AUDIO

JULY, 1958
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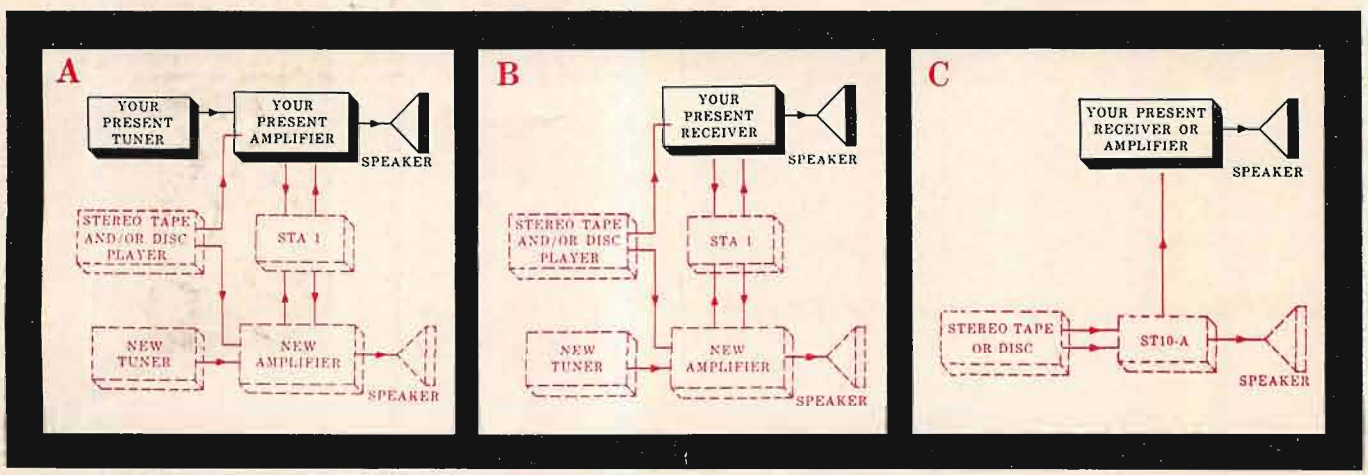

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JULY, 1958 VOL. 42 No. 7
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

COVER PHOTO: One of the country's most treasured recording activities is that performed by Recording for the Blind, Inc., a non-profit organization which records text books, free of charge, for any blind person seeking an education. Here is shown a section of the group's recording center. New embossing techniques and equipment, developed by CBS Laboratories, permit doubling the text content of each disc by conversion to 16⅔-rpm operation.

AUDIO (title registered U. S. Pat. Off.) is published monthly by Radio Magazines, Inc., Henry A. Schober, President; C. G. McProud, Secretary. Executive and Editorial Offices, 204 Front St., Mineola, N. Y. Subscription rates—U. S. Possessions, Canada and Mexico, $4.00 for one year, $7.00 for two years, all other countries, $5.00 per year. Single copies 50¢. Printed in U.S.A. at Lancaster, Pa. Entered as Second Class Matter February 9, 1950 at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

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

JOSEPH GIOVANELLI*

Crossover Networks

Q. I have seen very little published information concerning crossover networks. Would you supply information so that I can tackle construction of them? What is the reason for the use of such networks? Ray E. Roehrick, East Chicago, Indiana.

A. Research has not yet disclosed the perfect speaker. A good speaker should be capable of reproducing the entire audio frequency spectrum flat from 20 to 20,000 cps. Distortion other than frequency discrimination should be under 2 per cent throughout the range. It has been found that if a speaker reproduces the lows well, it cannot vibrate rapidly enough to reproduce the highs with sufficient magnitude. If the size of the speaker is reduced in order to enable it to vibrate at sufficient velocity and amplitude to reproduce the highs frequencies, the unit will lack low-frequency output because the speaker cannot couple to enough air to produce good low-frequency radiation. An 8- or 10-inch model is usually the best compromise.

Most of us dislike compromise and so we have found it advisable to use more than one speaker. Each speaker specializes in reproducing a specific portion of the spectrum. The obvious procedure is to connect all the speakers across the amplifier's output, and each will automatically reproduce its part of the spectrum. Division is automatic, since the speakers cannot reproduce each other's frequencies adequately. This method of connection is a poor one for at least three reasons, however:

(1) It is difficult to get good high-frequency response from even a small speaker unless all moving parts are extremely light. Therefore, many such units (tweeters) are structurally weak. If frequencies below those for which the unit was designed are allowed to enter it, their amplitude would be too great, the elastic limit of the mechanism would be exceeded, and of course, it would be destroyed. Even if the undesired frequencies did not ruin the mechanism, the output at these frequencies would be distorted because of the non-linear mode of vibration which the cone produces when confronted with frequencies which are beyond its capabilities.

(2) The low-frequency radiator (woofer) may have resonances in its upper register which are unpleasant. Therefore, it is best to restrict the range of this speaker so that the speaker will not be excited by energy at its resonant point.

(3) Each speaker placed across the line lowers the impedance presented to the amplifier. When each speaker is assigned a definite portion of the spectrum, this effect is minimized.

It is obvious now that we must divide the spectrum for use with specialized speakers. This division is accomplished through the use of circuits known as crossover networks, or frequency dividing networks. The discussion and circuits following illustrate the manner by which these networks accomplish their purpose. Notice that there is no sharp cutoff or transition at the point where one speaker takes over from the other, High-Q, sharp-cutoff filters would introduce ringing at each transition point, or crossover point as it is mostly commonly termed. 12 db/octave is usually the maximum gradient of attenuation above or below the crossover point, as the case may be. Some engineers advocate a more gradual slope. I personally favor slope between 3 and 6 db/octave. It must be remembered, however, that, with this gradual rolloff frequencies outside the range normally intended will be present in the various speakers comprising the system, and the speakers must be designed to handle more of these undesired frequencies than if they were used with a network having a higher degree of attenuation.

It sometimes happens that the woofer used with a particular speaker system is quite uniform in response up to, perhaps, 5000 cps, after which the highs roll off smoothly. There is, in this case, no need to limit the range the woofer is to handle. Obviously a tweeter must be used to restore the highs. It must not, however, operate to any great extent until 5000 cps is reached, after which point its output rises as that of the woofer falls. *Figure* 1 shows a circuit which could serve this purpose. C_1 is

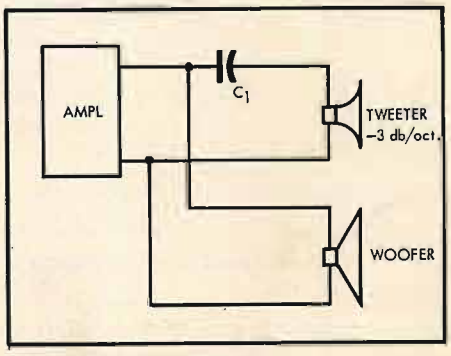

Fig. 1

chosen to have a reactance equal to that of the tweeter at 5000 cps. Below this frequency the capacitor has a reactance which is greater than that of the tweeter so more of the voltage is lost across the capacitor than is developed across the tweeter. As the frequency decreases, less and less power is available to the tweeter, since the reactance of the capacitor becomes larger and larger in comparison with that of the tweeter. As the frequency decreases, the tweeter is gradually isolated from the line. It therefore does not load the circuit when not in use.

Suppose the composition of the tweeter were such that, with the attenuation of-

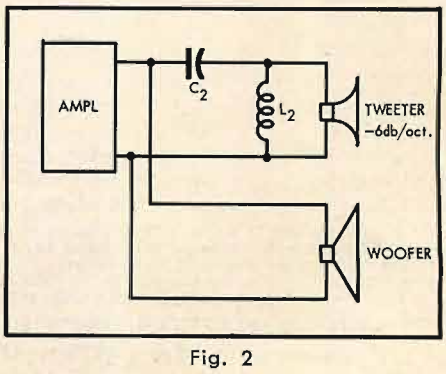

Fig. 2

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

record—as well as

yond its capabilities.

(2) The low-frequency radiator (woofer)

of the capacitor becomes larger and larger in comparison with that of the tweeter. As

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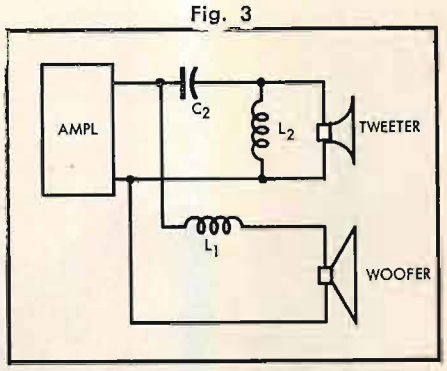
instrument; every Garrard automatic changer is a single record player as well. For this reason, it is a

Fig. 3



fered by this simple network, the low frequencies were great enough to cause tweeter damage. The circuit shown in *Fig.* 2 can be used to cause a more rapid attenuation of the lows. This circuit is similar to that of *Fig.* 1, but has a shunted inductance. C_2 functions as before, but its value should be decreased to 0.707 times the value as calculated above.

L_2 is designed to have a reactance at the crossover frequency which is equal to 1.414 times the reactance of the tweeter at

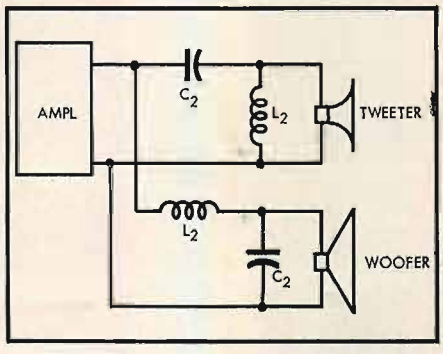


Fig. 4

the crossover point. As the frequency decreases, the reactance of L_2 increases. This results in the total reactance to the capacitor being less than it would without the inductance across the tweeter, with the result that the voltage division between capacitor and tweeter is greater than the attenuation offered by the circuit of *Fig.* 1.

Suppose now that we have found it necessary to attenuate the high-frequency signals feeding the woofer. We still wish to attenuate the lows fed to the tweeter a before. The circuit of *Fig.* 3 could be used. Notice the similarity between *Figs.* 1 and 3. (Consider the tweeter hookup in *Fig.* 1, and the woofer hookup shown in *Fig.* 3.) In *Fig.* 3, L_1 is in series with the woofer, whereas in *Fig.* 1 C_1 is in series with the tweeter. L_1 is designed to equal the reactance of the woofer at the crossover frequency. As the frequency rises above this point, the reactance rises higher than that of the woofer, and again a voltage divider is formed. Less and less signal is available to the woofer as the frequency increases. As the tweeter takes over, the woofer is gradually removed from the circuit, "unloading" the line except for the tweeter. In all of the preceding circuits, the impedance across the line varies somewhat.

A circuit known as a constant-impedance network is shown in *Fig.* 4. This circuit attenuates the response of the woofer still further. Notice that the circuit for the woofer branch of the network is similar to that of the tweeter branch. Of course, the roles of the capacitors and inductances are reversed, since they behave oppositely with regard to frequency attenuation. This circuit is the standard parallel configuration of a constant-impedance two-way crossover network, and the impedance presented to the amplifier is essentially constant throughout the entire audio range. Values are as follows: $L_2 = 1.414 \times R_o/2\pi f$ and $C_2 = .707/2\pi f R_o$ where R_o is the impedance of the speakers (and the output transformer tap) and f is the crossover frequency. Note that both inductances are of the same value and both capacitors are the same.

In many instances, it is desirable to add a third speaker to the system. The frequency range covered by the woofer is reduced to perhaps 250 cps. The third speaker covers the gap from 250 to 5000 cps, and is therefore known as the midrange speaker. *Figure* 5 shows the complete circuitry for a crossover network which can be used with a three-way speaker system. L_3 and C_3 are connected as in *Fig.* 4, and supply signal to the woofer. Also across the line from the amplifier are C_3 and L_3. Signals for the two remaining speakers are taken across L_3. C_3 is designed to attenuate all signals below 250 cps, as is L_3. From L_3 we use another crossover circuit similar to that of *Fig.* 4. The remainder of *Fig.* 5 is, therefore, a two-way network. The midrange speaker can be considered to be the woofer, and the tweeter to be itself. Since attenuation below 250 cps has already been accomplished by L_3 and C_3, it is necessary only to attenuate frequencies above 5000 cps from appearing in the midrange speaker,

(*Continued on page 45*)

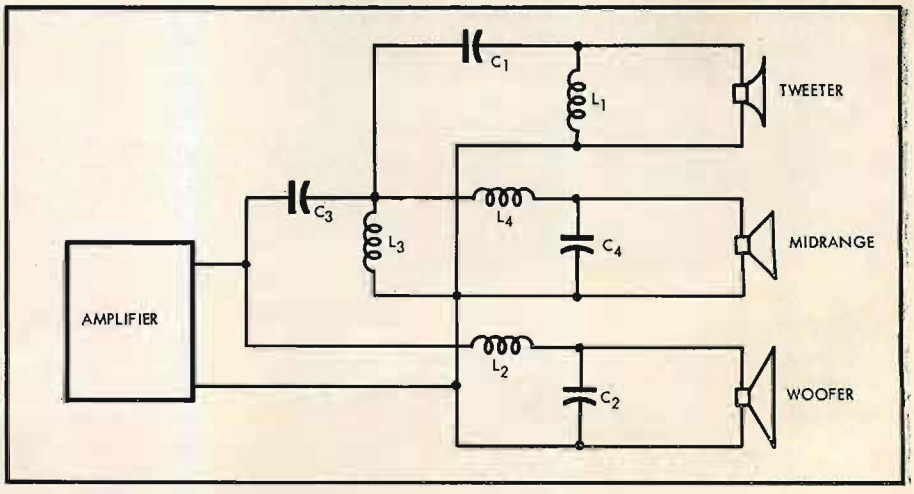


Fig. 5

bodied highs;" and other undesirable characteristics of crossovers, are thus eliminated.

Notice the similarity between *Figs.* 1 and

(*Continued on page 45*)

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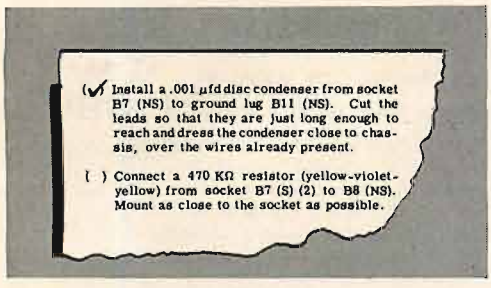

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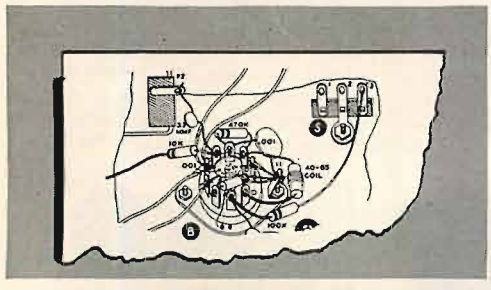

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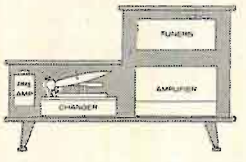

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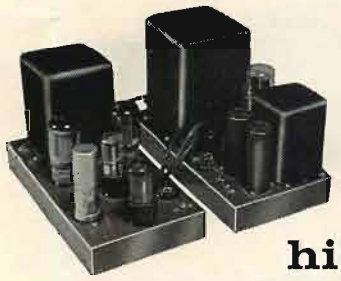

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high fidelity amplifier kit

MODEL A-9C **$35.50**

For maximum performance and versatility at the lowest possible cost the Heathkit model A-9C 20-watt audio amplifier offers you a tremendous hi-fi value. Whether for your home installation or public address requirements this power-packed kit answers every need and contains many features unusual in instruments of this price range. The preamplifier, main amplifier and power supply are all on one chassis providing a very compact and economical package. A very inexpensive way to start you on the road to true hi-fi enjoyment. Shpg. Wt. 23 lbs.

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One of the most exciting improvements you can make in your hi-fi system is the addition of this Heathkit Crossover model XO-1. This unique kit separates high and low frequencies and feeds them through two amplifiers into separate speakers. Because of its location ahead of the main amplifiers, IM distortion and matching problems are virtually eliminated. Crossover frequencies for each channel are 100, 200, 400, 700, 1200, 2000 and 3500 CPS. Amazing versatility at a moderate cost. Note: Not for use with Heathkit Legato Speaker System. Shpg. Wt. 6 lbs.

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HEATHKIT "LEGATO"

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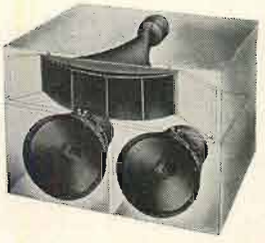

Wrap yourself in a blanket of high fidelity music in its true form. Thrill to sparkling treble tones, rich, resonant bass chords or the spine-tingling clash of percussion instruments in this masterpiece of sound reproduction. In the creation of the Legato no stone has been left unturned to bring you near-perfection in performance and sheer beauty of style. The secret of the Legato's phenomenal success is its unique balance of sound. The careful phasing of high and low frequency drivers takes you on a melodic toboggan ride from the heights of 20,000 CPS into the low 20's without the slightest bump or fade along the way. The elegant simplicity of style will complement your furnishings in any part of the home. No electronic know-how, no woodworking experience required for construction. Just follow clearly illustrated step-by-step instructions. We are proud to present the Legato—we know you will be proud to own it! Shpg. Wt. 195 lbs.

MODEL HH-1-C
(imported white birch)
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(African mahogany)

$299.95 each

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HEATHKIT RANGE EXTENDING

high fidelity speaker system kits

MODEL SS-2 **$39.95**

A truly outstanding performer for its size, the Heathkit model SS-2 provides you with an excellent basic high fidelity speaker system. The use of an 8" mid-range woofer and a high frequency speaker with flared horn enclosed in an especially designed cabinet allows you to enjoy a quality instrument at a very low cost. Can be used with the Heathkit "range extending" (SS-1B) speaker system. Easily assembled cabinet is made of veneer-surfaced furniture-grade ½" plywood. Impedance 16 ohms. Shpg. Wt. 25 lbs.

Designed to supply very high and very low frequencies to fill out the response of the basic (SS-1) speaker, this speaker system extends the range of your listening pleasure to practically the entire range of the audio scale. Giving the appearance of a single piece of furniture the two speakers together provide a superbly integrated four speaker system. Impedance 16 ohms. Shpg. Wt. 80 lbs.

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AUDIO ETC.

Edward Tatnall Canby

The Tape Cartridge

COMES THE REVOLUTION! That is the best way I can express my impressions of the first demonstration to the audio press of RCA's triple-threat line of stereo goods for the coming season.

Disc stereo—of course. That we had expected, these many months. The new stereo disc wasn't exactly a big secret.

Disc stereo players—to be taken for granted. But there was a considerable gasp of astonishment from the assembled press when it was revealed that RCA's *entire line* of new home phonographs (two held-over low-priced models excepted) would go stereo, complete with stereo ceramic pickup (RCA's own) and dual amplifier set-up, and that the cost of these machines, minus the extra speaker, would be only about $10 more than equivalent items in last year's line. (The second speaker, in most models, is sold as an extra. You don't have to play stereo unless you want to.)

But the biggest news by far was the new tape stereo cartridge or magazine and its matching player equipment. Rumors had been afloat for quite awhile on this score, too, but the details were kept unusually well wrapped and few of us had any clear idea as to what was afoot—though the virtual cessation of RCA standard tape releases was a straw in the wind. (The system was shown to the tape recorder industry people very early in the year—they managed to hold their tongues.)

And thus only a few of the pros in our business were prepared for the extent of the impact area, so to speak, when RCA let loose its little cartridge bombshell in the most casual manner.

Bombshell in a Cartridge

First—four tracks on a single tape, two tracks each direction for "half-track" stereo. This we knew about from previous Ampex announcements, but few of us had actually heard it.

Plus—sound quality not far from present 7½ ips standards, on all four tracks, at the slow speed of 3¾ ips. We heard it; I found it excellent. This represents a basic improvement in the functional frequency-range-*vs.*-speed ratio. (A reporter asked RCA point blank whether the sound recorded on the new cartridges was "as good" as that on present two-track stereo tape. The answer was an unequivocal "yes.")

Plus—a tape magazine or cartridge with two hubs, to right and left (no loops, no tricky angles of tape feed) that drops into place in an instant on its own special player, is operated entirely by pushbutton control, yet has most of the advantages and flexibility of present home tape. (Unscrew two screws, lift off the top half of the cartridge, and the tape is out in the open for patching, editing, adding new tape and so on.) The cartridge is turnover; you flip it to play back to the beginning. (Automatic players reverse its direction without the flipover.)

Plus—and this is the big pay-off—home recording in cartridge form. This is not merely a new stereo tape phonograph. It records, too, either monaurally *or* stereo. You can buy cartridges of blank tape (or reel your own); you can record on all four tracks singly, one after the other—two hours' playing time—or you may record stereo for a full hour using two tracks each direction. (I'm not much in favor of this, however. Home stereo recordings are apt to be nothing more than freakish monstrosities.)

So, it was revealed, the RCA cartridge system is actually an invader in every territory, with potentialities in each area that could turn whole industries inside out. You can see why a few of us, at least, were slightly overwhelmed by the possibilities, in what was surely the most offhand demonstration RCA has ever staged.

There's plenty to say about stereo disc and about RCA's stereo players, but I find the cartridge tape so much more significant at the moment that I'll put all the rest aside. Let me throw out to myself some simple questions of the sort that most people will be asking. Some may have been answered specifically and in detail by the time this is in print—but I'll take a chance, on the limited information we had at our disposal, to give you a bird's eye picture as well as I can.

Tape Mechanism? The new tape player-recorder is a minimum departure from the accepted and familiar standard, even with the cartridge in its middle. There are the conventional controls, including fast motion in either direction, for rewind or for locating a wanted passage. The tape simply moves from one side to the other, as usual, but within the cartridge. You can watch the hubs turning and you can see the size of the tape roll inside through windows in the cartridge body. The two hubs, about an inch and a quarter wide each, are set into two holes in the body of the cartridge; they turn on flanges at their edges. This is a highly sensible "compromise" cartridge—it sensibly avoids the complications that arise when endless loops or offset reels are brought into the picture. In effect, you have here simply a removable section of an ordinary tape transport system—two rolls of tape already in place and a set of guides to lead the tape in between to the right place. The rest of the transport is in the playing machine—the heads, the capstan, the driving power. (But see below for size and space.)

The whole thing, of course, is made possible only by the extraordinary saving in playing time that is the result of the slow-speed four-track system. Without that, the cartridge would have to be far too big for any practical use, in this two-reel form. No wonder we haven't had it before now.

Accidental erase? Beautifully taken care of, in the taped cartridge recordings, via an automatic safety switch actuated when the cartridge is plugged into the machine. You can't go wrong. For home recording there is a simple "defeat" that allows the record-erase circuit to be used, at will.

Turnover construction? The RCA cartridge is made in two symmetrical plastic halves with slots along the lower side arranged so that the cartridge looks the same on either side. Turn it over, plug it in the other way up and you play your tape back to the beginning, just as in present standard home tape. Fully automatic reversing is a sort of afterthought; in this mechanical configuration it was simple enough to design a fancier player that would reverse the play at the end of the reel, with a second head to play the reversed tracks. The idea is about the same as that in the Webcor "no reel turnover" models and originates in the once well-known "Twin Trax" machine that first promoted the idea of dual tracks on home tape, many years ago.

The tape cartridge, of course, is interchangeable on either type of machine, manual-turnover or automatic-reverse.

Tape stop? A crucial question in any semi-automatic pushbutton system for tape. Will the tape stop at the end, without pulling loose inside the cartridge? Two diagonal slots in the cartridge body (symmetrical, to right and left, as usual) allow feeler arms to sense tape tension, on each side, stop the tape. (In automatic models, the same device reverses the tape as well as stopping it at the end of play.)

I didn't get a chance at the RCA demonstration to try a nasty little test I had in mind—push the fast rewind button, then wait to see what would happen at the end of the reel. But RCA says the thing *does* stop, won't break the tape or pull it loose.

You can take that with a grain of salt if you want; but remember that RCA is in for some tall trouble if the automatic stop isn't what it claims to be! The first thing any home owner will do will be to put this to the test—by accident or on purpose. I think we can assume that the auto-stop feature was one of RCA's biggest preoccupations, and that the present system is pretty much foolproof. If not, RCA had better start running for cover.

Tape spill? The simplest of built-in brakes, spring actuated, clamps down on the tape automatically when the cartridge is taken off the player. Plugging it into the machine releases the brake. If you do manage to spill some tape, shaking the cartridge will often reel it back inside, due to the brake structure. If not, you can remove the two screws in a moment, take off the top half of the magazine and re-reel in conventional fashion. Since there's no hand threading in this system, tape spillage is not likely to occur very often.

Cross-talk between tracks? A big question! All that I can say about it at the moment, after one good hearing of stereo cartridge sound, is (a) that I couldn't *hear* any cross-talk and (b) RCA would not dare promote this system for single-track *monaural* recording in the home if

(*Continued on page 32*)

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

Bombshell in a Cartridge

Tape Mechanism? The new tape player-

disposal, to give you a bird's eye picture as well as I can.

think we can assume that the auto-stop feature was one of RCA's biggest preoc-

cupations, and that the present system is

EDITOR'S REVIEW

THE STEREO ISSUE

NOT, IF YOU PLEASE, the issue of whether or not we will convert to stereo—we've already done that—but the August issue of AUDIO which will be devoted entirely to stereo in all its aspects, or to as many of them as space will allow. More about that later. But first, a word from our own vast experience with stereo records—all of two weeks by this time.

Forgetting about the stereo effect itself, let us consider what happens when we play a monaural (more about that later, too) record on a stereo system. Believe us, if you will, when we say that mono . . . (no, we won't say it) records invariably sound better on a stereo system, played by a stereo pickup, than they do on a . . . single-channel rig, even though the same two speakers may be playing. Try it out for yourselves. And now, back to the story.

We believe you will find something of interest in next month's issue, both theory and constructional material. We have just finished a survey of all FM stations throughout the country and we have compiled the results of their thinking with regard to stereo, and more particularly with regard to their future intentions toward FM/FM Multiplex as the logical means for broadcasting stereo in a manner which will permit the FM listener who does not have the multiplex adapter to receive a well balanced program, rather than just one half of a two-channel program which is just what listeners to either AM or FM alone hear when a conventional stereo tape is played. We also have some interesting material on the type of device used for multiplex reception in conjunction with an FM receiver, as well as a short discussion of the difficulties encountered in actual practice.

In addition to a full complement of articles on the subject, we are augmenting the NEW PRODUCTS section to bring detailed information regarding the equipment that is now available for home use in stereo reproduction. And we also plan on a listing of all the stereo records which will be on the market by that time. Unfortunately we cannot include all stereo tapes, but those listings are already incorporated in the monthly record guides, and in at least one quarterly.

