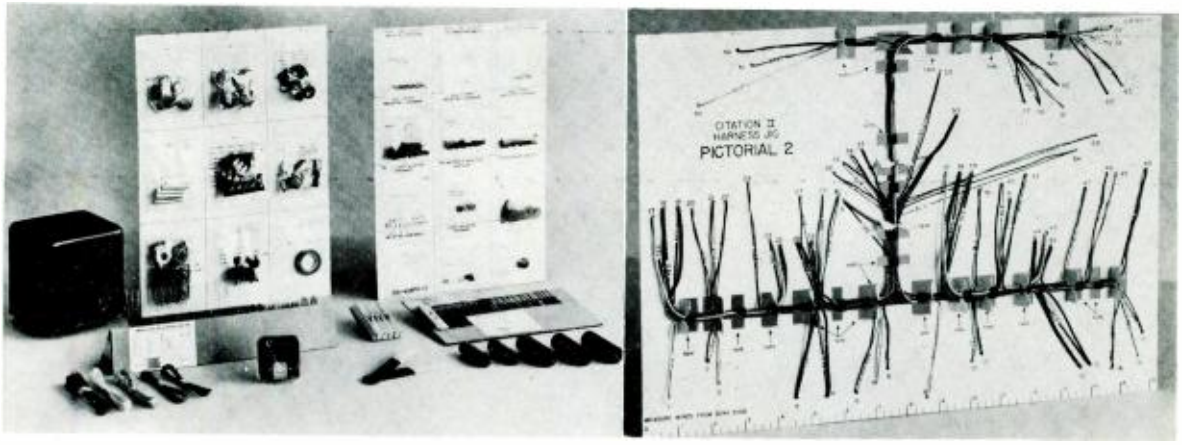

Fig. 2 (left). Packaging of kit parts in separate transparent bags makes identification simple, keeps parts separated. Note resistors in corrugated cardboard holders. Fig. 3 (right). Harness jig makes it possible for even the most inexperienced to fabricate an acceptable and neat harness for most of the wiring.

at 20 watts, and less than .05 per cent (which is essentially unmeasurable) from 10 watts down. Harmonics were measured at 60 watts, as follows: 20 cps (0.24 per cent), 100 cps (0.20) 400 cps (0.17), 5000 cps (0.16), 10,000 cps (0.30), and 15,000 cps (0.32). At 20 watts and over the same range of frequencies the highest distortion measured was .08 per cent, and at 2 watts the distortion was the same whether we measured the output of the oscillator alone —about .03 per cent—or with the amplifier in the circuit.

It is the firm policy of this department that no kit amplifier is ever profiled unless it is sent as a kit, to be assembled by us. This stand is taken because it is felt that the instruction book is a vital part of the kit, and unless the instructions are so clear and concise that an inexperienced constructor can end up with a satisfactory amplifier, the entire kit is a poor value. Thus we know that the Citation we built was not specially "groomed" for the measurements, nor were tubes matched especially for each location. With this knowledge, we feel that the measured figures are outstanding. Frequency response measurements were at least as good as the specifications, and hum and noise measured at 75 db below 1 watt, which is somewhat better than the rated 90 db below 60 watts. We feel that for comparison purposes the hum and noise rating should be made with a definite level, rather than to the maximum or rated power output, because regardless of the power of the amplifier, it is likely that the normal listening level in the home will be about the same. Thus while 90 db below 100 watts, for example, is the same as 70 db below 1 watt, if one compared such a 100-watt amplifier with a 1-watt amplifier, the former would appear to have a much lower hum level because of the higher numerical figure. However, let it be said that about 65 db below one watt is practically inaudible on even an efficient speaker.

Construction Details

The Citation II kit itself deserves some mention as regards the way it is packaged. Small parts and hardware are put together in polyethylene bags and stapled onto cards with descriptions of each. For example, all of the 4-40 screws for mounting the six noval sockets are in one bag, the lock washers in another, and the nuts in a third. All 6-32 hardware is similarly separated into three bags, as are all other hardware items. Furthermore, the 4-40 hardware is all gold colored, the 6-32 hardware black, and the heavier screws and nuts are cadmium plated. The small resistors (½ watt) and the ceramic capacitors are carried in a corrugated cardboard strip, as shown in *Fig.* 2, which keeps the leads straight and keeps the parts separated and easily identifiable. The strip is die-cut so it folds over to form a holder on the bench. The larger resistors are carried on another die-cut strip. Wire is furnished in nine colors and in two weights of insulation and the instructions make it clear which is to be used in each place, and a wire stripper is included to simplify the work.

Much of the wiring is in the form of a harness, which is likely to be a mystery to most constructors, but the cardboard jig shown in *Fig.* 3 even simplifies making the harness. The jig is die-cut, and turn-up flaps are provided with slots in which the wires are fed, one by one, with the lengths shown on the step-by-step instructions, and holes provided on the jig so that the leads extend the right amount at each end. When the harness wires are all laid in place, they are taped together, avoiding the need for learning the more complicated lacing technique.

Most of the small resistors and capacitors are mounted on a terminal board which is stenciled to show part numbers and the required strapping between the heavy terminal lugs. The terminal board mounts on stand-off rods, and wiring from the harness connects to the lugs before the resistors and capacitors are installed. *Figure* 4 shows a portion of one of the full-size pictorials furnished with the kit. Previously installed parts are shown in light outlines, while the steps covered by each pictorial are shown in heavy black lines for complete clarity. Even the transformers are shipped in individual close-fitting cardboard boxes which, after the covers are removed, are left on the transformers and serve to protect the finish until construction is completed.

It is obvious that considerable thought has gone into the preparation of the Citation as a kit, in addition to the many hours of development work which must have preceded the finalization of the circuitry itself. But when the amplifier is completed, the user may be assured of having a unit he can be proud of and one which will give him a quality of reproduction at least as good as any he has ever heard—and likely better.

The kit is a joy to construct, and the average construction time should be around 12 hours for the novice, 8 to 10 for the more experienced. **A-30**

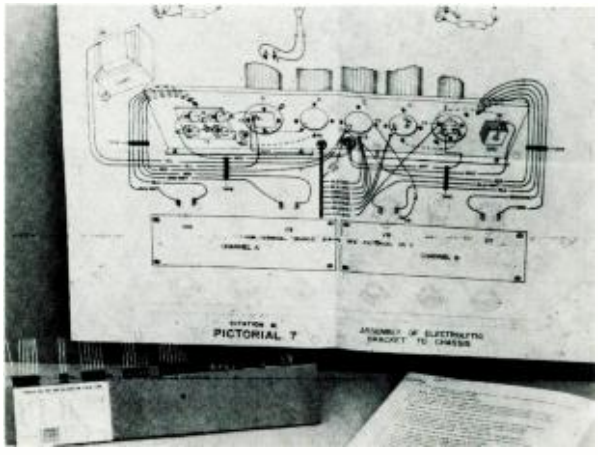

Fig. 4. Full-size pictorials clarify the work so each step can be followed readily.

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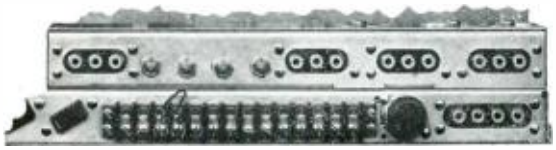

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(*from page 14*)

neat, good looking speaker systems placed at the optimum listening points in the living room. But for whatever myopic reasons that may apply, this is still beyond the scope of flexibility for most of the home-machine makers. The concept of the phonograph—any phonograph—as an "it," rather than "they," is too solidly entrenched, even after a dozen years of multiple-component hi-fi. (See my own book of 1953 and 1955, "Home Music Systems," where this singular concept was explored at length.)

The more conscientious manufacturers have done what they could, in this one-piece frame of reference, and we thus have a variety of special types, the simplest of which is the most effective—and the most evasively advertised—the "extra" speaker attachment, at extra cost. I suppose it has to be said all over again: if we do that in autos, then we might as well expect it in phonos too.

"Extra" equipment or standard, what counts in this arrangement is the match between the two speakers—for in many cases the "extra" cabinet is not equal to the built-in system. If adequate separation is the first stereo essential, then matched speaker sound is definitely the second, even if it is a question of matched fifty-centers, exactly alike.

I think the most ingenious of these compromise one-unit stereo systems are those wherein the speakers—or one speaker system, at least—are removable complete, inner cabinet and all. That really is having your cake and eating it, with excellent results and no indigestion. But it's an expensive idea at best, the cabinet-within-a-cabinet system.

Of course, I'm prejudiced in all of this, in that I was pre-sold on the advantages of component hi-fi years before there were any stereo phonographs and I am firmly persuaded that stereo has at least doubled the attractiveness—the necessity—of the component approach. And so you will forgive me for being a bit cynical about one-cabinet home stereo—to me, it just defies common sense, caters grossly to public prejudice, to false and fuzzy thinking, plays up people's supposed "wants" to the detriment of their own enjoyment and to the emptiment of their purses for no good purpose.

But stereo does seem to be booming in single cabinets. Maybe I'm the only one who . . . well, hardly that. But I do think we should all spread the true stereo gospel or, should I say, spread the speakers. Tell everybody that stereo is true and fine, even at $29.99—*if* your speakers and you make a nice, fat triangle with you on the fat side.

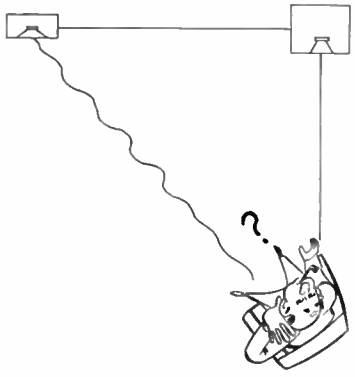
Just tell them, too, that a scrawny triangle, a thin, aenemic one with you at the sharp point, is a stereo gyp at any price at all. That ought to do it.

2. THE THIRD CHANNEL GOES TO WORK

Well, then, how about so-called three-channel stereo? As far as the bome machine of the preceding account is concerned, my frank opinion is that it needs three "channels" like I need three eyes. If the two speaker systems of the standard arrangement are going to be crammed together so close that stereo separation is all but non-existent, then it is the acme of redundancy to derive still a third "cbannel" from those two and squeeze it in, however you may, between the two that are already too close. Talk about three being a crowd! And yet, there are several lines of home phonographs that now advertise "three-channel" stereo, showing pictures, as per the above, of furniture cabinets in which there is barely room for one channel, let alone three.

Maybe these people have some way of justifying such a procedure to themselves, but they'd have a hard time convincing me. I've been trying it out on my own. But the funny thing is that, actually, I'm sold on three-*cabinet* stereo. Sold, that is, for certain purposes. The three-*cabinet* system works surprisingly well when you put it to work at seven or eight feet or more separation.

As I mentioned last month, I've been playing around with a home-made "Pilot" three-speaker system, an amplifier modified to give me, in addition to the regular pair of channels, a third that is A plus B, the two channels combined additively. There are numerous ways to do this—just hooking up your two channels in parallel is *not*



What counts is the match between the two speakers.

one of them—but surely one of the most intriguing is the above-mentioned "Pilot" arrangement, whereby the output transformer "zero" points are shifted upwards to the electrical center of the transformer (4 ohms) instead of the normal end positions, the feedback is readjusted and the center speaker feed is taken from the outside ends of the two transformers. (See *Fig.* 7, p. 116, October AUDIO.) Call it, as Pilot does, "stereo-plus" or what you will, it is a relatively simple arrangement and in an amplifier built specifically for the purpose can be set up with few complications, as far as I can see.

I'll leave the circuitry again to the mercies of those of you who know more about it than I do; I'm interested in the results. My first step was to doctor-up an amplifier of very simple pretentions, a little Eico, a stereo job that give out all of a dozen or so watts, both channels, and doesn't even bother with a preamp for magnetic pickups. (Thank you, I wasn't going to dicker with the insides of a bigger amplifier until I found out whether it was going to be worth it.) It turned out to be a simple job for my assistant engineer, who just happens to work for Eico and was in a position to rescue us from dire trouble in case things got too mixed up! As it turned out, we didn't need to run to the Eico people, who probably did not much approve of this operation on their baby, anyhow. It worked quite easily and gave us three 16-ohm outputs, power very close to the original output and no noticeable change in sound quality, at least to my ears. In our set-up we necessarily used a ceramic cartridge, but I'm eventually going to feed the output of a stereo preamp into the system so that we can use magnetic cartridges—by that time, however, we'll probably have another and larger amplifier modified; for I have every intention, at this point, of making a semi-permanent three-way installation in my New York apartment. That's where it worked out best.

Given three more or less equal outputs derived in this manner (or by any one of numerous other center-speaker set-ups), what can you do? Where and how is it useful?

The Wider Spread

Three-speaker stereo is a surprisingly good proposition only when you deal with *widely-spaced* stereo reproduction. I mean really wide. I started at around standard separation in my medium-sized living room, and moved all the way out to maybe twenty or twenty-five feet. The further out the side speakers were placed, the more useful and effective was the center speaker. To put it another way, the center speaker enables you to spread your speakers further apart, to widen the angle between them and you and so provide "bigger," fuller stereo sound without losing the center of the stereo picture. In cases where the speakers *must* be spaced rather widely, as in my apartment living room, the center speaker becomes virtually an essential. But closer than seven or eight feet, it is mostly useless.

I have a plaguey piano on the long wall of this particular room and, after much trial (thanks to irregularities at both ends of the room) I found that the only possible placing for two stereo speakers was one on each side of the piano—which is no baby grand but a relatively big "parlor" model of around 1905 or so. That puts them a good ten feet apart, what with the shape of the walls and other considerations of passage and of piano bench space.

From the sofa opposite the piano, the speakers are at best too widely spaced, at an angle that strains the stereo center pretty thin, to put it mildly. There isn't any hole in the middle; there is just a sort of over-emphasis on the sides of the music and a rather unconvincing placement of the central portions, the solos, and so on. They are in the center, but tenuously so. A bit too much movement while listening and I find them off in one of the speakers—while the orchestra smears itself sidewise in the same direction. No—definitely *not* a hole. (I phase my speakers right.) But not a solid wall of sound, either.

Center Volume Control

An essential part of the third speaker output is, of course, a volume control, ideally a T or L pad affair. (See diagram as mentioned above.) We had an old rheostatish object lying around and it does well enough for me, though the taper is entirely in the last quarter of its rotation. No need for finer precision than this gives us so long as there is a no-signal point and a full-signal point and a fair adjustment between.

If you build a third speaker arrangement, you will find that this volume control is extremely important. In our trials, we found quickly that for many records the optimum center volume was somewhat less than the full output of the circuit. But since the center speaker has rather precise effects on the apparent placement of the sounds, and since records differ radically

in their stereo, there were numerous times when the volume could be adjusted all the way from zero to maximum with interesting usefulness.

Definitely, it should not be set, fixed, for all recordings. Often, even with very wide speaker spacing, you will want no center speaker at all. Just confuses the issue, dilutes the effect. For—never forget—too much center is the same thing as a heavy dose of mono sound. It *is* exactly that, this center signal; it receives basically the mono portion of the total signal, the parts that are alike in both channels, the sounds that belong in the center. But blow those sounds up too high, relatively, and the mono aspect begins to dim the stereo.

