AUDIO

MAY, 1963
50¢

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Coming NEXT Month

Construction--

How to build a full-range electrostatic loudspeaker system suitable for home use. Many readers have asked for this one—and here it is.

Transistor Amplifiers

George Fletcher Cooper describes a transistor output amplifier system which depends on pulsed energy rather than the conventional audio frequency amplification now used.

Musical Instruments

Norman C. Pickering tells what can be done to make an electronic organ more musical and more representative of pipe organ sound than is usual.

And

Equipment Profiles--

Shure M/99 series of Gard-a-matic cartridge assemblies

The new ADC-18 loudspeakers

The Heath AA-21 Transistorized Amplifier

The Weathers MT-66 Universal Arm

In the June Issue —

On the newsstands or in your own mailbox

AUDIO CLINIC

Joseph Giovanelli

Send questions to:
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Brooklyn 3, N. Y.
Include stamped, self-addressed envelope.

Integrated Versus Separate Units

Q. What type of amplifier would you recommend for a top-quality stereo setup? Would it be integrated or separate units? What advantage does each type have? F. Copple, East Lansing, Mich.

A. I would say that the major advantage of the separate amplifier and preamplifier arrangement over the integrated system is that if you wish to change either of these components, you may do so without sacrificing the one which you do not wish to change.

The integrated unit has the advantage of compactness over music systems composed of separate amplifiers and preamplifiers.

Compactness, however, may result in a large amount of heat buildup. Ventilation, therefore, becomes more important.

Another advantage of the integrated system is that all wires lead to one place. Women can certainly appreciate the consequent reduction in the size and complexity of the spider web which accompanies most home music systems.

Separate units have the advantage that the amplifier, large as it often is, may be stored in some out-of-the way place. This is reasonable because the controls on the amplifier seldom need to be adjusted.

The larger amplifiers have a further advantage in that they are capable of better heat transfer to the atmosphere.

It is obvious, therefore, that no definite answer to the question of the superiority of one system over the other can be given. Your choice will depend upon the requirements of your home and upon your own predilections.

Influences on FM Reception

Q. Would aluminum siding on a house have any effect on FM or multiplex reception? Oscar Dreskin, Laurelton, N. Y.

A. The effects of the material making up the house is a factor in the performance of radio equipment only when the antenna used with such equipment is contained within the walls of the house.

If your antenna is on the roof—perhaps 10 or 12 feet above the rooftop, and well clear of surrounding objects—there should be no degradation of performance as a result of the siding material grounding out the signal.

When the antenna is located indoors, however, the grounded siding of the house will act as an electrostatic and electromagnetic shield, thus preventing radio signals from entering the house with the same strength they would have if the house was made of a nonconductive material.

Even under the last condition, if the tuner is a good one and if the reception in your locality is good, there is likely to be sufficient signal entering the house to cause good limiting on local stations.

Connecting Headphones to Preamplifiers

Q. Without going into the pros and cons of the question, I happen to be one of those persons who enjoys stereo program material through stereo headphones but finds stereo through speaker systems uninviting. In fact, I find single-speaker reproduction of stereo material preferable to stereo speaker reproduction. I say this even after hearing elaborate stereo speaker installations.