We trust you'll be seeing us next month.

MONOPHONIC REPRODUCTION

Without question, the term "monaural" has been used incorrectly ever since someone needed a term to describe the opposite of "binaural." Years ago we took a firm stand against *binaural* in any application except when it referred to reception of a two-channel signal directly to the individual ears by means of headphones. We were almost stumped when someone brought out a wing chair with a small speaker in each wing, because this is practically the same as binaural. Anyhow, we have stuck to the strict usage of "stereophonic" when it referred to reproduction through loudspeakers, both of which could be heard by both ears, and this seems to be almost solidly established throughout the industry by now. Only rarely do we encounter *binaural* when *stereophonic* is meant.

"Monaural" is an entirely different matter. No one is monaural, unless perhaps some few have tried to shave with a straight razor in a dark room or put an ear too close to the lawnmower and then left it there. At an IHFM meeting during the Los Angeles High Fidelity Show in February, Paul Klipsch dropped one of his not infrequent bombshells by introducing the term "monophonic" to describe a single-channel system. Everyone knew just what Mr. K. meant without needing to have it explained, but it does not seem to have caught on at all, even though there is good reason for it.

We may be slow, but anyhow we have decided that "monophonic" has finally caught on with us, and beginning with the August issue the term monaural will join our small but select list of taboos, rating the third place. (The other two taboos are: "must," when used as a noun, e.g., "the use of wirewound resistors is a must"; and the suffix "wise," used in place of more correct English to imply "from the standpoint of," e.g., "businesswise this is not a good policy.") We do not believe that either of these last two taboos has gotten into print in the editorial material in this magazine for years; we can't censor the ads, of course, and not everyone agrees with our idiosyncrasies. Actually, we see no reason why a semi-technical magazine must perforce shun the niceties of proper English.

This brings up another question—one about which we are on the fence, so to speak. This is the use of the letter "K" to mean thousand. We have long standardized, in drawings made by our own draftsmen, on written-out values from 0 to 99,000, and on values from 100,000 up we have always preferred to use the decimal part of a megohm, as 0.27 Meg. We can't blame the draftsmen for this (either way) since for about three years all our drawings have been lettered on a typewriter, using a simple process we believe we originated, and by an editorial assistant. The style is, therefore, of our own choosing. Actually, the "K" is somewhat shorter, but we have always felt it was not so precise.

Putting the question to you readers is, perhaps, a cowardly approach, but you are the people we strive to please. Some of you may have preferences one way or the other and we would like to know about them. Comments, anyone?

SIC TRANSIT GLORIA VIOLINO

Almost never does a new-product publicity release get mentioned on this page, but this one we can't pass up.

The first paragraphs of a release from the agency representing John J. Calborn Company, 1551 Thames Drive, Colnmbus 19, Ohio, read:

"Faced with the loss of a big percentage of their market, due to heavy competition from foreign imports, America's *only violin factory* (italics ours. ED.) is now producing a line of instruments designed to be seen and not heard.

"The firm's new "Flowering Fiddle" planters are genuine violins made to be hung on walls. They contain a cleverly concealed waterproof cannister to hold trailing vines, ivy, or small flowering plants."

Could someone be stringing us?

We trust you'll be seeing us next month.

or the other and we would like to know about them. Comments, anyone?

Complete* Compatibility

with no compromise in quality!

For the first time—a pickup with all of the compliance, frequency response and distortion-free performance required for the highest quality reproduction.

The *compatible* STANTON 45X45 Stereo-FLUXVALVE *defies obsolescence* . . . exclusive T-GUARD stylus assembly with .7 mil diamond will play all microgroove records . . . monophonic or stereophonic. No bothersome plugging, switching or other manipulations necessary when changing records, they can even be stacked on a record changer for fully automatic operation.

℠ STEREOBILITY—Pickering's trademark, established to serve as a quality mark which guarantees complete compatibility, stability and flexibility in operation and performance.

* *One pickup...one stylus... for all microgroove records, monophonic or stereophonic!*

STEREOBILITY℠ Series Model 371—.7D STANTON 45X45 Stereo-FLUXVALVE cartridge with .7 mil diamond in T-GUARD stylus assembly. $29.85

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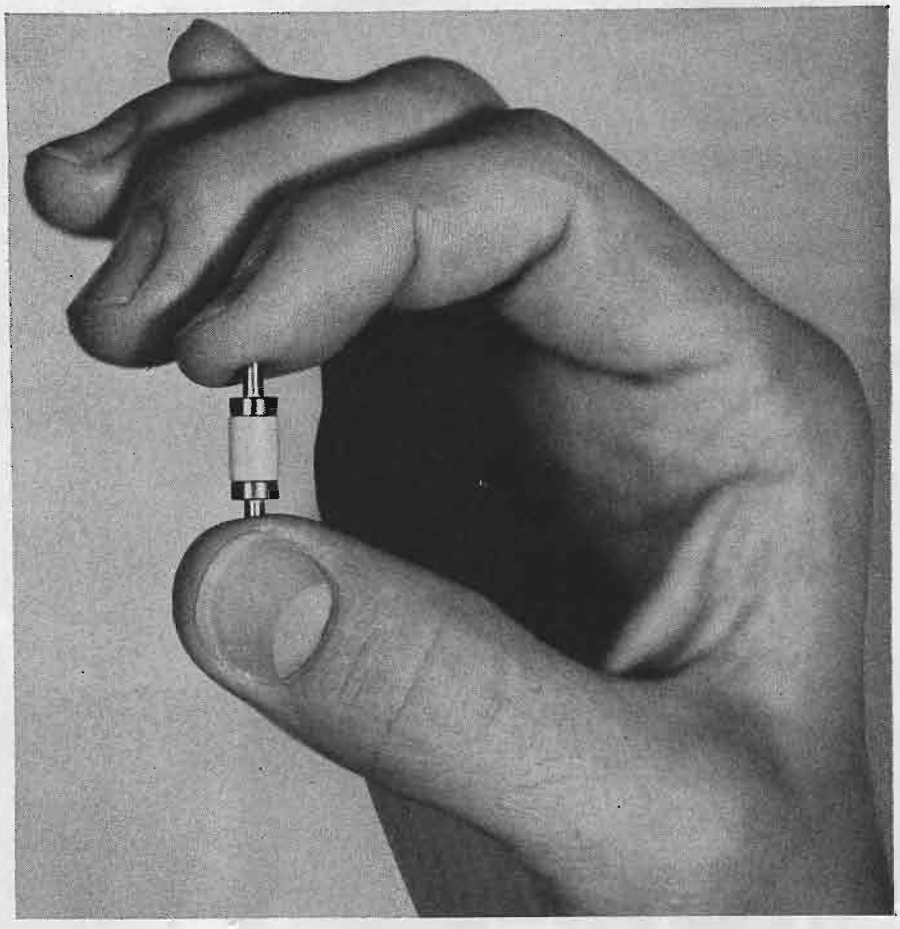


How the radio art can be improved through solid state science is illustrated by a recent development at Bell Telephone Laboratories. To make voice signals travel by microwaves they must first be "converted"—caused to vibrate at billions of cycles per second. To date, it has been possible to accomplish this conversion only at the cost of appreciable loss of signal energy. Could a more efficient converter be provided?

In the field of solid state science it was known—as a laboratory curiosity—that semiconductor diodes can be made not only to convert the frequency of signals, but also to amplify them. At Bell Laboratories Dr. Arthur Uhlir, Jr., and his associates calculated that this amplifying action could be put to practical use. They proved the point by developing a junction diode converter which can deliver up to 40 times as much signal energy as previous converters.

This efficient new converter will be applied in a new Bell System microwave highway able to transmit thousands of telephone conversations and a dozen television programs simultaneously at six billion cycles per second. In other forms it is being developed, under Signal Corps contract, for radar and military communications where more efficient frequency conversion can also be used to advantage.

This development is an example of the many different ways in which Bell Laboratories works to improve your telephone service and communications at large.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

Improving the Tape Amplifier

HERMAN BURSTEIN* and HENRY C. POLLAK

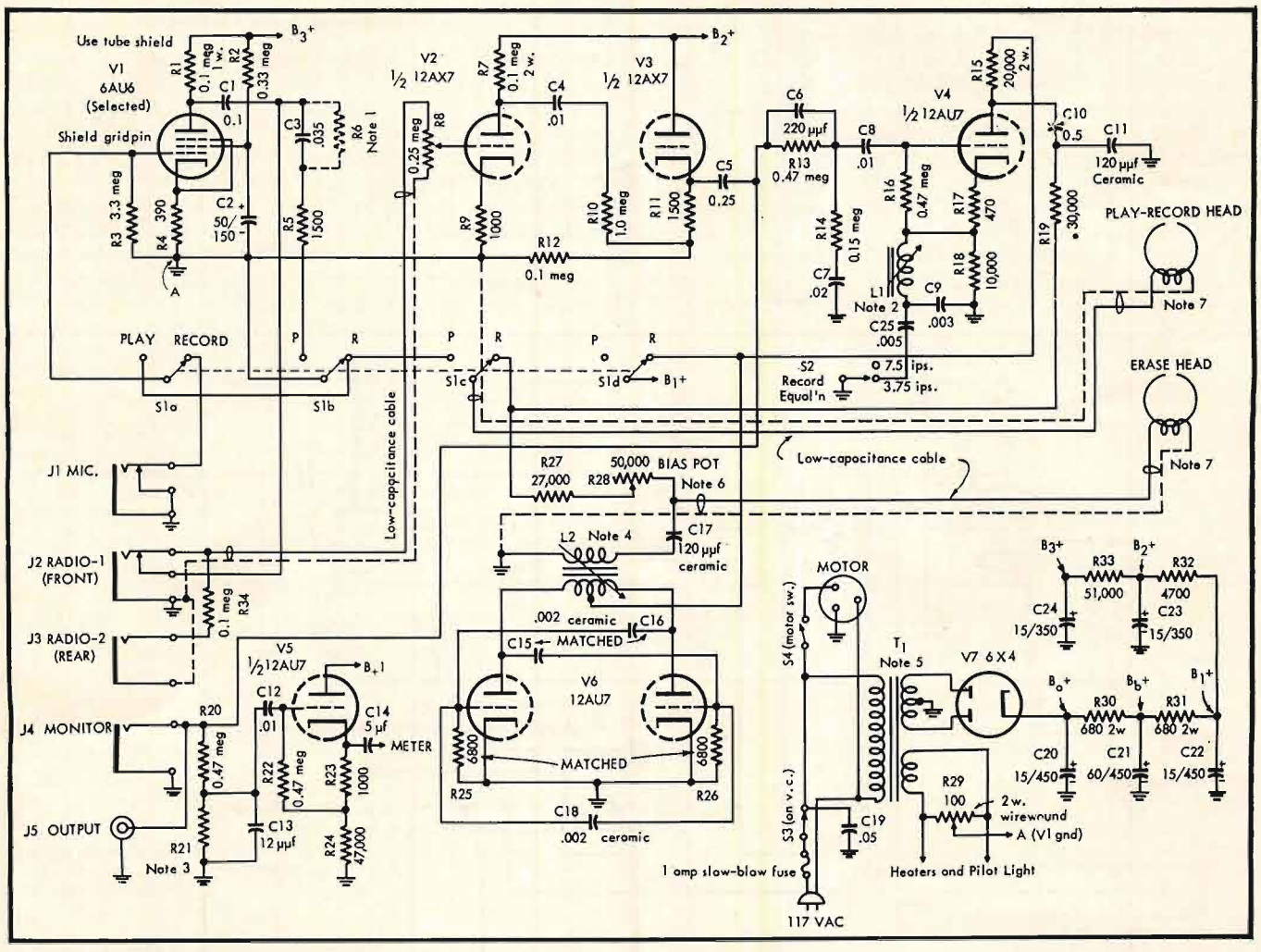
Changes in components often necessitate changes in circuit values in order to ensure optimum operation and to take advantage of the potentially improved performance. The authors' earlier tape amplifier is here brought up to date to permit the use of improved heads

A HIGH-QUALITY tape recorder amplifier was described in the January and February, 1957, issues of this magazine by the writers; the circuit is reprinted here as *Fig.* 1. Since then, the writers from time to time have made changes in the amplifier to improve its performance or operating convenience. The number and nature of changes that have accumulated now seem to warrant another article indicating how satisfactory performance may be won from the electronics of a tape recorder.

The changes concern installation of professional heads, a more stable oscillator, more accurate equalization, reduced noise and hum, and greater con-

* *280 Twin Lane E., Wantagh, N. Y.*

Fig. 1. The original circuit of the tape recorder amplifier as described by the author in the January and February, 1957, issues.



Note 1: If bass response is excessive due to the playback head characteristic, bass may be reduced by using R6 with a value in the range from 0.1 to 0.5 meg. If bass is insufficient, connect the .035-μf capacitor C2 to the plate of V1 instead of to the for side of the 0.1-μf coupling capacitor C1. See text.

Note 2: TV width coil variable from approximately 5 to 35 mh. Ram 201R3A or eq.

Note 3: Approximate value is 5 meg. Should be varied to produce correct indication on record-level meter or VU meter.

Note 4: Oscillator transformer used is a shielded unit furnished in Pentron HFP-1 amplifier and other Pentron models. Tuned to approximately 65 kc; see text. A suitable coil (part No. D501) may be obtained from Dynamu Magnetronics Corp., 21 N. Third St., Minneapolis, Minn., in which case the recommended Dynamu oscillator circuit should be employed.

Note 5: T1 is a shielded power transformer. 240-0-240 v at 50 ma, 6.3 v at 2.5 a. Merit P3047 or equivalent.

Note 6: Adjusted for 0.68 ma. See text.

Note 7: Dynamu heads. See Note 4 for company address.

Misc.: Resistors R1 and R4 are low-noise types. Others are ½-watt, 10% tolerance unless otherwise specified. Capacitors in μf, at least 400 v. rating, paper or ceramic, unless otherwise specified. Switch S1: 4-circuit, d.t., lever or rotary type. S2: toggle or slide. S3: on v.c. S4: toggle. Jacks: J1 and J2, shorting-type phone jacks; J3 and J4, standard phone jacks. J5, pin-plug receptacle ("phono" jack).

Changes as discussed in the text:

- C6 becomes 50 μμf
- C11 is omitted
- C13 becomes 100 μμf
- C15, C16, and C18 become silver mica instead of ceramic
- R18 becomes 20,000 ohms
- R21 becomes 0.22 meg
- R27 is omitted

venience in switching from record to playback.

Installation of New Heads

The design of the original amplifier was partly based upon use of Dynamu heads. When the Dynamu record-playback head had worn to the point where replacement was necessary—the gap having widened and high-frequency response deteriorated—it was decided to replace this and the erase head with Brush heads, which are in extensive professional and semi-professional use.

The Brush BK-1090 record-playback half-track head was used. It is of laminated-core construction, which minimizes eddy current losses; has a nominal .00025 in. gap, permitting good response to 15,000 cps at 7.5 ips; and has two coil windings, which are hum cancelling when properly connected in series or parallel for the audio signal. It was found that the Brush BK-1090, with its windings in series for maximum playback signal, had greater drive requirements than the Dynamu head, so that more voltage gain was required in recording. Therefore V_3 was converted from a cathode follower into a voltage amplifier stage, as shown in *Fig.* 2; at the same time, equalization was changed from losser to feedback type, as will be discussed later in more detail.

To obtain enough bias current through the new head, the 27,000-ohm resistor R_{27} was omitted and bias was taken directly from R_{28}. Bias was adjusted for 0.7 ma., as measured on an audio VTVM, by reading voltage across a 100-ohm resistor inserted between ground and the ground lead of the head. This represented an optimum compromise affording satisfactorily low distortion and extended high-frequency response. More bias current would have further reduced distortion at high recording levels, but would have caused treble response to deteriorate significantly. At the bias used by the writer, recordings sound clean, and if at 7.5 ips one A-B's tape recording of a high-quality phono disc with the disc itself, the two are virtually indistinguishable.

The Brush BK-1110 half-track erase head was used. For the voltage and current produced by the bias oscillator in *Fig.* 1, the head appeared to work most efficiently with its windings connected in parallel. Current was supplied, as before, through the 120-μμf capacitor C_{17} and measured 12 ma., which is enough for effective erasure with this head. Erase current was measured by reading voltage across a 100-ohm resistor between the head and ground.

The 100-ohm resistors employed to measure bias current through the record head and erase current through the erase head were left permanently in place. This facilitates quick checking of bias current and erase-head operation. It is only a matter of seconds to connect the audio VTVM across these resistors and take current readings. Occasionally, as the oscillator tube ages or when it is replaced, it may be necessary to adjust bias current by means of R_{28}. The recordist desiring top-quality results will want to maintain watch over bias current as religiously as he cleans the heads and guides, demagnetizes the heads, lubricates the tape mechanism, and so on.

Upon installation of the Brush record-playback head, the treble boost requirement for recording purposes appeared to change somewhat. The 10,000-ohm resistor R_{18} was replaced by a 20,000-ohm one, which permitted the series resonant circuit comprising L_1 and C_9 to produce a greater amount of treble emphasis. At the same time, the 200-μμf capacitor C_6 was replaced by a 50-μμf capacitor, shifting upward the frequency at which treble boost begins. The net result was in a steeper treble boost.

Oscillator Circuit Changes

Bias current is fairly critical at speeds of 7.5 ips and less. Relatively small changes, less than 1 db, can appreciably affect high-frequency response and distortion, which both vary inversely with bias. Thus a stable oscillator is much to be desired. Toward this end, ceramic capacitors C_{15}, C_{16}, and C_{18}, all .002 μf, were replaced by silver mica units, which are more stable over time and with temperature changes.

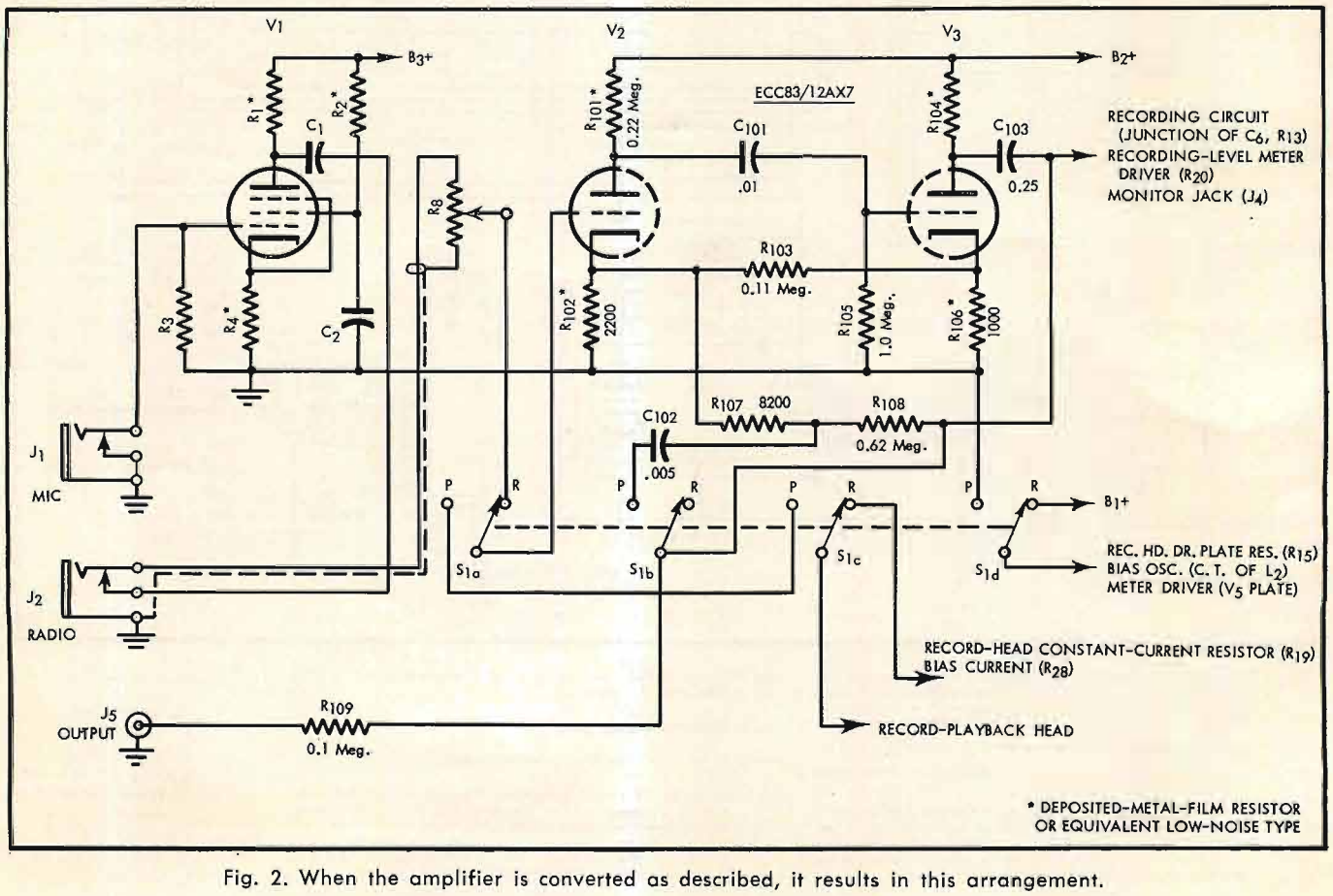


Fig. 2. When the amplifier is converted as described, it results in this arrangement.

Recording-Level Meter Circuit Changes

By providing more gain in the early stages to satisfy the greater drive requirements of the new record head, more signal was also presented to the grid of V_5, which drives the recording-level meter. Therefore it became necessary to reduce the signal reaching the grid of V_5 so that the meter would give the same indication as before for a given amount of signal *recorded on the tape*. Accordingly, the 5-meg resistor R_{21}, part of a voltage divider, was decreased to 0.22 meg, which caused the recording-level meter to be correctly driven. Thus the meter continued to indicate full scale for a signal about 6 db lower than that required to produce 2 per cent harmonic distortion on the tape at 400 cps. As explained in the original article, the meter is set "6 db ahead," so to speak, to make allowance for the fact that the meter indication falls behind the actual level of rapid transients.

Reducing R_{21} to 0.22 meg made it necessary to increase the bypass capacitor C_{13}, which prevents bias current from affecting the record-level indicator. Originally 12 μμf, it was increased to 100 μμf. On the other hand, the 120-μμf capacitor C_{11}, also used to shunt bias current to ground, was found no longer necessary and therefore removed.

Originally the plate of V_5 was permanently connected to B_1+ so that the meter would operate in record as well as playback. This permitted comparison of playback levels among various tapes and enabled one to correlate audible distortion with recorded signal level. Unfortunately, if a signal were fed into the amplifier for recording purposes but switch S_1 was left in the playback mode, the meter gave an indication as though everything were set for recording. For this reason the writer accidentally failed on a number of occasions to obtain a desired off-the-air recording. Therefore it was decided to obtain B+ for V_5 from the same point as the B+ supply for the record-head driver V_4 and the oscillator V_6, which are connected to B+ only in the record mode. This point is the arm of S_{1d}, as shown in *Fig.* 2.

Revised V_2-V_3 Electronics

The circuit revisions in *Fig.* 2 meet the following objectives: (1) V_3 is converted from a cathode follower to a voltage amplifier to provide the greater gain needed in recording. (2) Output impedance is kept low through negative feedback, thus maintaining high-frequency response and permitting a reasonably long run of cable between the tape recorder and the next component in the audio chain for playback (usually a control amplifier). (3) The volume-control setting does not affect playback equalization; in the original circuit, which employed a losser type of bass-boost network, boost at the very low end dropped a few db when the gain control was not at maximum setting. (4) Hum and noise generated in V_2 and V_3 are reduced by negative feedback.

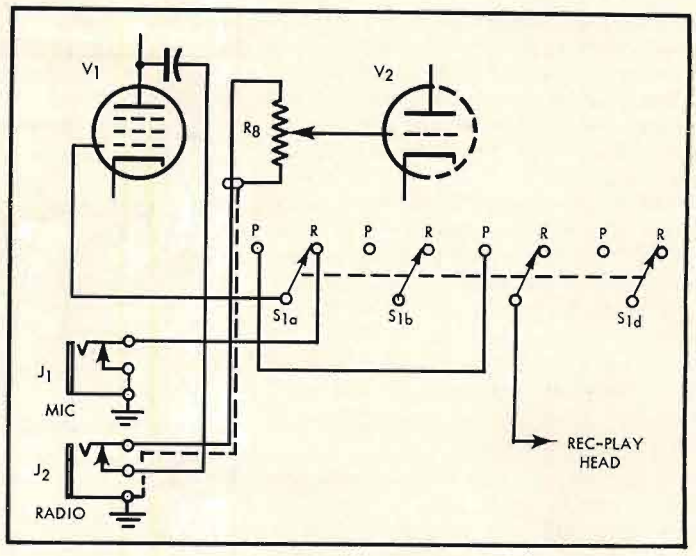


Fig. 3. Revision to increase playback gain by restoring V_1 to the circuit.

The feedback equalization network, comprising R_{102}, R_{103}, R_{107}, R_{108}, and C_{102}, produces a playback characteristic conforming very accurately to the NARTB curve. C_{102} and R_{102} plus R_{107} in series produce the high-frequency turnover of 3180 cps, while C_{102} and R_{108} produce the low-frequency turnover of 50 cps.

One of the problems in using feedback to obtain an equalization curve with a large amount of bass boost, such as the NARTB curve requires, is that at low frequencies the curve tends to lose its accuracy. That is, gain at the low end no longer varies exactly in inverse proportion to the amount of feedback. The feedback factor (ratio between gain without feedback and gain with feedback) is $1+AB$, where A is gain before feedback and B is percentage of output voltage fed back. At high frequencies, the quantity AB is much greater than 1, so that the feedback factor consists largely of AB; since A is a constant, it can be said that the gain ratio varies essentially with changes in B. At low frequencies, however, B is very small, and the quantity AB begins to approach 1. Therefore the value 1 can no longer be ignored in the expression $1+AB$. And the response curve no longer varies exactly with changes in B. In order to keep the quantity AB significantly higher than 1 (at least four times as great) and thus produce accurate equalization, it would be necessary to increase A, that is, gain before feedback. This can be done by positive feedback. The 0.11-meg resistor R_{103} in *Fig.* 2 produces several db of positive feedback for this purpose.

It should be noted that R_{109}, a 0.1-meg resistor, has been added in series between the output stage and the output jack J_5. A resistor of this sort (about 10,000 ohms) also should have appeared in the original circuit (*Fig.* 1). If the output of the tape recorder is left connected to a control amplifier, usually this output will be shorted to ground by the control amplifier's function switch when this switch is turned to another input source, say the FM tuner. The purpose of R_{109} is to prevent the signal at the plate of V_3 from being shorted out during recording.