I noticed this particularly in relation to that most subtle and sensational of all stereo effects, the "wall-bounce" stereo liveness. This sound, the sound of being inside a big hall, is the essence of the improved realism in many stereo record, esspecially in the classical field. Shift from stereo to mono and you hear it go away, for a deader, duller, more distant effect. Switch it back—and "you are there," practically in the stereo space.

Now in this respect the center speaker can be subtly devastating. The sound from the center adds nothing to the stereo reverberation. It detracts from it, in the degree to which it is a mono sound. The very first effect I noticed when I brought the center speaker in was the change in the liveness—away from stereo, towards the mono. Therefore, other things being equal, you must be careful with your center speaker, adding only as much as will leave the stereo liveness undamaged. And that, of course, depends on the liveness itself, on the stereo recording's particular character.

The Bulge In The Middle

But other things are not equal, and the center speaker has some more strikink effects, in two related ways. 1. It does fill out and strengthen the center area. 2. It also tends to "pull" the actual spacing towards the center position. This second effect is well worth studying.

It works this way. Take an average symphonic record, well spaced out, the violins on the right, cellos on the left, various brass and percussion sounds here and there, all of the sound at enough distance, in enough space, so that it appears not *at* your speakers but around and behind them. In the center of such a stereo spread you will hear the parts of the orchestra that belong dead-center—perhaps an oboe, or the violas in front; and you will also hear the soloist, if any, in a central position on most records. (A few put them to one side for special effect.)

Now in rightly phased and balanced two-chaunel stereo these central sounds will always be straight ahead. They may be weakly placed and inclined to jump to the sides, but if you are on the right spot, even with widely spaced speakers, you'll hear them in the middle. When you bring in your third and center speaker, straight ahead of you (under my piano), these center sounds do not move. They just get louder and, seemingly, *closer*. With extra center volume you can bring them right up front, though the effect is apt to be false and undesirable.

On the other hand, those sounds which are at the sides do not stay put; they move inwards as you bring up the center-speaker volume. A group of strings that seemed to be behind the right speaker when only two speakers were used is heard to move over towards the middle; at top center-volume they play from halfway be-

(Continued on page 61)

Record Review

EDWARD TATNALL CANBY*

Dear Rdr:

As stacks of new records keep growing, my conscience waxes uneasily (how else can it wax, after all?) as to our perennial problem of coverage. So much wonderful material at hand and more coming all the time.

To my surprise, though, I find I can listen to more records than I can write about. Writing, may I suggest, isn't easy—especially when it must come out *sounding* easy. (That's when you work the hardest.) So I've tried a new trick this month, with partial success. I pledged myself to cram at least two reviews onto every narrow-columned page of my chicken-track typing, come what would. The challenge, in this New Year resolution, was to make a half page say what could so easily run to four or five sheets of deathless prose. An excellent idea, wasn't it?

Ah, resolutions! Luckily, I'm not paid by the word, so the problem was strictly in the realm of writesmanship. I did pretty well, as you'll see, but I'll admit that some of those single typed pages came out in two parts, the second marked "page one, cont."

Yrs succnctly,

ETC

SATURDAY NIGHT & SUNDAY

Gold Coast Saturday Night. Saka Acquaye and His African Ensemble.
Elektra 267-X stereo

This interesting stuff is that newly popular sort somewhere between the untouched "folk" and the sophisticated Western-style entertainment. These people try hard to be Western," but their very attempts have an exotic flavor (probably quite unbenownst to themselves) that is charming. A mixture of primitive instruments and singing plus the expected outlander night club sort of material. What'll you bet it was recorded in New York.

On the Road to Elath. Oranim Zabar Israeli Troupe. **Elektra 156**

Here is one of those topical sound-documents in entertainment form that blossom with the political and geographic winds; a group of Isrealis sing songs of the Negev, ostensibly out of the back seat of a desert jeep, complete with accordion. Frankly, I think this sort of show conveys lots of special emotion but not much of anything musically inuportant. It just goes along, full of pep and a mixture of very conventional Western harmonies plus near-East inflection. Judge for yourself whether it's for you. Lots more of similar nature from Elektra, and nobody will challenge the genuineness of the feelings conveyed. It's just the music itself. . . .

Tom Glazer Concert—for and with children. **Washington WC 301**

The "with children" aspect of this intrigued me, and I'll admit the kids love it, all thousand or so of them, in this Saturday-morning type audience! Glazer has them in his pocket and no two ways about it. Only trouble is, the music really isn't much though the songs and words are amusing. Let's just not call it a concert but let it go as a darned good kids' entertainment.

A Yuletide Song Fest (For the Entire Family). Rosalind Elias, Giorgio Tozzi; Chorus, Orch. Lehmann Engel.
RCA Victor LSC 2350 stereo

As I say each year, an Xmas record that's worth listening to ought to stand up at least until January 15. This one most certainly will not. It is the dismallest potpourri of forced, rigged Xmas good humor I ever heard and, I suppose, was mainly issued not for the Entire Family—Heaven forbid—but probably with an eye to department store public address systems, beginning around Thanksgiving week. I trust most copies are safely worn out by now.

What a way to treat two perfectly good operatic singers.

Carols of All Seasons. Jean Ritchie, with dulcimer; R. Abrahamson, harps., LaNoue Davenport, recorder. **Tradition TLP 1031**

I'm sure Jean Ritchie is human enough to have hoped for department store profits on this one, too, but some artists just can't do anything but the artisttically right thing, no matter how they try. This disc will endure all 366 days of this fine Leap Year and you won't put it aside even then. They are mostly our own native carols out of Kentucky and from England; Ritchie sings them with exquisite taste and musicianship—how many opera singers have a tenth of her musical sense!

Polish State Folk Ballet Slask. (Solos, chorus, orchestra.) **Monitor MF 325**

It's pronounced "Schlonsk" if you want to know, and this is the ballet that came to New York recently for a big show, via S. Hurok, no less. The deal might seem pretty commercial, and this recording is put on with much slickness and impressively large forces, but I liked most of it a lot, all the same.

The iron-curtain countries have evolved a peculiar sort of popular folk music that comes off remarkably well, all things considered. It is highly organized, its music "arranged" for huge orchestras, fancy chorus singing and solo work, but somehow it does retain not only a real spontaneity and excitement but also a considerable—even an astonishing—degree of so-called authenticity. These people really sing as though they loved it, and the effect is practically never that of the professional, hired entertaining group. Good! The old-fashioned tunes are highly catchy, too.

Prokofiev: Sinfonia Concertante for Cello and Orch., Op. 125. Shostakovitch: Concertino for Two Pianos. Rostropovitch, cello; Leningrad Philharmonic, Sanderling; Maxim and Dmitri Shostakovitch, pianists. **Monitor MC 2040**

Sputniks—yes; but no stereo from Russia so far. Instead, we've been getting very high grade mono tapes, typified by this excellent disc.

The late Prokofiev piece is wonderfully played by Russia's odd-ball top cellist (I watched him in Philadelphia last fall—where he didn't play as well as this). The warm, popular-style piece is music to hear, often quite beautiful if for our ears somewhat uneven. The piece has a rival recording—done in the West by the very same cellist, on exchange tour.

Shostakovitch and his son Maxim play the short, brilliantly conventional Concertino for two pianos (without orchestra) and you'll find it interesting if a bit tame. Works up to a good climax.

The Birth of Christ. Netherlands Chamber Choir, de Nobel. **Epic BC 1041 stereo**

This earnest, expressive Dutch choir has sung before on records, to my great pleasure. These are almost twenty short unaccompanied motets of the sixteenth century and early seventeenth by such as Lassus, Palestrina, Sweelinck, Handl, Hassler, Clemens non papa (the Clemens who wasn't the pope!), Praetorius—a roster of names familiar to all who know the music of this period. The singing is most musical and full of understanding; I can feel reservations only about a certain too-metrical quality, marching along in fairly strict time—but this is minimized by the excellent phrasing and pronunciation. Another all-year-'round disc.

Brahms: Liebeslieder Waltzes, complete (Opp. 52, 65). Elsie Morison, Marjorie Thomas, Richard Lewis, Donald Bell; Vronsky and Babin, duo-pianists.
Capitol SG 7189

They've done it again—put down still another version of these ever-fresh vocal waltzes just like too many versions in the past, sung by big, wobbly, operatic sololists who, for all their earnestness, simply kill this music's spontaneity and verve.

I don't know just what singers Brahms had in mind, almost a century ago, but I'm dead sure it could not have been this type. When sung by whole groups of simpler voices, college amateurs, choruses and the like, the waltzes come into their own today, and those who've tried them know just what I mean. Unforgettable, delightful. Take out the wobbles, remove the vocal fuss and feathers, and then you really have something.

The four-hand piano parts are nicely done by Vronsky and Babin—*they* sound like a Liebeslied should.

Beethoven: The Early Quartets (Opus 18, #1–#6). Budapest Quartet.
Columbia M3S 606 (3) stereo

Which is preferable—the brilliant young artist, at the top of his technique, full of confidence and skill but raw in experience, or the long-time professional, veteran of thousands of performances, whose muscular skill is on the wane, whose verve is tempered by time and too many repetitions, but who knows the musical secrets that come, and come only, from long, exacting, profitable experience.

Here are four such artists, making one artistic group. They play all six of the first group of Beethoven quartets, on three stereo records. Enough said.

Bab Ballads and Cautionary Tales. (W. S. Gilbert, Hillaire Belloc.) Stanley Holloway and Joyce Grenfell.
Caedmon TC 1104

Are you a Gilbert & Sullivan fan? Prick up your ears, then, for here is Gilbert minus Sullivan, in the oft-mentioned Bab Ballads that

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NEW!!

nobody ever gets around to reading. Belloc is more of the same, more or less.

Both poets write humorously in rickety verse about all sorts of odd and preciously improbable people, mostly small kids of the Dennis-the-Menace or Eloise type. Tell the truth, I enjoyed Belloc more than Gilbert; the combination of Joyce Grenfell's throaty, maddeningly reasonable voice and Belloc's racy whimsy is quite priceless. Wonderful party stuff!

Gilbert's somewhat tamer fancies, including the well known "Wreck of the Nancy Bell" (with its very polite cannibal sailor), somehow don't stand up by themselves as well as the similar Gilbert that attached itself to Sir Arthur Sullivan's music with such wonderful verve. G & S definitely beats just G. But this is a nice record side, even so.

Boogie & Blues. The Aristocrats. **HifiRecord R610**

Not bad. Even I, classical soul that I supposedly am, found these three guitar boys lots of fun to listen-to-and-relax. Guess they must be pretty good and there's no doubt about the slickness and polish of their arrangements, for two electric guitars and . . . well, uh, something that looks like a guitar that didn't stop growing. (*Electronic bass?* ED.) Just the three of them and they make an unusually docile sound without the familiar rhythm effects that come in most pops packages.

Fancy hifi, from half-inch tape via AKG, Neumann, and Teldec.

John Williams Guitar Recital. Washington WR 424

According to Washington, this "nineteen year old" star, out of Australia and England, was born in 1946 and gave his first recital in 1951. Somebody got absent-minded on that, but admittedly the youth is a fabulous guitar technician and could well grow into a worthy successor to the great Segovia, who has hailed him as a chip off the old block (he didn't use those words).

Williams plays straight through a long Bach suite (originally cello) and a brace of semi-modern items including the now familiar First Etude of Villa-Lobos, with extraordinary ease and fluency. Somehow, his musical sense could use more developing—as is to be expected in a young artist. There's that wholly natural feeling that his style and expression are mostly unoriginal, learned—with ease—from his immediate guitar sources. Give him another ten years. . . .

An Anthology of Guitar Music. Charles Byrd. **Washington WR 411**

This companion release is much more recondite, played by an older guitar man who here assembles an interesting collection of sixteenth century Spanish music for the *vihuela*, an aristocratic double-stringed earlier relative of the guitar and a Spanish alternative to the ever-popular lute.

The younger guitarists, like other modern players of instrumental music, tend to keep a rigid beat in their music—where old Segovia played his guitar classics with much sweet sliding and slurring, the tempo practically buried in *rubato* (expressive slowings-down). This man Byrd plays straight ahead with nary a glance to right or left; if he doesn't audibly tap his foot, you're likely to tap yours. The effect is one of initial monotony, but the sense of the music in the end is much clearer, I'll have to admit.

The music, by names like Valderrabano, Mudarra, de Narvaez, as well as Luys Milan, is characteristically sixteenth century (and it is the model for much familiar British Elizabethan music), sturdy tunes of a square, folkish sort, very simply harmonized and elaborately ornamented with runs and *arpeggio* broken-up chords. Byrd knows the stuff well and makes it sound human, understandable. But don't expect any flamenco—it's another age.

FANCY SINGING

Mahler: Lieder eines fahrenden Gesellen; Kindertotenlieder (Songs of a Wayfarer; Songs on the Death of Children). Christa

Ludwig; Philharmonia Orch., Boult, Vandernoot. **Angel 5-35776 stereo**

What a beautifully recorded disc—and what incredibly expressive music! These two sets of songs with orchestra are done here with a warm, solicitous British touch, slowly for the most part, exploiting every curve of melody and shade of instrumentation; the two performances are similar in this, though the conductors are different. A superb stereo orchestra—note, for instance, the startling sound of a nasal oboe, almost off-mike at the back of the stage. The singer is held to a surprisingly low volume level, as in an actual concert, quite OK for direct stereo listening. Spatially she tends to wander a bit, perhaps due to confusing wall reflections.

Christa Ludwig sings superbly, though much of the music is low for her. A trace more volume would add recorded drama—but maybe this new quiet style of solo recording is good for us to get used to, in stereo. Much more natural.

Mozart: Cosi fan tutte. Della Casa, Ludwig, Loose, Kunz, Dermota, Schoeffler; Vienna State Opera, Orch. Boehm. **London OSA 1312 (3) stereo**

A wonderfully lyric, lively, but never bumptuous "Cosi" with an impressive set of star voices to sing the humorous double-take pairing of two couples, the husbands out to prove their wives' constancy by seducing them in disguise—each the other's girl. An odd plot; the two gals might as well be one, they are so much alike and sing so often in duet, and so also with the hubbies.

My album lacked the libretto—shocking! So I couldn't even decide who was singing what, though I suspect the more lithesome, flexible soprano is Christa Ludwig (of the utterly different Mahler song, above) and the more florid soprano is Della Casa. One of the husbands blurs his pitch now and then, but both are dynamic and musical; the musicianship throughout is top-level with that gentle, warm Viennese quality so appropriate to Mozart.

The stereo is imaginative. The abundant recitative is spread out, conversationally, not so much in motion (which is confusing) as in sharply contrasting locations at different times. The orchestra is slanted towards the left, the singers make a balance, closer, on the right side mostly. The pair of couples in their nicely balanced pairs of arias has each a spatial location, to keep things straight. All in all, this is the best and most constructive operatic stereo I've yet heard and worth close study (along with the music itself) by all interested parties.

Prokofieff: War and Peace. Soloists Nat. Opera of Belgrade; Vienna State Opera Orch., Vienna Kammerchor, Werner Janssen. **M-G-M 3 GC-2 (3)**

"War and Peace," after the famous Tolstoi novel about Napoleon's invasion of Russia, has been waiting a long time for an appearance in America and many record owners will jump at this chance to hear it complete in its final version—medium length. (The first was insufficient, the second too long.) The opera was begun just before the war but got its further impetus from the Hitlerian invasion, so arrestingly like that of Napoleon.