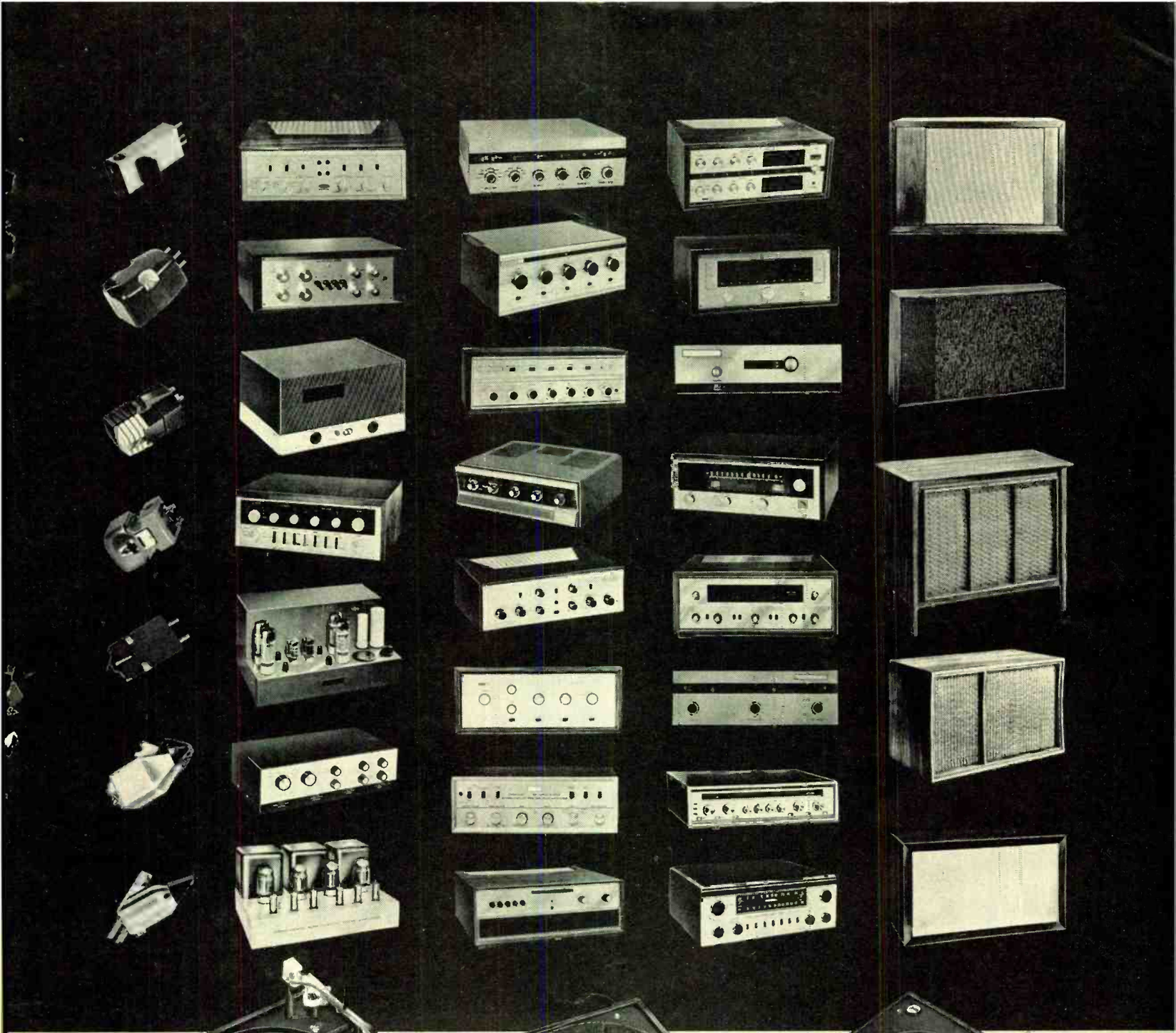
I do my monophonic speaker listening by way of a preamplifier feeding a 55-watt power amplifier driving my loudspeaker. My favorite stereo headphones have an impedance of 8 ohms. To use them I have to add an old ten-watt amplifier to drive the second channel with the result that there is definite degradation of that channel. To correct this, I could add another 55-watt amplifier, but, because I have no ambition to own a stereo speaker system, it seems a waste of money and power to put out 110 watts for a pair of headphones.

The stereo preamplifier has an output of 2.5 volts to be fed into a load of at least 200k ohms. My question is this: Is there any simple method of impedance conversion so that my 8-ohm headphones could be driven by the preamplifier without using high-power amplifiers? James A. Cutter, M. D., Oklahoma City, Oklahoma.

A. To accomplish this, use a 12AU7 and connect one triode section to each channel. Feed the grids from the two preamplifier outputs, and connect an output transformer in the plate circuit of each triode section. Output transformers having primary-to-secondary impedances of 14,000 to 8 ohms should be satisfactory. Connect the phones to the 8-ohm secondaries. Since each of these stages is single ended, you do not need push-pull transformers. Universal output transformers such as Stancor A-3856 are suitable for this application when connected according to directions for impedances of 14,000 and 8 ohms.