Revised Switching

As pointed out in the original article, the hardware employed was that found in a Pentron HFP-1 tape amplifier. This included the function switch, a four-pole double-throw type. Because of the limited number of poles, when switching from record to playback it was necessary to remove the phone plug that had been inserted into the input jack J_2 for recording from a high-level source, such as the tape output jack of a control amplifier. If the phone plug were left in during playback, it would provide a feedback path from the tape output jack of the control amplifier to the tape-recorder input and from the tape-recorder output back into the input of the control unit.

Having to insert and remove the phone plug continually proved to be a nuisance. Therefore the revised switching arrangement of *Fig.* 2 was used, which enabled the phone plug to be left in J_2 during playback. V_1 is now permanently connected to the microphone input jack J_1. Only V_2 and V_3 are used for playback; more will be said about this shortly. In playback, the volume control R_8 and the input jack J_2 are disconnected from the circuit by S_{1a}. Prior to this change, the gain control had always been left in maximum position during playback. Since the change, the lack of command over playback gain *at the recorder* (gain is governed by the control amplifier) has caused no inconvenience.

The function of S_{1b} remains that of introducing playback equalization, but

in a different manner from the original circuit. Now S_{1b} places C_{102} across R_{108}, resulting in the NARTB characteristic. When C_{102} is out of the circuit in the record mode of the switch, there is an equal amount of feedback at all frequencies.

There is no change in the purpose or action of S_{1c}. Some alteration was made in S_{1d}. Now the record terminal instead of the arm is connected to B_1+. The arm goes to the plate load resistor of V_4, the plate of V_5, and the plate of V_6 via the center-tap of L_2. The play terminal of S_{1d}, previously not used, is now connected to ground as a means of bypassing stray bias current.

Using only V_2-V_3 as a playback amplifier results in an output signal of only about 0.1 volt or slightly less on peaks. For many or most audio systems this should be enough. A number of control amplifiers have high sensitivity, enabling them to produce an output of 1 volt or more for input signals of 0.1 volt. And the typical power amplifier can be driven to full output or to within a few db of full output by an input signal of 1 volt.

However, if more playback gain is needed, V_1 can be restored to the circuit as in *Fig.* 3. Switch S_{1a} is used to transfer the grid of V_1 between the playback head in playback and the microphone input jack J_1 in recording. The grid of V_2 goes directly to the gain control R_8 instead of being switched to this control in recording and to the playback head in playback. But if V_1 is used for playback, it is again necessary to remove the phone plug from J_2 in this mode.

If V_1 is used in the playback circuit, the tape recorder preferably should be operated in playback with the gain control at maximum. Level should be reduced subsequently by the input level-set and/or gain control of the control amplifier to which the tape machine is connected. Thus when the playback signal is reduced to the desired level, noise and hum in V_2 and V_3 are simultaneously attenuated. The chances of overloading V_2 are small when the gain control of the amplifier is at maximum. The signal from the playback head is a few millivolts at the most. Since V_1 has less than 40 db gain, the signal presented to the grid of V_2 with the gain control full on is less than 1 volt. V_2 can easily handle this with low distortion, especially because of the large amount of negative feedback applied to its cathode. Feedback is greatest at high frequencies, where the output of the tape head, a velocity device, is also greatest.

Reduction of Noise and Hum

To reduce noise, deposited-carbon resistors were used at the plate and cathode of V_1 and an oversize resistor (2 watts) at the plate of V_2 in the original

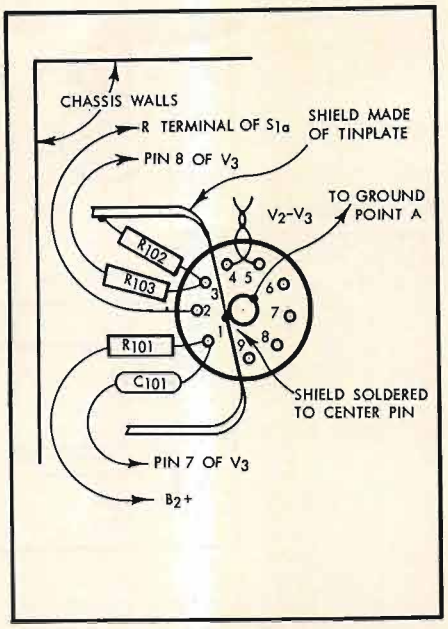


Fig. 4. Physical arrangement of shield and circuit components to minimize hum.

circuit. In the circuit of *Fig.* 2, however, deposited-metal-film resistors are used for noise reduction. These can be virtually as noise-free as wirewound resistors and about one-third as expensive, costing about one dollar each. Moreover, wirewound resistors have some residual inductance, although wound in a manner designed to cancel inductance. This may lead to pickup of hum or possibly to pickup of the audio signal and consequent positive feedback and oscillation in a high-gain circuit.

In view of the fact that deposited-metal-film resistors are not too readily available to the individual hobbyist, it is appropriate to mention here that the Davohm Series 850 resistors, covering the range of 2 to 850,000 ohms, are carried by Harvey Radio, 103 W. 43rd St., New York City. The writer has also obtained excellent results with the Nobleloy deposited-metal-film resistors made by Continental Carbon, Inc., and with the S20 resistors recently introduced by Corning Glass Works.

In *Fig.* 2, deposited-metal-film resistors are used as the plate and cathode resistances for V_1, V_2, and V_3. Prior to use of metal-film types, deposited-carbons had been tried for V_2 and V_3 as well as V_1. But each time a metal-film resistor was substituted for a deposited-carbon one, there was a striking improvement, even in late stages. This is not to say that all deposited-carbon resistors are inferior to metal-film ones. In fact, the writer has been given to understand that there are some deposited-carbon resistors of foreign make which have excellent noise characteristics, closely approaching those of wirewounds. However, his personal experience with American-made resistors has been that deposited-metal-film ones have given far better results than the deposited-carbon type.

It may be wondered why the cathode resistors, whose values are quite small compared with the plate resistors, should also be low-noise types. However, when the cathode resistor is unbypassed, as in *Figs.* 1 and 2, its effective value is increased by the amplification factor, μ, of the tube. Thus if the μ of V_2 is 36, then the 2200-ohm cathode resistor is effectively increased by 36×2200, or by 79,200 times. The total effective value is the actual 2200 ohms plus the 79,200 increase, or 81,400 ohm.

This can be explained as follows. Assume that the noise voltage produced by the cathode resistor is 1 per cent of the voltage across the resistor due to tube current flow. The grid-cathode voltage changes accordingly, since the cathode resistor is unbypassed, and the voltage change is amplified μ times by the tube. So far as the output of the tube is concerned, this is equivalent to a 1 per cent noise voltage in a resistor μ times greater than the actual cathode resistance. In effect, the cathode resistance is increased by μ times its physical resistance. Adding the increase to the actual cathode resistance, the total effective value is $\mu+1$ times the physical resistance.

To reduce hum, V_2-V_3 was enclosed in a tube shield. Underneath the socket, a shield, fashioned from a piece of tin can, was mounted as shown in *Fig.* 4 to isolate the grid of V_2 from heater leads and other possible sources of hum. The shield was soldered to the center pin of the socket and grounded to the main ground point A at V_1 (*Fig.* 1). All components in the circuit of V_2—plate resistor, cathode resistor, positive-feedback resistor, and coupling capacitor—were mounted between the shield and the side wall of the chassis. The cathode resistor R_{102} was grounded to the shield, while insulated leads were used to run the other components to the appropriate points.

Another hum reduction measure was to shield the power transformer with silicon steel I-strips from a junked power transformer. Cellophane tape was used to bind the strips together. The transformer is located in a corner of the tape recorder, as far away as possible from the electronics and heads.

By this time, hum was virtually nonexistent so far as the *amplifier proper* was concerned, being virtually inaudible at correct setting of the hum balance pot R_{29}. However, the playback head picked up a slight but noticeable amount of hum from the power transformer, mostly third harmonic (180 cps). In the original amplifier a "gimmick," consisting of a silicon steel I-strip doubled in hairpin fashion and clamped to the head bracket, was fairly effective in warping the hum field at the head. But this did not con-

(*Continued on page 47*)

noise and hum in V_2 and V_3 are simul- the S20 resistors recently introduced by to shield the power transformer with

Transistor Beta Tester With Linear Scale

SERGIO BERNSTEIN*

Tube testers are accepted as necessary units of test equipment. Increased use of transistors makes some means for testing them almost imperative, and this design gives a direct reading with a minimum of manipulation.

THIS SIMPLE AND LOW-COST instrument has a linear, direct-reading dial and two "beta" ranges. The accuracy can be made as high as one per cent depending on the components used, while the cost of the instrument is relatively low.

Basically, the circuit[1] is that of an oscillator. The point at which oscillation starts is determined by the β of the transistor and by a potentiometer R_1 in *Fig.* 1. The frequency of oscillation which lies in the audio range, depends mostly on the transformer characteristics.

Theory

To understand the operation of the circuit, let us examine the conditions which prevail when the circuit just begins to oscillate: (see *Fig. 1*)

let N = Transformer turns ratio
I_c = a.c. collector current
I_b = a.c. base current
β = the base-to-collector current gain

We have:

$$I_1 + I_2 = I_c; \text{ and } I_b = \frac{I}{N}(I_1)$$

Also:

$$I_2 = \frac{R_1}{R_o}(I_1)$$

Then:

$$I_c = I_1\left(1+\frac{R_1}{R_o}\right); \; I_1 = \frac{I_c}{1+\frac{R_1}{R_o}}$$

Therefore:

$$I_b = -\frac{I_c}{N}\left(\frac{1}{1+\frac{R_1}{R_o}}\right)$$

since

$$\beta = -\frac{I_c}{I_b}$$

we see that

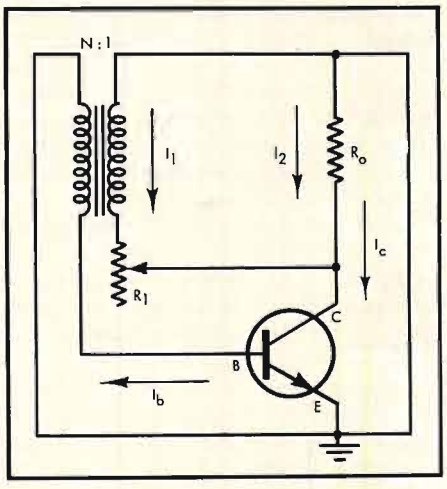


Fig. 1. Simplied schematic of basic arrangement for testing transistors.

$$\beta = N\left(1+\frac{R_1}{R_o}\right) \qquad (1)$$

Therefore, for a given transformer ratio and a given transistor β, the circuit will start oscillating only when R_1 is *above* a certain critical value, given by the relationship of Eq. (*1*). Thus the potentiometer R_1 can be calibrated to read β directly.

Let us investigate the circuit further to see what other useful relationships we can determine, and how we can make a *linear*, direct-reading, dial scale. Suppose we make the resistor R_1 a 10-turn potentiometer, and we use a 15-turn dial such as a Beckman type "RB" (or other similar device) to read out our β values directly. This dial has 100 major divisions per turn, and a total of 15 turns or 1500 divisions. If we determine the *minimum* β value we wish to read, we automatically set the *maximum* value of β we can read on one range. This is true since our resistor R_1 in *Fig.* 1 goes from a minimum value of zero ohms to its maximum value when rotated the full 10-turns, and β varies with R_1 according to Eq. (*1*).

Let us call our minimum value of β by the term β_{min}. Then our maximum value, β_{max}, will be $\beta_{min} + 100.0$ since, after 10 turns, the dial will read 100.0 divisions *more* than at its initial position.

Let us call R_{min} the total circuit resistance, including the transformer primary resistance, when R_1 equals zero. Let us call R_p the total resistance of the potentiometer.

Then using Eq. (*1*) we can write the following:

$$\beta_{min} = N\left(1+\frac{R_{min}}{R_o}\right) \qquad (2)$$

$$\beta_{max} = 100.0 + \beta_{min} = N\left(1+\frac{R_{min}+R_p}{R_o}\right) \qquad (3)$$

Combining (*2*) and (*3*):

$$100.0 + (N)\left(1+\frac{R_{min}}{R_o}\right) = N\left(1+\frac{R_{min}}{R_o}+\frac{R_p}{R_o}\right)$$

Therefore:

$$100.0 = N\left(\frac{R_p}{R_o}\right)$$

and

$$\frac{R_o}{N} = \frac{R_p}{100} \qquad (4)$$

This equation gives the relationship necessary to get the correct dial reading for β_{min} and β_{max} for a given N, R_o, and R_p. Note that this relationship is independent of R_{min}.

If we substitute Eq. (*4*) back into Eq. (*2*) we get:

$$\beta_{min} = N + \frac{R_{min} \times 100}{R_p} \qquad (5)$$

This equation tells us what the minimum value of β is we can read, with a given turns ratio N, R_{min}, and R_p.

From Eqs. (*2*) and (*3*) we note an important property of this circuit, namely: we can change the range of β readings

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* *205 South Broadway, Tarrytown, N.Y.*

[1] G. F. Montgomery, "Transistor beta tester." *Electronics*, May, 1957, pg. 198.

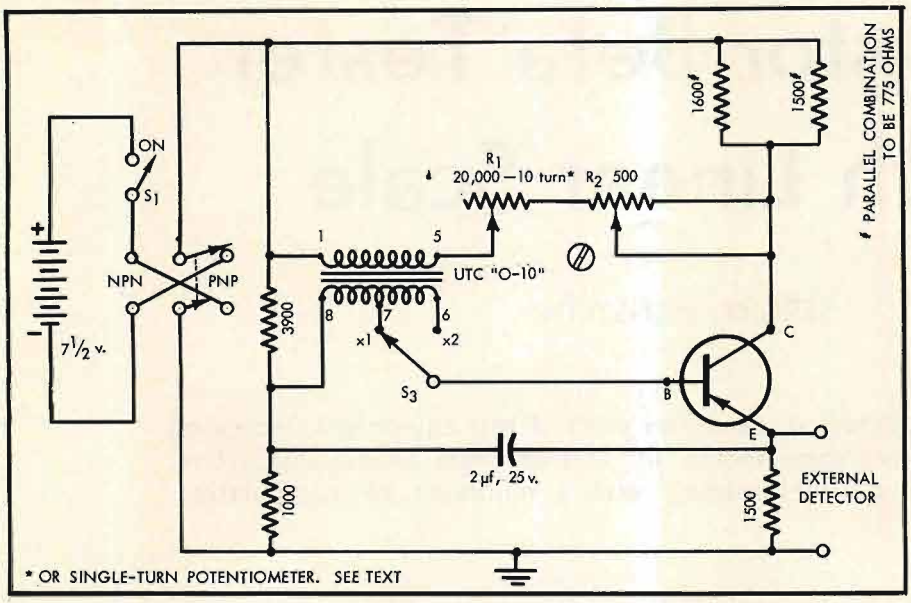

Fig. 2. Complete schematic of transistor tester. R_1 may be a special 10-turn potentiometer, used with a 15-turn dial, although a single-turn four-watt type of pot may be used instead.

directly by changing only the transformer ratio N. Thus, if we use a multitap winding in the base circuit, having transformation ratios of N and KN, we can have two ranges of β namely: from β_{min} to $(100+\beta_{min})$ and from $K\times(\beta_{min})$ and from $K\times(\beta_{min})$ to $K\times(100.0+\beta_{min})$. All we have to do is multiply our dial reading by the factor K.

Having established the relationships which govern the operation of this circuit, a practical form of it can be designed as in *Fig.* 2.

To keep the cost at a minimum, the surplus market was scanned, and it was found that 10-turn, 20,000-ohm, potentiometers were available. R_p then is 20,000 ohms.

Next T_1 was chosen so as to get two β ranges. A UTC type 0–10 was selected. For this transformer, $N = 3.875$ using ½ primary to full secondary, or $N = 7.75$, using full primary to full secondary.

Using $N = 3.875$ we find R_o from Eq. (4):

$$R_o = N \times \frac{20{,}000}{100} = 775 \text{ ohms.}$$

R_o should be measured accurately on a bridge. This will eliminate the necessity of using a variable adjustment for R_o.

β_{min} can now be chosen. A value of $\beta_{min} = 5.0$ seemed reasonable after looking over the characteristics of transistors presently available. Then:

$$5.0 = \beta_{min} = N\left(1+\frac{R_{min}}{R_o}\right) = (3.875)\times\left(1+\frac{R_{min}}{775}\right)$$

Thus, $R_{min} = 225$ ohms.

A 500-ohm potentiometer (R_2 in *Fig.* 2), is used to adjust R_{min} to its exact value.

The rest of the circuit is designed so that any transistor inserted in the test instrument will operate at approximately 6 volts collector voltage and approximately 1 ma emitter current. Switch S_2 is included so that either PNP or NPN units can be tested, and switch S_3 changes the dial reading from "times 1" to "times 2." One word of caution: check to see that the transformer is wired with the same phasing shown in *Fig.* 2—otherwise the circuit will not oscillate. To keep the instrument as simple and inexpensive as possible, no detector or meter was incorporated in the circuit. Any detector, such as earphones, VTVM, or oscilloscope can be used to detect when oscillation just starts.

When taking a reading, start from a high dial setting towards the low one. A reading should be taken when the oscillations just start, *not* when they stop, as indicated when going from a low reading to a high one.

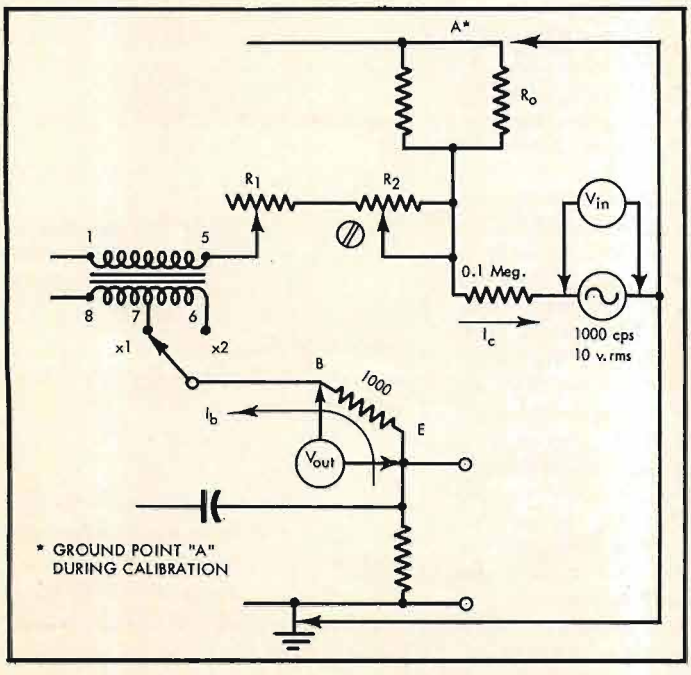

Fig. 3. Circuit used for calibration of the transistor tester.

Calibration

To calibrate the β tester, an oscillator, a VTVM (such as a Ballatine Model 300) and two precision resistors are required, one of 0.1 megohms and one of 1000 ohms, as in *Fig.* 3. The audio oscillator is set for 1000 cps, and its output at about 10 volts. The battery leads are shorted and are the "ground point." The 0.1-meg. resistor is wired between the collector terminal and the oscillator. The 1000-ohm resistor is wired between the base and emitter terminals. S_3 should be in the "X1" position.

By comparing *Fig.* 3 to *Fig.* 1 it will be noted that:

$$\beta = \frac{I_c}{I_b} = \frac{V_{in}}{100{,}000} \div \frac{V_{out}}{1000} = \frac{V_{in}}{V_{out}\times 100}$$

The dial should now be set so that when the 10-turn potentiometer is at zero resistance, it reads β_{min}, i.e. 5.0. Rotate the dial ten full turns to check if it reads 105.0 i.e.: $\beta_{min}+100.0$. (To avoid turning the potentiometer ten turns every time, leave it at its maximum resistance setting and use a short clip lead to short it out when zero resistance is required during calibration measurements). With R_1 at zero ohms (using clip lead) adjust R_2 to get:

$$\frac{V_{in}}{100\times V_{out}} = \beta_{min}.$$

With R_1 at maximum resistance see if:

$$\frac{V_{in}}{100\times V_{out}} = 100+\beta_{min}$$

If R_o is the proper value then the measurements should check. If not, R_o has to be trimmed slightly, leaving R_2 set, until

(*Continued on page 53*)

An Amplifier Using New 6CZ5's

NATHAN GROSSMAN*

Most experimenters have sufficient equipment in the "surplus" department to construct this simple amplifier which gives good performance in a small package

THE 6CZ5, a new RCA miniature power tube, holds much promise for the art of audio power amplification. This tube is not to be confused with the 6AQ5, or the English 6BQ5, both of which it resembles in construction and purpose. It is not interchangeable with them.

It has the same filament, plate and screen, and load characteristics as the 6V6, of which the 6AQ5 is the minature type, and costs about the same. However, the other characteristics are different and provide a considerable improvement over the latter types. The negative bias on the signal grid and the transconductance are about 15 per cent greater and the power output about 20 per cent greater for a plate voltage of 250. In push-pull operation the 6CZ5 resembles the 6L6 in that it generates a low percentage of odd harmonics and can be operated as a pentode with a plate voltage of 350. Under this latter circumstance and with 280 volts on the screen, a bias of −23.5 volts on the signal grid, and a plate-to-plate load of 7500 ohms, two 6CZ5's are rated by the manufacturer to deliver 21.5 watts of audio power and with only 1 per cent of harmonic distortion.

This adds up to lower supply requirements, lower distortion, lower all around cost, and higher power output.

To try out a pair of 6CZ5's the writer built an amplifier from parts in the junk box including a husky output transformer which was manufactured about 20 years ago. To avoid expense in obtaining good voltage regulation, the writer used a large bleeder and worked the amplifier half way between the recommended pentode and the lower-plate-voltage tetrode operation. With 325 volts from plate to cathode, the results proved better than expected. The plate voltage did not vary from minimum to maximum power output, and the total variation of the screen voltage was only 3.5 per cent.

Figure 1 is a schematic of the amplifier as constructed. If it is desired to operate the amplifier in accordance with the manufacturer's specifications—that is, at 350 volts from plate to cathode—the 100-ohm resistor, R_{14}, in the first filter section of the plate supply should be shorted. It would also be necessary to replace the 5Y3 rectifier with a 5U4 and to increase the size of the step-down resistor R_{11} to 1500 ohms. Plate and screen voltages under these conditions will vary somewhat with power output.

The amplifier shown in *Fig.* 1. has about 22 db of negative feedback. Just before clipping the amplifier delivered to a resistive load 13.7 watts at 30 cps, 16 watts at 60 cps, and 17 watts at 400 cps. At 400 cps the total harmonic distortion at various outputs measured, in per cent: 1 watt, .08; 4 watts, 0.18; 8 watts, 0.2; 14 watts 0.23. Listening tests showed that this amplifier can deliver a great deal of very clean bass.

To obtain similar results it is necessary that the output transformer have a large iron core and that the windings have low d.c. resistance. The one used weighed about 4 lbs. and had a total primary resistance of 225 ohms. Both Triad S-60A and Stancor A-3801 should be suitable. For the ultimate in high fidelity either Triad S-146A or Stancor A-8056 should be employed. The reflected impedance of these transformers is 6600 ohms, which is close enough to the required 7500 ohms to cause only a slight loss of power output.

The characteristics of the 6CZ5 lend themselves to Ultra-Linear operation, and for this either the Triad S-146A or the Acrosound TO-310 would be appropriate. For such operation 350 volts should be applied to the plates. This can be obtained by omitting the bleeder circuit (resistors R_{10} and R_{11}, and capacitor C_5). Æ

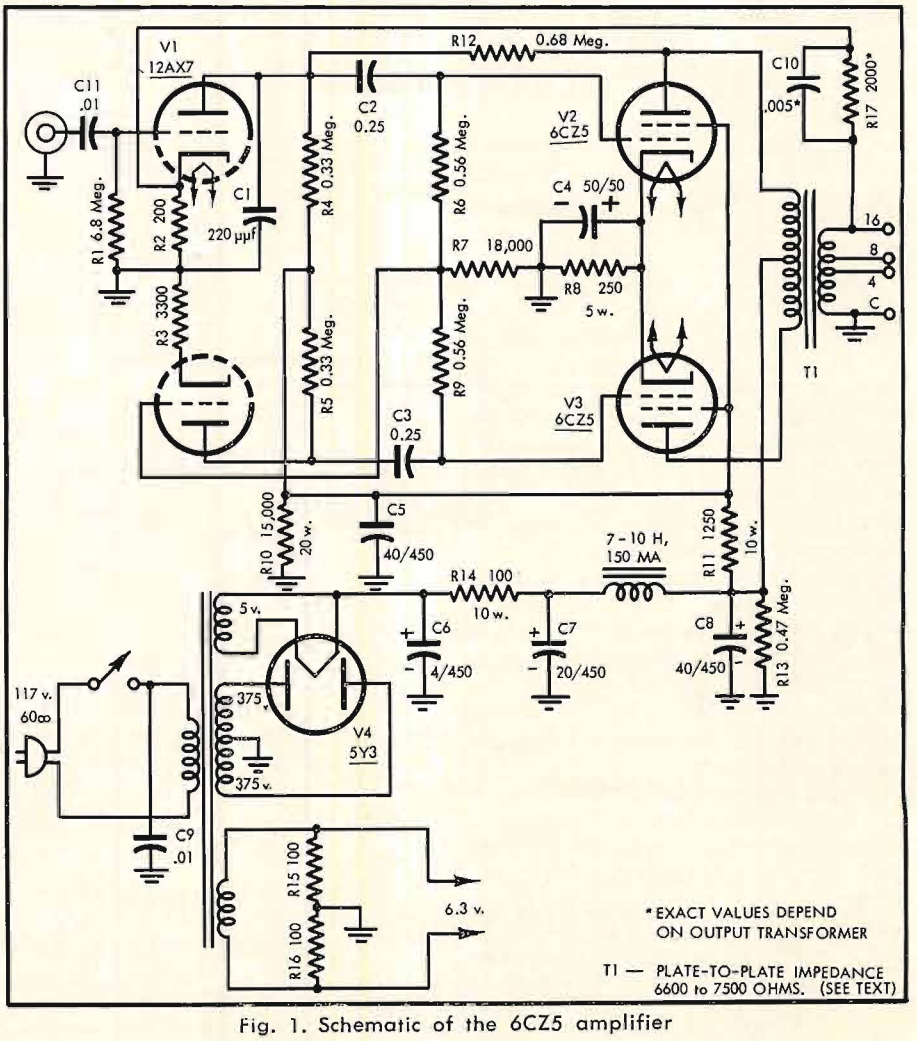

Fig. 1. Schematic of the 6CZ5 amplifier

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Hearing, the Determining Factor for High-Fidelity Transmission*

HARVEY FLETCHER**

In two parts—Part 1

FROM THE ARCHIVES OF BELL TELEPHONE LABORATORIES

This is perhaps the first authoritative study of the requirements for ideal systems for the transmission of speech and music. Much of our present-day knowledge and practice stems from this article, which presents conclusions derived from measurements of hearing on more than 500,000 people during the World's Fairs in 1939 and 1940.