Those who knew Prokofieff's earlier big-scale works of patriotism, especially the film music (and concert cantata) for "Alexander Nevsky" will know what to expect here. The work, for our ears, is spotty, with mixed values., though the Russians themselves may have their own ideas on this score. There is superb music throughout, an enchanting waltz scene (and a "valse triste" theme that is haunting), plus that stark, grand, military music for which Prokofieff is already famous. There are big choral scenes, and an end full of rejoicing that—again for us—turns corny and overblown.

It would be foolish to toss this aside as mere politically inspired propaganda music; Prokofieff was much too big for that. But you can't help wondering what he could have done if a more original idiom had been possible for him. Idle speculation—what is here is worth many a playing, and you can follow the story in English and Russian (Western

alphabet) as you go along. The oddly international cast does a brilliant, slightly hysterical job, full of drama and sincerity; the mono recording is excellent.

Mozart: The Marriage of Figaro. Tozzi, Peters, Della Casa, London, Elias; Vienna Philharmonic, State Opera Chorus, Leinsdorf. **RCA Victor LSC 6408 (4) stereo**

This recording, which has been "selected" by the Metropolitan Opera—whatever that means—is the type which has finally made the Met's singing a success on discs, after some pretty dismal failures in past years. The backing-up forces are not from the Met at all but strictly top-Viennese, and the locale is Vienna, too. The singers are out of the RCA American stable, and the Met's, though they have their own musical lives as well, of course. The conductor is again RCA and Met property.

This combination—with heavy stress on the Met aspect, in the album's publicity—is actually a good example, of the best Metropolitan opera style of production, as American as all get-out wherever the personnel may have come from. It is loud, dramatic Mozart, strong and somewhat brash but enormously professional; there isn't a trace (in the singing) of that slightly dewy sentiment that comes over most Mozart in Austrian or German productions, yet there's nothing careless or musically sloppy to provoke criticism on grounds of musical accuracy.

Skillful stage gusto, not very profound, is the way I'd put it—the style is more Rossini than Mozart and could easily become slapstick if it weren't so expert. Mozart lovers will probably be wounded at a great many points but I'll have to credit these performers for putting over a lot of the real iron in Mozart's semi-satire. No harm done there.

With libretto in hand, you'll find the complex stereo stage motions both interesting and helpful; but you must know *exactly* what is going on. For more casual listening, this sort of stereo is apt to confuse; there's too much and too constant motion yet without enough precision to keep the singers' feet on the ground—they seem often to sail vaguely through the air, hither and yon. Disconcerting. Better, I say, to simplify and exaggerate the stereo placement, as London does; you can't be literal anyhow, and you might as well not try.

The big Viennese orchestra, draped around the rear, is just wonderful—and it stays put, too.

SYMPHONY ORCHESTRA

Overtures by Weber. Philharmonia Orch., Sawallisch. **Angel S 35754 stereo**

Rossini Overtures. Paris Conservatoire Orch., Maag. **London CS 6089 stereo**

Suppé Overtures. Hallé Orch., Sir John Barbirolli. **Mercury SR 19016 stereo**

Here is the audible history of the Nineteenth century overture on a trio of fine discs—you'll be dizzy if you play them straight through, but a sampling of one or two of each at a time is most rewarding. No wonder the overture as such became so popular as an independent musical form! The type is sure-fire; almost every one begins with a solemn or mysterious idea (occasionally set off by some sudden loud motto), followed for minutes by sweet, slow, leisurely Romantic dalliance in musical terms (with all that big orchestra just waiting to go), often no more than a single cello solo or the like—then suddenly, bang! and we're off in a whirlwind of sound. The endings are typical, too, full of brass and cymbal clashings, loud, triumphant repeated chords. Yes, it was a grand time for the overture, back in those days.

If you'll start with the least of these three, von Suppé, you'll be gratified to find him quite surprisingly interesting, in a not too profound way. Last time I heard "Poet & Peasant" was on a mechanical carousel organ—I found the original to be a "real good piece." So, too, with the others, most of which in these imaginative Barbirolli readings will be fresh and new for your ears.

Moving on to Rossini, you'll encounter a

bigger mind, that still knows how to turn out an effective show piece with all the trimmings and no great profundities either; he's just more original, more electric than Suppé. And as for Weber, the earliest of the three and the best, his music is just plain superb, in overture after overture. Weber has the *umph* and drama of the other two, but his musical ideas strike suddenly deep, to bring the tears to your eyes. A great man and splendid musical dramatist, his music unusually well sensed by the British orchestra under the German conductor.

All three bring stereo's dramatic advantages, in the Suppé from Mercury a close-up, sharp clarity a bit on the dry side, in the Weber just the opposite, Angel's being a warm, bosky, golden liveness, somewhat distant. London hits a very pleasant medium point, right for Rossini, who needs to glitter a bit.

Schubert: Symphony in C Major ("The Great"). Boston Symphony, Munch.
RCA Victor LSC 2344 stereo

There have been some splendid releases in this Boston Symphony stereo series, with Munch. This one strikes me as a fifty-fifty proposition.

Lady of my acquaintance recently heard the BSO (Boston Symphony) "live," on tour in New Haven, Conn. She's a regular subscriber. Dear me, she said, they play so *loud*.

I think I know what she means. This performance has the big, impressive effect demanded by the symphony, and not always achieved in today's hectic-paced stylings (the Toscanini version, for example); this one is both note-perfect and style-perfect, for the BSO is a very skillful ensemble of top-rank players. But, somehow, Munch whomps up every climax a bit beyond its due; the utterly lovely detail, again and again, are given merely an accurate lip-service, so to speak, without great conviction. It is an outward performance of a work that is all inward beauty.

Nothing wrong with RCA's fine BSO stereo, as effective as anything in the business.

Beethoven: Symphony #6 ("Pastorale"). Vienna Symphony, Dorati.
Epic BC 1038 stereo

Most surprising. On another label, with his own home orchestra, the Minneapolis, Dorati has struck me again and again as a hard, driving, often unmusical conductor. Here is a sweet, yielding, gentle, ever-moving "Sixth" that I found unusually good. Is it the Viennese players, who know this music so intimately? Is it in part the difference in mike technique—whereby Dorati's home-grown readings are made exaggeratedly hard and driving via closeup mike accentuation? I suspect both elements are involved, but I do recommend this version as in excellent taste and style, very musical. Could also be a good combination of Dorati drive with traditional Viennese softness.

Beethoven: Symphony #6 ("Pastoral"). Vienna Philharmonic, Monteux.
RCA Victor LSC 2316 stereo

Oh-oh. Now here's still another Pastoral" (RCA likes it without the final e) and the orchestra is "almost" the same as in the Epic—moreover, the over-all qualities are similar to that in the Dorati-Epic version. Would that I could compare the two in detail, and at length! It would be well worth it, time and space allowing. But I can say that both display a fine sense of the rather touchy and exacting style needed for this tricky work, with all its tone painting. Out of dozens of recordings, only a handful really hit it right in this respect; these two do it.

"Papa" Monteux, remember, is one of the best and most musical of older conductors, French but broadmindedly so, and good in any music he chooses to conduct. It's a privilege to hear him with a Viennese orchestra.

Schumann: Symphony #1 ("Spring"). Manfred Overture. Cleveland Orch., Szell. Epic BC 1039 stereo

Szell's Cleveland Orchestra is getting hot-

(Continued on page 69)

CHARLES A. ROBERTSON*

STEREOPHONIC

Quincy Jones: The Birth Of A Band
Mercury Stereo SR60129

When an aspiring leader receives a guarantee of two years work, the time has come to believe in the return of big bands. An auspicious beginning like this, of course, is dependent on unusual circumstances. Quincy Jones has supplied original scores and arrangements for some of the leading jazz organizations in this country and Europe, but his experience as head of such a group is limited largely to recording studios. The chance to strike out on his own arose due to Harold Arlen's need for an orchestrator with a knowledge of jazz. The composer's new musical, "Free and Easy," had fallen heir to the numerous troubles that can come from trying to mount a blues opera in the same manner as the ordinary Broadway show. On the advice of that tireless worker behind the scenes, John Hammond, the job of reshaping the score was given to Jones.

Hammond is credited also with the idea of having *bona fide* jazz musicians, dressed in the 1890 costumes of the show's period setting, grace the stage during performances and play at dances and concerts while on tour. An assignment to assemble the group launched Jones on his new career. And the promise of a lengthy engagement brought some of the best musicians in the business into the fold. The show will tour Europe and return in the spring to make its American debut, reaching New York after playing in San Francisco and Los Angeles. Following the December opening in Amsterdam, the itinerary lists Brussels, Munich, Essen, Stockholm, London, and possibly some cities behind the Iron Curtain.

Before departing these shores, the band was able to make its recording debut, playing numbers to be featured at its appearances apart from the show. Not everyone present at the studio left on the trip and the band may be completely different by the time it gets back, but the program gives a good sampling of the varied treats in store for jazz fans overseas. For dancers, there are *Tuxedo Junction*, with Harry Edison and Sam Taylor, and *A Change Of Pace*, which bears a close resemblance to Ellington's *In A Mellotone*. Bobby Timmons' tune *Moanin'*, as arranged by Jones, becomes a real crowd pleaser. For the serious listener, there is Clark Terry's soulful trumpet on *I Remember Clifford*, and Zoot Sims' tenor-sax solo on *Whisper Not*. Bob Fine, the engineer at the session, centers the saxophone soloists, in stereo, and places the section at the left with Milt Hinton's bass. The brass and drummer Sam Woodyard are on the right.

Dukes Of Dixieland: The Dukes At Carnegie Hall
Audio Fidelity Stereodisc AFSD 5918

Something about Carnegie Hall brings out the best in any performer, and all its magical properties were at work on the night in 1958 when the Dukes of Dixieland stepped on stage. On this recording of the event, the little group from New Orleans is completely at ease before the ovations of an audience that packed the house to overflowing. The melodic introductions, provided on *Tin Roof Blues*, help create an atmosphere favorable to an amiable review of such past successes as *Royal Garden Blues*, and *Muskrat Ramble*. Fred Assunto slips into his trombone specialty on *Slide, Frog, Slide*, and stops the show as usual.

A pair of show tunes prove to be wholly in character. Kurt Weill's *Mack The Knife*, with brother Frank carrying both vocal and trumpet honors, is especially adaptable to New Orleans style improvisation. Meredith Willson's *76 Trombones*, with Papa Jac making a belated entrance to complete the trombone team, moves along briskly to a traditional marching beat. Eugene Bolen, an asset throughout, plays a moving clarinet solo on *Yellow Dog Blues*, and soars above the ensemble on *Sweet Georgia Brown*, which brings a memorable evening to a rousing close. Stereo adds to the depth and definitions, without being too directional.

Recording techniques have improved considerably since a single microphone was hung over the Carnegie Hall stage at the first Benny Goodman concert, but the auditorium still lends a special sound to a recorded concert. It has qualities of depth and presence not found in a studio, although some halls in other cities are more generally acclaimed. It happens to be located in Manhattan, however, where it will be sorely missed should the new buildings at the Lincoln Center of Performing Arts turn out to be no more suitable for recording than London's Royal Festival Hall. Perhaps the richer disk jockeys could buy the place, thereby turning a share of their profits back to the record companies. With reduced rates after midnight, it could operate twenty-four hours a day and might break even as a combination recording studio and concert hall.

Coleman Hawkins: Hawk Eyes
Prestige Stereo 7156

This is free and easy mainstream jazz, heard as it heads with undiminished vigor into a new decade. The lead has always indicated his liking for a stomping band, even stating that he would rather work in rock and roll than not play at all, and allows nothing to inhibit him here. The one ballad, *La Rosita*, on which the Hawkins tenor tax is the lone horn, finds him rhapsodizing in brisk and assertive fashion. His own blues composition, *C'mon In*, checks out at twelve minutes and he is still going strong when it fades away on his final chorus. Trummy Young's *Through For The Night*, a smartly-styled riff tune, receives forceful treatment.

Joining him in the sextet is the irrepressible Charlie Shavers and their swift exchanges on the title tune are very effective in stereo. Besides indulging in his customary open-horn dynamics, the trumpeter turns in a fine muted chorus on the blues. Ray Bryant, a perfect pianist for the group, delivers an expressive solo on a blues contributed by drummer Osie Johnson. Bassist George Duvivier and guitarist Tiny Grimes complete the rhythm section, which is well distributed in stereo.

Lionel Hampton: Hamp's Big Band
Audio Fidelity Stereodisc AFSD5913

When Lionel Hampton makes one of his frequent television appearances, the leader leaps from the piano to drums or vibraphone, pausing momentarily in mid-flight to deliver a hasty vocal chorus, while the band is heard dimly in the background. On this occasion, both the star attraction and a full crew of nineteen men have time to stretch out. Although Hampton runs through a number of his specialties, he does so as an integral part of the band, setting a lively pace on *Flying Home*, and *Air Mail Special*. His drum gymnastics receive the active support of drummers Wilbur Hogan and Charlie Persip on *Hamp's Mambo*, all three being spread across the stereo stage. Guitarist William Mackel helps drive the leader's piano home on *Hamp's Boogie Woogie*, and returns to exchange solos with flutist Bob Plater on *Elaine & Duffy*.

The arrival of Cat Anderson, a guest artist borrowed from Duke Ellington's trumpet section, is the signal for the band to take off its wraps. A high-note expert who practices more than two hours every day to keep in trim, Anderson is somewhat of a maverick when soloing on his own, being inclined to bolt into the stratosphere at the slightest provocation. Since last playing for Hampton back in 1943, he has trained on the showpieces and seemingly impossible brass climaxes which Ellington wrote to accommodate his specific talents. But his real alter ego is still Hampton, who gives him a prodigal son's welcome by way of extended solo space on *Big Brass*, and *Le Chat Noir*. Anderson uses the knowledge gained from Ellington to play with admirable taste. The band backs his dazzling technique exuberantly, mounting massive sonorities on *Night Train*. There can be no doubts about Hampton's band after this, and the recording is excellent.

Joe Wilder: The Pretty Sound
Columbia Stereo CS8173

Jonah Jones: Swingin' Around The World
Capitol Stereo ST1237

A happy aftermath to the rise of Jonah Jones on the list of best-selling LP's is the number of opportunities offered to his fellow trumpet luminaries. The latest to bid for public approval is Joe Wilder, a veteran of the Lionel Hampton and Count Basie band, who is also no stranger to the pretty sound. It earns him a pretty good living in television studios, enabling him to relax later on jazz dates. This is the first time it has been exploited to such a degree on records, and the pleasure is all yours and mine. Wilder is featured on romantic ballads, helped out by Jerome Richardson, Urbie Green, Hank Jones and other accomplished players. Included are *Harbor Lights*, *Blue Moon*, *Greensleeves*, and Brahms' *Lullaby*.

Meanwhile, Jones continues on his merry way, calling at such ports as *Shanghai*, *Brazil*, and *Isle Of Capri*. Many rivals have tried to imitate his style and capture his formula, without success. As Wilder makes no such attempt, the two albums complement each other to perfection, and the trumpet sounds are beautifully recorded.