Power for this 12AU7 can probably be derived from your stereo preamplifier.

I receive countless questions about headphones and their connections to various circuits. I have printed a few in this and some recent columns. I trust that this information will help those who have found this subject of interest.



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world's finest

What has earned this unique acceptance? Is it features, creative engineering, quality control, Garrard's 50 years of experience? All are important. But actually none of these is as significant as the enduring satisfaction...the special pride and pleasure...which Garrard owners enjoy. That is why more dealers recommend Garrard, and more people are buying these incomparable Garrard units—than any other high-fidelity record-playing component!

For Comparator Guide, write Department GD -1 3, Garrard Sales Corporation, Port Washington, New York.

Canadian inquiries to Chas. W. Pointon Ltd., 66 Racine Road, Rexdale, Ontario. Territories other than U. S. A. and Canada to Garrard Engineering and Mfg. Co., Ltd., Swindon, Wilts., England

Biasing an Output Stage

Q. If the bias control of my amplifier is adjusted so that the grid voltage reading of both EL34's is more-or-less minus 38 volts (a fixed bias is employed) the voltage reading at pin 8 of the output tubes is about 0.3 volt, with the plate and screen voltage of 480v d.c. (In this circuit arrangement, the cathode is not directly grounded, but rather goes through a metering resistor. This accounts for the voltage developed at pin 8.) If I readjust the bias control to obtain an indication of 0.65 volts at pin 8—which means that the cathode current of 65 mA per tube—the grid bias (measured again between pin 5 and ground) comes down dangerously low to about minus 27 volts. In one instance, maintaining the latter state for 15 minutes resulted in "blowing up" of the 0.25 ampere fuse inserted in series with the centertap of tne output transformer primary.

I have checked and rechecked everything in the circuit. I followed the original circuit faithfully. I tried using three different pairs of EL34's. The result was the same each time. Components were checked by a meter having a sensitivity of 20,000-ohms-per-volt d.c., 1000 ohms-per-volt a.c. Edilberto P. Bustillo, Ormoc City, Philippines.

A. I believe that you will find that your bias problem is one of improper measurement. Let's consider this for a moment. Your meter has a sensitivity of 20,000-ohms-per-volt and you are reading minus 38 volts. The meter's sensitivity on the 50-volt range is only 500,000 ohms. Rather than call this "sensitivity" we will now call it input resistance. You are placing this input resistance across the grid resistor when measuring the bias. The value of the grid resistor is, in all likelihood, very nearly that of the input resistor of your meter. The bias voltage is developed across the bias resistor. When the meter is connected to this resistor, however, the actual resistance between grid and ground is smaller than required in the circuit you have followed. Hence, the voltage developed between grid and ground is smaller than it should be.