WHENEVER a sound is made by a sudden impact of one solid body upon another, a wave train is set up in the air which contains components ranging in frequency from zero to infinity. As the impact becomes more sudden, the higher-frequency components carry a greater portion of the total acoustic energy. An ideal transmission system from a physicist's standpoint might be defined as one which would transmit such sounds to a distant point and there reproduce a disturbance in the air which is a facsimile of that produced by the original source. The requirements for such a system are very severe and it is difficult, if not impossible, to attain them.

The purpose of transmitting sounds to a distant place is usually so that persons may hear them. Certainly this is true of broadcast systems, telephone systems, and sound-picture systems. Under such conditions the properties of the hearing mechanism and the characteristics of the listening location, rather than the properties of the sounds transmitted, will very largely determine the fundamental requirements of the transmission system. This will certainly be true if we wish to transmit all kinds of sounds which can be heard. However, if we are interested in only a limited number of sounds, then the characteristics of these sounds play a greater part in determining the requirements for the transmission system.

During the years 1938–1940 a survey of the hearing capabilities of persons in a typical population was made by the Bell Telephone Laboratories. This was done in connection with the exhibits at the World's Fairs at San Francisco and New York City, sponsored by the Bell Telephone companies. At these exhibits records of the hearing of more than one half million persons were analyzed. The record expressed the hearing acuity as a relative hearing loss or gain with respect to an arbitrary reference. Measurements at the Laboratories on this reference have made it possible to express these data on an absolute scale and the results have been published by Steinberg, Montgomery, and Gardner.[1] *Figure* 1 has been constructed from data taken from this paper. The lower curve labeled 95 indicates that 95 out of 100 persons in a typical group cannot hear pure tones whose frequency and intensity levels lie below this curve. The top curve indicates that 5 out of 100 cannot hear these tones until they exceed the intensity levels indicated by this curve. The middle curve indicates the levels where one half the group can hear and the other half cannot hear. The dashed portions of the curves indicate regions where no measurements have been made. Feeling and hurting levels lie somewhere above 120 decibels as indicated by the field of dots at the top of the chart. Our experience with reproduced music has tanght us that it is undesirable and probably unsafe to reproduce for a general audience sounds that have greater intensity levels than 120 decibels.

If the listener is in a quiet place, these curves set the limits for the ideal transmission system. This ideal of no noise is seldom if ever realized by listeners. Measurements of room noise have been made by the Bell Telephone Laboratories and from these measurements the average noise spectrum can be deduced. In a paper by Seacord[2] it was found that 43

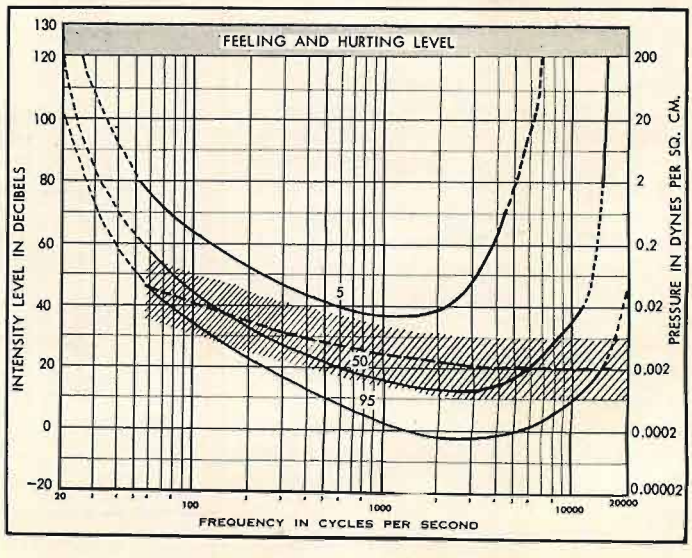

Fig. 1. Contours of hearing loss and room noise.

[1] J. C. Steinberg, H. C. Montgomery, and M. B. Gardner, "Results of the World's Fair hearing tests," *Bell Sys. Tech. Jour.*, vol. 19, pp. 533–562; October, 1940.

[2] D. F. Seacord, "Room noise at subscriber's telephone locations," *J. Acous. Soc. Am.*, vol. 12, pp. 183–187; July, 1940.

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decibels was the average sound level in residences not having radios playing. The standard deviation of levels in different residences from this figure was 5.5 decibels. The distribution about this average value indicated that about one half the residences have noise levels between 39 and 47 decibels, and 90 per cent are in the range between 33 and 52 decibels.

Hoth[3] found that the form of the noise spectrum was about the same for all types of rooms. Using his relation, the spectrum for the average room noise having a total level of 43 decibels is that shown in *Fig.* 2, lower curve. The ordinates give the spectrum level. This is obtained as follows. The intensity I in a band of frequency width W is measured. Then the ordinates y are given by

$$y = 10 \log I/WI_0$$

where I_0 is the reference level of 10^{-16} watt per square centimeter. It has been shown[4] that the masking level could be obtained directly from the spectrum level. Using this relation, the curve shown in *Fig.* 2, labeled MASKING LEVEL, was obtained. This curve then gives the level of pure tones which can just be perceived in the presence of average room noise. This masking curve is the one which is shown in *Fig.* 1 as a cross-hatched band. It shows the range of the masking levels for about 90 per cent of the residences in a typical group. The dashed curve gives the average. If we wish to include only the middle 50 per cent of the residences, the top part of this masking-level band would be lowered about 5 decibels.

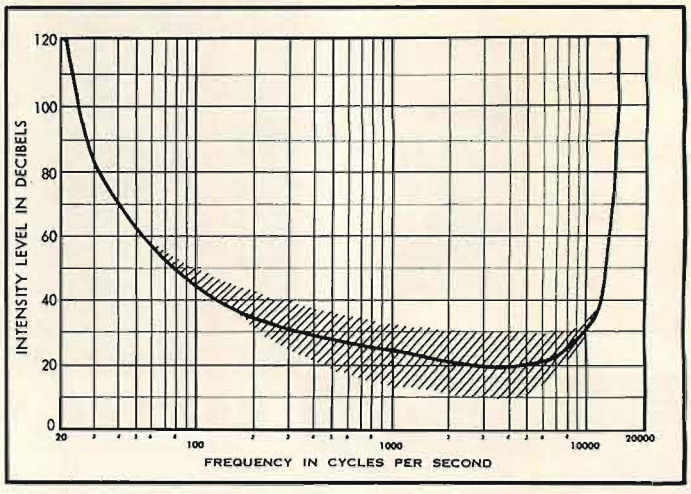

Fig. 3. Hearing limits for pure tones—typical listener in typical residential room noise.

Transmission Limits

Figure 1 then enables us to set several limits for an ideal transmission system. If the noise emitted by the radio set in a typical residence is not to be heard, its level should be below the average threshold of hearing in the room. For an average room this is seen to be determined by the hearing mechanism from low frequencies to 200 cps, and by the room noise from 200 to 6000 cps, and again by the hearing mechanism above 6000 cps. For example, the fundamental of a 60-cps hum should be kept below a 57-decibel level, whereas any components of this hum around 1000 cps should be kept below 25-decibel intensity level for the average room. It is seen that for the 5 per cent of the rooms which are quietest the limit is set entirely by the hearing-acuity curve. From *Figure* 1 one can also set the frequency limits for an average listener if all sounds that can be heard are to be used in the broadcast. This range is from 20 to 15,000 cps for the highest possible levels, and for any lower levels this frequency range is smaller, as indicated.

Figure 1 also gives the maximum levels such an ideal system might be called upon to transmit. This maximum level is taken as 120 decibels and the same for all frequencies. There is an uncertainty of about 10 decibels concerning the level that can be tolerated by the average ear. Our experience with reproduced sounds near this level indicates that it is very unlikely that higher levels will be used even though levels somewhat higher than 120 decibels may be tolerated by an average listener without producing permanent injury to the ear. It is probable that there will seldom if ever be a demand for such high intensity levels in a home, but if we are thinking in terms of an ideal which is set by human-hearing capabilities the upper limit must be taken at least as high as 120 decibels. The power P for producing the maximum level of 120 decibels varies from 3 watts for a typical residential room to 400 watts for a concert hall such as the Academy of Music in Philadelphia. It may be obtained from the formula

$$P = 0.00012\ V/T\ watts$$

where V is the volume of the room in cubic feet and T is the reverberation time in seconds.

If we utilize the entire intensity level range from the average threshold in a room having average noise to 120 decibels level, it will be seen that from 2000 to 6000 cps this range is approximately 100 decibels. From 500 to 2000 cps it is about 5 decibels less than this figure, while for 100 cps the range is only 75 decibels. It should be emphasized that these figures refer to the level range of single-frequency tones. When talking about program material where complex sounds are used which are rapidly varying in intensity and frequency, the matter of measuring intensity level range is not simple as will be evident from later discussions.

A summary of these conclusions is given by the curves in *Fig.* 3, which give the limits imposed by the hearing of an average person in a room having average room noise. In using this curve it must be remembered that the lower limiting curve may be anywhere in the shaded area, depending upon the room noise condition. This shaded area covers 90 per cent of noise conditions in residences. For an average business office the lower curve will be raised about 15 decibels, and for a factory location the lower curve will be raised nearly 35 decibels, leaving a range of only 60 decibels even if the highest levels that can be tolerated by the ear are used.

(*Continued on page 49*)

[3] D. F. Hoth, "Room noise spectra at subscribers' telephone locations," *J. Acous. Soc. Am.*, vol. 12, pp. 499–504; April, 1941.

[4] H. Fletcher and W. A. Munson, "Relation between loudness and masking," *J. Acous. Soc. Am.*, vol. 9, pp. 1–10; July, 1937.

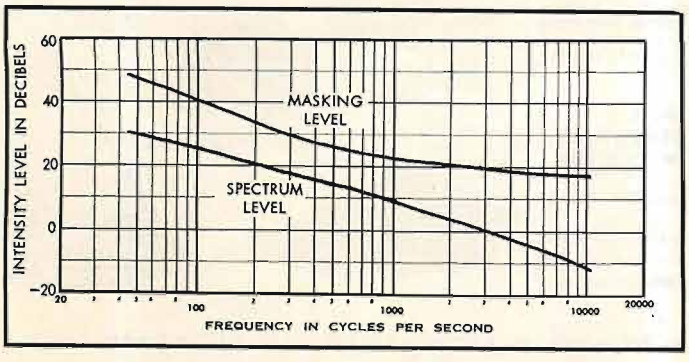

Fig. 2. Average room noise spectrum.

[3] D. F. Hoth, "Room noise spectra at sub-

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Equipment Review

Tandberg Model 3 Stereo Tape Recorder—Lektrostat Record Cleaner—Heathkit EA-2 12-watt Amplifier

Fig. 3. Rear panel of recorder indicates line voltage to which set, and provides for the outputs and the high-level input. Small compartment at right holds power card.

TANDBERG STEREO TAPE MACHINE

The Tandberg Model 3 stereo tape recorder (*Figs.* 1, 2, 3), a product of Norway, is designed to play in-line stereo tapes and to record monaurally. It is a small, versatile, high-quality 32-pound (with case) package crammed with features reflecting the designers' efforts to anticipate the stereofan's public needs, whether for a limited cost or money-no-object installation.

With this machine, a reel of stereo tape, and just one speaker, stereo can immediately be brought into the home, at least on a modest basis, for the Tandberg already contains two power amplifiers and a speaker, a 5½" × 8" unit. Thus the would-be stereofan can get off the ground without having to wait until he acquires a second chain of high fidelity components—control amplifier, power amplifier, and speaker. Eventually, depending upon his sights, he may wish to use a better amplifier and better speaker in place of those in the Tandberg. In the interim, however, the latter enable him to enjoy stereo.

The Tandberg's internal speaker can be connected either to its channel 1 amplifier (upper track; left speaker) or to its channel 2 amplifier (lower track; right speaker) by flicking the monitor speaker switch respectively to left or right. In mid-position of the switch, the speaker is disconnected altogether.

Figure 3 shows the output jack arrangement, intended for banana plugs, which may be used to feed a signal either directly to external speakers or to the inputs of control or power amplifiers. Should the listener wish to combine both stereo channels into a single speaker, he can do so by taking the output from jacks 2 and 4, thus putting the two output transformer secondaries in series and thereby feeding the outputs from both tracks to the single speaker.

The Tandberg's power amplifiers have single-ended outputs, each using one EL-84, but are able to put out enough power at reasonably low distortion to drive an efficient speaker to a very substantial level. On a Tandberg that he used for several weeks, the writer found that IM distortion of each amplifier measured below 2 per cent at 1 watt output (equivalent sine wave power), which was enough to drive his speakers well above the desired level. If the machine is used to supply signal voltages to external amplifiers, with the gain control set between positions 2 and 3 it can supply 0.5 volt on each channel—ample for any control amplifier—at about 0.5 per cent IM, which is consistent with high fidelity performance; this data is also based on the writer's measurements.

If it is desired to play a monaural tape, one can feed the monaural signal into both amplifiers by turning the monaural-stereo switch to the monaural position. This connects both amplifiers to the upper track signal and prevents playing both tracks at once, which would result in garbled sound, particularly since one of the tracks would be played backwards.

All or most stereo tapes are now recorded with NARTB equalization, wherefore it is important that the playback machine incorporate NARTB playback equalization. This the Tandberg does, and quite accurately. On the machine used by the writer, equalization remained within 1.5 db of the NARTB standard over virtually the entire audio range. There is a strong temptation not to maintain full bass boost at the very low end inasmuch as this accentuates the problem of hum. However, the Tandberg does not succumb to this temptation and maintains NARTB bass boost, within 1.5 db, down to at least 30 cps. The record-playback response (monaural) of the Tandberg is also excellent, being flat within 1 db between 50 and 10,000 cps, and only 2 db down at 15 kc and 3 db at 20 cps.

There are many features of interest from the viewpoint of designing a quality tape machine and from the operating viewpoint. The motor has a one-pound, large diameter, dynamically balanced flywheel, which helps account for the exceptionally good wow and flutter characteristics of the Tandberg, less than 0.1 per cent at 7.5 ips. For minimum hum, the heaters of the first tube of each amplifier are d.c. operated, and the tube is shielded by mu-metal; the entire amplifier is screened by metal foil. The magic-eye record level indicator is damped so that the eye may follow its peak indications. The in-line head achieves a cross-talk ratio of better than 60 db by means of a mu-metal shield between its two sections; this is important when a dual-track monaural tape is played, so that the signal picked up by the lower section of the head is not coupled to the upper section and thereby heard in playback. The gaps of each section are sufficiently co-linear that the head may be used to play full-track recordings without an apparent time difference between the signals from each section.

When the tape is rewound or wound in the forward direction, the tape is lifted away from the heads to prevent head wear due to abrasive action of the tape coating. No pressure pad is required to maintain firm contact between the tape and in-line head—good contact is very important in

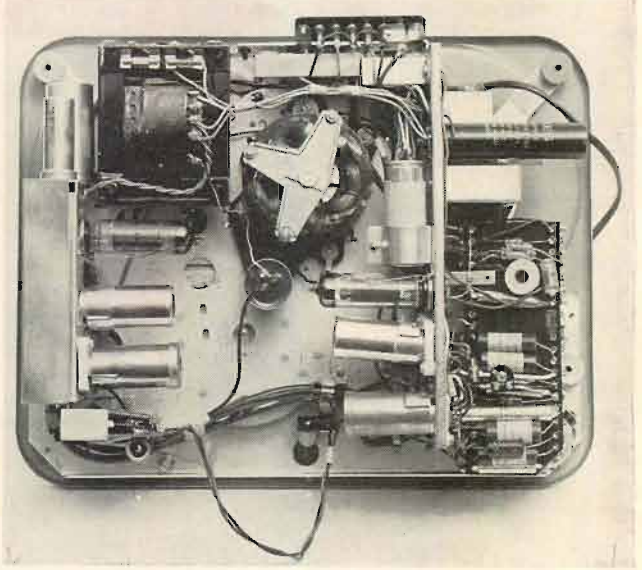

Fig. 1 (left). Panel view of Tandberg Model 3 Stereo Tape Recorder. Fig. 2 (right). Underside view of Tandberg recorder. Section at right is "B" channel in which the output tube serves as the erase-bias oscillator when used as a monaural recorder.

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preserving high-frequency response—and the absence of a pad reduces flutter and prolongs head life. Tape tension when the machine is running is kept to a low 10 grams, which serves to minimize wear of heads, tape guides, and capstan. Starting and stopping tensions are respectively about 40 and 120 grams, which means that the very thin "half-mil" tape, which affords twice the playing time of standard tape on a given size reel, can be handled without danger of breakage or stretching.

For the purpose of easily spotting a desired passage, the Tandberg incorporates a program counter with clock-type dial and two hands. The machine can be used for public address purposes by putting the mode selector switch in the lowest position; the monitor speaker or an external speaker or both can then be utilized. A microphone rated as having response to 13,000 cps within 3 db is supplied.

Fig. 5. Heathkit EA-2 amplifier "sounds as good as it measures" and looks as good as it sounds.

LEKTROSTAT RECORD CLEANER

Since the appearance of vinylite microgroove records, their users have had to contend with a serious problem of dust (and other forms of dirt). As dust gathers on the record, noise and distortion and abrasion increase. With the low tracking pressures now prevalent, and becoming ever lower, the stylus can accumulate enough dust to lift it virtually from the groove. Those who like to use changers find it futile to load on a large stack of microgroove records unless some dust-combatting device is employed, for otherwise the stylus becomes insufferably clogged after only a record or two.

Hence there has been a ready market for record cleaning agents, some having anti-static properties, some detergent properties, and some both. A newcomer to this field, the Lektrostat Record Cleaning kit (*Fig.* 4), contains a fluid with both characteristics and claimed to be non-gumming. Much of its effectiveness, however, owes to the special groove-cleaning applicator that is part of the kit. The writer has used Lektrostat on his records and found it very effective.

The applicator is flat and round and has a sponge rubber core surrounded by a velvet synthetic material with a pile of soft bristles. The fluid is squirted onto the record and distributed by a rotary motion of the applicator, following the grooves. In fact, it is difficult not to follow the grooves, as the user soon finds out, for he can feel the bristles slide into them. The applicator not only spreads the fluid, but, equally important, lifts the dust and grime right out of the grooves, leaving no gumming residue. If one wishes to clean an old record containing a good deal of dirt, it is advisable first to dislodge most of it by several wipes with the dry applicator.

The core of the applicator is of sponge rubber so that it will not mat down or become lumpy. Since the bristles are synthetic, they do not crush down, which is the tendency for natural fibers, especially when wet. The synthetic sheds water, oil, dirt, and so on. It is merely necessary from time to time to wipe or blow off the dirt it has picked up.

Dexter Chemical Corporation, which makes Lektrostat, is well known as a manufacturer of anti-static agents and detergents for the textile and paper industries. Starting with one of the anti-static fluids made for these fields, they have tailored it to have detergent properties as well and, very important, to be non-gumming. The solvent employed for the agent is water, which is capable of dissolving the salts and sugars deposited on the record by human hands. Lektrostat will not evaporate except at temperatures which would harm or destroy the record.

A little bit of the Lektrostat fluid goes a long way—about 5 drops per side. However, an excess dostage does no harm since the excess is carried away by the applicator. If the record is stored in a plastic bag, the anti-static agent deposited in the grooves is claimed to be effective for months. But paper and cardboard covers absorb the fluid, limiting its effectiveness to weeks or days.

A not unimportant member of the Lektrostat kit is the bag itself. It is made of polyethylene for strength and life, so that the applicator may receive maximum protection against dirt, dust, and humidity.

Fig. 4. Lektrostat record cleaning kit includes anti-static detergent, applicator, and plastic container.

THE HEATHKIT EA-2 AMPLIFIER

At $27.95, the Heathkit EA-2 composite amplifier—phono preamp, tone controls, and 12-watt power amplifier, on one chassis, as shown in *Fig.* 5—is a surprise package. Its low price might lead the casual observer to dismiss it as something of a toy, perhaps worthy only of a junior audio system for the children or the den or the workshop, or the like. Actually, it is a grown-up performer, within its 12-watt rating. And it must be remembered that the difference between a 12-watt amplifier and a 30-watter, which few sneeze at, is only 4 db, a relatively slight volume difference to the ear.

The circuit of the EA-2 is essentially orthodox and at the same time up to date. The magnetic phono preamp consists of a single stage, followed by losser type equalization. Subsequently there is a stage of gain for all the inputs, a volume control, another stage of gain, and the tone controls, which are the conventional Sterling type. The power amplifier section follows the trend toward use of a pentode input stage direct-coupled to a triode employed both as a phase inverter and driver for the output tubes. Pentode and triode are in a single envelope, the now widely used 6AN8. The phase inverter is the familiar split-load type, which some experts hold to be as good as any. The output stage is ultra-linear, using the highly-regarded EL84's.

The EA-2 is easy to assemble and took this reviewer the equivalent of four evenings. (The reviewer probably takes a good deal more time than the average, because he checks all resistors for value, checks capacitors for value and leakage, checks continuity of connections by means of an ohmmeter, doubles back after every dozen steps or so to check his work, and so on. On the other hand, the careful approach has paid off in that every one of the dozen or more kits he has built in this manner has worked correctly right from the start.) Although the chassis is only 8-3/16" deep by 12½" wide, the layout is uncramped and at no time requires a surgeon's dexterity.

trols, which are the conventional Sterling type. The power amplifier section follows the trend toward use of a pentode input

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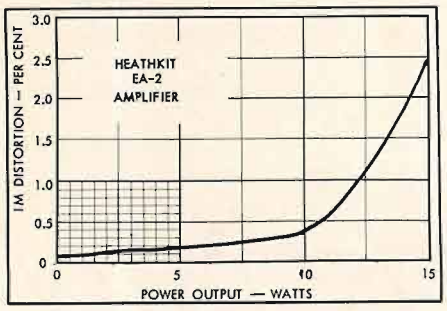

Fig. 6. IM distortion curves for the Heathkit EA-2.

Parts of high quality, as for example the use of molded paper capacitors, an ECC83 as the input tube, EL84's as the output tubes, an EZ81 as the rectifier, and power and output transformers about as husky as can be accommodated within the amplifier's dimensions.

Size of the output transformer is reflected in the ability of the EA-2 to turn out at least 12 solid, clean watts at 20 cps, as viewed on an oscilloscope. At the rated power of 12 watts, the frequency response measured was ±0.5 db between 30 and 10,000 cps, and 1.5 db down at 20 and 15,000 cps, and 3 db down at 20,000 cps. Below 12 watts, frequency response remained essentially the same within this range.

High-frequency response was also checked with the gain control set at 6 db below maximum; the resistance of the gain pot acts as a low-pass filter in conjunction with the input capacitance of the 6C4 (largely due to Miller effect), and the low-pass action is greatest when the pot is at mid-resistance. At this setting, response was down only 0.5 db more at 10,000 cps, 1.2 db more at 15,000 cps, and 2 db more at 20,000. This slight a deterioration in treble response is hardly apt to be noticed. Moreover, it is quite unlikely that one will be operating the amplifier with gain as far advanced as 6 db below maximum. With gain 10 db below maximum, there was no additional loss at 10,000 cps, about 0.5 db at 15,000, and 1 db at 20,000. At 20 db down, no additional losses were observed.

To obtain maximum flatness of response, with bass and treble control knobs pointing straight up (12 o'clock), it was necessary to rotate the treble control pot about 15° counter-clockwise (center lug pointing to about 11:30). Parts tolerances would account for this. It was not necessary to adjust the mounting of the bass control pot.

Probably the most fascinating thing about the EA-2 is its low distortion. As shown in *Fig.* 6, it does not exceed 1 per cent IM until equivalent sine wave power (the wattmeter reading of two signals mixed in 4:1 ratio is multiplied by 1.47 to obtain the power of a sine wave having the same peak) is above 12 watts. At 10 watts equivalent sine wave power, IM was only 0.33 per cent. From 3 watts down, it measured 0.1 per cent or less. The IM meter employed for these measurements uses frequencies of 60 and 5000 cps and has a residual reading of about .06 per cent. At 10 watts and below, the performance of the EA-2 leaves little if anything to be desired with respect to distortion. And it bears repeating that most audiofans will not be using more thau five watts.

An amplifier that measures well with respect to distortion may not sound clean. Often it will be found that such an amplifier displays excessive ringing when square waves upward of 1000 cps are passed through it. The EA-2 exhibited *no ringing whatsoever* on square waves of 1000, 5000, 10,000 and 20,000 cps, and even with treble boost applied.

Still on the subject of distortion, it was found that at 1000 cps the EA-2 clipped at just about 15 watts. So one can think of the EA-2 as a 15-watt amplifier since IM is just a little over 2 per cent at this point.

Sensitivity of this Heathkit is quite sufficient. It was measured at approximately 0.3 volts on high-level inputs and 8.6 mv on the magnetic phono input for 12 watts output. Since one can count on approximately 15 to 20 mv on peaks from even the weakest magnetic cartridges, no problem of inadequate gain is anticipated on magnetic phono input. High-level sources generally turn out from 0.5 to 3 volts on peaks, so there is no problem in this respect either. In fact, the problem may be too much signal input. For example, some piezoelectric cartridges deliver a volt or two on peaks, and some magnetic cartridges put out much as 100 mv or more. In the case of high-level sources, the input signal could easily be cut by reducing the lower leg of the voltage divider at the input. The signal of a high output magnetic cartridge can be reduced by replacing the 47,000-ohm load resistor with an appropriate voltage divider consisting of two resistors having a total value recommended by the cartridge manufacturer.

Only RIAA phono equalization is provided; however, this suits virtually all records presently made and, with slight adjustment of the tone controls, is adequate for records made prior to 1954. Between 30 and 15,000 cps, equalization did not deviate more than 1.5 db from the RIAA curve.

The tone controls of the EA-2 provide a substantial range of boost and cut. Ample bass boost is particularly welcome since no loudness compensation is provided for the Fletcher-Munson effect. At 30 cps, a maximum of 16.5 db boost and 17.5 db cut were measured. Maximum treble boost measured 16 db at 15,000 cps, and cut 21.5 db.

Since the EA-2 aims so high, it is not unfair to talk about its drawbacks, even though its price is so low. One drawback is the provision of only three inputs—tuner, crystal-phono (suitable for ceramic cartridges as well), and magnetic phono. However, a tuner, TV, tape machine, or other high level source can also be fed into the crystal-phono input. The audiofan desiring more iuputs probably would not find it difficult to replace the existing selector switch and to mount an additional input jack or two.