Shelly Manne & His Men Play More "Peter Gunn"
Contemporary Stereo S7566

Elmer Bernstein: Staccato
Capitol Stereo ST1287

A new front line swings into action to aid Shelly Manne in the drummer's second encounter with the music from "Peter Gunn." Richie Kamuca, tenor sax, and Joe Gordon, trumpet, join in the free improvisation on the Henry Mancini television themes. As the originals in these episodes contain more solos, the sextet takes greater liberty with time signatures and tempos. There is no need to play for visual impact, only aural. Manne, apparently having just listened to Max Roach, trips into three-quarter passages on several occasions. Vibraharpist Vic Feldman again doubles on marimba, creating a beautiful sound in stereo.

Elmer Bernstein conducts three groups of different sizes on his modern jazz score for a

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competing series. Rumor has it that the show will undergo considerable alterations, possibly dropping the jazz backgrounds, although the one time I watched the faults were every place but the score. Some of Bernstein's concepts seem too large for a 21-inch screen, being more suited to a movie theater. Mancini made the walking bass his trademark, and Bernstein might look for some simple device that would be equally popular. Bernstein was the first to break the barrier in scoring for the movie "Man With the Golden Arm," and his work is well worth study. As the liner fails to list personnel, possibly because many of the soloists are under contract to other labels, you need to be a detective to discover the operatives.

Art Farmer: Brass Shout
United Artists Stereo UAS5047

Stepping out of his working role as a tenor-sax improvisor, Benny Golson conducts a basic jazz brass ensemble, augmented with French horn, tuba, and baritone horn, on seven of his own orchestrations. Although several of his compositions are noted as vehicles for trumpet players, this is the first time he has attempted so ambitious a project. As principal soloist, Art Farmer interprets an exacting variety of moods, earning the nominal title of leader. His clean, lyrical trumpet voice is the answer to the arranger's desire to get "a round, full sound out of the horns, instead of the usual brassy blare."

Golson attains this effect most dramatically on ballads, obtaining a sound close to that of a symphonic band. Here the intent is to reach a wider audience. Should the same people who enjoy hearing a featured cornetist in front of the Goldman Band also like Art Farmer's solo on *April In Paris*, it is no accident. Golson deserves a commission to compose for a full symphonic band, provided there is time left over to write such driving jazz originals as *Five Spot After Dark*, and *Minor Vamp*. The French horn of Julius Watkins, the tuba of Don Butterfield, and the baritone horn of James Haughton are all splendidly arrayed in stereo by engineer Lewis Merritt.

Count Basie: Basie/Eckstine, Inc.
Roulette Stereo SR52029
Van Alexander: The Home Of Happy Feet
Capitol Stereo ST1243

The sound of yesterday becomes as fresh as that of today on these two albums. With or without the Count at the piano, the Basie band is in great demand to lend support to vocalists of varying degrees of ability. This time its efforts are on behalf of one of the best, and Basie is willing and eager to enact the role of the leader who gave Billy Eckstine his start. As the singer recalls the days spent with Earl Hines and at the head of his own band, Basie provides the steady pulse of the blues on *Don't Cry Baby*, *Jelly Jelly*, and *Stormy Monday Blues*. Both are in rare form while paying tribute on *Piano Man*, aided and abetted by the rhythmic chording of guitarist Freddie Green. The stereo spread is just right and the voice unencumbered by echo.

While still in his teens, Van Alexander began arranging for Chick Webb and knew the Savoy Ballroom from the inside. He offers new arrangements of a dozen jazz classics created by bands that made the place their home. There are Webb's *Let's Get Together*, Teddy Hill's *Uptown Rhapsody*, Don Redman's *Chant Of The Weed*, and Ellington's *East St. Louis*. Plas Johnson, on tenor sax, duplicates Pha Terrell's vocal on *Until The Real Thing Comes Along*, and Shorty Sherock plays Red Allen's trumpet chorus on *Ride, Red, Ride*. The original arrangement, which made Alexander and Ella Fitzgerald famous, is followed on *A-Tisket A-Tasket*. Some of the best Hollywood musicians are distributed about the studio and Capitol turns out its usual fine big band sound.

Annie Ross: Gypsy
World Pacific Stereo 1028

Both collectors of Broadway musicals and jazz fans should be pleased with the chance to hear Annie Ross singing about the trials

and tribulations of the Lee family. No song belter (except when hitting a trumpet riff), the better third of the Lambert-Hendricks-Ross vocal trio is winningly feminine on *Everything's Coming Up Roses*, and does the 'boy song' of the show as *All I Need Is A Boy*. Even Ethel Merman, as a stage mother, might blush at the slightly naughty version of *Let Me Entertain You*. Buddy Bregman leads his dance band on an overture and provides a skillful setting for the singer. Besides being a nephew of Jule Styne, the composer of the score, he has backed Ethel Merman on all her television appearances. All in all a swinging delight, and the stereo sound is wonderful.

Larry Adler: Harmonica Virtuosa
Audio Fidelity Stereodisc AFSD5916

In the first sentence of an entertaining set of liner notes, Larry Adler states quite honestly that he is no jazz musician. Part of this disclaimer is due to the fact that he has no consistent desire to play his harmonica like a horn, preferring at times to adopt the phrasing of a violin or the cascading obligattos of a harp. On many of his lyric passages, the sound resembles that of Eddie South, and his more intense moments are apt to remind one of Stuff Smith or Ray Nance. He does confess to a genuine liking for jazz and its players, selecting Ruby Braff and Ellis Larkins as fellow soloists on a dozen tunes.

Adler was the first American to win the Grand Prix du Disque, acquiring the prize in 1953 with a recording of Jean Wiener's *Le Grisbi*, a blues theme from a French gangster film. Improvising on it again for the benefit of stereo, he accounts for some remarkable playing and evokes a scene of melancholy beauty. One of Adler's own movie scores is the source of *Genevieve*, a lilting waltz, and Rodgers and Hart are represented four times. There are also two songs from "Porgy and Bess," Harold Arlen's *Blues In The Night*, and Ellington's *Sophisticated Lady*. Larkins proves again to be a sensitive piano accompanist, while Braff's trumpet sorties add a touch of spice and color. The stereo version furnishes the harmonica with an ideal setting amongst a rhythm section.

Robert Merrill: Take Me Along
RCA Victor Stereo LSO1050
Hal Holbrook: Mark Twain Tonight!
Columbia Stereo OS2019

The stereo versions of both these Broadway productions contain elements to commend them above the monophonic. In a lightning display of how fast it can get a hand in the till, RCA Victor had plain ordinary LP's of "Take Me Along" in retail stores on the day the show opened. Customers who wanted to hear the original cast singing the Robert Merrill score in stereo had to wait two or three weeks longer. Their patience was amply rewarded. By now it should be general knowledge that the highlights are the vocal duets, and these are the numbers which stereo enhances best. Jackie Gleason engages Walter Pidgeon on the title song, Robert Morse declares an adolescent's love to Susan Luckey, and Gleason returns to spar with Eileen Herlie, who seems destined to carve a niche beside Bea Lillie and the late Gertrude Lawrence, Capitol should have demanded that she do an album in return for the loan of Gleason. Stereo also brightens such scenes as the opening parade, the volunteer firemen's picnic, and Pidgeon shuffling merrily through the old soft-shoe. Lehman Engel conducts with his customary buoyancy.

Until Hal Holbrook is heard pacing the stereo stage and delivering Mark Twain's words of wisdom from calculated vantage points, it is reasonable to doubt the need for recording a monologuist in stereo. But listen to carefully timed afterthoughts or witty ripostes to his own remarks, as they come from unexpected quarters, and be convinced. The New York critics were unanimous in praise of the actor's performance, and in the words of William Dean Howells about Twain, "he gathered that audience up in the palm of his hand and tickled it."

Cecil Taylor: Looking Ahead!
Contemporary Stereo 7562
Cecil Taylor: Love For Sale
United Artists Stereo UAS5046

About the best thing that can happen to a new jazz artist is to have a great deal of controversy thunder over his head. It is louder and attracts more attention than paeans of praise. Notices of Cecil Taylor's challenging piano explorations have ranged from an abrupt dismissal to such detailed analysis as to surprise even him. His third and fourth LP's are in current release as a result, and it seems likely that each stage in his future development will be exposed on records. On Contemporary, he plays five originals, including one named for Fats Waller, and his own version of Ellington's famed subway ride, now retitled *Excursion On A Wobbly Rail*. The trio becomes a quartet with the addition of Earl Griffith, a vibraharpist capable of complementing the leader's style. Although lacking Taylor's imagination, his one piece of writing, *African Violets*, is well worth hearing.

That even such prickly characters as Taylor are responsive to recognition is shown on his work for United Artists. Like a cactus flowering after rain descends on a desert garden, the pianist bursts into full bloom on three Cole Porter songs. With Rudy Collins, a new drummer, and Buell Neidlinger, his associate from the start on bass, he applies his magical formula to the title tune, *Get Out of Town*, and *I Love Paris*. Anyone who has yet to meet Taylor is advised to make his acquaintance here, with the warning that it may lead to an acquired taste and end in the purchase of his other LP's. Blue Note intends to reissue his initial album from the Transition label. Ted Curzon, trumpet, and tenor-saxist Bill Barron are added on two Taylor originals. Both recordings were made at Nola Studios and the astringent piano sound is clearly defined.

John Klein: A Christmas Sound Spectacular
RCA Victor Stereo LSP2023

Although this item arrived too late for review before Christmas, it is being brought to the attention of those audio fans who might like a 1,453-bell carillon in the living room. If they do not agree that it is the most spectacular sound on records today, the manufacturer promises to refund the purchase price, provided the record is returned by January 31, 1960. John Klein plays the Carillon Americana, said to be the largest in the world, at the Schulmerich Carillon Studio in Sellersville, Pa. An electronic instrument, its design permits direct pickup and no open mikes are needed to record the dual sets of bells. These are rung from a two manual keyboard, making an ideal setup for stereo. A lively chorus and orchestra help out on a dozen tunes, and an informative booklet is enclosed. Component dealers will find it ideal demonstration material at any season of the year. On a dismal afternoon in March, nothing promotes a feeling of affluence and general goodwill like the sound of *Jingle Bells*.

MONOPHONIC

Bob Gibson: Ski Songs **Elektra EKL177**

After all the tall tales have been told and the group singing begins, skiers can finish off an evening now by working out on eleven of their own songs. Bob Gibson, a folk singer of some repute, knows the hazards of the ski run and relates a number of perils and pleasures learned from experience. Accompanying himself on banjo and 12-string guitar, he tells of *Highland Lassie, Bend In His Knees*, and *Ski Patrol*. Many of the tunes are familiar, including *Battle Hymn Of The Republic*. There is a lament for the arrival of spring, but none for a January thaw. Perhaps the next collection will contain one, along with a dirge set to *When The Saints Go Marching In*. AE

ABOUT MUSIC

THE MUSICIAN'S SCHEMATIC

HAROLD LAWRENCE*

TO THE LAYMAN, the full orchestral score of *The Rite of Spring*, with its profusion of staves, notes, numbers, and verbal indications in Italian is as formidable a sight as the intricate schematic of a stereo control unit. Only a trained musician can decipher Stravinsky's musical symbols and conjure up in his mind the orchestral picture, and only an audioman can tell you exactly how the preamplifier in question will operate. But who would suggest for a moment that the musician curl up with a good score rather than go to concerts or listen to records, or that the audioman content himself with examining schematics and never take up a soldering iron? This unlikely proposal, as it applies to music, has nevertheless been put forth by some who claim that because a skilled score-reader can hear a given work in his inner ear he can dispense with the physical sounds most of the time and thus free himself from total dependency on performers. Fortunately for the performers and the public, music is still a recreative art, and is in no imminent danger of falling into the category of books, which can be read and enjoyed without benefit of interpreters. Besides, as the composer, Gordon Jacob, observed, "One might as well say that the imaginary taste of a glass of champagne is preferable to the real thing or that a hungry man can be satisfied by a 'still life' of a beef-steak."

Certainly the eye will never replace the ear in musical enjoyment, no matter how many fluent score-readers there are. And, by the looks of it, schematic-readers will continue to outnumber score-readers for a long time to come. In the latter group, there are various degrees of literacy. Take the case of the non-professional music lover who listens to a performance with the score in his lap, spotting entrances, locating themes, and turning pages at the proper time. What he is doing is not *reading* the score: he is *following* it. As a score-follower, he need only relate the sounds he hears emanating from the stage or from the loudspeaker to the notes in the score. He must be able to distinguish between the oboe and the English horn, trombone and tuba, snare and kettle-drum, cello and viola, and so on, he must have a working knowledge of notation, and he must be able to hang on to rhythmic values even when an avalauche of notes slides down the pages of a modern orchestral work.

There is a world of difference between the score-follower and the score-reader. Place the latter in a room devoid of phonograph or piano, give him an orchestral score, and he will "imagine" the performance of this score from start to finish, in detail and unerring precision. Now this does not mean acquiring a rough idea of the mood of the piece, and of its tempi and thematic development alone. It means all this and more. The score-reader does not merely perceive the fact that certain instruments are sounding notes in a particular tonality and at a given intensity: he is able to put all this information together and evoke a sonic image that transcends the isolated details. The end result is that he hears the over-all sound of the work.

When the hypnotist suggests to his subject: "You are now on a subway platform, you smell the ozone in the air, you hear the screech of brakes as the train lurches into the station, and so on," the latter instantly senses all these sights, sounds, and smells. The same kind of sensuous recall is one of the basic ingredients that go into the making of a proficient score-reader. But before this, he must have a thoroughgoing knowledge of orchestration, since he cannot very well recall what he does not know consciously. Therefore he must acquaint himself with the timbres, capabilities, and ranges of every instrument in the orchestra. He must know, for example, that each of the viola's four strings has its own distinctive color: the A string is nasal and piercing, the D mellow and softer, the G rich and songful, and the C powerful and full. He must likewise be familiar with the performance characteristics of all the other instruments in their different registers. He must develop the capacity to tell at a glance which instruments will emerge from the orchestral fabric, and which will remain subdued under a given circumstance: when the violins play an arpeggio figure that bounces lightly over the strings, he should be able to hear in his mind those notes that are meant to sound *above* the other instruments. In another instance, the trumpets may be playing along with the tutti, merely adding solidity to the accompaniment, when suddenly, they come to the fore for part of a bar, only to melt as quickly into the background in the next measure.

Add to the perception of timbres and instrumental balance the ability to "hear" harmonic progressions and transpose notation of such instruments as the clarinet, horn, and trumpet, which are written in one key but actually sound in another, and you have a general idea of the full extent of the score-reader's task.

Score-reading is an essential aspect of the musical lives of the composer, musicologist, and conductor. The composer reads scores for obvious reasons, the musicologist exploring unfamiliar musical territory has to be a score-reader in order to write competently about his subject, and the conductor cannot direct an orchestra unless he knows the score. Ignorance of the full score, however, did not prevent

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

many conductors in the last century from wielding a baton, as Hector Berlioz acidly reported: "There is an art indispensable to the conductor . . . the absence or presence of which makes the conductor either the composer's best interpreter or his most formidable enemy. This indispensable art is that of *reading the score.*

"He who employs a simplified score, or a simple first violin part, as is often done in our day especially in France, cannot detect half the mistakes in the performance and, if he does point out a fault, exposes himself to some such answer as this from the musician addressed: 'What do you know about it? You don't have my part,'—one of the least of the inconveniences arising from this deplorable custom."