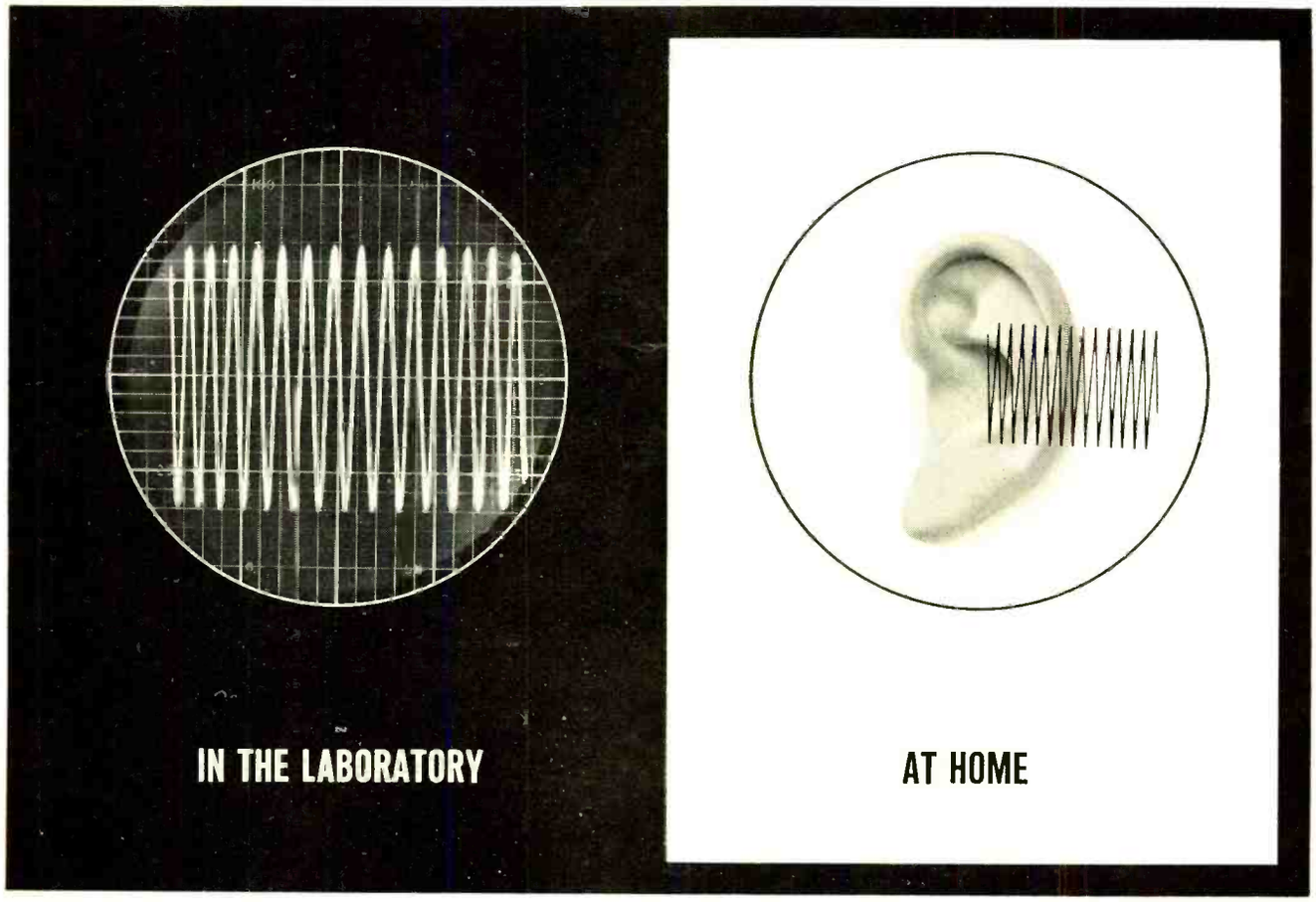
To make this kind of measurement correctly you need a d.c. VTVM with an input sensitivity of the order of 11 megohms. Most other circuit measurements can be made with the meter you are now using.

The problem probably does not end here. Remember that when your bias was low—27 volts as opposed to 38—the measurement of the current drawn by the output stage was correct. Nevertheless, a fuse capable of handling more than twice this amount of current, opened. It is, of course, possible that this fuse was defective, thereby leading to premature burnout. However, it is also likely that one of two factors could have played a part in blowing that fuse.

If the resistor between the two cathodes and ground decreased in value more current would have to flow to produce a particular voltage drop across this resistor than would have been required if the resistor had not changed in value. Measure the value of this resistor with an ohmmeter of known accuracy.

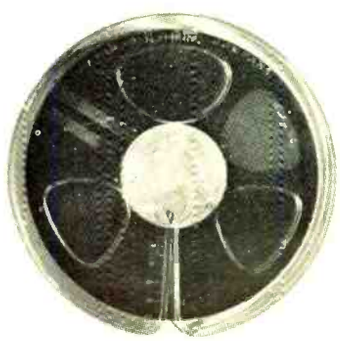
It is possible that the meter you are using is poorly calibrated, presenting you with erroneous readings. Check the calibration of this instrument as recommended by its manufacturer. Æ

TWO WAYS TO MEASURE THE RESPONSE OF KODAK SOUND RECORDING TAPE



In the lab you can see the playback of a constant signal recorded on KODAK Sound Recording Tape appearing as a beautifully symmetrical pattern on an oscilloscope—visual proof of the distortion-free, uniform output of KODAK Tape.