A salient omission is an output for feeding a tape recorder. But this could be rectified quite easily, if desired. In fact, in constructing his EA-2, the reviewer paved the way for such an addition in the future. Instead of mounting a seven-pin wafer socket for V2, a 6C4, he mounted a nine-pin ceramic socket in the same hole and employed half of a 12AU7, which is the same as a 6C4. The other half of the 12AU7 can eventually be employed as a cathode follower, requiring only a coupling capacitor and three resistors to be added to the circuit. The cathode follower would be inserted between V2 and V3, and a jack intended for feeding a tape recorder would be connected to the output of the new stage.

In terms of performance, the only criticism that can be directed at the EA-2 is its modest signal-to-noise ratio. On high level inputs the reviewer measured 60 db noise and hum below 12 watts output at 1000 cps. On magnetic phono input he measured a 47 db signal to noise ratio. Ratios at least 10 db higher would be more in line with professional performance.

With gain control full down, slight hum can be heard within a few feet of a speaker of average efficiency. This originates in the power amplifier section (V3, V4, V5) and is likely due to inadequate filtering of the B+ supply for the output tubes. In a quiet listening room and when the program source contains little noise, the hum might be bothersome to a listener sitting close to the speaker. We tried adding a 30-ohm resistor between the rectifier cathode and the B+ lead of the output transformer, bypassing this point to ground with a 40 μf electrolytic capacitor for the additional filtering and increased the signal-to-noise ratio by about 11 db.

But overall, as it stands, the EA-2 provides exceptional performance at its price, and in a number of respects excellent performance at any price. To the handy audiophile, it furthermore offers attractive opportunities for increasing flexibility of performance; and possibly he may find a way to reduce hum, if it does turn out to be a problem in his case. **Æ**

AUDIO ETC

(*from page 12*)

there were sufficient cross-talk between tracks to be noticeable. The tracks are interleaved, two each direction, so that each track has at least one other adjacent to it that runs in the opposite direction. (I might be wrong but at this point I gather this is the case.)

Cross-talk simply *must* have been reduced to acceptable limits—or RCA is sticking its neck out. So is Ampex. The basic four-track system used by RCA is the same as that recently announced by Ampex. Maybe you distrust one or the other of these concerns; I doubt if you will feel like distrusting both of them on this matter. However—we shall see. If cross-talk is apparent in the four-track recording and is obnoxious, then a huge commercial development has been falsely and mistakenly launched! As I say, in the demonstrations I heard no cross talk at all when the stereo tape was played from two of the four tracks. I must assume that no tricks were played on us. I doubt if it would be worth RCA's time to do so, even if it were so inclined.

Cartridge size? The thing is amazingly compact, considering the full hour of stereo sound (two hours of monaural home recording) that it can contain. I forgot to measure the box, but the cartridge itself is as thin as a cigarette lighter and just seven inches long, five inches wide. Not unlike one of those "flat 50" metal cigarette cases in general shape. Its packing box is like those for present tapes but smaller, oblong instead of square.

The long side of the cartridge is horizontal in the playing position; the tape runs along the lower edge, past a series of five inset slots in the cartridge body. It is here that the playing and drive mechanisms operate, from the machine itself. To put the cartridge in place you simply slip the top edge under a flange on the machine and drop the rest down in place. The slight crack between the cartridge and the business part of the machinery that lies against it represents the usual "slot" on the average home tape machine—but here the tape, reels, and holder all come out in a piece. Simple.

The cartridge itself is of the utmost simplicity—the two halves are almost identical plastic sections that fit together. The simple spring-loaded brake mechanism is about all there is in addition, plus the two hubs, loose in their cut-out holes and two sheets of cellophane-like material.

subtly angled baffle board, which also minimizes reflections within the compression

balanced mid-range; and HF-206 Hypersonic Tweeter for flawless reproduction of

bination . . . a veritable powerhouse of acoustic energy. Magnificent performance from an enclo-

Reel size? Ah—what a neat trick! There aren't any reel flanges (the cartridge holds the roll of tape in place) and so the two tape rolls can be placed close together. As one grows larger, the other diminishes, getting out of the way. This allows a relatively large roll of tape in a surprisingly small space.

It's a brilliant, utterly simple idea, real Columbus-and-the-egg stuff, and it excites my deepest admiration. I enjoy seeing things used for the first time that are so obvious that you can't believe they are truly innovations. This is one of them, for me anyhow. There hasn't been any application of the idea before now, at least in the hi-fi field. (I suppose this sort of tape reeling has been used in plenty of other applications—probably in a Sputnik or Explorer or two.)

Cartridge drive? Alas, I was so fascinated by the whole gadget that I forgot to notice how the tape transport actually worked—except that it starts almost instantly when the cartridge is slipped under the rear flange and dropped in place. No fumbling for prongs or levers to fit into holes—the thing just drops right in; then the little hubs begin to turn.

Head contact? The tape, as you may have already figured out, is wound in the "B" fashion, with the coated magnetic side out instead of in. The heads, obviously, face away from you as you look at the machine, towards the back; in standard machines they face towards you. The erase head is dead center (operating with the cartridge in either position, turnover). The record head is at an adjacent slot—two heads for the automatic reversing models, one on each side of the erase. The capstan comes up behind the tape through another space, as you drop the cartridge in place. The heads, of course, are double stacked, of the new type that operates on two of the four tracks, staggered horizontally.

So it goes, as to detail. There's plenty more—but soon after this appears, you'll be able to get one for yourself, if you haven't already. (The cartridges were supposedly issued in June, but the machines on which they play weren't due until the end of this month, as of publication time.)

Players available? A slight financial snag here; RCA's semi-automatic (hand turnover) stereo tape recorder-player will sell for just under $300, which ain't hay. The automatic (self-reversing) model will be around $450. You can buy the cartridges cheap but you can't play 'em so cheaply—now.

However, RCA has given the specs for the whole system to the industry, in today's usual fashion. There is some reason to think that a wide variety of tape playing and recording equipment for the new cartridge will soon be on the way. RCA says it has no plans for a tape deck. But other companies are supposed to be working on that. I expect that by fall there will be a good beginning in this direction, assuming that the cartridge looks good to all of us. It looks good to me, right now.

As of a first inspection, I see no reason why the new tape player should be any more expensive than a roughly comparable standard machine. The basic mechanisms for the drive are pretty much the same—fast speed each way via pushbuttons, the usual start button, plus a track selector (for monaural recording on all four tracks, one at a time) that should be no more than a simple switch. The whole thing is really extraordinarily simple; that's why it appeals to me. It seems to be extraordinarily foolproof too, in simple and ingenious ways; that also appeals to me and will to you.

Compatibility? RCA has struck firmly towards a constructive and healthy incompatibility. The new cartridge plays on its own special machine, and that is that. There really wasn't much use trying for a compromise. The heads are different, the tracks are different, the entire geometry was necessarily different if the system was to take full advantage of cartridge operation and of four-track recording. This, it seems to me, was both inevitable and reasonable. We have here what is usually called a clean break, for a new approach.

Ampex, to be sure, is offering conversions for its present home tape players that will allow them to play four-track tape. But these are for standard reeling—not cartridge tape. (You can buy an RCA cartridge and reel the tape out of it onto an ordinary reel, then play it on the Ampex, if I get it straight.) This is my present information, anyhow, as of our usual ahead-of-time publication date.

I suppose some ingenious soul will soon devise a marketable two-way machine, to play both the cartridged tape and the conventional reels—two-tracked at 7½ ips and four-tracked, inter-leaved, at 3¾ ips—but this will hardly make for true compatibility. It'll be a necessary makeshift, like the turnover cartridge and the 45 rpm-removable center spindle.

The editor suggests that the construction won't be too tough a problem even so. The cartridge tape is wound coated side out, the heads play from the near or lower side as you look down on the machine, whereas present recorders work just oppositely. To get all the heads on one side, the lower side, you could (he suggests) mount your standard 7" reels to play with the feed and take-up from the side nearest the center, the reels turning the opposite direction from at present; this would bring the coated side down. Looks funny but it is entirely feasible. All the tape heads, new-type and old, would then operate from the lower side, to leave the necessary space for the cartridge. I can imagine the tricky arrangement whereby the cartridged tape would hit only the heads it requires, while the manual tape would be threaded to contact one or more different heads. Not too complicated.

There would have to be a double drive. The two spindles for the cartridge would be close together in the center and retractable below deck-level for manual play. The larger 7" reels would mount more or less as now except for the reverse turn. Their flanges would overlap the cartridge space in the middle in order to get them as close together as possible (natch, only one system would be used at a time).

Possible—but with this dual drive and with extra heads the home machines of this sort aren't going to be too cheap. It will be interesting to see what is forthcoming when the tape machine makers have finally had a chance to catch their breath.

Incompatibility, you see, is an essential part of this radically new system and it might just as well be faced up to, for the time being. A disadvantage—an agony for many who have standard tapes they want to play. RCA has had to close its corporate eyes to the woes of the good people who have been buying all those RCA two-track stereo tapes, at the fabulous high prices, these last few years. The old tapes will be supplied, incidentally, "as long as there's a demand," says RCA. That probably means not for long. Demand, at the price, is likely to fall off pretty fast now.

Specifications? The big missing factor, as of the time I am writing, is the body of specifications that would give us a concrete clue to the claimed performance of this cartridge tape system. The Ampex announcement of four-track tape, somewhat earlier, also avoided direct specifications. But the clear implication, from both Ampex and RCA, is that this new four-track slow tape is fully satisfactory for home use—at a cost higher than standard records and higher than stereo disc. That indicates pretty clearly what we have to deal with. Nobody is going to buy a noticeably inferior sound on tape for *more* than the cost of high quality disc.

The four-track tape has to be good, then. It must be, or it would not have been launched in the present form. It sounded good, as I say, on my first hearing—very good.

The necessary improvements, moreover, were in the cards, in line with the constant bettering of tape equipment over the years and especially in connection with the fabulously rapid development of tape in the science fields, in computer work, telemetering, missiles and a million and one other industrial uses. Though I'm not exactly up on the details of all of this, I am very much of the impression that a four-track home tape of hi-fi quality, equivalent to the sound of the best two-track 7½ ips tape in the past, is just the sort of thing we should be getting, about now. I fully expect to find, on closer listening, that the RCA tape is just that. Again—it has to be. So has the Ampex tape, the same four-track system.

Are there bugs? Not yet in public—but you can bet your life there will be. Why not? Will some people groan and shake their heads, as each bug appears? Definitely—there's always a plethora of doom-prophets around when a new system tries its sonic wings. I do hope you can remember back ten years to the LP and its first days. If all the prophets of doom that condemned the LP had been right, we wouldn't have 20,000 LP records in the current LP catalogue.

It looks to me as though there were indeed room for a few bugs in this cartridge system—but I suspect the major ones have been pretty much by-passed already. The early 45 record warped and wouldn't change on its fancy little changer—but the cartridge tape probably *won't* pull loose from its hubs at the end of a run, nor is the tape likely to snarl easily. It's well protected and the machinery ought to work.

Maybe the tracks, or some of them will overlap a bit now and then, at first. Could be. But it'll be corrected. I'll bet you a hat, too, there has been a lot of trouble over equalization already, behind the scenes, and there'll probably be more, with maybe some distortion to set our hi-fi enthusiasts grumbling. Quite likely. We had a bit of equalization trouble with LP, didn't we, not to mention a raft of major tracking and compliance troubles, now largely ironed out. I doubt if it will be that bad, this time, with cartridge tape.

Yes, there'll probably be a mechanical crack-up or two, here and there. Aunt Minnie, my favorite character, will doubtless manage to manhandle her new cartridge so that the tape gets caught in the crack between the two halves of the container and tears itself to pieces—or something of equivalent nature. At least *one* of those nice hubs is going to let go its tape at the end of the playing, just as the 35-mm camera film cartridge lets go at the end, once in a blue moon. I will refuse to be stampeded into acute disapproval by these happenings unless they point to a definite and deep-seated difficulty, which isn't likely to be the case, I'd guess. You'd be wise to feel the same way.

Competition? That's the big point. The tape cartridge isn't even going to bother to

(*Continued on page 38*)

however, RCA has given the specs for the whole system to the industry, in today's usual fashion. There is some reason tem would be used at a time). with maybe some distortion to set our hi-fi enthusiasts grumbling. Quite likely.

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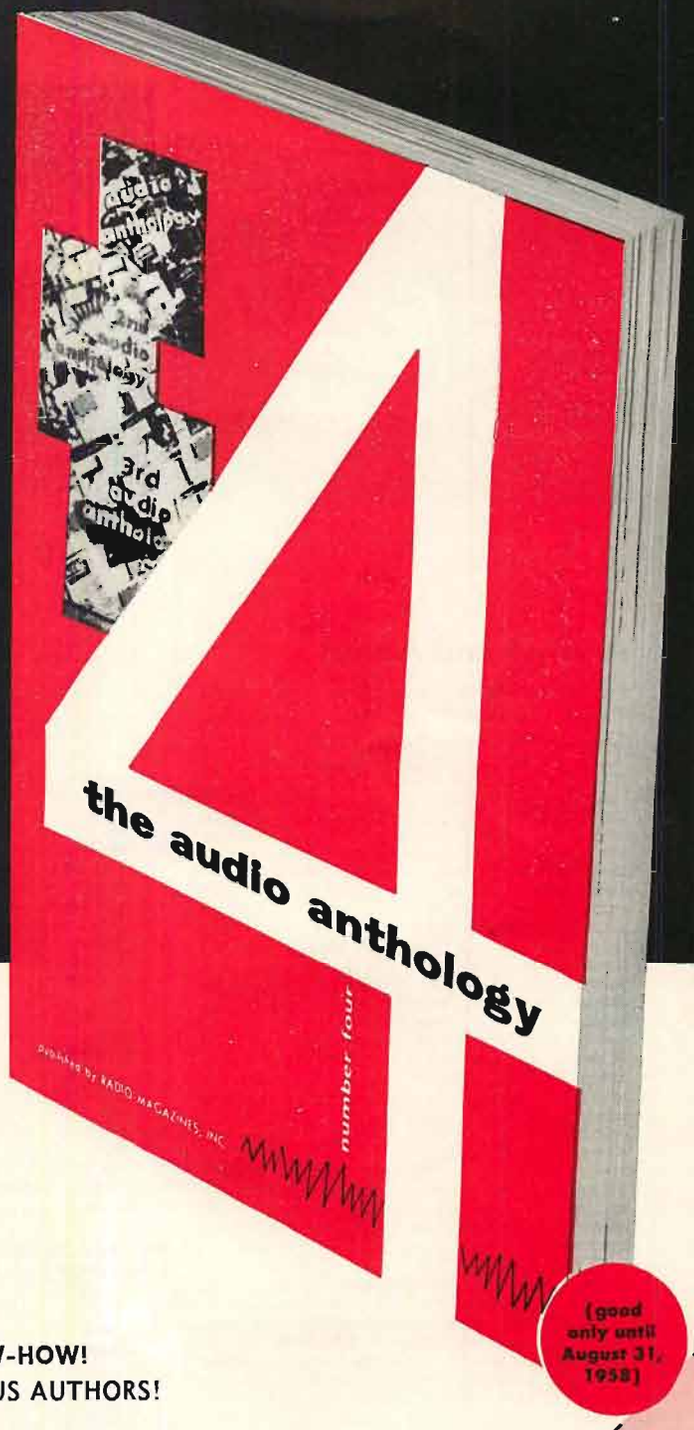

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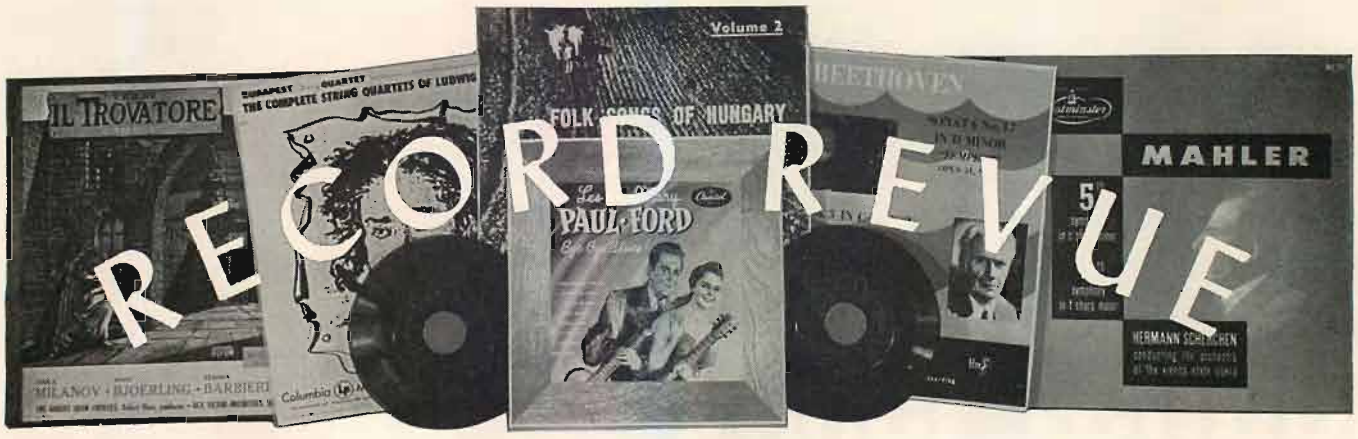


RECORD REVUE

EDWARD TATNALL CANBY*

Around and About

Prokofiev: Piano Concerto # 3; 17 Piano Pieces. Prokofieff; London Symphony, Coppola (recorded 1932, 1935).
Angel COLH 34

This is one of the new Angel series, "Great Recordings of the Century," and it's a most interesting record, faithfully restored without sound-tampering of any kind. It reveals Prokofieff (my customary spelling) in his early middle age as still a whirlwind, high-charge, ball-of-fire pianist of tremendous power and steely ruggedness. It's odd that this side of his character—which appears musically in many early works and some later ones—is so contrasted to the more familiar aspect, his sweet, human, warm nature, expressed in the famous lyricism that has endeared him to a world popular audience.

Here, after all, he was barely out of the noisy Twenties, as he played the concerto; his later and more Romantically inclined music was largely ahead of him, always excepting the extraordinary little "'Classical" Symphony. The solo piano works, too, on the reverse, are from his early and prolific French-influenced piano period, by turns fierce and coy, neatly dissonant and diabolically clever. It is cat-like music and fascinating in his fluent playing.

The Concerto offers some points of technical interest in the recording, too. It is, first, a fine example of the early pre-close-up style of solo microphoning with orchestra. You'll be surprised to hear Prokofieff so far away, at a distance down on the stage along with the orchestra—which sometimes drowns him out. This was, of course, no more than a literal representation of the concert hall sound—but we don't do our recordings that way any more and we are right, I think. Our close-up solo technique, blowing up the soloist to relatively huge volume, is better for the music itself in terms of the unique recorded medium.

The record is also interesting for its typically dry, deadish acoustics—standard sound for the time. This was merely the normal effect in these early days of the electrical 78; our huge reverberations, whether real or artificial, would have seemed monstrously exaggerated to the phonograph ears of 1932. The pure art of recorded sound has moved a long way since then towards its own independence, free of the concert hall, and this in spite of the fact that we still obstinately invoke the concert hall as though our recordings really sounded like it! They don't, and they shouldn't.

Gounod: Symphony #2.
Bizet: Jeux d'Enfants. Lamoureux Orch., Markevitch. **Decca DL 9982**

This is a charmer. If you've ever run into the now familiar little Symphony in C of Bizet, written when he was about 18, you'll jump for this hitherto unknown companion-piece by Gounod, composed in the very same year, 1855, though Gounod was older, in his late thirties. It's interesting that both Bizet (Carmen) and Gounod (Faust) are famous French opera composers—these symphonies were in both cases temporary side-excursions into a field of music that was highly unpopular in France at the time.

This symphony is very much in the style of the Bizet, an effervescent French mixture of well-chosen German influences—Hadyn-like in texture, with a little Schubert, a Mendelssohnian zing and a strong whiff of Schumann. The first movement, particularly, is clearly reminiscent (in a lighthearted way) of the Schumann "Rhenish" Symphony of a few years earlier—it's in the same key and has the same triple-time syncopations.

This is a better developed symphony than the Bizet, though just as tuneful, and it is a more important work. The aforementioned first movement is a big piece, first rank; the rest is of somewhat lesser calibre though fine for easy listening. The Lamoureux-Markevitch performance is a marvel of lightness and discipline.

Bizet's little children's suite, written in later years, makes a pleasant LP companion work.

Milhaud: Globetrotter Suite; The Joys of Life (1957). Chamber Orch., Milhaud.
Decca DL 9965

It was Saint-Saëns who claimed that he composed music as easily as a fruit tree bears fruit; Darius Milhaud, French composer turned Californian, is surely the modern edition of old Saint-Saëns. He is famous for turning out music at the drop of a hat, for any old practical purpose. Like Villa-Lobos, he is especially interested in popular and student music, to be performed by "the people"—by them and for them.

These two little chamber orchestra suites were commissioned, for use by trained music students as working material but also for popular listening. They fill the bill neatly. The style is typically good humored, acid Milhaud, full of tuneful little ditties, harmonized with violent dissonance yet as straightforward as Yankee Doodle.

You'll find plenty of local influence here, superimposed on the French Milhaud—the movies are in every page of the music (the sort of music used for filmed shorts, travelogues, humorous bits, animations). And there are neat touches of Americana, intriguing bits of pseudo-Bernstein, suggestions of Copland—no doubt about it, Milhaud is an omnivorous listener and everything he hears comes right back out again in his own musical mixture.

The Globetrotter Suite, each movement a country (but oh-so-different from the mood-music travelogues in vogue of late) is somewhat on the brassy, twangy side, a sort of modern version of the musical equivalent of the sack and the trapeze. (Milhaud never can quite get away from the lure of the Twenties, when he first became famous.) The Joys of Life, homage to a set of Watteau pictures, is very casually of an 18th century mood, with tweaky, twangy little minuets, pastorales, Musettes; less brass and percussion in this one, a smoother blend.

I suspect that this record will grow on you subtly, if you acquire it. There's not a thing spectacular in it, but the intimate, almost conversational tone of the instruments, the modest clarity of the sound and the skill with which it is so good humoredly put together are likely to intrigue your ear. Use it as background music—you'll be bringing it out in the foreground before you know it.

Album de Musique. Suzanne Danco, sop., F. Molinari-Pradelli, pf. **Epic LC 3442**

A nice idea, this, a complete recording of a private album of little arias and songs copied out in 1835 for a French lady friend by none other than the great Rossini himself. The only trouble is that, at least as sung here, the little tidbits are pretty dull, in the main. I got bored after about three of them.

You can't expect a list of popular tunes of 1835 to make any overwhelming appeal to us today anyway; but Suzanne Danco's relatively heavy and overflorid singing doesn't help a bit. She seems to be one of those who do splendidly in big pieces, are lost in the little ones. She works hard, but these sound mostly very tired. Maybe that's the way she felt about them.

Franck: Violin Sonata. Debussy: Violin Sonata. Ravel: Pièce en Forme de Habanera; Fauré: Berceuse. David Nadien, vl., David Hancock, pf.
Monitor MC 2017

If you'll look closely, you may be surprised. The pianist in this recording is a good illustration of the model recording engineer of the future—for he's the David Hancock who is also well known as one of the best engineers in the recording business. This is his triple-threat deal—he also writes the printed notes on the back of the album. He started as a pianist (Juillard) and now is back at his old tricks, officially.

The performance of the French music isn't perfect, but it has what plenty of recordings do not have—excitement, earnestness, and intensity of expression. I found it thoroughly enjoyable, though both Franck and Debussy can take more polish, a more suave exterior over the inner turmoil. The recording itself, needless to say, is excellent. The engineer: David Hancock. He also cut the LP master.

Strauss: Die Frau ohne Schatten (1919). Soloists, Chorus, Orch. the Vienna State Opera, Böhm. **London XLLA 46 (5)**

I keep postponing these enormous and compelling opera albums for a suitably leisurely evening; they aren't made for sampling nor for any sort of quickie review, but that's

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

sound—out we don't do our recordings that way any more and we are right, I think. Our close-up solo technique, blowing up the
any old practical purpose. Like Villa-Lobos,
Monitor MC 2017
If you'll look closely, you may be sur-

what is in order at the moment, perforce. I've waited too long already.

This is a strange, wild opera, coming soon after the familiar early Strauss operas—Salome, Elektra, Rosenkavalier—but only the first of a long string that continued into the late Thirties. The theme is a sort of pagan legend, full of magic, symbolism, and not a little horror, deadly serious; it mainly concerns a spirit woman who becomes mortal, wedded to a wild hunter-king; she is without a shadow and must at all costs regain one. There is an elaborate plot to acquire the shadow of a lowly peasant woman . . . the tale and its symbolism is too complex to go into, but the music is powerfully sweeping, and beautifully performed here, even if it is dreadfully long.

If you'll gear yourself to Wagnerian proportions, settle down with the libretto and follow the opera closely, you'll be heavily rewarded for your pains. It's a big, potent late-German opera. Chief solos: Goltz, Ryanek, Höngen, Schoeffler, Hopf—a top cast, throughout.

Elisabeth Schumann—Lieder by Hugo Wolf, Richard Strauss. (Recorded 1927–1946). **Angel COLH 102**

Another of the "Great Recordings of the Century" Angels, and this qualifies in a number of ways. If you have any yen at all for lovely singing of German song, you'll be thrilled by this great lady, singing mostly back in her prime—though she did not fade nor grow coarse and inaccurate in her later years. The voice is exquisitely high and brilliant, the expression is of a sort that is now just plain outdated; nobody can do it today—nobody could get away with it, with the slides and swoops, the chest tones. But here, in the perspective of recorded history, it is beautiful.

Two things are remarkable in the recordings themselves. There is relatively slight improvement in tone quality over the long stretch of 78-rpm recording, right up through the end of World War II (the last discs made, no doubt, on leftover pre-war equipment, reactivated). But one recording, made in the summer of 1935, is about as fine a job of voice recording as I hope to hear, quite distortionless and with a surprisingly wide tonal range, plenty to bring out all the sibilants of the speech. The later records—11 years later—really aren't quite as good.