Robert Schumann summed up the matter of score-reading in the following succinct words: "He is a good musician who understands the music without the score, and the score without the music. The ear should not need the eye, the eye should not need the (outer) ear." Æ

AUDIO ETC

(*from page 49*)

tween the side and the center, or perhaps even nearer the middle.

A clarinet that seemed halfway between center and side, via two speakers, will bisect that pie-shaped segment of the space in front of you and move over to the three-quarter position—three-quarters of the way between side and center speaker.

Aha! You begin to see a Grand Principle emerging. The plain fact is that the center speaker can very well *narrow* the apparent stereo spatial effect by actually pulling it away from the sides—and the further out the sound is placed, the further inwards does it move. Far from a hole in the middle, this stereo with too much center speaker develops a colossal bulge which if you increase the volume still some more—can simply take over the entire sound. Then you have a huge middle, straight monophonic, and two feeble little stereo side outposts that have all but lost their voices.

This, my friends, is quite possible and practicable. I did it, by mistake, with the Weathers type of center-speaker set-up, whereby the central signal, properly additive (A+B), is fed to a third power amplifier and thus can be blown up to almost any exaggeration. I did just that, until I figured what was wrong. However, with the Pilot system only the original pair of amplifiers is used, the power divided three ways, and thus the center speaker is theoretically equal to the outer two, and no more.

I found that—once I had set up my three speakers for continued listening—I used the center-speaker volume control constantly, and at many different settings; but the average and best overall arrangement was at roughly three-quarters full volume, or at a level where the middle speaker could be distinguished separately only when I walked up to within two or three feet of it. (The sound was quite loud, but so was that from the outer speakers.) It should *never* stand out on its own—unless you want mono sound. Blend it, always.

For those records in which the side elements were close-up and unusually well defined, the center signal could be cranked up a bit higher. For big, misty, distant-pickup stereo orchestra, the center took care of itself and I turned the middle speaker down or all the way off. The degree of control that this provides is really astonishing. Also, the degree of choice

among differing effects, for you may take your pick and nobody can prove one way better or worse than another if you don't want to agree.

In another plane, the center speaker gives you an even more important control over the actual width of your speaker spacing and this, as I said above, is the first value of all. Many an impossible stereo set-up becomes practicable with a center speaker. Many a wide system can be stretched even wider via the useful cohesiveness of the variable center speaker. If you are a speaker mover, an adjustable-stereo man, you'll find yourself doing even more speaker-lugging with three speakers than with two. I'm always moving my two speakers sidewise, for different recordings; now I can move them even further, ever wider. And do I love it! Note to stereo lecturers on big platforms in large halls: if you really want stereo effectiveness, quick get yourself a center speaker and blanket your stage with speakers.

—Which brings up a penultimate point. Does the third speaker help to widen the practicable listening area in front of the stereo reproduction? That is a big claim of some users.

Well, I *think* it does. But I'm not really very positive. My first-hand impression, without prejudice, is that your center speaker, properly balanced (as above) against the sides, does make possible a somewhat wider range of listener positioning than minus the center speaker. Not much—if you're looking for stereo. You can enjoy stereo sound from the sides quite nicely, in both three-speaker and two-speaker set-ups, though it is not spatially very accurate. The music is there and the stereo liveness is audible almost anywhere in a room.

If you mean, can you hear the soloist in the center from a wider seating area? I can only say that the louder the center speaker, the further to the side can you sit and still hear the soloist spang in the middle. But you lose out in the stereo.

Indeed, as you'll now understand, if you *really* want your soloist in the middle from a wide range of seating positions the answer is simple enough! Just whomp up the center speaker all the way and turn off the side ones.

It's a question of what you want out of your stereo. I don't feel that hearing the soloist in the center from a side position is of any great importance, in my way of life. I'm after subtler and more varied stereo effects, and—in moderation—the center speaker is helping me to get them, helping me to get good stereo under a wider variety of conditions, helping me towards a bigger range of stereo sensation. That's enough.

Three-way Phasing

Whoa—can't end yet. What about phasing? Well, oughtn't to waste much space on that. Your three speakers must be in phase—all three. I tried all possible combinations, in and out, just to see what happens. I did it this way, with my handy pluggable extension phase switches that insert into any of my speaker lines, can be switched directly from the listening position.

First, phase the outside speakers rightly, the center speaker turned off. Use a mono sound-source, for clear audible difference. Better—move the two speakers up face to face, a quarter inch or less apart. In phase, the sound is muffled and bassy. Out of phase, it virtually disappears—the two speakers just pump each other back and forth. Very dramatic. (I learned this trick from Jan Syrjala.)

Then phase one side speaker with the middle. You can't turn the other side's amplifier off, because the center speaker uses the output of both amplifirs; so you unplug the speaker on one side (the amplifier can take it if you're careful) and switch phasing on the *center* speaker, to agree with the other side. If you want to double-check, try it with both sides, but you shouldn't have to. If $A = B$ and $A = C$, then $B = C$.

What happens when your speakers are out of phase? All sorts of merry things.

1. If the outside (main) speakers are out of phase, then the middle speaker must agree with one or the other. You hear the entire sound crammed into one half of your space, right or left, in between the two agreeing speakers. The other half, on the other side, is as dead as though the speaker over there were turned off. Switch the center speaker's terminals and the sound jumps over to the other half. *Very* odd.

2. If the outside speakers are correctly phased but the center speaker is out (out of phase with both), then instead of filling in the center, it does exactly the opposite—it digs a large hole, pushing the center sound off to each side.

The louder the center speaker, the bigger is the hole, and there, dear readers, is the way to get a whopping hole-in-the-middle if you really want to hear one! It's the genuine article.

* * *

P.S. What about the speakers themselves—what sort? I'll suggest only one good principle, in two parts. First, always use identical speakers for your main (outer) channels, or as close to identical as you can manage. (Same-brand speakers often match pretty well; or identical

speakers can perhaps go into differing cabinets.)

Second, the center speaker should ideally make three of a kind but if you *must* use a different speaker somewhere, put it in the middle. At first trial I had two KLHs on the outside, and an AR-2 in the center. Plenty close enough in sound.

P.P.S. In view of prevailing "three-channel" commercial systems, what again is the minimum width in spacing for a true third channel? I say seven or eight feet—no closer. The usefulness of the central speaker goes down very rapidly as you narrow the spacing, and the disadvantages, the monoizing effects, go sharply up. A center "channel" at three-foot spacing is just a killing parasite, spoiling what little stereo effect there is. That's the way I hear it, anyhow.

3. B & O

Hey—I promised months ago I'd report on two very nice mikes I got hold of 'way back last summer, originally for my stereo four-track experiments. I call them the Baltimore and Ohio mikes because their name comes out B & O, the initials of the Danish company that makes them. They sell through Dynaco, Inc., of Dynakit, they are bi-directional ribbons with multiple impedance and a close-talk feature, slim, trim, brown, thin like a rather large test tube, and not very expensive—for a good mike. Their correct designation, which I keep forgetting, is the Dynaco-B&O 53.

Unfortunately, something about the hi-impedance position of this particular mike didn't match the needs of my Tandberg Model 5-2 four-track recorder, as mentioned last fall, and I wasn't able to latch onto a pair of proper transformers, to make use of the more normal low-impedance professional position. I got along with the tricky little Tandberg ceramics, and reserved the B & O pair for later use.

I finally thought of a good interim way to try them out and I duly report on same. I hooked one of them into my regular broadcast tape set-up, in Connecticut, low-impedance. I have a fine big mixer to go with my Ampex 350 and so I put the B & O on one mike input, my regular professional Western Electric 639A cardioid on another and proceeded to record test AB comparisons by voice—and let me tell you, the speaking voice is a better test of sound quality than any music I can think of. It shows up the slightest irregularity, especially on AB trial, in both mikes and speakers not to mention all other possible sources of distortion.

I could hear no difference at all between the "B & O" and the professional cardioid, which costs at least twice as much, even though one was dead at the rear and the other live. (There wasn't much to be picked up in the rear, luckily.) There was a difference in background hiss, but I quickly traced that to my own mixer. One channel has more noise than another. So I switched the two mikes, and the hiss went over to the Western Electric.

Pending further use, this is the highest recommendation I can give this mike from Dynaco, but I suspect it's plenty. Just try three or four cheap mikes, one after the other, and see whether they all sound the same! This mike is sturdy, for a ribbon, nicely shaped and easy to use; you can get a special stereo close-up dual mount, with sound-deadened separator, that's supposed to give stereo from a one-foot spacing. Just fine (without the separator, I found) for "true binaural" earphone recordings. They remain a much neglected hobby and I hope, soon to make a few more with the aid of these two mikes. AE

NEW PRODUCTS

Sony Wireless Microphone. Announced recently as the newest addition to the expanding line of Sony electronic products is the CR-4 wireles microphone. Operating on the license-free FM band of 27.12 mc, the complete CR-4 assembly consists of an all-transistor FM transmitter and an 8-tube FM receiver with wide-band a.f.c., a small lavalier-type dynamic microphone, and a portable carrying case. The tiny transmitter, which is self-powered by two miniature batteries, has a squelch-on range of up to 300 ft.; with squelch off

the range is up to 800 ft. Maximum frequency is ±10 kc. Audio frequency range of the transmitter assembly, including microphone, is 70 to 10,000 cps ±5.0 db. The microphone is detachable, and may be hand-held, desk-mounted, or concealed, along with the transmitter, on the person of the user. Signal-to-noise ratio of the receiver is better than 40 db. The CR-4 is ideally suited for all applications where short-range wireless communication is desired, and is especially useful for TV performers, night club entertainers and private investigators. For descriptive literature, write Superscope, Inc., Audio-Electronics Division, Sun Valley, Calif. **A-1**

• **Ampex Stereo Audio Control Center.** The ability to select instantly any desired source of sound for stereo or monophonic reproduction is featured in the new Ampex Model 403. Pushbutton selection automatically assures the proper matching, equalization, and balance for input signals from tape, records, tuner, microphone or other external program sources. For use with any quality audio system, the 403 is the same as that used in Ampex console home music systems. Separate bass and treble controls permit individual adjustment as desired, with a maximum boost or cut of approximately 15 db. Two loudness

controls — one for each channel — are mounted on concentric shafts and friction-coupled to permit setting and maintaining uniform calibration and balance of audio levels. A pushbutton control is provided for reversing left and right channels. The most advanced type of tone control contour is used—one especially designed with constant slope and variable turnover point. Frequency response is 20 to 20,000 cps within 2.0 db when feeding a 270,000-ohm load. Available uncased for built-ins, or with handsome hardwood cabinet, unfinished or in walnut, for open or shelf mounting. Ampex Audio Inc., 1020 Kifer Road, Sunnyvale, Calif. **A-2**

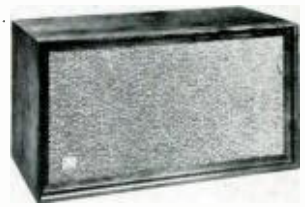
• **Altec Speaker System.** A direct-radiator tweeter which eliminates the need for an expensive crossover network has recently been added to the line of high fidelity reproducers manufactured by Altec Lansing Corporation, 1515 S. Manchester Ave., Anaheim, Calif. The 200B, illustrated, has a gap suspension of novel design which forms a mechanical high-pass filter, thereby protecting the unit against damage

by low-frequency signals. Frequency response of the tweeter is 1500 to 18,000 cps. Companion bass driver for the 200B is the 402B, an 8-in. controlled-linear-excursion speaker with stress-free assembly. Frequency response is 40 to 10,000 cps. Both units have a power rating of 14 watts. Used together, with a capacitor serving as the crossover network, the two speakers provide a high-quality sound system for a small investment. **A-3**

• **Sargent-Rayment Tuners-Preamps.** Based on the same engineering and styling concepts established with the earlier Model SR-1000, Sargent-Rayment is introducing two new stereo components, each of which combines the functions of an FM-AM stereo tuner and a stereo preamplifier with flexible audio controls. Designated Models SR-7000 and SR-8000 (illustrated), both instruments feature "Stereo Separation Control," designed for control of the degree of separation between stereo channels. With this control

equal portions of each channel may be blended into the other, thereby achieving a marked three-source-stereo effect. Extremely low noise characteristics are assured through the use of carbon-deposited resistors throughout the preamps. The SR-8000 offers such deluxe features as phase alternation switch, push-button rumble and scratch filters, and separate electronic tuning indicators for AM and FM. The SR-7000 offers the same basic functions but its control assembly is tailored to offer maximum economy. Literature is available from the manufacturer, Sargent-Rayment Company, 4926 E. 12th St., Oakland, Calif. **A-4**

Knight Electrostatic Speaker System. Consisting of a newly-developed 12-in. high-compliance woofer and two Janszen electrostatic radiators installed in a compact acoustically-correct enclosure, the Knight Model KN-3000 has a power handling capacity of 50 watts, with 100 watt peaks. Small in size, measuring only 14" × 26½" × 13", the cabinet fits in a book-



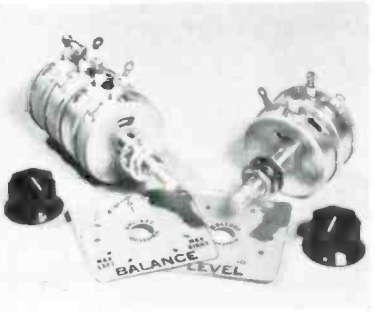
shelf or mantel, and may be turned upright as a highboy, since it is finished on four sides. Frequency response of the KN-3000 is given as 30 to 25,000 cps ±3.0 db. Harmonic distortion at 50 watts input is stated to be 0.16 per cent at 4000 cps. Impedance is 8 ohms. Tweeters operate from regular line voltage and are equipped with an on-off switch. Available from Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. **A-5**

• **G-E Stereo Amplifiers.** Dual concentric bass and treble controls are featured in two new stereo amplifiers recently introduced by General Electric. Similar in most respects, the G-7700 series (illustrated) has a per-channel IHFM music power

rating of 28 watts, while the more economical G-7600 is rated at 20 watts per channel. Tone controls are of the split friction type to permit individual channel adjustment of bass or treble to compensate for room acoustics and for non-matching speaker systems. The friction drive between the split knobs also permits convenient dual rotation by rotating either knob. Other control features of the new G-E amplifiers include: a balance control to adjust for different speaker efficiencies and for variations in channel levels; an input selector for stereo or monophonic tape, phono, or tuner; a mode selector for stereo channel reverse, normal or parallel, and monophonic two channels or either channel individually; a contour control, and a rumble filter. Frequency response is 20 to 20,000 cps ±0.5 db, and harmonic distortion is below 1.0 per cent per channel at full rated mid-frequency output. The model RG-1000 Remote Control unit, available as an accessory, allows adjustment of both channel balance and volume anywhere within a listening distance of 30 feet. Audio Components Product Section, General Electric, Bridgeport, Conn. **A-6**