When you listen at home, your ear tells you the same story—distortion-free sound. The oxide layer of magnetic tape is formulated and applied with the same degree of precision as a KODAK Film emulsion. Every roll of KODAK Tape reproduces exactly what it hears.



And there's a convenience bonus! The KODAK Thread-Easy Reel loads fast. Just pull the tape through a slot. There's also a handy indexing scale and a tape splicer on each reel side.

Enjoy the faithful response of KODAK Sound Recording Tape soon. It's on sale at your Kodak dealer's.

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TRADEMARK

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LETTERS

Takes Issue with Meyers and Kahn

SIR:

As an engineer and a long time hi-fi nut, I must take exception to some of the statements of Meyers and Kahn in the January issue of Audio.

1. "Music is full of instantaneous pulses and transients. The transistor can capture this while a vacuum tube with its slower action cannot." False. A vacuum tube is inherently a faster device than a transistor. Most vacuum tube amplifiers are limited in their speed by the output transformer and not the tubes. It is possible, although expensive, to build a vacuum tube amplifier whose response can extend from d.c. to several megacycles. There are no frequency-response curves given for the amplifier presented, but I would be very surprised if several vacuum tube amplifiers previously discussed in AUDIO did not have equivalent, or better, high-frequency response.

2. "Much of the (high frequency) problem can be attributed to the use of germanium output transistors which are hard put to produce power at high frequencies." Not so. Theoretically, there is not a vast amount of advantage in high-frequency response between silicon and germanium. As a practical matter there are several germanium power transistors available with a beta cutoff above the audio range. There will undoubtedly be more in the future.

3. "Publishing power ratings based on a 4-ohm output is misleading." Nonsense. It is no more misleading than basing it on any other impedance that is in common usage. The proper procedure, it seems to me, is to give the power rating at some established distortion, say 1 per cent, for 4, 8, and 16 ohms.

4. "If we accept a square wave as providing a closer approximation of musical patterns, then by rights an amplifier should be able to reproduce square waves from 20 to 20,000 cps." Horsefeathers! The logical completion of this argument would require that the human ear be capable of producing signals corresponding to square waves from 20 to 20,000 cps, and that the brain be capable of responding to these stimuli. Human hearing is not that adroit. From all the experiments conducted in human hearing it would seem that sinusoidal testing in the range of 20 to 20,000 cps is adequate.

At this point I would like to say that I agree with many of the viewpoints expressed by the authors, particularly with regards to steady-state *vs.* music-power ratings. I would also like to congratulate them on the simplicity and design philosophy of their amplifier, but I would qualify my praise by bringing out a few points of discussion:

5. As shown the amplifier has a maximum gain of 3. To produce the rated power of 40 watts at an impedance of 16 ohms would require an input of over 8 volts rms. This is beyond the capabilities of most preamplifiers, particularly transistor preamplifiers.

6. Assuming an average beta of 50, at maximum sensitivity and with a load of 4 ohms, the negative feedback is less than 17 db. Transistors are notoriously nonlinear devices, and class-B operation can lead to more distortion at low levels than at rated power. It would be interesting to see the intermodulation distortion versus power output curve of this amplifier to see if the distortion at low levels is appreciably smaller (say by a factor of 10) than it is at rated power.

I hope I have not appeared too critical in this letter as I believe that silicon transistor power amplifiers are the coming thing, and I think that this design represents a good-sized step in that direction.

RICHARD D. CRAWFORD
880 Palo Alto Ave.
Palo Alto, Calif.

That Ceramic Sound

SIR:

I was quite impressed with Mr. Canby's February article—Changers, Etc. He highlights a problem with which I am very familiar and is characterized by the phrase he uses, ". . . it still has that ceramic sound."