Irmgard Seefried—Goethe Songs. Erik Werba, pf. **Decca DL 9974**
Irmgard Seefried sings Schumann: Frauenliebe und Leben; Mozart: Nine Songs. Erik Werba, pf. **Decca DL 9971**

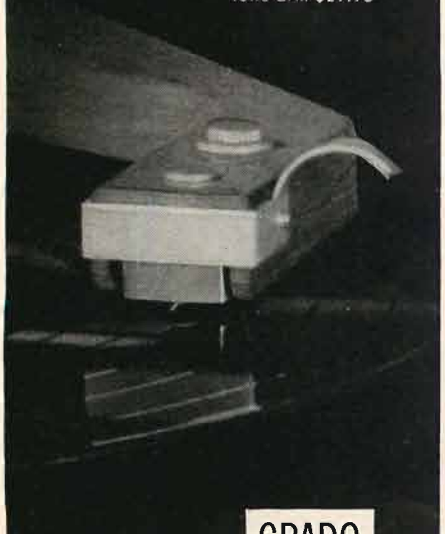
Irmgard Seefried's exquisitely high soprano voice is becoming one of the most respected and expressive for German lieder singing today. She has a fabulous sense of musical pitch and for shades of harmony—she sings "true" to an astonishing degree and it is a pleasure to listen to her for that reason alone. She is also a marvelous singing actor, expressing through speech the long tradition of emotional excitement that runs through all German song.

Seefried's voice has the same high range as that of Elizabeth Schumann, whose prime was around 1920, and it is interesting to compare them directly. Schumann is the larger dramatist, the bigger power. But Seefried has developed her own modern way of presentation, minus the now unsuitable slides and swoops of tone, making use of the close-up, intimate quality that has come to us with the microphone—just as today's orators tend to speak in lighter tones instead of orating at the top of their voices, as of old.

These are both superb records. Seefried's Mozart is outstandingly beautiful—her light, accurate, true voice is ideal for him. But, surpisingly, she also sings Schumann's songs about a woman's love and life with a poignant truthfulness of expression rare today. And as for Wolf, with his extremely tricky and difficult harmonic changes in almost every measure of his songs, there is no one today who understands them and sings them better. Child's play, for this intelligent voice, though many a singer flounders high and dry

she sings "true" to an astonishing degree and it is a pleasure to listen to her for that reason alone. She is also a marvelous singing actor, expressing through speech the long

stiffness of its mechanical suspensions; in AR speakers this stiffness is missing, and the cone works instead against the springiness of the enclosed air-cushion. Like the new air-suspension cars, the speaker literally rides on air.



when Wolf pulls his lightning-fast jumps of key!

The Goethe songs, to texts by the German poet and novelist, are by illustrious composers all—Mozart, Beethoven, Schubert, Wolf, Schumann. A far cry from the dreary collections of songs to Shakespeare that we occasionally hear; Shakespeare has had notably bad luck with his musical collaborators.

Schumann: Manfred (complete). Actors, B.B.C. Chorus, Royal Philharmonic, Beecham. **Columbia M2L 245 (2)**

A strange dramatic piece, this, and highly interesting too. The text is taken from the long poem by Byron, of the same name (Schumann, I suppose, set it in German; it is here used in its original English form). The work is cast for a group of speaking actors and a background chorus with groups of solos. The actors speak against almost continuous music for orchestra—an early example of the now-common device of background music for dramatic spoken texts, though here, of course, with no microphone to lend its powerful aid. (There was a good deal of such drama in the early 19th century, including, for example, Beethoven's "Egmont" and a number of spoken passages against music in his opera "Fidelio.")

The ever-present and indefinable *malaise* of Manfred, who is tortured by consuming guilt and yet cannot die, though he invokes all sorts of dreadful magic spirits to absolve him in vain, is one of those typical early Romantic expressions that are so familiar to us in various musical dramas. In Berlioz, the doleful poet who dreams lurid dreams in the "Fantastic Symphony"; the invocation of dreadful spirits and the casting of the magic bullets in Weber's "Der Freischütz"; the eternally dismal feelings of Schubert's restless lovers and wanderers in his beautiful songs—these vaporous and ill-defined outpourings of disembodied grief are the essence of early Romanticism. The fogginess of them, the utterly insubstantial "motivation," grief for grief's sake, is the great preoccupation, along with the magic and the occult invokings.

So it is in "Manfred." In cold English print, the Byron poetry is all but unreadable for most of us. But when it is set to a musical drama like this, it suddenly comes to life—though the "plot" is as meaningless as ever in literal terms. Oddly, we are able to sense, through music, what is hopelessly unintelligible to us in non-musical form. It's the same with many an opera with its preposterous story!

The speaking voices are excellent here, with just the right amount of old fashioned oratory, not a bit overdone nor anticlimatic. The Schumann overture is familiar already; the rest, the constant background music, is tantalizingly fragmentary, very lovely but all but inaudible. Too much mike technique, making the speaking voices louder than Schumann had envisioned, I would say.

American Anthology, Vol. 1. K. Brock, tenor, James Pease, bar., Concord Philharmoniam Korn. **Concord 3007**

Just caught up with this one, issued last fall. It's a new history of American music in the actual sound, and quite fascinating. There hasn't been anything like it since the famous old 78-rpm album by the Eastman-Rochester Symphony with Hanson, pre-war, that paraded out some of these same doughty American musical warriors.

The album starts rather uninterestingly with Francis Hopkinson and a typically yankee 18th century toast to Washington Sort of corn. Then it plunges into American musical Romanticism and we're off with a roar and a sob. A Death Song for an Indian chief by Gram precedes a really remarkably effective large-scale symphonic overture by our pioneer symphonic composer, William Henry Fry, whose name has been heard more than his music. It pulls out all the stops on the subject of Macbeth.

Then comes a rare orchestral work by the excellent Louis Gottschalk, an overture by Paine, whose name is still painfully attached to Harvard's music department building—Paine Hall. MacDowell, Chadwick, and Yale's Horatio Parker troop onto the scene and Romanticism turns towards a lustily American impressionism, with Griffes and Hadley—the latter a dead beat for Dukas and the Sorcerer's Apprentice.

No doubt the Concord Philharmonia is a trade name for a European orchestra, probably the Hamburg Philharmonia; alas, American orchestras cost too much for this kind of recording. But Richard Korn is a good conductor and the Germans (?) sound quite American, especially since most of the music is wholeheartedly Germanic in style, as was everything in Nineteenth Century America! A fine album, and there's evidently more to come.

First International Congress of Organists, London 1957. Six volumes. (Vols. 1 & 2 now available). **Mirrosonic (12 LPs)**

Only a brief note to signalize this rather huge project, now being issued volume by volume. The Congress is of British, American, and Canadian organists of traditional persuasion—there isn't a Baroque tweet to be heard anywhere on these very proper and discreet British organs. You'll call some of it downright stuffy, but I found that, within the somewhat conservative cast of the whole, there are interesting differences in approach. I enjoyed Vol. 2, all I've played so far (four long sides, at that) for the contrast between a solid British organist and a very accomplished American player, organist at both a Presbyterian church and a Synagogue in New York.

An odd feature (for the moment) of significance to engineers is that this series has been cut laterally—non-stereo—with the Westrex 3A 45/45 cutter. It's the first example that I've seen of this usage and should go a way to prove that a stereo cutter can, indeed, be used to make standard lateral masters. Interesting. If you want to test quality, get yourself one of these. (Each volume has two records.)

John Sebastian Plays Bach (harmonica). Paul Ulanowsky, pf. **Columbia ML 5264**

This isn't as far-fetched as it may sound—Bach on the harmonica is quite something. It's only a pleasant coincidence that the harmonica player's name fits into the picture.

There are two sonatas on this record, originally for flute and harpsichord. I'm sorry that a piano is used; oddly enough, its sound is further from Bach than that of the harmonica, which is truly a mouth "organ," equivalent more or less to one of the bright reed stops on the sort of organ that was Bach's own special instrument. Aside from a few bumpy places, the harmonica sound here is good for Bach and Mr. Sebastian's playing is sensible and musically intelligent.

This harmonica is a large chromatic instrument (it plays all the half-tones) and some of its low notes are of a most unusual timbre. Pocket harmonicas can't touch them. Æ

AUDIO ETC

(*from page 34*)

compete with its stereo tape predecessor, the standard stereo reel. It will outprice it so completely (once you have the playing machine) that there won't be any competition.

Even at the beginning, the most expensive stereo cartridge costs only a bit more than the cheapest standard stereo tape. The price will vary by length, as with present tape, but the full hour of RCA stereo will cost only $9 to begin with and could easily come down later and elsewhere, with success and mass production. The shortest tapes will run around $5, the blank cartridges, if I'm right, somewhere near $3.50. You can check these prices for yourself.

American Anthology, Vol. 1. K. Brock, tenor, James Pease, bar., Concord Phil-
that a piano is used; oddly enough, its sound is further from Bach than that of the harmonica, which is truly a mouth "organ,"

Two hours of home recording for $3.50, hi-fi! Pretty good.

Cartridge tape, on the other hand, will compete closely with stereo disc. The discs are fixed in price, the tapes variable, so comparisons aren't exact; but the tape equivalent of a $6 disc stereo record might average around $7, for the same music. Pretty close, and the added feature of home recording with the tape system can easily make up the difference. For the first time, then, tape and disc will compete on comparable, if not equal terms.

Disc will surely win, in volume. Even in automatic form, tape isn't as simple nor as convenient and quick. (You still must rewind your cartridge, unless you play it all the way through, once in each direction. You still must hunt for wanted items in the middle. And the tape mechanism is still inherently more expensive than the disc—though this may change in time with mass production.)

But the biggest competition, as I see it, will be between the tape cartridge machine and the present home tape recorder—in all its abounding millions. This is the real area of bombshell impact, speaking commercially, or so it would seem to me.

For here is a new home recorder that can give better economy and (possibly) better quality of sound at the 3¾ ips speed than virtually any present machine. For this big reason, and because of its new and radical versatility, I suspect that the tape cartridge player-recorder *may drive every present home tape recorder straight off the market and into limbo*—the types used by the ordinary layman, that is.

That will be a sizeable revolution, you'll grant. But if the cartridge is what it claims to be, this is what is bound to happen.

To be sure, it'll take awhile. Present recorders must be sold off, drastic re-designing and re-tooling will be required, even with plenty of enthusiasm. The doubters, rightly or wrongly, will go slow if they can. I'd guess that it might take as long as it did to convert the disc record player solidly to three speeds. (The fourth speed didn't take any time at all, but the other three were a long time a'coming.)

The best thing about the cartridge, aside from its simplicity, is the fact that it doesn't go too far, that the new system preserves so much of the presently familiar ways of tape recording. You will find it somehow heartening to see that the two reels still go 'round and 'round, that the pushbuttons still make the tape go forward and back, fast or slow, that you can even get at the tape itself in quick order. These things were cleverly envisioned. They may have seemed like obstructions to the more radical-minded; to the conservative home user they will be assets, removing that sense of strangeness that gets in the way of all radical innovations for a mass public. Excellent reason for wide success—provided the cartridge works.

Now maybe I'm wrong on all of this. Maybe the RCA cartridge will pop onto the market—in the middle of a sea of stereo discs—fizzle awhile and die with a wet plop. Maybe it'll be a dud. Maybe its coming is timed unfortunately. There'll surely be something of a howl on this score, any way you look at it.

But my hunch is that, first, sound quality and general operational flexibility are going to be just right for the intended uses in the home (even if the sound isn't perhaps quite up to super-hi-fi specialist standards). And, second, this cartridge offers exactly what is now needed for a larger home tape market: pushbutton ease with a minimum of complications and of strangeness, a maximum of economy, adaptability, dependability. A big order, but this cartridge could fill it. It could have been so much worse! It could hardly be better and be pushbutton too.

As to sound quality, I remind you that this column a good many years ago (AUDIO ETC, March, 1955) devoted two enthusiastic months' worth of comment to the appearance of the first Ampex narrow-gap head for wide-range sound at the then slow speed of 7½ ips. That step, applied to the relatively expensive Ampex 400 models (now discontinued) and then later to the simpler 600 series, now has reached down to the present home Ampex equipment at a still lower price. But in the same period the wider range response has been applied to virtually every home tape machine to some degree. Back in the old days, the standard top limit for 7½ ips was about 8000 cps. Now, almost any recorder can take down a 12- or 15-thousand cps tone at this speed, and the standard 3¾ ips recording gets the 8000 cps tones, for reasonably unmuffled sound.

Further progress was inevitable, as I think I remember observing. Now we have the next step-up in efficiency: 3¾ ips takes over where 7½ ips formerly led the way. Now we'll have adequately wide-range sound at the ultra-slow 3¾ ips speed, and we double its effectiveness by using four tracks in place of two.

I know it sounds fishy. I find it hard to believe that the thing works. I can understand why plenty of engineers are going to be very, very doubtful, until convinced. I have a sense of lingering doubt myself; how is it possible to avoid serious troubles? But this feeling, you see, is too much like those which so many of us had when microgroove LP came in. I suspect that in the end, the same clarifications, the same slow perfection, will lead to the same results. Good sound, excellent sound, within the framework of requirements.

You can still buy old-fashioned two-track, fast-play stereo tapes if you want. You can even get 'em at fifteen inches, here and there, if you try hard. If you're a purist of the first water, with cash, you can go right ahead and make your own 30-inch tapes. But it looks to me as if a good segment of the home music world, at least, will be swinging over to pushbutton play at 3¾. We shall soon see. Æ

JAZZ and all that

CHARLES A. ROBERTSON*

Electro-Voice Stereo Demonstration Record ABC-Paramount EVD

Stereo Demonstration Record Hallmark HLP310

With the entry of several new companies into the field in May, and the issuance by Audio Fidelity of its second set of four releases, the trickle of stereo discs swelled into a thriving spring freshet. Contemporary announced a total of six, including one classical item and its perennial best-selling jazz version of "My Fair Lady." Urania scheduled five, headed with two ballets by the London Philharmonic Orchestra, and Cook Laboratories was ready to make its debut.

In addition was the revelation of Rudy Van Gelder of material mastered for Elektra, Savoy, Vox, and Boston by use of a newly designed stereo cutting head. Said to be a refinement of the 45/45 principle, it was engineered and constructed by Rein Narma of Fairchild at Van Gelder's motivation. Among its features is an improved and more direct linkage between stylus and coils, and test pressings show a high level of recovery from the tapes. It will be manufactured by Fairchild. To prepare for the fall market, the majors will begin building catalogs this summer, making that season one of unusual activity for sound fanciers and adding to the burdens of reviewers.

Two companies have simplified this problem by issuing demonstration discs. In a joint promotion in connection with the Electro-Voice line of loudspeakers, furniture enclosures and new stereo cartridges, ABC-Paramount has placed excerpts from its six initial releases on a 10-inch disc. To introduce a new label and a grand total of eleven popular and six classical albums, Hallmark has assembled a sampler of the normal 12-inch size. Though they cannot fill all the requirements of a reviewer, they serve to lighten his load by allowing him to pass some of his task on to the prospective buyer.

I am able to give an account of a critical step in their manufacture, however, due to the coincidence that the same firm handled both at this point. All the stereo masters were cut at Olmsted Sound Studios, Inc., under the direction of Lewis G. Whittier, chief of engineering, who said in a brief outline of some of the new techniques involved in the process, "Our primary effort was directed at increasing the level on each channel. I feel this is most important when the stereo disc reaches a mass market where it will be played on all grades of equipment. The first releases needed the high gain of good high fidelity components.

"Two matching cutting amplifiers of 300 watts were redesigned to allow a monaural recovery from both tracks comparable to the level of most LPs. This much gain may not be necessary in stereo playback, but it should not be underestimated as a factor in the reaction of the public to the new discs. Tests show them to measure 6 db above the first releases."

As to another area occupying much of his attention, Whittier would commit himself only so far. On the delicate subject of compatibility, he said, "If the choice were mine, I must admit I would rather concentrate on the best stereo possible, but I am not a record salesman. Their reports on public acceptance are going to carry great weight. It is not a matter to be settled in a few months. Until it is, we are working toward greater compatibility.

"In this respect, we have developed a unique system of variable depth control. It is designed to control the two channels effectively and to contribute to compatibility. It is not to be confused with the system demonstrated by Columbia, as the principle is not the same. We are now doing stereo dates for several companies in our studios. There may be some surprises when they are released, but I'm afraid you must wait until then to see what they are.

"Our investment in a Westrex cutter has also brought us mastering assignments from Urania, Cook, Atlantic, and Rondo, a new label. None of the present recordings was made in our studios, and we did not master them in the monaural versions. Creed Taylor of ABC-Paramount, along with Jack Hodin of Hallmark, gave us every cooperation. By now there is no news in the fact that the problems of stereo on discs are different, in matters of separation of instruments and fading, from those of stereo on tape. Everyone is learning during this period and some companies are finding a number of their tapes are not suitable for stereo discs. In cutting a master, we must consider each type individually to determine how best to handle it. Our work will be a lot easier when procedures are more standardized."

The studios occupy two floors of the Elizabeth Arden building at 1 E. 54th Street. Founded in 1955 by Henry C. Olmsted and his son Richard to service advertising agencies, the firm does only about a tenth of its business with record companies. According to Richard, who supervises many of the sessions, "Father was always a sound *hobbyist* and owned the Vanderbilt Theater before the space requirements of Broadway shows made it obsolete. I became interested while making pilot films for television on the West Coast, after a period in the Marine Corps. We

* *732 The Parkway, Mamaroneck, N. Y.*

have one motto—Quality and Delivery. A year after we opened, it was necessary to add the second floor and Whittier was engaged then. He helped plan the new layout, supervised its construction and now makes himself invaluable as head of our engineering staff.

One result of the expansion is resplendently evident in the control room adjoining the largest studio. It is a console built by Rein Narma to accommodate fourteen microphones, each equipped with its own equalizers. These in turn feed either A or B channels of the stereo console with excellent distortion characteristics and a signal-to-noise ratio of better than 80 db. "It was ahead of its time then," said Whittier, "and still is. As you know, he made similar ones for Rudy Van Gelder and for the home studio of Les Paul and Mary Ford, and I believe that's all. You might say that equipment like this brought the record companies to us.

"We have two Scully cutting lathes and a modified Fairchild. At that time, the Cinema Engineering console was rebuilt and used to equip a slightly smaller studio. And a still smaller studio with a modified Altec console is used for recording, copying, and dubbing voice. We have numerous tape machines and many of the copying techniques developed for advertising are adaptable to stereo."

Before the war, Whittier studied two years at the RCA Institutes, and while serving in the Marine Corps attended a Navy radio materiel school. Three years were spent with Finch Telecommunication in engineering work on UHF transmitters and receivers and on radar equipment for the Navy. Another three years of experience were gained with Langevin as a field engineer in broadcast and public address work. Then came four years with the Voice of America in studio facility engineering. Before his present position, he was recording equipment service manager at Fairchild for three years. Numbered in his staff of seven are Ian Thomson, Bruno Vineis, David De Noon, Joe Ryan, Amatruto and Don Young, and Fred Roberts is right-hand technical engineer.

"Quite a bit of my interest centers on the new cartridges," concluded Whittier. "We try each one as it becomes available but now have only one magnetic, an Audiogersh-Stereotwin, in addition to the ceramics. When here on a visit, the managing director of Vega, a French recording company, convinced us he needed our Fairchild and we are awaiting a replacement."

Aimed at the heart of the mass market, both releases rely heavily on popular and semi-popular material. A short narration by Bill Lipton on the Electro-Voice disc introduces the new dimension in sound and provides test tones for setting the volume of each speaker. His only claim of compatibility is for the cartridge. The excerpts are from Eydie Gorme Vamps the Roaring '20s (ABCS-218), More College Drinking Songs (ABCS-219), Hi-Fi in an Oriental Garden (ABCS-224), World War II Songs (ABCS-222), Ferrante and Teicher (ABCS-221), and a Strauss waltz album (ABCS-143). It was pressed by Raleigh Records Inc.

The Hallmark disc seems designed for use in retail store demonstrations of its packaged phonographs as each side duplicates the other. Introduced in glowing terms by Del Sharbutt, the material includes a train arrival and a passing DC-7, in place of the test tones, before descending into an echoed Dick Haymes vocal and rock and roll. None of the classical items is represented and only a small number of the popular. A better idea of the label's work is given by The Empire City Six, an eager young dixieland group, on HLP312.

Just how quickly stereo intends to reach all levels of distribution can be seen in the fact that Hallmark is owned by Paramount Enterprises Inc., which has previously manufactured in its pressing plant only Hollywood, a low-priced label sold in Woolworth's. Despite the similarity in name, there is no connection between the two companies. Neither is trying to sell stereo to be played monaurally, indicating their belief that the new medium is going to catch on with the public. Due to the variety of recording techniques used in stereo at this stage, it seems that the sampler, absent from the LP picture until fairly late, can render a real service.

The current Audio Fidelity releases also have an appreciably higher level. The first discs were mastered before Westrex modified its 45/45 cutting head by the addition of a damping device. They are Leon Berry at the Giant Wurlitzer, Vol. 3, (AFSD 1844), Lionel Hampton (AFSD 1849), Ninth Regiment Pipe Band (AFSD 1857), and Dukes of Dixieland on Bourbon Street (AFSD 1860).

Brunies Brothers Dixieland Jazz Band
American Music ALP651

This is one of the most welcome releases of recent months, not only on its own terms, but because it signals the resumption of a label which has followed its founder since 1942 to its various residences throughout the midwest. During the '40s, it boasted a comprehensive catalog by New Orleans musicians, many of them previously unrecorded, as played in their local haunts. Now settled in the city as proprietor of a record shop at 600 Chartres Street, its owner went to Biloxi, Miss., to tape this Saturday night dance session, his first since 1949, by a band led by two of the six Brunies brothers.

One of the contributors to "Jazzmen," the first book to examine the subject with any authenticity, Bill Russell has combined his recording activities with a long and intensive study of jazz backgrounds. Soon after this record was released, his persistence was rewarded by a grant of $75,000 from the Ford Foundation to develop, through taped interviews with surviving musicians, a systematic oral history of the 1885 to 1917 period of jazz in New Orleans. The funds will be administered by the history and music departments of Tulane University.

Aiding him in the five-year project will be Richard Allen, who encouraged Samuel Barclay Charters IV, in a preliminary study "Jazz: New Orleans 1885–1957." Published as one of a series of monographs by Walter C. Allen of Belleville, N.J., a preceding volume on King Joe Oliver is no longer in print in this country. It is still available to members of the Jazz Book Club, 38 William IV Street, London, England. A year's subscription brings six reprints of worthy jazz books at a cost of less than one dollar each.

Before making their headquarters in Biloxi, Merritt and Abbie Brunies led some of the most famous Chicago and New Orleans Dixieland groups, but have not recorded in more than thirty years. Unlike his wandering brothers, Abbie never left the south and is best known for his rare collector's items by his Halfway House orchestra of 1919 to 1926, with clarinetists Leon Rappolo or Sidney Arodin. His trumpet style is always melodious and makes up in sureness what it may lack in fire. Merritt made fourteen sides when his band, with brother Henry, followed the New Orleans Rhythm Kings, featuring brother George on trombone, into Chicago's Friars Inn. He returned south in the late '20s, and now plays valve trombone in the typical Brunies manner.

The present group has worked together five years and is *uncompromising* in its view of early Dixieland, playing with the relaxed beat and smoothly-woven ensembles of long acquaintance. "We're fakers," Merritt notes, "There's only one man in the band that reads.

acoustic output at 30 cycles or lower)
Vastly improved transient response
both releases rely heavily on popular and semi-popular material. A short narration
in this country. It is still available to members of the Jazz Book Club, 38 William IV Street, London, England. A year's subscription brings six reprints of worthy jazz books

When we play, we play from the heart, and we get that good old sock rhythm, and that's what counts."

Jules Galle, a clarinetist with a beautiful low register and agile upper tones, plays best, having bought his Albert system instrument after hearing Rappolo one night. Eddie James, the only member under fifty, is a strongly rhythmic pianist. On bass is Tony Fountain, a cousin of Pete Fountain of Lawrence Welk notoriety. And the tom-toms of drummer Joe Wentz give the delightfully muffled sound of the brass-studded Chinese relic of another day.

The program lists the Dixieland classic *Zero, Tin Roof Blues,* and *Jazz Me Blues,* plus such Brunies specialties as *Till We Meet Again, Let Me Call You Sweetheart,* and *It's a Sin to Tell a Lie.* Both brothers sing on *Angry,* the family anthem. Because it was taped on location, the recording has a natural dance hall sound and is quite a bit less plagued by distortion than earlier efforts. Prospects of an oral history give rise to the hope that funds may become available to preserve other aspects of this native American music. If sent out into the byways, a station wagon filled with good equipment, similar to the one outfitted by Mercury, could accomplish wonders.

Brownie McGhee And Sonny Terry Sing
Folkways FW2327

Formed after years spent in perfecting their individual ways of playing country blues, the partnership of Sonny Terry and Brownie McGhee is based on a long friendship. Coming at a stage in their development when they are ready to join in the give and take of collaboration, it enriches the work of both singers. In remolding their styles to mesh in a pleasant blend of voices in several duets, they retain a creative freedom which makes familiar themes, such as the saga of *John Henry,* take on new force and meaning in their interpretation. Sonny's custom of punctuating his harmonica solos with quaint falsetto cries is abandoned in favor of the strong accents of Brownie's guitar.

Besides a European tour this summer, their teamwork has won them a firm place in folk-singing circles and led them to fashion original urban blues along the lines of *If You Lose Your Money,* and *I Love You, Baby.* On these, and the basic rhythms of *Preachin' The Blues,* they are joined by the firm beat of drummer Gene Moore. In a concluding tribute to Huddie Ledbetter, they recapture his vital drive on *Best of Friends.* Even when poorly recorded the Terry harmonica was an amazing instrument, and here in good sound the fullness of its harmony in the accompaniments is a revelation.

Horace Silver: Further Explorations
Blue Note 1589

By now the periodic release of a new Horace Silver album is greeted as an event in modern jazz, both for the interest of his compositions and the increasing integration of the group centered on his highly personal piano style. Cliff Jordan makes his first recorded appearance in the tenor sax assignment he took over last summer, and fits the knubby texture of the group admirably. In pulling his weight beside trumpeter Art Farmer, he assumes new stature. With drummer Louis Hayes and bassist Teddy Kotick both capable of developing his rhythmic ideas, Silver has a swift vehicle for projecting a passing fancy or sifting an untried concept. It gives his explorations an advantage enjoyed by too few leaders, and he consolidates his gains on a firm base before moving ahead.

At the moment the rhythms which permeated *Señor Blues,* the most resurgent example of the Latin phase of his career, seem to be assimilated so well that he can call upon them at will, distributing them intermittently as added spice to new works such as *Pyramid,* a Near-Eastern theme modishly stated by Farmer, or the balladic *Moon Rays.* Combined with these discreet accents, more fully absorbed as jazz than ever before, is his growing concern for form and construction on *The Outlaw,* as unmasked in Jordan's solos, and the seven-bar phrases of *Melancholy Mood.* Included are *Safari,* an early effort, and *Ill Wind.* Throughout, Silver draws nuances from the band as nimbly as he does from the keyboard in his own pungently worded solos.