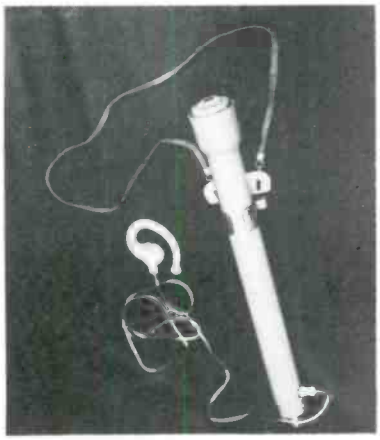
• **Level Controls.** Two new Series "L" controls, recently introduced by P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind., were designed with current requirements of stereo and monophonic hi-fi equipment in mind. The new "LL" pad provides single-knob adjustment of both channels in a stereo system. It is of dual-tandem design and can

also be used as a stereo balance or master volume control for low-level low-impedance audio circuits. It includes two separate "L" pads mounted in a piggy-back arrangement and operated by a common



shaft. The new "LA" control was developed as a level control for monophonic equipment and features an extra-long bushing to facilitate mounting on speaker cabinets without need for an extension bushing. **A-7**

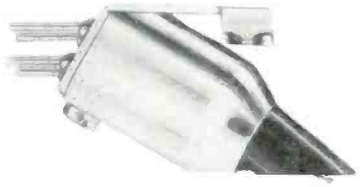
• **Remote Microphone.** This 12-ounce microphone-amplifier assembly is the newest addition to the line of broadcast equipment manufactured by Collins Radio Company, P. O. Box 1891, Dallas 21, Texas. Developed to take the place of as much as 45 pounds of conventional amplifier, battery and cable equipment, the M-60 is



only 11⅝ inches long and is designed for swift mobility. The amplifier has six 2N241A transistors. It has a special phase splitter coupled to a push-pull output stage providing wide frequency response with low distortion. The transistors are of the plug-in type for easy removal. The unit is equipped with a non-directional lavalier-type microphone head. Its "Dynaflex" non-metallic diaphragm gives smooth response and withstands temperature extremes, mechanical shock and high humidity. The mike is a sealed unit. It attaches to the threaded amplifier housing in such a manner that the two may be separated without disturbing the factory-sealed microphone chamber. By unscrewing the base plug, the entire amplifier and battery case can be pulled out, allowing immediate replacement of the battery and transistors. Frequency response is 60 to 15,000 cps ±1.5 db. Amplifier output is +12 dbm. **A-8**

Improved Stereo Cartridge. The Stereodyne II uses the same push-pull magnetic principle as the earlier Stereodyne I, but features a new high-compliance stylus suspension which is readily interchanged by the user. A four-coil structure combined with a moving-iron member gives completely symmetrical performance in

each stereo channel. This symmetry permits channel separation of 30 db or more. High compliance and small moving mass permit 2-gram tracking. Frequency response is smooth and essentially flat from 20 to above 15,000 cps with exceptionally

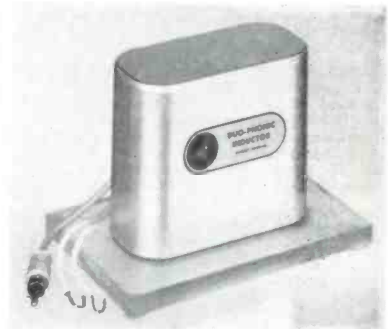


low distortion. The coil structure is balanced to reject hum, and the body is double shielded with a mu-metal housing. Complete information on the Stereodyne II is available from Dynaco, Inc., 3916 Powelton Ave., Philadelphia, Pa. **A-9**

• **Madison Fielding Stereo Receiver.** Soon to be advertised as "the receiver that will do everything but fly," the new M-F 440 mounts on a single chassis an AM-FM

stereo tuner, a 40-watt (dual 20) power amplifier, and a complete audio control center. All the user must supply is his own loudspeaker and record player for a complete stereo hi-fi music system. Among circuit features of the 440 is an automatic additive mixing of both channels, ideal for a three-speaker system or for stereo in one room and monophonic reproduction in another. An "Aural Zero Null" circuit affords electronic balancing of stereo outputs. Amplifier frequency response is 10 to 30,000 cps within ±0.5 db at 1.0 watt; 30 to 20,000 cps within ±1.0 db at full output. Tone control ranges are ±12 db at 50 and 10,000 cps. Mixing is afforded for any two high- or low-level inputs. So complete and flexible is the 440 that there is virtually no audio control function which it will not perform. Manufactured by Crosby Electronics, a subsidiary of Crosby-Teletronics Corporation, Westbury, N. Y. All Madison Fielding equipment is marketed by Brand Products, Inc., 39 W. 55th St., New York 19, N. Y. **A-10**

• **Duo-Phonic Inductor.** This device is unique in that it affords a distinct stereo effect with the playing of standard monophonic records. With monophonic music systems it requires the use of a second amplifier and speaker, or it may be used



with dual stereo systems. In essence, it is an electro-mechanical transducer which creates a time delay and phase shift between two audio channels, without frequency cancellation. For further information write The Audionics Company, 8 W. Walnut St., Metuchen, N. J. **A-11**

• **Compact Tape Recorder.** The Hosho 105 is a compact, portable recorder weighing only 18 lbs., yet including power amplifier and twin speakers. It is a dual-speed unit, operating at 7½ and 3¾ ips, and offers many of the features usually found in

more expensive recorders. Some of the outstanding qualities of the Hosho 105 are: remote control, precision transport mechanism with dynamically balanced flywheel assembly, optically lapped heads, high-frequency erasure, magic-eye level indicator, and provision for headphone monitoring. Inputs are provided for recording from radio, television, phonograph, and microphone. For complete information, write Hosho of America, Inc., 1549 N. Vine St., Hollywood 28, Calif. **A-12**

NEW LITERATURE

• **Bozak,** Darien, Conn., has just released an attractive two-color brochure which illustrates and describes the company's impressive new line of high-fidelity equipment cabinets. The "Provincial," "Urban," and "Spinet" models are identical with Bozak speaker enclosures bearing corresponding model designations, thus enabling Bozak speaker owners to form complete harmonizing monophonic or stereo music-center ensembles. Your copy of this interesting publication will be mailed free upon written request. **A-15**

• **H. H. Scott, Inc.,** 111 Powdermill Road, Maynard, Mass., announces a new 20-page catalog featuring the company's Stereomaster high fidelity components for 1960. In addition to complete descriptions and technical specifications of all H. H. Scott components, the catalog includes: a complete high fidelity guide; explanation of stereo, what it is and how it works, and pictures of typical home installations of H. H. Scott equipment. Your copy of this excellent catalog will be mailed free upon written request. **A-16**

• **James B. Lansing Sound, Inc.,** 3249 Casitas Ave., Los Angeles 39, Calif., has available a new 24-page general catalog with photographs and descriptive data for all JBL speakers and systems. The Paragon and Metregon JBL-Ranger stereo reproducers are featured in an impressive center spread. Extended range speakers, woofers, tweeters, dividing networks and enclosures, as well as the product list for the JBL linear efficiency series, are given full treatment. **A-17**

• **Seco Manufacturing Company,** 5015 Penn Ave. South, Minneapolis, Minn., has just released a handy, pocket-sized brochure which provides full details and specifications on its complete line of tube testers, battery eliminator, VTVM, and other service aids. Of particular interest to audio technicians is a new transister tester. Fully illustrated, this attractive folder also gives prices on all Seco units. For your free copy ask for Form No. M-C099. **A-18**

• **Bogen-Presto Company,** Box 500, Paramus, N. J., is publishing a new, fifth edition of "Understanding High Fidelity," the 64-page book which has sold nearly 300,000 copies in four earlier editions. Written for the general reader as well as for the confirmed hi-fi enthusiast, the new edition reflects all of the latest developments in stereophonic sound. Distinguishing between monophonic and stereophonic sound systems, the handbook describes in detail equipment needed for a complete high fidelity installation. The new edition contains numerous photographs as well as detailed diagrams, making for clarity and easy understanding of the test. An expanded glossary of technical terms is included. The publication is available at 25 cents per copy from all Bogen-Presto dealers or it may be ordered direct from the company.

• **Motorola, Inc., Semiconductor Products Division,** 5005 E. McDowell Road, Phoenix, Ariz., has just published a comprehensive 130-page manual covering basic theory, design characteristics and applications for zener (voltage limiting) diodes. The book covers quite thoroughly the use of zener diodes in regulated power supplies, also their use to protect against load current surges, supply voltage surges, decreasing supply voltage, arcing, and over-voltage in transistor circuits and circuits incorporating meters. Design engineers, hams, and hobbyists will find the Motorola zener diode handbook an excellent reference as well as a good introduction to a relatively little-known electrical component. Copies of the book are available for $1.00 from any Motorola semiconductor distributor, or by writing direct to Dept. ZDH at the address shown above.

WHAT'S A GOOD LOUDSPEAKER?

(*from page 23*)

the room, and mid-way between the ceiling and floor. The bounding surfaces of the room were covered with hair felt one-half inch thick. Although an attempt was thus made to reduce the magnitude of the reflections, the curve obtained is very irregular.

One method of compensating for the effect of standing waves, and of thereby obtaining indoors a curve that is representative of the performance of the loudspeaker, is to average the measurements at several positions or within a region rather than at one position. This is accomplished in these Laboratories by a machine which rotates the condenser microphone in a circle which is nearly six feet in diameter and whose plane is inclined at an angle with the horizontal. *Figure* 6 shows a curve for the piston-diaphragm loudspeaker measured under the same conditions as the curve in *Fig.* 5, but with the rotating condenser microphone. The center of the circle was located at the same point as the condenser microphone for *Fig.* 5. A comparison of the solid curve in *Fig.* 6 with the dotted curve, obtained outdoors for the same loudspeaker, shows the extent to which rotating the transmitter in this manner obviates the effect of wall reflections.

The uniformly greater response at low frequencies of the indoor curve in *Fig.* 6 can be attributed to the fact that the sound absorbing ability of the measuring room varies with frequency. Indoors the energy reaching the condenser-microphone position directly from the loudspeaker is supplemented by energy reflected to the same position from the walls of the measuring room. Variations with frequency in the reflecting or absorbing ability of the walls of the room will, therefore, cause variations in the magnitude of the response measurements. From the difference between the two curves in *Fig.* 6 it is possible to calculate the ratio of the outdoor to indoor energy densities at different frequencies at the transmitter position and to obtain the solid curve shown in *Fig.* 7. The dotted curve is an average curve showing the trend. A comparison of this dotted curve, with the dot-dash curve of the absorbing ability of one-half inch of hair felt, shows an interesting correlation in the trends of the two curves. The difference in magnitude of the two curves can be accounted for by the fact that the sound passing through the microphone position probably undergoes several reflections before returning to this position again.

Conclusions

From the above illustrations it is obviously quite impossible to determine from acoustic measurements whether or not a loudspeaker is "good," unless the curves expressing the measurements are qualified by statements regarding the measuring conditions. Especially must information be given as to the position of the condenser microphone relative to the loudspeaker, the method of measurement (whether pressures are measured at one position or averaged within a region), and the size and nature of the medium. In general, response measurements, to be most indicative of the capabilities of a loudspeaker, should be made with the condenser microphone at a distance from the loudspeaker commensurate with or equivalent to the most likely listening distance of an observer. In addition, determining which of two loudspeaker response curves is the better requires an interpretation of the auditory significance of the magnitude and position in the frequency spectrum of departures in the curves from a straight horizontal line. Such an interpretation involves physiological considerations. Although complicated by such a wide variety of factors, the response-frequency characteristic has been found the most significant single criterion upon which to base a judgment of the merits of a loudspeaker. Æ

RECORDS

(from page 55)

ter and hotter on records. This is one of the best "Spring" Symphonies I can remember—and it's a tough work to put over, too. Again its rightly styled, the real sense of the Schumann language understood. A fine buy, I'd say.

Tchaikowsky: Symphony #6 ("Pathétique"). Vienna State Opera Orch., Golschmann. (Stereo demo disc).
Vanguard SRV112SD stereo

Vanguard picks interesting items for its occasional demo discs, at pleasantly low prices. This one will please the demo people as well as the bargain hunters; it's a honey.

Trouble with this piece is that I've heard it so often I forget what the performance is like about ten minutes after I finish playing it. This one, I say hastily, is excellent; my ears pricked up when I saw the name Golschmann, for the retired long-time conductor of the St. Louis Orchestra is particularly good at French and Russian music of the last 75 years or so (and very bad at Mozart, Haydn, and the like). He does a splendid job here with the plastic but sometimes sluggish Viennese ensemble, whipping them to an ideal intensity never one bit over-done.

BACH, HANDEL & CO.

Bach: Complete Organ Works; Trio Sonatas and Trios. Carl Weinrich, organ.
Westminster WST 302 (3) stereo

I sample this perennial series every so often to see how it's coming along—this one was a find. I've disliked earlier Weinrich because of his rather dogmatic and not-too-accurate playing, exaggerated by extreme close-up multimike stereo; but these three-voiced works were his first recorded offering on Musicraft years ago and he plays them generally with a great deal of thought and expression. But in addition, the superb tone colors of the Swedish organ, one "color" for each of the three simultaneous melodies, are absolutely lovely on the ears, as are the interwoven musical strands themselves; close-up stereo here makes it better. Very nice and only a few not-so-good spots in the playing.

Bach: Six French Suites; Fantasia and Fugue in A Minor. Ralph Kirkpatrick harpsichord. **Archive ARC 3112, 3113**

Bach: Clavier-Ubung, First Part—Six Partitas. Ralph Kirkpatrick.
Archive 73129, -30, -31 stereo

These are part of the grand project at Deutsche Grammophon that is systematically covering everything in sight by Bach, and dozens of other masters as well. I made a brief direct comparison out of curiosity, here—stereo, the new release, *vs.* mono, from awhile back. The stereo recording is mainly just somewhat louder, surprisingly enough. I tried the stereo disc on mono (the two channels paralleled) and can only say that the difference, while almost non-existent, does add a higher sense of presence to the harpsichord sound. I'd pay the difference, if I were you and had good stereo.

Kirkpatrick is now one of the finest harpsichordists we have and is honored by the Germans in this choice—an American, recording the central essence of all German harpsichord music of the time! His playing is forceful, accurate, beautifully registered and just as concentrated, for listening, as is old Bach himself. Not easy—but if you want a good start, try the melodious French Suites; they are by far the easiest material to absorb. (See also the English Suites.)

Bach: Overtures (Suites) #2, #3 for Orchestra. (#2) Kammermusikkreis Scheck; G. Scheck, German flute. (#3) Solisten-

vereinigung der Bachwoche Ansbach, Rieger. **Archive ARC 3114**

Bach: Harpsichord Concerti #1, #2. Ralph Kirkpatrick; Festival Strings Lucerne, Baumgartner.
Archive ARC 73132 stereo

As I say, this project is nothing if not thorough. Here is another pair, a mono and a brand new stereo, featuring Kirkpatrick again. The Bach "overtures"—actually, the familiar two suites so often played—are of course, done here in the new authentic manner; the B Minor Suite even uses an 18th century German flute (minus the modern Boehm finger system), and there is the proper harpsichord accompaniment. But the spirit of the two performing groups is quite different; the Second Suite is done most correctly, but the styling is a bit stiff, the (correct) added ornamentation isn't very spontaneous. Not bad at all. But the Third Suite is so much more musically alive and vigorous that there is quite a contrast; Suite #3 (Overture #3, that is) gets one of the nicest performances I remember hearing—and "authentic" too.