The "ceramic sound" is the direct result of mechanical resonances, with only partial damping, that are associated with both the cartridge and the record itself. These are, first, the natural resonance of the ceramic bar, and second, the resonance between the effective stylus-tip mass and the record material. These mechanical resonances are used to obtain the rising response desired by "package" equipment manufacturers but, unfortunately, the transients related to them and the intermodulation effects created by the tracing inaccuracies that occur near tip resonance, create the characteristic coloring to varying degree. The effect, though small in the better designs, is quite recognizable to the trained listener, particularly if the loudspeaker system used is of high quality and has extended frequency range.

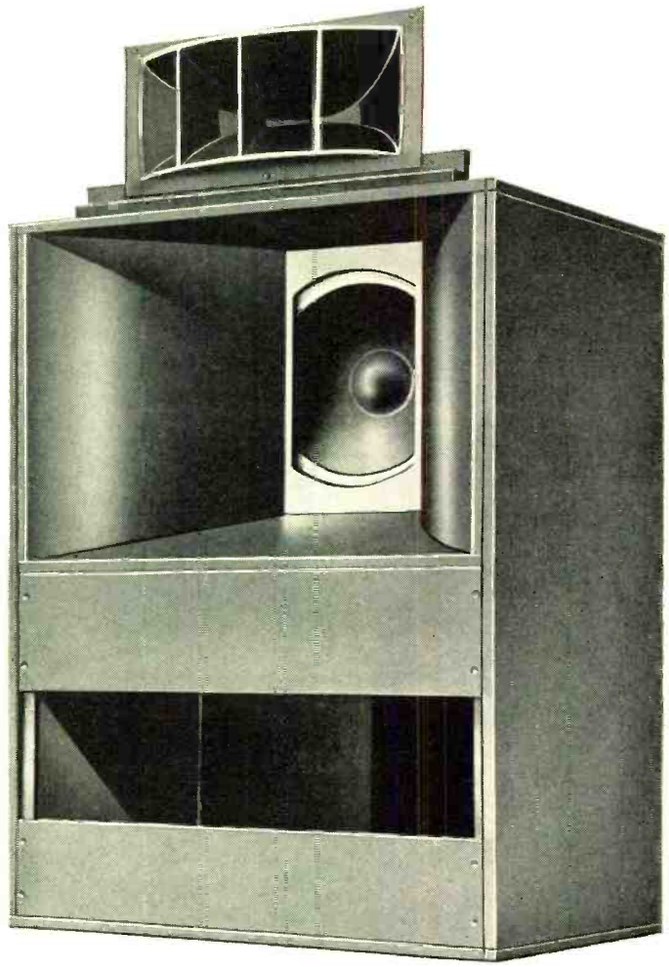
The interesting thing about all this is that at the present state of the art, if one *wants* really fine performance, it is quite possible to design and manufacture a truly linear phonograph pickup at moderate cost using ceramic generators. This will be critically damped at the generator and so coupled to a low-mass stylus system that an effective tip mass and compliance of the order of 1 milligram and 15×10^{-6} cm/dyne, respectively, is achieved. Following these design parameters results in complete elimination of the "ceramic sound" and, since the tip resonance is beyond 20,000 cps there is no mechanical resonance involved in the tracing of the record groove within the audio spectrum.

Electrically, such a transducer represents a generating capacitor, the unterminated output of which voltage is *constant* with amplitude of stylus-tip displacement over a considerably wider pass band than the audible spectrum. If desired, this output may be differentiated using a suitable shunt resistance, resulting in output that is *constant* with tip velocity or, alternately, a small series capacitance may be used and the whole shunted by the 47,000-ohm standard input resistance of a "magnetic" input on audiofan amplifying equipment. In either case the resulting output is in the order of 10 millivolts, which is fully equivalent to that of the typical magnetic cartridge. Better yet, the output of the constant displacement cartridge may be connected-directly to the control grid of a flat amplifier through a simple equalizer circuit (*Fig.* 1) having inverse transmission to the RIAA standard recording characteristic expressed as displacement. In *Fig.* 1, C_t is the capacitance of the transducer plus cable, and:

(*Continued on page 50*)

THIS IS NO COMPACT!