Mike Sarkissian: Grecian Holiday
Audio Fidelity AFLP1866

For a likely hit successor to his "Armenian Wedding" set, Michael Sarkissian leaves the mountainous regions bordering the Black Sea to visit the scene of similar festivities along the fabled shore of the Aegean. The shift in locale finds his Cafe Bagdad ensemble in a land where East meets West. Its oriental instrumentation is fully at home in the musical language of the countryside. Here the ceremonies attendant on a wedding may last several weeks and the events of the day are full of holiday spirit. Each Greek province or island has its characteristic dance and the tempos can be mild or strenuous. As before, a choral group outlines the simple patterns of sultry themes to prepare the way for the endeavors of the dancers. Strange instruments and sounds in an excellent recording make this an unusual listening experience.

Wilbur Ware: The Chicago Sound
Riverside RLP12-252

Max Roach: On The Chicago Scene
EmArcy MG36132

Chicago still trains its share of young musicians, but often they must seek recognition in greener pastures, due to the concentration of record companies on either coast. To spotlight some recent graduates who have gravitated to the East, Riverside presents bassist Wilbur Ware in the company of John Jenkins, alto sax; Johnny Griffin, tenor sax; Junior Mance, piano; and drummer Wilbur Campbell. After a singularly effective review of rudi-

By now the periodic release of a new Horace Silver album is greeted as an event in modern jazz, both for the interest of his com-

ments on his *Mamma-Daddy*, Ware solos on *The Man I Love, Body and Soul*, and turns *Lullaby of the Leaves* into a vehicle for extended improvisation. Jenkins contributes *Latin Quarters* and *Be-Ware*, and Griffin shows the beneficial effects of his stint with the Jazz Messengers. The leader makes the reunion complete with his tune dedicated to *31st and State*.

In his Chicago excursion, Max Roach previews the abilities of four jazzmen still developing in its environs. There is the pianist Eddie Baker, who demonstrates an affinity for the blues on his original *Memo: To Maurice*, to work with bassist Bob Cranshaw in the rhythm section. George Coleman, an incisive modern tenor saxist, is able to soften his tone on the ballads *My Old Flame, Stella By Starlight*, and his own *Shirley*. On trumpet is Booker Little, a 19-year-old student at the Chicago Conservatory of Music, whose feeling for jazz is unimpaired by his academic pursuits. In giving guidance to such a willing group, Roach is at his best, never pushing the soloists as he uses his command of the drums to reinforce their efforts with taste and restraint.

Dinah Washington: Sings Fats Waller
EmArcy 36119

Louis Prima: Live From Las Vegas
Capitol T1010

Two matrimonial teams, noted for their power to hold the attention of a late evening crowd of merrymakers, offer choice bits of their uninhibited performances. To recreate tunes associated with Fats Waller, the small group used on tour by Dinah Washington is enlarged to a big band conducted by Ernie Wilkins, who refurbished the scores with his customary skill. Dinah puts lyrics to *Jitterbug Waltz* for the first time, revamps *Black and Blue*, and makes *Christopher Columbus* singable by giving it a blues flavor. The tenor-sax of Eddie Chamblee, her husband and vocal partner on *Everybody Loves My Baby* and *Honeysuckle Rose*, is featured on *I've Got a*

cone speaker requiring no baffle, and having almost the ideal,

Feeling I'm Falling. Other soloists are Renauld Jones, Charlie Shavers, Jerome Richardson, Frank Wess and Jack Wilson, her regular pianist.

Recorded before his usual audience in the Casbar Theater of the Hotel Sahara, Louis Prima indulges in extroverted byplay on trumpet and in his vocals with shining spouse Keely Smith, a sane but not restraining influence. He blasts *White Cliffs of Dover*, demolishes *Holiday for Strings*, and restores *Greenback Dollar Bill* to preinflation value. Prodded by the roistering tenor-sax of Sam Butera, the Witnesses give rollicking support on *Them There Eyes*, *Love of My Life*, and *Tiger Rag*. A Las Vegas favorite for four years, Prima may tame the town yet.

Bob Cooper: Coop

Contemporary C3544

To date the only modern jazz oboist and an exponent of the English horn, Bob Cooper is here intent on exhibiting his style on tenor sax to best advantage. The 23-and-a-half minutes of his *Jazz Theme and Four Variations*, an unassuming piece with roomy solos by Victor Feldman on vibes, trombonist Frank Rosolino and the composer, fills one side of the disc. It is deceptive in its seeming simplicity and will repay repeated hearings. Cooper makes this procedure relatively painless by avoiding the familiar cliches of arranging in developing the theme stated in *Sunday Mood*. After a blues motif, a brass section of the Candoli brothers and Don Fagerquist on trumpet, plus trombonist John Halliburton, is added to the sextet for the descriptive *Happy Changes*, *Night Stroll*, and *Saturday Dance*.

That Cooper keeps his orchestrations clean and uncluttered, never overwriting, is a measure of his studies with Castelnuovo-Tedesco. The soloists are allowed considerable leeway in his frameworks and the zest of their response carries over to the remaining numbers, ranging from a dramatic *Frankie and Johnny* to Parker's *Confirmation*. Cooper pays his respects to Johnny Hodges on *Day Dream*, Feldman defines *Easy Living* and pianist Lou Levy solos on *Somebody Loves Me*. Æ

AUDIOCLINIC

(*from page 4*)

and to attenuate those below this figure for the tweeter. Values for C_1, C_2, L_1 and L_2 are calculated as for C_3 and L_3 in *Fig.* 4, using a crossover frequency of 5000 cps, the point where the tweeter takes over. This wiring of the midrange is exactly the same as that of the woofer in *Fig.* 4, except that the values of its associated inductance and capacitor are different from those associated with the woofer. Like the midrange, the tweeter derives its signal across L_3. L_2 shunts the lows around the tweeter, while C_1 provides an easier path for highs than for lows. C_1 and C_4 have the same values, as do L_1 and L_4.

The frequencies chosen for purposes of this discussion are purely arbitrary. Some tweeters are made to take over at 7000 cps, while still others are designed to function at frequencies as low as 1000 cps. There is also considerable latitude with regard to woofers and midrange units.

The circuits presented here are basic, but there are variations. Some networks are designed to attenuate the response at even a more rapid rate than *Fig.* 5. Others are provided with switching provisions, so that a wide variety of crossover points can be obtained. Still others are series circuits; these are more costly to build, but many engineers favor them over the more common parallel constant-impedance networks.

In a future installment of my other column, AUDIO TECHNIQUES, you will find an interesting means of making test inductances for experimental networks. Watch for it. Æ

shunts the lows around the tweeter, while C_1 provides an easier path for highs than

distribution so that non-linear distortion is brought all but to nil while very little is caused by the damper.

NEW PRODUCTS

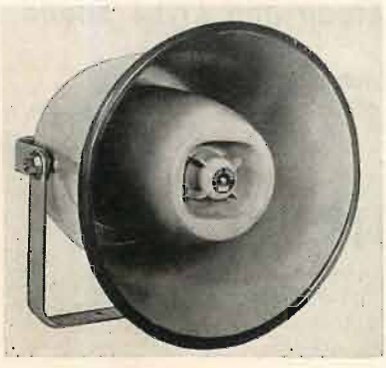
• **Ronette Stereo Cartridge.** Designed for new record players and as a replacement cartridge for existing phonographs, this dual-element pickup is compatible with both monaural and stereo recordings. Lateral and vertical compliances are

stated by the manufacturer to be 3.5×10^{-6} dyne/cm. Optimum stylus pressure is specified as 4 to 6 grams. Frequency response is said to be flat from 20 to 12,000 cps. The cartridge uses a clip-on stylus. The Ronette Binofluid cartridge is distributed in the U. S. by Ronette Acoustical Corporation, Lynbrook, N. Y. **G-1**

• **Stereo Magnecordette.** Engineered to perform with professional quality, the new Stereo Magnecordette is a home instrument which is capable of both recording and reproducing stereophonic sound, as well as standard monaural half-track signals. Stereo heads are of the stacked, or in-line, type and recording speeds of standard models are 7.5 and 3.75 ips, with 15 ips and 7.5 ips available on request. Frequency response is 50 to 12,000 cps within ±2 db at 7.5 ips; 50 to 6000 cps within ±2 db at 3.75 ips, and 40 to 15,000

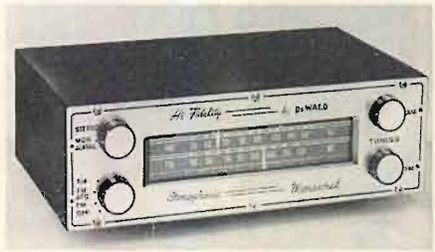
cps within ±2 db at 15 ips. Signal-to-noise ratio is approximately 50 db. Channel-to-channel crosstalk is down more than 50 db. The unit is equipped with two high-impedance microphone inputs and cathode-follower outputs. Matching VU meters are provided for monitoring both input channels. Three gain controls permit individual adjustment of each channel, as well as master control of both simultaneously. Although normally supplied for placement in the user's existing cabinetry, the Stereo Magnecordette is available with custom cases and cabinets when desired. Panel dimensions of the amplifier unit are 5¼ × 17 ins., the tape transport is 7 × 17 ins. Magnecord Division of Midwestern Instruments, Inc., Tulsa, Okla. **G-2**

• **Atlas Coax Weatherproof Speaker.** Suited for both voice and music, the Atlas Coax Projector Model WT-6 incorporates two individual drivers, each with its own horn, and a built-in electronic crossover, all combined in a single weatherproof



unit. Low frequencies are reproduced by a high-efficiency woofer properly loaded with a folded exponential horn, while highs are handled by a wide-angle tweeter completely protected against all climatic conditions. Power handling capacity is 15 watts. Bell opening is 15 ins. and depth is 11 ins. For full information write Atlas Sound Corporation, 1449 39th St., Brooklyn 18, N. Y. **G-3**

• **DeWald Stereo/Monaural Tuner.** This tuner can be used for stereo reception or in the conventional manner for monaural FM or AM broadcasts. Designated Model 1000, it contains eight tubes plus diode and rectifier. The unit incorporates four stages of i.f. including discriminator and



automatic frequency control. Housed in an attractive black and gold case, the moderately-priced Model 1000 measures only 13" w × 4⅛" h × 9" d. Manufactured by DeWald Radio, Division of United Scientific Laboratories, Inc., 35-15 37th Ave., Long Island City 1, N. Y. **G-4**

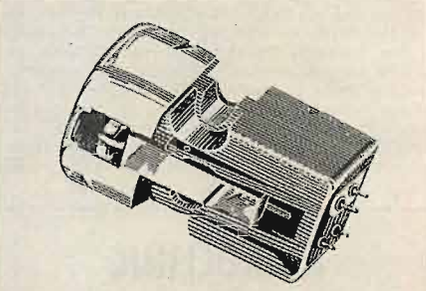
• **Pilot Stereo Conversion Console.** Introduced as the answer to many requests received from owners of Pilot monaural high-fidelity systems who want to convert to stereophonic operation, the Model SA-1032 amplifier-speaker unit contains the new Pilot AA-903B amplifier-preamplifier

and a matched four-way speaker system in an acoustically isolated enclosure. Supplied with complete operating instructions, and all necessary materials for the simple conversion, the SA-1032 may be used with any stereo pickup cartridge, according to the preference of the user. Contemporary in style, the unit measures 28½"h × 25¾"w × 16½"d and is available in a choice of four finishes—cordovan, cherry or blonde mahogany, or American walnut. Pilot Radio Corporation, 37-06 36th St., Long Island City 1, N. Y. **G-5**

• **Bell Tuner-Amplifier.** The new Bell Model 2521 combines an FM-AM tuner with a 15-watt high-fidelity amplifier on a single compact chassis. Among features of the tuning unit is a unique "electronic tuning bar", in which segments of a broken bar of light come together to indicate correct tuning. AFC may be disabled at will. A multiplex output on the rear of the chassis will facilitate the reception of all-FM stereo broadcasts when they become available. Input for tape head is equalized to standard NARTB curve, making it possible to play back direct from the tape head of any standard tape transport; auxiliary input is provided for tape preamplifiers. Tuner specifications are: FM sensitivity, 3.5 microvolts for 20 db quieting, 6.0 microvolts for 30 db quieting; AM sensitivity, 20 microvolts for 20 db quieting. Fre-

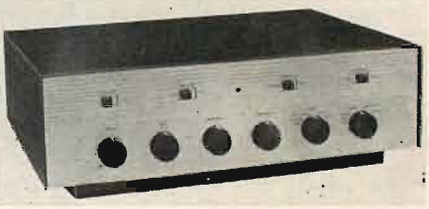
quency response on FM is 20 to 20,000 cps ±1.0 db; on AM, 20 to 5000 cps ±3.0 db. The amplifier section has rated power output of 15 watts at less than 1.0 per cent distortion, with frequency range of 20 to 20,000 cps ±0.5 db. Bell Sound Systems, 555 Marion Road, Columbus, Ohio. **G-6**

• **G-E Stereo Cartridge.** Announced as being available to the consumer market in August, the new G-E stereophonic cartridge will be supplied in two models—the "Golden Classic" and the "Stereo Classic", differing only in the fact that the former will have a 0.7-mil diamond stylus, while the latter will be equipped with a 0.7-mil sapphire. Both models may be used in either high-quality record changers or turntables. Frequency response is 20 to 17,000 cps. Output is 10 mv, nominal, per channel at stylus velocity of 10 cm/sec. Channel separation is 20 db, nominal, from



100 to 7000 cps. Lateral compliance is 3×10^{-6} cm/dyne; vertical compliance is 2×10^{-6} cm/dyne. Recommended load, each channel, for flat response is 0.1 megohm. Recommended tracking force is 3.5 to 7.0 grams. The cartridge has a dual mu-metal shield to protect against hum, and a highly-flexible ground strap design which allows it to be used in either a three-wire or a four-wire stereo system. The shield also may be grounded individually with a separate wire. Stylus replacement is simple. Further information on the G-E stereo cartridge is available from: Specialty Electronic Components Department, General Electric Company, Auburn, N. Y. **G-7**

• **Harman-Kardon Stereo Amplifier.** Introduced as part of the Harman-Kardon "Crest" stereo line, the new "Trio" Model A-224 stereo amplifier is, in essence, three individual instruments. It is a complete stereo amplifier with two separate 12-watt power amplifiers; it can be used as a complete 24-watt monaural amplifier, and it



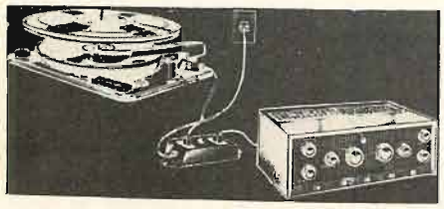
is also a 24-watt monaural amplifier with complete stereo preamplifier so arranged that an existing monaural amplifier may be incorporated into a stereo system. Features include: separate ganged bass and treble controls, balance control, rumble filter, mode switch, speaker selector switch, contour control, and tape output (after tone controls) for recording. Manufactured by Harman-Kardon, Inc., Westbury, N. Y. **G-8**

Panel dimensions of the amplifier unit are 5¼ × 17 ins., the tape transport is 7 × 17 ins. Magnecord Division of Midwestern Instruments, Inc., Tulsa, Okla. G-2

G-7

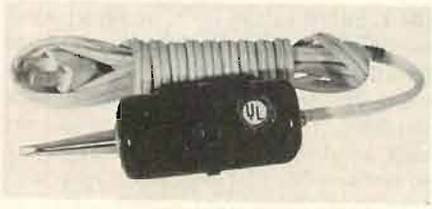
• **Harman-Kardon Stereo Amplifier.** Introduced as part of the Harman-Kardon

• **"Music Minder."** Thanks to this device, the music lover who enjoys listening to records while relaxing may do so without the irksome task of turning off the hi-fi system after the last record has played. The Music Minder performs the job automatically. Operation is completely electrical. The record changer is plugged into



one of two sockets, the remainder of the hi-fi system into the other. If the user does not want the automatic feature he simply sets an "auto-manual" switch to the manual position. Literature is available from C. B. C. Electronics Co., Inc., 2601 N. Howard St., Philadelphia 33, Pa. **G-10**

• **Head Demagnetizer.** Featuring a thin extended pole piece which fits most tape recorders without any disassembly, the Model HD-6 degausser consists of a 110-volt 60 cps coil in a handfitting phenolic housing. Contact of the energized pole piece with the pole tips of the recording



head causes the head to be saturated by an alternating magnetic field. Gradual removal of the saturating field from the head neutralizes any residual permanent (d.c.) magnetism. The HD-6 is manufactured by Robins Industries Corp., 36-27 Prince St., Flushing 54, N. Y. **G-11**

AMPLIFIER

(*from page 20*)

tinue to be true when the Dynamu head was replaced by the Brush unit. However, a different and more workmanlike shielding measure was employed, with considerably greater effectiveness than the gimmick.

A small piece of Co-Netic Shielding[1] was affixed to the reverse side of the bracket that holds the pressure pad on the tape transport. The material is almost paper-thin, cuts easily with a scissors, is easily worked by fingers or simple tools into the desired shape, yet is rigid enough to hold this shape, and does not lose its shielding properties because of shock, repeated bending, temperature changes, etc. Several layers of Co-Netic material were used, each layer

[1] Made by Perfection Mica Company, 1322 N. Elston Avenue, Chicago 22, Illinois.

tinue to be true when the Dynamu head was replaced by the Brush unit. How-

the Institute of Contemporary Art as The high quality loudspeaker in its price class and above for ex-

increasing the protection against hum. Some experimentation was necessary to find the optimum size of the Co-Netic Shielding and its best location on the pressure pad bracket. It is interesting to note that a small section of this shielding, about ½" wide, afforded considerably greater hum reduction than a piece double that width. The final result was considerable attenuation of hum. The reduction was not measured, because without the use of filters one would be measuring noise along with hum. To the ear the reduction appeared to be at least 6 db.

Co-Netic Shielding is expensive. In small quantities it is over $3.00 per linear foot for a strip 4 in. wide, and the minimum order is 3 feet. However, for the habitual experimenter or tinkerer it can be a worthwhile investment. A less expensive alternative, closely approaching the Co-Netic material in effectiveness, is a shield made from a piece of silicon steel I-strip. The latter material is more difficult to work and eventually becomes magnetized, while the Co-Netic does not. A magnetized material adjacent to the tape can cause erasure, noise and hum.

For minimum noise and hum, an ECC83, the European version of the 12AX7, was used for V_2-V_3. Of two Mullard ECC83's purchased, both were excellent with respect to noise and microphonics, but one had serious hum. Demagnetizing this tube with a bulk eraser and resetting the hum balance pot did not improve matters. The tube was exchanged for another Mullard ECC83, which proved to be excellent. It is unfair to draw conclusions from a sample of three, but this experience corroborates the writers' experience with other tubes, such as the 5879 and Z729, that one must be selective even when using premium types, which cost appreciably more. The two good Mullards were definitely superior both in noise and hum to each of half a dozen American 12AX7's in the writer's tube chest. A couple of Telefunken 12AX7's were of quality similar to the Mullards.

The ultimate result of the above measures was to reduce noise and hum in the tape amplifier substantially below that inherent in the tape itself, namely tape hiss. Even when a tape has been carefully bulk erased, leaving it as noise-free as a tape can be, it still makes the dominating contribution to noise on the writer's tape recorder, Considering the additional noise produced in recording —at least modulation noise if not also noise due to distortion in the bias waveform—it may safely be said that the tape electronics described here do not constitute a limitation to signal to noise ratio in tape recording and playback. On the other hand, it is to be expected that eventual improvement in the tape, resulting in less tape hiss, will inspire a search for further means of reducing noise and hum.

Stereo Playback Amplifier

There is an increasing demand for a second playback amplifier for stereo purposes. A simple way to satisfy this demand would be to construct a one-tube affair, either on the main amplifier chassis or separately, patterned after the circuit of V_2 and V_3 in *Fig.* 2. Power could be drawn from the main tape amplifier, from an easily built supply such as shown in *Fig.* 5, or from the power amplifier of the audio system.

If power is drawn from the main amplifier of *Figs.* 1 and 2, connection should be made to the point B_2+ via an additional decoupling network consisting of another 4700-ohm resistor and another 15-μf, 350-volt filter capacitor. Since the loading of the main power supply is considerably lighter in playback than in record, this supply can take care of another 12AX7 for stereo playback. At the same time, however, it is highly desirable that a switch be incorporated to remove B+ from the extra 12AX7 during record. Similarly, the heater supply to this tube, if obtained from the main amplifier, should be disconnected during record. On the other hand, if the power transformer used is large enough, these disconnections are not necessary. Æ

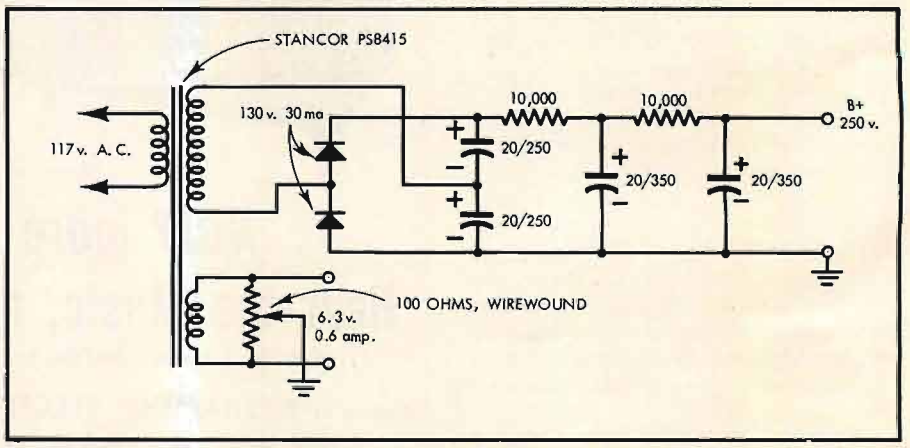


Fig. 5. Simple power supply circuit suitable for second-channel amplifier for stereo.

HEARING

(*from page 26*)

Noise in Theaters

Measurements of noise have also been made in motion-picture theaters. Mueller found the average level in theaters without an audience to be 25 decibels and with an audience present it was 42 decibels. This last figure is within 1 decibel of that given above for the average noise level in residences. So all the limits mentioned above for residence room noise can also be applied to motion-picture theaters, that is, *Fig.* 3 gives the limits if no limitation is to be placed upon the sounds to be recorded.

Noise measurements made in the Academy of Music in Philadelphia and Constitution Hall, in Washington, D. C., during a quiet listening period indicated levels about 10 decibels lower than that given in *Fig.* 3 for residences. So at least for these concert halls the lower part of the shaded area should be used for determining minimum levels. It will be seen from *Fig.* 1 that for the average person in such quiet intervals in these concert halls the lower limit is set by the acuity of hearing rather than by the audience noise.

The foregoing gives the ideal limits of frequency and intensity for high fidelity. It is well known that within these limits the system must have a sufficiently uniform response with different frequencies so that the ear will not detect it from one having a perfectly uniform response. Due no doubt to the fact that persons usually listen in rooms which have resonances, it is difficult to detect departures of 3 or 4 decibels from uniformity —in fact, it is very difficult to measure them. Here again it would be helpful if we had some precise measurements on this point. Also, it is well known that the system must be linear with intensity, that is, the acoustic output must be proportional to the acoustic input. Also there must be no asymmetry in the vibration during transmission. Any departures from these ideals must not be larger than can be detected by the average ear.

Facsimile Requirements

When all of these requirements are met, a facsimile of the original source cannot be produced unless another factor is considered which is sometimes overlooked, namely, the spatial or auditory perspective character of the sound. If we are reproducing a moving sound source it must appear to move, and if the sound source is broad it must appear that way when reproduced. In nearly all systems now used this factor is neglected. It can be preserved in two ways, namely, by a binaural system or by a stereophonic system. In the former, two channels only are required while in the latter, theoretically an infinite number is required but practically three give a good illusion.

In the binaural system two microphones are placed in the ears of a dummy who sits in the position where the listener would like to sit if he were listening to the original sound. Two transmission lines meeting the requirements above connect these microphones to two head receivers respectively, one being placed on each ear of the observer. With such a system a complete facsimile of the original sound at the dummy is reproduced to the listener. The Oscar system presented at the World's Fair in Chicago by the Bell System was one meeting the stringent requirements outlined above.

In the stereophonic system an attempt is made to produce this spatial effect by using loudspeakers instead of head receivers in the reproduction. Suppose there were interposed between the source of sound and the audience which would normally listen to it, a sound-transparent curtain. A large number of microphones are mounted all over this curtain. An ideal line connects each microphone to a recording unit of a recording system, or to a loudspeaker if a simple transmission system is used. The loudspeakers are spaced over a similar curtain when the sound is reproduced. If the microphones and loudspeakers are close together a curtain of sound will be reproduced similar in all respects to the original sound. Again three such channels for most stages will give a sufficiently close approximation that, due to the limitations of hearing most observers cannot detect the reproduced from the original when all the other requirements discussed above are met. Indeed two channels go a long way toward this ideal. However, if the sounds were not confined essentially to the level of the stage but were permitted to go up and down as far as they went right and left, then nine channels instead of three would be required. Or if we wished the sounds to appear to come from all directions around the listeners, then channels sufficient to cover a sphere surrounding them would be necessary.

The question then arises, how much loss in quality of the reproduced sound is experienced as we depart from such an ideal? To answer this question we must know the kind of material that is used in the transmission. Without such an ideal transmission system, there is always placed some limitation on the type of material used. In general, this material may be classified as either music, speech, or noise.

TO BE CONTINUED

there must be no asymmetry in the vibration during transmission. Any depar-

confined essentially to the level of the stage but were permitted to go up and

ABOUT MUSIC

The Bells Are Ringing

HAROLD LAWRENCE*

AT EIGHT O'CLOCK on a bright sunny morning in May, while fast-moving clouds driven by a brisk wind chopped the waters of the Hudson, a maroon-colored truck[1] parked outside the Riverside Church. Trunks of equipment were promptly unloaded from within the deceptively small confines of the truck. Inside the trunks were several sets of cables, each long enough to reach from the ground to the belfry (some 400 feet), a number of Telefunken microphones and their power supplies, quantities of rope, and some intercommunication apparatus.

The cables were unwound and laid neatly along the entire length of 122nd-123rd Street and Riverside Drive in New York City. At the top of the tower, rope was lowered to the sidewalk, the cable-ends attached to the rope, and the cables hauled up to the belfry, past gargoyles and the profusely decorated exterior of the church. Members of the crew were stationed on various floors of the church to help pull up the cables and prevent them from getting entangled in any of the abutments. Finally, close to four hours after the truck's arrival, all the connections were plugged in, the microphones hung, power supplies and tape recorders switched on—and a rather unusual recording session was in progress.