The two harpsichord concerti, one the familiar D. Minor "piano" concerto in its proper guise, are played with really fine effect, but the best feature in both is the natural miked balance between harpsichord and orchestra—no solo mike, no accentuation, no added loudness and closeness. The harpsichord is, indeed, remarkably faint; but in these works it should sound exactly this way and in no time your ears adjust and are able to hear its potent expression even at the lower volume.

Oddly, the only other similar job of proper harpsichord balance I know of is on London records, but with the Ansbach Festival performers featured in the excellent Third Suite above.

Needless to repeat, Ralph Kirkpatrick is a fine soloist in both of these dynamic concerti and the stereo addition is well worthwhile.

Russell Oberlin Handel Arias. Orch. conducted by Thomas Dunn.
Decca DL 79407 stereo

Russell Oberlin has a gorgeous, beautifully controlled voice of the ancient and honorable variety known as the countertenor: he sings up into the high alto and soprano range. By this time, most concert and record audiences are completely used to the once-odd sound and can simply judge the voice and the music as with other sorts of vocal production.

Handel, in his strongly sinewed contralto arias, is dead-center perfect for this particular voice and Oberlin is accordingly at his very best in this recording. His instrument hasn't much variety nor has he any particular historical sense; his Elizabethan music and his Handel all sounds about the same, lacking often in musical imaginativeness. But in Handel—and with a superbly intelligent accompanying orchestral force here—he does nobly, from "Messiah" and "Israel in Egypt" through several opera selections in Handelian Italian. Thomas Dunn does the unusually alive orchestral accompaniments.

Bach: Cantatas #54, #53, #200; arias for contralto. Helen Watts; Philomusica of London, Thurston Dart.
L'Oiseau-Lyre SOL 60003 stereo

Suddenly, London's L'Oiseau reappears, for another group of works in the manner of the long and distinguished series of records by this British group, back in mono days. (The Philomusica name is new but the spirit is as of old.)

These are very British performances, in a genteel English tradition that lacks only the once-usual English texts—these are in German—to fit straight into the distinguished Bach of England's musical past. The Watts voice is one of those typically earnest, breathy, British instruments full of expressive wobbles and lunges—but don't think it isn't musical. The orchestra accompanies with due reverence, and one piece isn't by Bach at all. Somebody made a mistake, back in the nineteenth century. It has bells in it, this piece. AB

"UNCLEAN HANDS" FORFEIT PATENT PROTECTION

(*from page 32*)

ventiveness of the devious mind staggers the imagination. It is simply the difference between right and wrong, honesty and dishonesty, which is the touchstone in an issue of this kind."

To this general comment on the patent law doctrine of "unclean hands" and the loss through wrongdoing by a patent owner of the right to the benefits of his patent, the court added its review of these circumstances.

"In April, 1947, Hastings owned business information and trade secrets which Seismograph badly needed. Seismograph's principal client was pressing Seismograph for solution of the radio location problem involved in offshore surveying. Instead of going to Hastings as upright business men, Seismograph determined to steal his work. An officer and director of Seismograph on learning the details of the Raydist system, immediately applied for patents on the system and variations thereon in the hope that inexperienced and impecunious Hastings had not already done so.

"But Seismograph did not stop there. It sent its executive vice-president to Virginia to learn more of Hastings' secrets and to offer him a brave plan by which they would form a joint venture to exploit the system. The brave plan was even reduced to writing and presented to Hastings for his consideration. Seismograph invited Hastings to its home office further to pick his brains and milk him of the information on Raydist he had been so long acquiring."

As an authority for this decision holding that by reason of this wrongdoing no relief could be granted against this claimed infringement the Federal District Court referred to a ruling by the United States Supreme Court in a similar controversy a few years before.

"The guiding doctrine in this case," said that court of the penalty for the unclean hands of the patentee, "is the equitable maxim that he who comes into equity must come with clean hands. This maxim is far more than a mere banality.

"It is a self imposed ordinance that closes the door of a court of equity to one tainted with inequitableness or bad faith relative to a matter in which he seeks relief, however improper may have been the behavior of the other party.

"That doctrine is rooted in the historical concept of a court of equity as a vehicle for affirmatively enforcing the requirements of conscience and good faith. This presupposes a refusal on its part to be 'the abetter of inequity.' Thus while equity does not demand that its suitors shall have led blameless lives as to other matters it does require that they shall have acted fairly and without fraud or deceit as to the controversy in issue."[2]

From this decision the Seismograph Service Corporation appealed. In the affirmance of that judgment in October, 1958, the United States Court of Appeals added this comment to those of the trial court,

"In conclusion it is evident that throughout their relationship Seismograph was playing a 'cat and mouse' game with Hastings. Since Dr. Hawkins described his conduct as 'clean, hard play' and declared that he and his company would repeat their performance if given an opportunity, saying he spoke for his company in so declaring, we can only conclude that the officers of Seismograph have erroneous concepts of fair play in business morals and ethics.

"Beyond a reasonable doubt the evidence here shows that Seismograph led Hastings through a tortuous path laden with deception, knavery, and misrepresentation. Not once throughout their relationship did Seismograph 'play it straight' with Hastings." Æ

[2] Precision Instrument Mfg. Co. v. Automotive Maintenance Machinery Co., 324 U. S. 866, April 23, 1945.

HANDBOOK

(*from page 30*)

tude to the grids of the push-pull output tubes. These signals should be balanced and of low distortion content. In addition, if a considerable amount of gain can be obtained it may possibly eliminate the need for additional stages. Naturally, the fewer the stages, the less the phase shift will be so that stability can be maintained even with heavy negative feedback.

Some designers prefer a high gain at the cost of high distortion and use a higher negative feedback factor to reduce the extra distortion produced. Other designers prefer a minimum of distortion in the phase-splitter stage and obtain their gain by an extra amplifier stage. A typical circuit used by designers of the first group is shown in *Fig.* 5 whereas *Fig.* 6 shows a low distortion phase inverter. The high-mu, low-hum twin triode 12AX7/ECC83 is used in both circuits. Table 2 shows the operating conditions for this tube in each circuit.

Although the first circuit does achieve higher output voltage, the second achieves much lower distortion and very little phase shift because of the phase splitter. Since the gain of the 12AX7/ECC83 is still reasonable in the cathode-coupled circuit, it has become very popular with the designers of high-quality equipment.

The drive required for a pair of 6CA7/EL34 type pentodes for full output is about 2×21 volts rms while the 6BQ5/EL84 type pentodes require 2×10 volts rms. In both cases the requirements are similar for triode, pentode, or distributed-load connection. This implies that the input voltage of the 12AX7/ECC83 with a 350-volt plate supply should be in the order of 0.4 volts rms to drive a pair of 6CA7/EL34 pentodes in push-pull; with a cathode-coupled phase splitter roughly 0.9 volts rms is required. For a pair of 6BQ5/EL84 pentodes these figures are 0.17 and 0.4 volts rms respectively with the plate supply at 250 volts.

With 26 db of feedback, the input voltage requirements are increased by a factor of 20. In this case, the normal phase splitter requires a preamplifier stage. One of the most effective preamplifier tubes in use today is the 6267/EF86, a low noise pentode. If this tube is adjusted for maximum gain, which is the general practice, the total sensitivity of the complete amplifier is too high for use with a high-output pickup. In the amplifier shown in Circuit A[3] advantage is taken of the excess gain by incorporating tone-control circuits. On the other hand when a magnetic pickup is used, the sensitivity is usually insufficient. In

[3] See Part II.

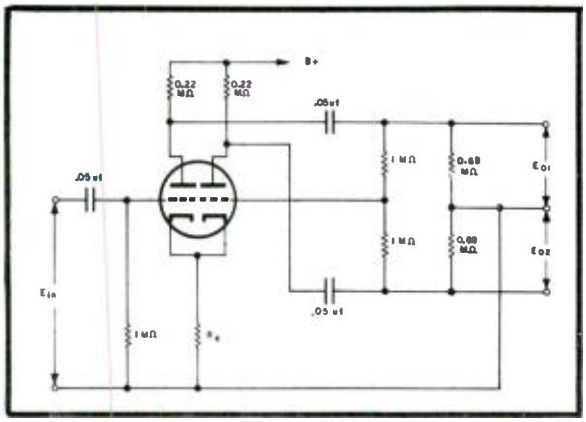


Fig. 5. "Paraphase" type of phase splitter.

that case additional stages of premplification will be required and this again can be used for control and equalization networks.

With the problem of sensitivity in mind a new type of phase splitter has been developed in which a combination of positive and negative feedback leads to an extremely high gain combined with adequate stability and reasonably low distortion. A gain of about 800 can be obtained with this circuit but the attenuation at high frequencies is considerable. Therefore, the gain of the practical circuit shown in *Fig.* 7 has been reduced to about 220.

The plate of the left section of the 12AX7/ECC83 is fed through R_2 from the cathode of the right section. The low end of the right cathode resistor is connected to the left cathode resistor R_2 resulting in positive feedback which increases the gain of the circuits. The positive feedback through R_2 might easily lead to instability if the lower end of R_3 were not connected to the cathode of the right section. The cathode circuit acts as a high resistance in series with the plate resistor of the left section for d.c. This results in negative feedback to the plate of the left section, preventing runaway.

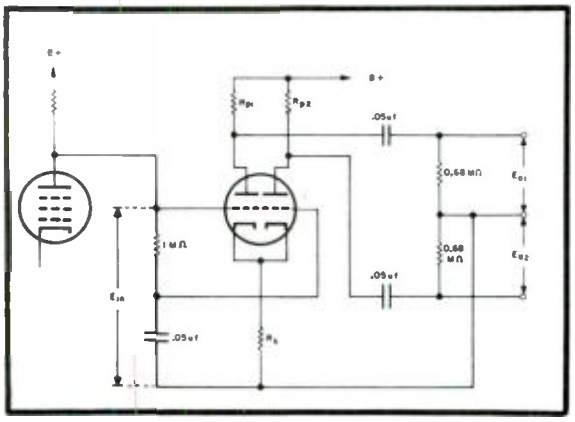


Fig. 6. "Lang-tailed pair" phase splitter stage.

This phase splitter and a conventional push-pull output stage when used with 26–30 db of negative feedback makes a voltage-amplifier stage unnecessary. If separate tone and equalizing controls are used, then a voltage amplifier stage is required.

(TO BE CONTINUED)

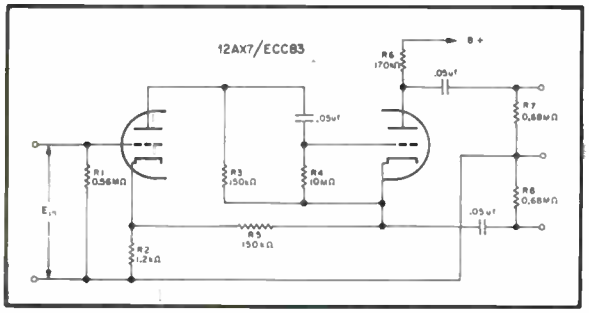


Fig. 7. Phase-splitter circuit employing both positive and negative feedback.

TAPE GUIDE

(from page 10)

have as an inductance and pick up a slight amount of hum, which is then subject to great amplification in the tape amplifier.

The audiofan seeking to improve the signal-to-noise ratio of his tape recorder will find that some of the deposited-metal-film resistors are virtually as good as the wirewound and cost only about half as much or less. The Davohm 850 series is recommended.

Deposited-carbon resistors have frequently been acclaimed for their low-noise properties, but one must be very careful here. It is true that certain deposited-carbon resistors, particularly of foreign manufacture, produce extremely little noise and are suitable for high-grade applications. Unfortunately, a number of other deposited-carbon resistors are hardly, if at all, better than the conventional molded ones that sell for a few cents apiece.

Accordingly, the audiofan desiring a high degree of assurance of good results will invest in wirewound or deposited metal resistors. If he uses the latter, he should bear in mind that occasionally a poor one will get into the lot, and that failure to get improved results might be due to such an occasional mischance.

If a cost of $1 or more for each resistor seems too high for a not necessarily successful attempt to reduce noise, the audiofan may try another expedient, which is to use conventional resistors of relatively large wattage rating. Whereas ½-watt resistors are usually employed in the plate, cathode, and grid circuits, he may substitute 2-watt resistors and thereby possibly achieve an appreciable noise reduction.

Demagnetization of Heads

Noise is often due to heads that have become magnetized. Every time that a recorded tape is played back, noise is added to it by the magnetized heads. In recording, a magnetized head presents a d.c. component that serves to bring up modulation noise on the tape, which is due to unevenness in the coating and/or base.

The tape heads can be quickly and easily demagnetized by exposing them for a few seconds to a head demagnetizer. One should follow a regular course of preventive maintenance in this regard, namely demagnetizing the heads after about every 8 hours of use. Once noise has been added to a tape by a magnetized head, the noise cannot be removed without also removing the audio signal.

(TO BE CONTINUED)

ACOUSTIC SUSPENSION

(*from page 25*)

Thus even the tiny amount of distortion associated with air non-linearity is not present in an acoustic suspension system designed according to the writer's patent.[5] It is true that the primary purpose of the fiberglass is not to eliminate distortion due to air non-linearity (which is so small in amount as to be without significance to begin with), but it is interesting to note that even this small amount of distortion does not remain. The air-cushion of the acoustic suspension speaker enclosure has been described, and I believe with accuracy, as a near-perfect spring.

Further Effects of Fiberglass in the Cabinet

The article referred to also contains the following statements:

> "Curves were run on a sealed box system . . . with and without the interior of the box filled with sound absorbent material. . . . With accurate recording equipment the results show a negligible difference between the two curves. Filling the interior of small cavities with sound absorbent material is unnecessary."

This, too, is in direct contradiction to theory and practice described by the writer.

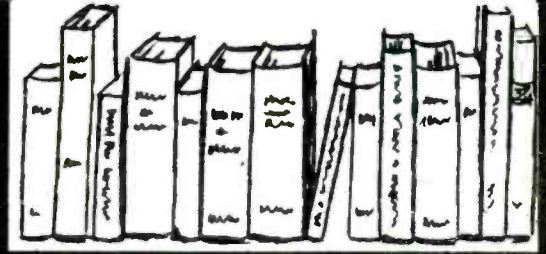
The change from adiabatic to isothermal conditions created by the fiberglass, as we have seen, decreases the stiffness of the enclosed air by a factor of 1.4. This is the equivalent of saying that the effective cubic volume of the cabinet is increased 1.4 times. The result is a reduction of the resonant frequency of the speaker as mounted (assuming that at least three-quarters of the elastic restoring force is due to the air cushion) by about 16 per cent.

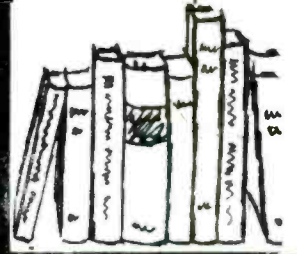
Such a difference would have to show up clearly in the response curve. Since no difference in bass response was noted by Messrs. Avedon, Kooy, and Burchfield, it must be assumed that their (unspecified) sound absorbent material was not of the type that created isothermal conditions in the amounts used.