54 inches high
9 feet around the middle



That's a lot of speaker system. Enough for what pleases you. It can whisper or it can bellow. It does both superbly, and anything in between. So much so that Hollywood's famous United Recording Corp. (sound studio for record, tape, film, and tv industries) employs 15 of them. As does Ray Heindorf, musical director of Warner Bros.' production "The Music Man" and holder of 2 Oscars, who has four right in his living room.

No, this is definitely not a compact. It's a giant, this A-7 "Voice of the Theatre" by Altec. A full-size speaker system with quality to match. That's why it belongs in your home. Unless you are willing to settle for a compact "book shelf" speaker . . . and compact sound. Of course if you are a critical listener, you'll want your sound brought to life by Altec; sound so realistically reproduced, you'll find its equal only in the concert hall.

That much the A-7 will give you, and more. Almost in direct proportion to your own desire for perfection. If you insist on hearing the "full sound," the most subtle contribution of each instrument, the effortless reproduction of massive orchestrations at concert-hall listening levels, then the A-7 is for you.

Now here is a hint: you can't make it any smaller, but you can make it a lot prettier. All it takes is a bit of effort, some grille cloth, some veneer or paint and you can transform the A-7 into a custom furniture piece. For built-in installation, there's nothing so perfect. At only $279.00 each, it's a wonderful do-it-yourself project . . . for the critical listener.

However, if you prefer your A-7 sound coming from a more civilized version, we have several solutions, in walnut or mahogany. There's the 831A "Capistrano," a full-size beauty that offers speaker components identical to the A-7 in a classically styled cabinet. It stands 30" high, 47" wide, and is priced at $399.00.

The modern 838A "Carmel" is also a full-size, floor-standing system. It features two 12" low frequency speakers (instead of the one 15-incher in the A-7) and the same high frequency section. It's priced at $324.00 with decorator base (shown) extra; standard model comes with round legs. The "Carmel" is also available with one low frequency speaker in a model called the 837A "Avalon," priced at $261.00.

ALTEC 838A "CARMEL"

ALTEC 831A "CAPISTRANO"

NEW! ALTEC 841A "CORONADO" SPEAKER SYSTEM

Apartment-size version of the full-size Altec speaker systems, the "Coronado" is styled to match a pair of "Carmels" when used as the center speaker in an Altec 3-channel stereo system. Recommended for small apartments where space will not tolerate larger speakers. The "Coronado" is 30" H, 18" W, 14" D and is priced at $199.50.

Go ahead, convince yourself! The A-7 (and its prettier mates) are ready to tantalize you now, at your Altec Distributor's. Or, for latest stereo catalog, write Dept. A-5.

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LIGHT LISTENING

Chester Santon

Screamers (Marches from the Circus Ring)
Mercury SR 90314

The sound enthusiasts within the Mercury organization have hit upon a splendid way to welcome the arrival of Spring. Ignoring the fact that the ground may still be too soft in some parts of the country to support the weight of a circus wagon, Frederick Fennell and the Eastman Wind Ensemble have rolled out a spanking new collection of circus marches that puts to shame earlier recordings of this type. Lest such a statement of praise strike some readers as a product of the free-wheeling school of press agents that still is part of the circus, let me admit at once that some of the older mono performances by actual circus bands may have been rousing affairs when heard in the recording studios. It was hardly the band's fault that the earlier recording process simply couldn't bring into the home the full flavor and excitement of its work. A distinct step forward was taken when stereo recording came along. Perhaps the most noticeable demonstration of the change in sound took place when the famous Merle Evans Band switched its allegiance from the Decca to the Everest label. Prior to the release of these "Screamers" (the trade name for circus march music) by Fennell and the Eastman groups, Evans' Everest stereo disc entitled *Big Top* ruled the roost where circus fans were concerned. With the demise of the original Everest organization some months ago, the number of releases still in circulation on that label have dwindled significantly. This new Fennell recording is therefore welcome on several counts. Mercury has tried its hand in the circus ring on several occasions in the past (Carl) Stevens' *Circus is in Town* and *Music from the Big Top*) but never with these results. Certainly the musicianship of the Eastman Wind Ensemble cannot be topped by any group, including bands that have followed the circus for a living. As recorded on 35MM magnetic film, the sound of this latest release by Fennell is reason enough to set this disc apart from all other stereo recordings of circus music. Couple the sound with truly outstanding playing and you have a release that's bound to attract attention wherever good audio is appreciated. The forty-five members of the Eastman Wind Ensemble were placed in their usual straight rows for this recording at the Eastman Theatre in Rochester, New York. In order to give the trombone section the prominence it deserves in these marches, the recording setup kept the other instruments out of the trombone's immediate vicinity. The trombones, along with the rest of the low-brass instruments, occupy most of the area to the right of center while the higher brasses and crisp percussion have stage left pretty much to themselves.