Magnetic tape recorders have found their way undersea to pick up the speech of fish, and atop mountains for the sound of thunder and lightning. Sooner or later, someone was bound to send an expeditionary force up the walls of the Riverside Church to record the impressive Riverside Carillon. The idea behind this project was hatched when Mercury Records, whose monaural recording of Tchaikovsky's *Overture 1812* (complete with muzzle-loaded brass cannon and bells) is an almost legendary LP best seller, decided to re-record the work in stereophonic sound. The bells used in the disc version were those of Yale University's Harkness Memorial Tower. For the stereo release, however, louder and deeper bells were in order. After scouting around for months, the nod was given to the Riverside Carillon.

A glance at the dimensions of this gigantic instrument will suffice to explain the reason for Mercury's choice. The Riverside Carillon contains the heaviest and largest tuned bell in the world, a Bourdon weighing 40,926 pounds and measuring 122½ inches in diameter and about the same in height. The bell may be struck by three clappers whose combined weight is three tons. Of the 73 other bells, five of the bass bells are "swingers." But power is only one of many admirable aspects of the Riverside Carillon.

Even to the musically uninitiated, the sound of most carillons is oddly discordant. This condition is caused by improper tuning. Like other vibrating bodies, the bell produces several notes simultaneously. Unlike other instruments, three of the bell's notes are heard with exceptional clarity. They are the *fundamental*, or strike note; the *nominal*, an octave above the fundamental; and the *hum note*, an octave below the fundamental. In relation to the nominal, the fundamental tends to be flatter, and the hum note sharper. There are two principal methods of tuning the bell; one focuses on the fundamental, the other on the nominal. The first is satisfactory only when bells are struck at long intervals, allowing the fuller and more prominent notes of the fundamental to resonate. In carillons, where the nominal or "melody" notes are featured, this results in sour peals. If the carillon is to produce sweet sounds, it is essential that the fundamentals be tuned to the nominals.

After the Riverside Carillon was first installed in 1931, it was soon apparent that, although each bell was individually tuned perfectly, the scale was not properly tempered. In 1955, fifty-six bells in the carillon were sent to a bell foundry in Holland to be recast and retuned. During their absence, New York's West Side heard private recordings made of the Riverside Carillon as reproduced by a huge loudspeaker system located on the eleventh floor. When the bells were returned to their home on the Hudson, the tones they produced were superbly pure.

The recording session was scheduled for Saturday morning. In case of rain, the date was to be changed to the following day. Wind was also a factor; the mere suggestion of a breeze on the street became a howling blizzard up in the tower. Fortunately the weather was perfect and, shortly before noon, the distinguished carillonist of the Riverside Carillon, Dr. Kamiel Lefévere, assumed his place at the carillon console.

It had been decided to first record an album of Christmas music prior to unleashing the storm of bells for the *Overture 1812*. Consequently Dr. Lefévere performed a recital of Yuletide carols. For some 40 minutes, it was December in May for the doubtless bewildered residents of Riverside Drive. Following this unseasonal

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

[1] The mobile recording plant belonging to C. Robert Fine, who is responsible for all of Mercury's classical recording. ED.

Fig. 1

apéritif, this writer was invited to assist in creating as much din as was possible for the *Overture 1812* bell effect. Dr. Lefévere cordially made room for me on his bench. While he concerned himself with the majority of the bells, my job was to pound away at a small number of high bells. It was at this point that I learned to fully appreciate the reason for the leather bandages which the carillonist wraps around his fingers, as seen vaguely in *Fig.* 1.

Confronting the carillon player is a keyboard comprising two rows of tough-looking, rounded oak keys, ¾" in diameter. The keys are connected to wires which can be seen over the head of the carillonist in *Fig.* 2 which activate the clapper mechanism. The player must adjust the tension of his stroke for each bell since a larger bell requires more force than a small bell. Hand strokes are not employed for the colossal six lowest bells of the Riverside Carillon. The upper row of keys corresponds to the black keys of the piano, the lower to the white notes, and the pedals to their organ counterpart. The keys are struck vigorously with the side of the hand, hence the finger coverings. After a brief period of striking repeatedly a number of high bell keys, my tender, bare fingers were as bruised as a gloveless palm after an energetic handball match.

Carillon playing may be the most strenuous musical art, but the carillonist has two compensations (among many others) for the unusual physical demands of his profession: (1), he produces a bigger sound than any other instrumentalist, and (2), every time he strikes a key, hundreds hear him. Æ

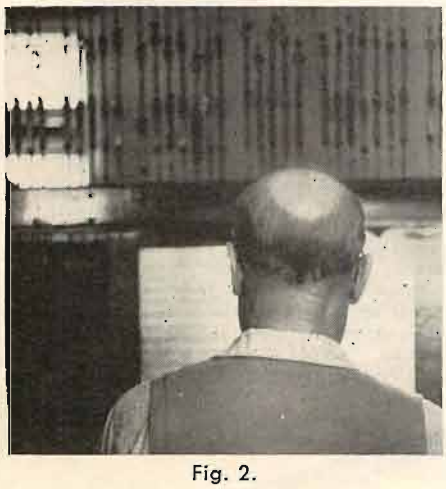


Fig. 2.

than any other instrumentalist, and (2), every time he strikes a key, hundreds hear

To feel the gigantic realism of stereo, you must hear it on the fin-

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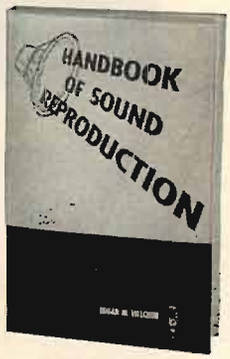

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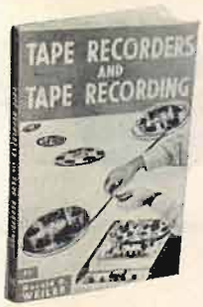

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NEW! *How-to Book on Hi-Fi Repair*
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Latest information on hi-fi components for efficient repair and maintenance. Complete, down-to-earth information that is not punctuated with complicated mathematics. Helpful to the hi-fi enthusiast, technician or engineer, this first volume includes many important features: Example schematics with tube layouts, descriptive illustrations and hook up diagrams, buyers' guide. *156 pages profusely illustrated. $2.50 Postpaid.*

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TRANSISTOR BETA TESTER

(*from page 22*)

the values of β_{min} and $100+\beta_{min}$ coincide with the meter indications.

It should be emphasized that the meter should be calibrated first to make sure an accurate calibration is obtained for the β tester.

When R_6 and R_2 are adjusted to give the proper values of β at both ends of the scale, all other points in between are automatically calibrated to an accuracy equal to the linearity of the potentiometer used. The points can be checked as a matter of routine, and will be found to coincide exactly with the dial readings. Readings with switch S_3 in the "X2" position will be exactly one-half those taken with S_3 in the "X" position.

Single-turn Potentiometer

If a more common type, single-turn, wire-wound linear potentiometer is used with a dial marked from "0" to "100," the method of calibration is the same, with the following exception. Since the β_{min} reading should be "5.0", and the dial reads "0", and the β_{max} reading should be "105", and the dial reads "100", the user should always make a note to *add* the quantity "5.0" to every reading he makes with the instrument. Thus, a reading of $\beta = 42.0$ on the dial, really indicates a true β value of 47.0 and so on. This constant offset between true β and dial reading does not diminish the usefulness of the instrument and enables the builder to save the cost of a more expensive potentiometer. A dial can be especially made to suit the requirements, or *Fig.* 4 can be cut out and glued to the cabinet to serve as the dial, preferably under a thin piece of transparent plastic for protection.

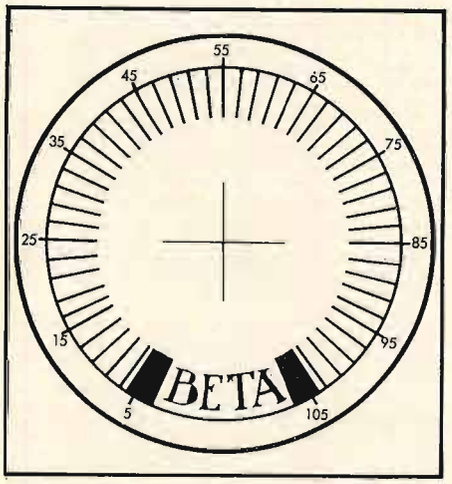

Fig. 4. Dial scale may be cut out and used with the single-turn potentiometer.

Construction

All the components can be placed inside a $3'' \times 4'' \times 5''$ aluminum box. The placement of the parts can be seen from the photographs. All resistors and capacitors can be mounted on a small terminal board, and wires run to the battery, switches, and potentiometers as required. An "L" or "U" shaped bracket is used to secure the battery, or it can be mounted on the bottom cover plate.

Three type X-2146 spring loaded diode clips (manufactured by Cambridge Thermonic Corp.) are used to clip the transistor leads during the measurement other types may be found equally suitable.

COMING EVENTS

August 6–8—Special Technical Conference on Non-linear Magnetic Amplifiers; Hotel Statler, Los Angeles. Sponsored by IRE-PGIE and AIEE.

Aug. 13–15—Electronic Standards and Measurements Conference; Boulder Labs, Bureau of Standards, Boulder, Colo. Sponsored by IRE-PGI, AIEE, NBS.

Aug. 19–22 — WESCON — Western Electronic Show and Convention; Ambassador Hotel and Pan Pacific Auditorium, Los Angeles. Sponsored by IRE sections in LA and SF, and WCEMA.

October 2–3—Engineering Writing and Speech Symposium; New York. Sponsored by IRE-PGEWS.

Hi-Fi Shows

September 19–21—Chicago, Ill.; Palmer House Hotel. (*International Sight & Sound Exposition, Inc.*)

Sept. 30–Oct. 4—New York High Fidelity Show, New York Trade Show Building, New York. (*Institute of High Fidelity Manufacturers*).

Oct. 10–12 — Philadelphia; Benjamin Franklin Hotel. (*Institute of High Fidelity Manufacturers.*)

Oct. 17–19—Boston High Fidelity Show; Hotel Touraine, Boston. (*Independent*).

Oct. 24–26—Milwaukee; Wisconsin; Hotel. (*Institute of High Fidelity Manufacturers.*)

COMING EVENTS

NEW LITERATURE

• **Cinema Engineering,** 1100 Chestnut St., Burbank, Calif. displays its entire line of precision wire-wound resistors in a new 20-page Catalog 14RC. With the issuance of the publication a number of resistor series have been renumbered for conformance with a new specification pattern. Resistance values from 0.1 ohm to 20 megohms are available in accuracies from 0.025 to 1.0 per cent. Nearly a hundred types of precision wire-wound resistors are covered in complete detail. Requests for copies should be directed to the attention of James L. Fouch at the address shown above. **G-16**

• **Panalarm Division of Panellit, Inc.,** 7401 N. Hamlin Ave., Skokie, Ill., producers of annunciators and other industrial information systems, is now issuing a four-page folder describing a new type of ultra-reliable annunciator. Contained in the folder is information on a new static-magnetic annunciator recently developed for monitoring complex automatic-machine and continuous-process operations. The unit uses static-magnetic controls in place of conventional relays. There are no moving parts, resulting in a high degree of reliability and reduced maintenance. Requests should specify Bulletin No. 101. **G-17**

• **Specialty Electronic Components Dept., General Electric Company,** Auburn, N. Y., has available a handsome four-page folder which illustrates and describes the G-E 20-watt high-fidelity amplifier Model PA-20, the "Transi-Tube" preamplifier Model A1-203, and the dual-function preamplifier Model UFX-003B. Equipped with one n-p-n junction transistor and one 12AX7 double-triode, the A1-203 is virtually free of hum and microphonics while providing high nominal output voltage. The UPX-003B is a self-powered high-fidelity conversion preamplifier for either phonograph or microphone use. Requests for copies of Bulletin EP-237 should be addressed to G-E Hi-Fi, Box 101 Liverpool, N. Y. **G-13**

• **GFW Service, Inc.,** 1220 Broadway, New York 1, N. Y. suppliers of custom grille fabrics for high fidelity, has available for dealers a new illustrated folder which explains the company's service and its unique approach to grille fabric selling. The folder explains that the GFW Service offers customized grille fabrics, sold from sample books, and delivered to the ultimate customer cut-to-size. The Service functions without inventory or investment by subscribers. Copy will be mailed to hi-fi dealers on request. **G-14**

• **Amplifier Corporation of America,** 398 Broadway, New York 13, N. Y., describes the complete line of Magneloop continuous-loop magnetic-tape recorders-reproducers in a newly-issued four-page folder. The brochure completely delineates features of 21 basic models, which are available in single or dual speeds, as well as in single-, dual- and triple-channel models. Mechanical and electrical features are fully explained. Complete technical specifications, recommended accessories, as well as direct factory prices are furnished on all units. The brochure will be mailed free of charge upon written request. **G-18**

• **Carter Motor Company,** 2748-A W. George St., Chicago 18, Ill., has just released a new 28-page dynamotor catalog which lists the entire line of Carter rotary power supplies. Publication of the catalog, originally scheduled for last Fall, was held up when it was decided to make major changes in 1958 models. The catalog lists the new Carter fan-cooled Genemotor for the first time, as well as several new models comprising the Genemotor line, which has been materially improved in appearance, performance and service accessibility. A copy of Catalog No. 158 may be obtained free upon written request. **E-16**

CLASSIFIED

Rates: 10¢ per word per insertion for noncommercial advertisements; 25¢ per word for commercial advertisements. Rates are net, and no discounts will be allowed. Copy must be accompanied by remittance in full, and must reach the New York office by the first of the month preceding the date of issue.

THE AUDIO EXCHANGE has the largest selection of new and fully guaranteed used equipment. Catalog of used equipment on request. Audio Exchange, Dept. AE, 159-19 Hillside Ave., Jamaica 32, N. Y. AXtel 7-7577; 367 Mamaroneck Ave., White Plains, N. Y., WH 8-3380; 836 Flatbush Ave., Brooklyn, N. Y., BUckminster 2-5300.

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ENJOY PLEASANT SURPRISES? Then write us before you purchase any hi-fi. You'll be glad you did. Unusual savings. Key Electronics, 120 Liberty St., New York 6, N. Y. EVergreen 4-6071.

TRADE for new-used AMPEX's Grove Enterprises, Roslyn, Pa. TUrner 7-4277.

FOR SALE: 1-year-old National Criterion AM-FM stereo tuner, Horizon 5 preamp, Dynakit 4-8-16-ohm, 50-watt amplifier; all for $205 postpaid (cost $315). Keuneth R. Williams, 407 W. Gorham St., Madison 3, Wis.

WANTED: Cook 5B or 5C head or entire system; FOR SALE: Rek-O-Kut M-12 lathe and T-12 turntable. Foran, 3452 N. Hackett, Milwaukee 11, Wisconsin.

SPEAKER CABINETS
Manufacturer's over-run, brand name enclosures, genuine mahogany, completely finished, with or without speakers. 50% off audiophile list. Write for details. Custom Craft, P. O. Box 304, Jasper, Indiana.

AMPEX 350 console, $850, also include portable cases. Excellent condition, has had little use. R. J. Entringer, 2211 Camino Del Reposo, La Jolla, California.

TAPE RENTALS! Wide selection of stereo and monaural pre-recorded tapes available at lowest rentals, no membership fees. For full details and free price list, write NATIONAL RENT-A-TAPE, Dept. A, P. O. Box I, Winnetka, Ill.

TAPE AND DISC DUPLICATING
Write for prices and available services. MERLE ENTERPRISES, Box 145, Lombard, Ill.

WRITE for confidential money saving prices on your HI-Fidelity amplifiers, tuners, tape recorders. Individual quotations only; no catalogs. Classified Camera, Dept. A, 2057 Coney Island Ave., Brooklyn, N. Y.

WANTED: Presto RC-10-14 or PB-10-14 Tape Mechanisms, Altec 603B Loudspeakers. State price and serial number or if interested in trade for other professional or hi-fi equipment. MASQUE, 331 W. 51st St., New York 19, N. Y.

HI-FI-HAVEN—New Jersey's leading sound center. Write for information on unique mail order plan that offers professional advice and low prices. "Awarded Institute of High Fidelity Manufacturers' Plaque as registered component dealer." 28 Easton Ave., New Brunswick, N. J.

WANTED: Western Electric 755A loudspeaker. FOR SALE: Antique Victor Talking Machine Electrola. Robert Langevin, 2613 Elmdale Place, Palo Alto, California.

FOR SALE: AMPEX 620 speaker, $125. Ampex case for 350 tape transport, $50. Seven 10½" plexiglass, 14 aluminum empty reels, $1 each. Fentone 350A cartridge, $10. Altec N-3000B crossover, $15. Shipped prepaid and insured. M. E. Boyd, 903 Salmon Drive, Dallas, Texas.

NEW low-distortion PRE-preamp. Transistorized for use with low-level cartridges, $8. See May AUDIO for specs or write. Vic Pitre, 3216 Barker Ave., Bronx, N. Y.

ONLY SONORAMIC OFFERS HIGH QUALITY TAPE IN A PERMANENT PLASTIC CASE!
SONORAMIC

the complete line of Magneloop continuous-loop magnetic-tape recorders-reproducers in a newly-issued four-page folder.

Coney Island Ave., Brooklyn, N. Y.

WANTED: Presto RC-10-14 or PB-10-14

PROFESSIONAL DIRECTORY

EMPLOYMENT

HEATH COMPANY's expanding Audio program calls for several experienced audio engineers. Requirements are a minimum of five years' design experience with power amplifiers, preamplifiers, AM and FM tuners, and electromechanical devices related to audio. Equal experience in all of these fields is not required, but some acquaintance with the total field is necessary. Write HEATH COMPANY, Box 698, Benton Harbor, Michigan.

A TEXTILE MILL operating weaving mills in Paterson, New Jersey, and Chicago Heights, Illinois, needs sales representatives for complete line of woven radio and television grille cloth. Liberal straight commision basis. Box CG-1, AUDIO, P. O. Box 629, Mineola, N. Y.

Industry Notes . . .

U. S. Department of Commerce has issued a report which lists High Fidelity as one of four industries which are "recession proof". . . Bearing out the D. of C. bulletin, **British Industries Corporation** reports sales and earnings for the first quarter of 1958 as highest in the company's history—29 per cent greater than a year ago . . . Stereo, both tape and disc, dominated the annual **EIA** electronics parts show in Chicago. Equipment manufacturers are almost unaminous in their belief that availability of records will bring the market for amplifiers, cartridges, speakers, etc., to boom proportions. Major record companies have announced plans to release stereo discs by the hundreds come July and August. So there.

Speaking of stereo, the August issue of AUDIO will be the most complete compilation of stereo information ever assembled between two covers. An all-stereo issue, it will cover the subject from all aspects. Of particular, if not revolutionary, interest will be an article by Benjamin B. Bauer, vice-president of **CBS Laboratories,** which will describe a means of achieving stereo reproduction from a single, fairly conventional, amplifier.

Livingston Audio Products Corporation has been named national distributor for **Counterpoint** stereo tapes . . . **Allied Radio Corporation,** Chicago, will begin mailing its general catalog No. 180 to customers in September . . . **Ampex Audio** has begun shipment of a conversion kit for converting Ampex home music systems to 4-track stereo operation. The assembly enables the music lover to play either the new 4-track tapes or regular 2-track tapes at the simple flick of a lever. . . . Speakers at the first annual distribution congress sponsored by the **Magnetic Recording Industry Association** included: Nat Welch, ORRadio Industries, Inc.; Ed Altshuler, MIRA; Phil Gundy and C. D. DuBois, Ampex Audio; Irving Rossman, Pentron Corporation; Quinn Pritchard, Pritchard & Mann; Martin Solow and Adrian Price, Wexton Company, Inc., and Tom Dempsey, Reeves Soundcraft Corporation.

Preliminary negotiations have been completed for the purchase of **Westrex Corporation,** a wholly-owned subsidiary of **Western Electric Company,** by **Litton Industries, Inc.** . . . **General Cement Manufacturing Company,** a division of **Textron, Inc.,** has purchased the **American Microphone Division** of **Elgin National Watch Company** . . . **Electro-Acoustic Engineers and Consultants,** 82/83 New Bond St., London W.1. has been appointed sole United Kingdom distributors for **Altec Lansing Corporation** and **Stancil Hoffman Corporation.**

AN EYE FOR VALUE?
Write us your hi-fi needs now

Amplifiers, pre-amplifiers, tuners, speakers, housings, cabinets

ADVERTISING INDEX

NECESSITY...is the mother of this invention

Just 300 years ago, in 1658, Richard Frank penned in his memoirs . . . "Art imitates nature—and necessity is the mother of invention." Today, in 1958, this parable has become a reality, for art has truly imitated nature with the development of the remarkable stereophonic phonograph record . . . and Pickering & Company has, of *necessity* invented the "Gyropoise 800" *airborne* Stereotable, *specifically* for the stereo record.

The Gyropoise 800—the first really *new idea* in quality phonograph turntables since Berliner modified Edison's "talking machine" at the turn of the century—obviates the most serious problem encountered in playing the stereo record, *vertical rumble!*

Vertical rumble, once regarded by engineers as a major handicap in stereo reproduction, is no longer a problem with the "Gyropoise 800" Stereotable. Only the Gyropoise revolves with precise accuracy in *magnetic suspension*, on a bearing-of-air —void of stiff mechanical linkage inherent in conventional turntables.

Designed specifically for microgroove records . . . monophonic and stereophonic . . . the "Gyropoise 800" Stereotable is single speed at 33⅓ rpm and employs a built-in precision leveling adjustment with indicator. Foam rubber turntable mat obviates any possibility of marring the delicate record surface.

The Gyropoise is an exclusive invention of Pickering & Company, Inc. Patents are pending, and all rights are reserved.

ALL UNITS AVAILABLE SEPARATELY

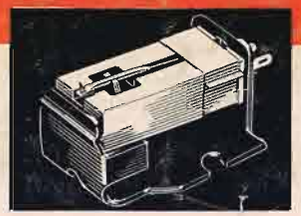
Model 800-C Gyropoise Turnable, chassis only.....$59.85
Model 196-.7D, UNIPOISE Arm with Integrated Stereo FLUXVALVE cartridge..... 59.85
Model 800-TB, Tray base in Mahogany, Walnut or Blond..... 7.50
Model 800-CB, Complete base in Mahogany, Walnut or Blond..... 12.00

"For those who can hear the difference" **FINE QUALITY HIGH FIDELITY PRODUCTS BY**

PICKERING & COMPANY, INC., Plainview, N. Y.

Visit your Pickering dealer today for a demonstration . . . you will be amazed at the smooth, precise performance of the "Gyropoise 800". . . while you're there, ask for your free copy of "It Takes Two To Stereo" by Walter O. Stanton.

STEREO'S STANDARD



stereo's standard! the Electro-Voice totally compatible stereo cartridge

Model 505 Stereo Control with dual-channel magnetic adapter
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Model 504 single magnetic Adapter only .....Price $3.60 Net
Model 21D Stereo Cartridge with Diamond Stylus ...Price $19.50 Net
Model 21S Stereo Cartridge with Sapphire Stylus ....Price $9.90 Net
Model 26DST Stereo Turnover to 78 Monaural, Diamond and Sapphire
Price $22.50 Net
Model 26ST Stereo Turnover to 78 Monaural, Two Sapphires
Price $12.90 Net

Good stereo depends on these vital features: Range Response: 20-16,000 cps ± 2½ db to RIAA; Distortion: Less than 2%; Channel Isolation: 20 db; Vertical Rumble Rejection: 15 db with 5 meg input; Elements: dual ceramic, (lead-zirconium titanate); Weight: 21D 2.4 grams, 26DST 2.6 grams; Tracking Force: 6 grams; Stylus: 21D—standard .7 mil diamond; 26DST—standard .7 mil diamond—standard 3 mil sapphire; Vertical Compliance: 2 x 10^{-6} cm/dyne; Lateral Compliance: 2 x 10^{-6} cm/dyne; Output: .5 Volt RMS from Westrex standard RIAA Test Record; Capacity: 500 mmfd per element for stereo; 1000 mmfd paralleled for monaural; Mounting: EIA (RETMA) standard ½" and 7/16" centers; Recommended Amplifier Input Impedance: 5 megohms or higher.

Thousands being installed as original equipment attest to industry acceptance; thousands in use prove its unquestioned superiority for monaural as well as stereo. The E-V Stereo Cartridge uses a .7 mil replaceable stylus and dual high fidelity ceramic elements so essential to the exacting demands of stereo reproduction. Pickup from stray magnetic fields is non-existent, hum and rumble are *far* below the level of even the most expensive magnetic cartridges, and PZT ceramic elements deliver a precise RIAA curve. The E-V Stereo Cartridges exclusive Rumble Suppressor (pat. pend.) virtually eliminates vertical turntable rumble without degrading full frequency response range of the cartridge . . . allows you to use it with *any* turntable or record changer. Totally Compatible . . . for stereo, it's superb; for monaural . . . it's superior to even your present cartridge.

THE FIRST STEP TO STEREO. Many fine monaural cartridges are too "stiff" to play stereo records without seriously damaging them; therefore, if you replace your present cartridge with the new E-V Compatible Stereo Cartridge, you may continue playing your present library of LP's plus all the new stereo records monaurally.

THE SECOND STEP TO STEREO. Connect the E-V Stereo Cartridge leads to the 505 Stereo Control Center (net $11.50). You can then select from "monaural," "stereo," or "channel reverse" for easy balancing. The 505 also converts your magnetic input to high impedance ceramic input, if required. Run one lead to your present high fidelity system, run the second channel lead to a second amplifier (and speaker). NOTE: The E-V Stereo Cartridge is corrected for RIAA curve, doesn't need the equalization of a second preamplifier.

If you do not plan to purchase a second amplifier and speaker now, you can still get stereo by running the second channel lead through the 505 to your radio or TV set phono input. You can improve your system later by simply adding a second amplifier and speaker. Stereo records are available now. Why wait? Enjoy the vivid reality of stereophonic sound today. Whether you're purchasing your first system or converting now, use the Electro-Voice Compatible Stereo Cartridge. See your high fidelity dealer, or write Electro-Voice for free booklet on choosing stereo equipment, and a special Stereo Demonstration Record ($1.50 prepaid).

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BUCHANAN, MICHIGAN

FOREMOST IN ELECTRO-ACOUSTICS—High Fidelity Loudspeakers and Enclosures for STEREO, Phono-Cartridges, Microphones and Public Address Speakers, Marine Instruments, EVI Professional Electronic Instruments and Military Materiel

ADD-ON STEREON—THE UNIQUE ELECTRO-VOICE CONCEPT THAT ELIMINATES THE NEED FOR A SECOND FULL-RANGE SPEAKER.

± 2½ db to RIAA; Distortion: Less than 2%; Channel Isolation: 20 db; converts your magnetic input to high impedance ceramic input, if required. Run one lead to your present high fidelity