At the Acoustic Research plant the amount of fiberglass that is used in the cabinet (see *Fig.* 2) is determined by measurements of the bass resonant frequency of the system with and without the fiberglass; that amount of fiberglass which reduces the resonant frequency from approximately 51 cps to 43 cps is the correct amount for the AR-1 or AR-3.

In addition to the function just described, the fiberglass damps out the familiar standing-wave resonances that

[5] E. M. Villchur, "Sound Translating Devices," U. S. Patent No. 2,775,309, Dec., 1956.





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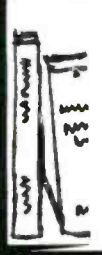

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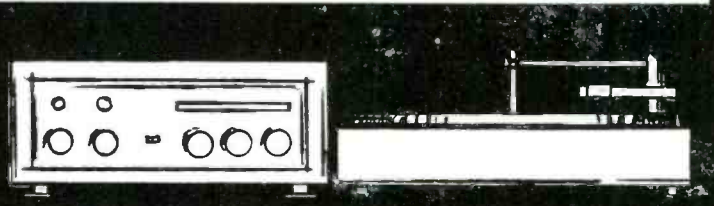

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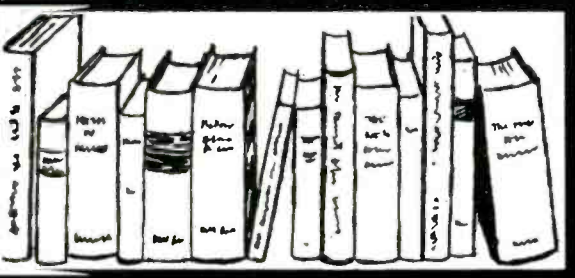

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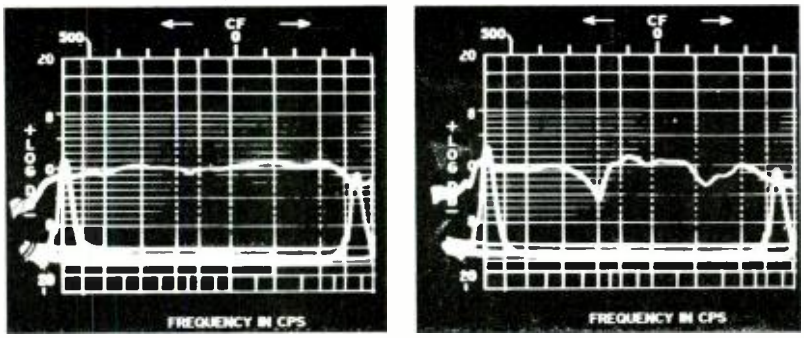

Fig. 3. (A), left. Automatic frequency-response trace, on a linear 1000-cps sweep, of a standard AR-2. Marker pips are at 350 and 1350 cps. (AR's anechoic chambers are not suitable for measurements at low frequencies.) Horizontal divisions are in 1-db steps. (B), right. Response trace of the same speaker system over the same frequency range, with the fiberglass removed from the cabinet. All other measurements are the same as in (A). Display is on a Panoramic Sonic Analyzer, model LP1a.

would form in a rectangular wooden enclosure, resonances which would create easily measurable peaks and dips in the frequency response of an otherwise smooth loudspeaker. In *Fig.* 3, (A) shows the acoustic frequency response trace, recorded automatically, of a standard AR-2 woofer in the range between 350 and 1350 cps. (AR's indoor measuring facilities are not adequate at lower frequencies) (B) in *Fig.* 3 is the response trace of the same speaker system with the fiberglass removed from the cabinet, measured in the same anechoic chamber with all conditions held constant. The response irregularities of the latter are obvious.

Enclosure Leaks

The three authors are quoted again:

"Need the cavity behind the driver be sealed absolutely air tight, resorting even to a stethoscope to determine air leaks? . . . It is seen that nowhere was the output reduced by more than 1 db with a total of 8 ¼-in. holes. . . . Therefore, a well crafted box with reasonable joinery is all that is necessary."

Fig. 4. Stethoscope check for air leaks. The speaker is being driven by a 20-cps signal.

Here the writer must plead half-guilty to the implied charges of over-design. The extreme care used in conserving a good acoustic seal at the AR plant, care which involves gaskets between the speaker flange and the cabinet, and stethoscope checks (see *Fig.* 4), is a "touch-up" rather than a basic operation. In return for a relatively inexpensive additional procedure, we receive freedom from the danger of slightly decreased low-bass output, and more important, freedom from a sort of hissing noise that would accompany low-frequency program material of high power when leaks are present.

Conclusion

Messrs. A., K., and B. state:

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

It should be clear by now that the authors do not have to worry about nonlinearity of the air in the cabinet, and I can find no other disadvantages to the box described in their article that have to do directly with the fidelity of sound reproduction rather than with efficiency.

There is a group of old wives' tales in the audio field which are not subject to the attack of reason, but only give way to time. For example, there is the old saying, almost forgotten by now: "Triodes are always sweeter-sounding than pentodes." Another oft-repeated maxim states that bass reproduction from a small speaker enclosure is inevitably inferior to that from a large one. In my opinion, the support for this principle derives merely from its own repetition. AE

BOOK REVIEW

SOUND IN THE THEATRE, by Harold Burris-Meyer and Vincent Mallory. Radio Magazines, Inc., $10.00.

This book contains fascinating things for anyone who enjoys the theatre and likes to know what goes on behind the scenes, but it is specifically addressed to the professional backstage people who are responsible for making theatrical makebelieve believable. It tells how to use modern electroacoustic equipment not merely to reinforce or magnify sound (a use so commonplace as to be taken for granted) but to control sound so as to make stage illusions convincing and to enhance and extend them. Sound can be controlled as artfully and artistically as stage scenery and lighting, but it rarely is, because of ignorance of the available technical resources and lack of imagination. The writers have demonstrated their practical knowledge and bold imagination in many theatrical productions over the last thirty years. The book is based on their experience.

Their approach is not academic or theoretical. Even the background information they present on the characteristics of sound and hearing is not the standard textbook material, although the familiar graphs of the Fletcher-Munson curves and optimum reverberation times are included (along with many others not so familiar).

The introductory chapters are followed by a discussion of the sound sources, conventional and unconventional, encountered in the theatre, and how they should be picked up.

The chapter on control techniques describes procedures the authors have followed in thirty-two actual production problems ranging from making speech understandable in a 3500-seat house to making fantasy believable in such plays as "The Tempest," "A Midsummer Night's Dream," and "Lazarus Laughed." Chapters on systems, equipment, organization and planning, installation, operation and maintenance make up the remainder of the book.

It is in these last-named chapters that the user will get his money's worth. They constitute a practical handbook of sound control in the theatre. Hardware is described in detail, even to the manufacturer's catalog number for the recommended push-button switches in the input and output lines, for example. Sample set-up schedules and operating sheets are reproduced. Hard truths about such things as budget (sound should get as large a share as lighting), assignment of adequate authority to the sound director, and time for rehearsals ("sound needs more rehearsal than any other technical element of the show") are not omitted.

"Controlling sound electronically looks easy. It isn't," the authors say, and anyone who reads their last fifty pages will find this easy to believe.

The book is handsome in format, with many clear charts and pictures.

—*William J. Temple*

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SELL: AR-1, mahogany, $115; University C15W woofer, $50; University SA-HF midrange driver, Cobraflex horn, $20; Stephens 214 tweeter, $20; crossovers, L-pads, $10. All perfect. S. R. Slovenko, 63-204 Alderton, Rego Park 74, N. Y.

SELL: Presto 8D-G disc recording lathe, excellent condition. Fairchild disc lathe with cutter. Presto 92-B amplifier. Tom Jones Recordings, 519 Fourth St., N.W., Rochester, Minn.

SELL: Leak Varislope III Preamp, TL/50-watt amplifier. Like new. Best offer.
BUY: Used KLH 4 speaker system. Frankel, 309 W. 57th St., New York 19, N. Y.

FOR SALE: 15" Jensen Tri-axial speaker in superb mahogany enclosure, stiffly braced with tuned port. A real buy at $60. Raskin, 316 West 79th St., N. Y. C. SU 7-0145.

NEW: Dyna preamp; DSC-1 stereo adapter. LIKE NEW: Dyna preamp, Heath W5M amplifier, each meticulously wired; National AM-FM stereo tuner; Gonset auto FM tuner. Reasonable. M. Kramer, 141-05 Pershing Crescent, Jamaica 35, N. Y.

WANTED: Diameter equalizer for microgroove disc cutting. Draeger Recording, 1910½ Taylor Avenue, Racine, Wisconsin.

SELL: Factory tested Heath SP-2 stereo preamp, $60; XO-1 crossover, $20; 10-watt amplifier, $20. $85 takes all. Shipped express collect. Irvin Block, 4002 Herndon St., Corpus Christi, Texas.

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Industry Notes . . .

Glaser-Steers Corp. has just appointed John Pacconi, Jr. as customer service manager to be in charge of the company's authorized national service agency network and to handle customer correspondence regarding service information. Mr. Pacconi was formerly with Lafayette Radio in a similar capacity . . . Abraham B. Cohen, president of **Advanced Acoustics Corporation**, has just appointed Edward V. Reiss as plant manager of its new facilities at Nutley, N. J. Mr. Reiss' previous connections in the industry include Langevin Company and University Loudspeakers, Inc. The corporation, which has recently been acquired by **Electronic Research Associates, Inc.**, Cedar Grove, N. J., will manufacture and market newly designed high fidelity industrial sound equipment, ultrasonic and military transducers, and related devices.

United Stereo Tapes, a division of **Ampex Audio, Inc.**, opened its first company-owned branch in Montclair, N. J. on October 5. Mounting demand for 4-track stereo tapes throughout the East made the move necessary. John Beaumont, formerly with Vanguard Records, is general manager of the new branch. United Stereo Tapes has just signed an exclusive contract with London Records, Inc., bringing the number of recording companies for which they produce and/or distribute four-track tapes to twenty three. Among the early London tape releases will be eleven complete operas, and within a month some 35 classical tapes will be available from this label.

Ronald L. McFarlan, consultant to the DATAmatic Corp. and Raytheon Manufacturing Co., has been elected president of the **Institute of Radio Engineers** for 1960. The world's largest engineering society, the IRE now has some 76,000 members.

CORRECTION

The price of the ALTEC 412B Biflex speaker advertised in the November issue was incorrectly listed as $51.00. Correct price is $54.00.

ADVERTISING INDEX

ACOUSTIC RESEARCH ANNOUNCES A NEW AR SPEAKER SYSTEM,

the AR-2a

The AR-2a consists of an AR-2 (ten-inch acoustic suspension woofer with a newly improved cone, and two five-inch cone tweeters) in combination with our 1⅜-inch dome-type super-tweeter (the same one used in the AR-3).

The AR-2 has earned a unique reputation in both home and professional use. The 1⅜-inch super-tweeter that converts the AR-2 to an AR-2a is our most nearly perfect driver—its performance, in the high treble range, conforms more closely to the ideal* than any of our other speaker drivers in their frequency ranges.

AR-2a prices range from $109 to $128, depending on cabinet finish. Except for the pine model, cabinets are finished on all four sides. Further information is available on request.

**On-axis response from 7,500 cps to 20,000 cps is ± 1½ db; maintenance of excellent (although somewhat attenuated) response off-axis, both horizontally and vertically, is inherent in the use of the very small, stiff diaphragm as a direct-radiator.*

We invite you to hear this and other models of AR speakers at the AR Music Room, our permanent display on the west balcony of New York's Grand Central Terminal.

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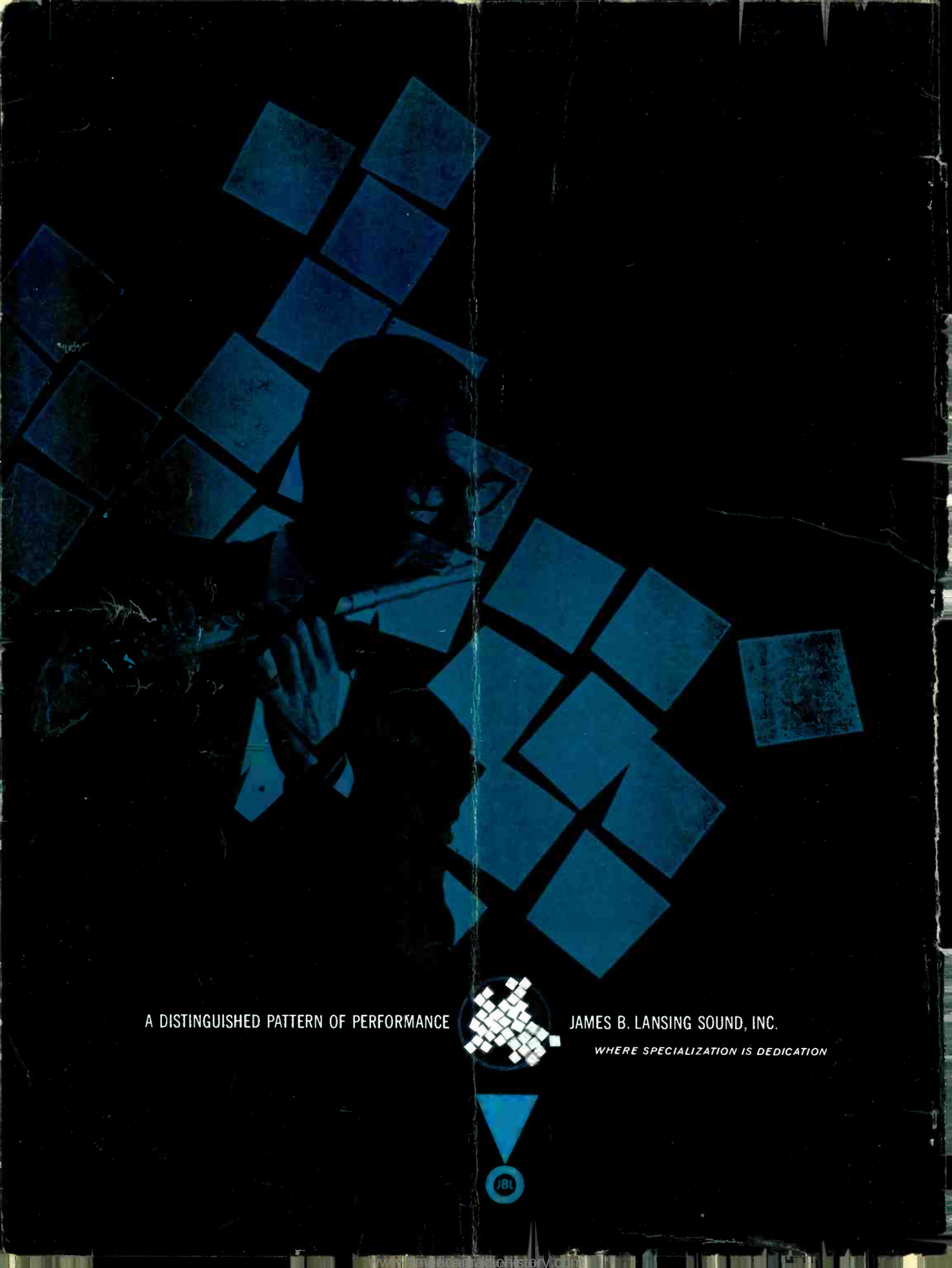

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