Frederick Fennell has never indulged in halfway measures when digging into a subject for an album. Here he has collected a group of marches that goes back to the year 1895. This album drives home several points. One is the fact that many of these marches sprang from the fast polkas and gallops of the music halls of the 19th century. Equally fascinating is the point that the famous *Entry of the Gladiators* by Julius Fucik is by no means the only march that deserves top billing on a circus program. Easily the most familiar piece in any circus band's repertory, the Fucik composition is listed here under its more proper title—*Thunder and Blazes*. It takes an exhaustive collection such as this to place Fucik in proper perspective with such circus band composers as Karl King of Barnum and Bailey fame, Fred Jewell and Henry Fillmore who immortalized the trombone in the "smear" classic—*Bones Trombone*.

In the opinion of this listener, the importance of this release does not derive entirely from its contents, spine tingling though these marches may be. The heartening development here is the fact that Mercury Records, as in the "Balalaika Favorites" reviewed two months ago, is now spreading the benefits of its 35 MM magnetic film process to releases other than its straight classical line. This is very good news. At a time when labels far older than Mercury are busy dreaming up new ways to falsify the sound on their light-music discs, it is a pleasure to note real progress toward even more honest reproduction in both the master tape and the stereo groove.

How the West Was Won (Original Sound Track) **M-G-M SE 5**

The Cinerama sound process developed for theater use has finally been transferred to a commercial recording that offers pretty good resemblance to the original series of tracks. Earlier Cinerama recordings released for public consumption fell far short of the theater recordings in just about every specification that sets this process apart from the conventional movie sound track. In both frequency response and dynamic range, mono and stereo discs have heretofore suggested a fraction of what was on the original track. MGM has now changed all this in the present stereo pressing of "How the West Was Won". Anyone familiar with the 50-15,000 cycle range of Cinerama multiple sound tracks may find it difficult to believe that a stereo disc can do justice to them but the hard evidence is on hand when this record is played on a big system. Perhaps more than most listeners, I can relish the nature of this accomplishment because I know from personal experience some of the problems involved in the transfer of Cinerama's sound to another medium. Back in the mid-Fifties when I was producing a series of experimental stereo broadcasts (AM–FM) on WQXR Sunday evenings, I went out to Cinerama's studios at Oyster Bay, Long Island and persuaded them to re-record for my use a jet plane sequence which I then played over the air on two-track stereo tape at 15 IPS. Working with screening and playback facilities that were a duplicate of their special theatre installations, we made the tape by means of a carefully placed mike setup consisting of two Telefunkens that had actually been used during the recording of the picture's six sound channels. These two mikes gave us the stereo sound of all six audio channels as the sequence was re-enacted on the screen. It took several visits to their sound stage to complete the project but we did succeed in making a tape with excellent stereo directionality and frequency response that was completely convincing when heard on the Cinerama speaker array and in the broadcast control room. More than one opportunity presented itself during the course of that project to savor at top volume the full impact of the Cinerama sound process without the deadening effects of theatre carpeting and an absorbing as well as absorbed theatre audience. Listening to the sound track of the latest Cinerama production on MGM disc I SE 5, it is hard to avoid speculation on the nature of the audio that must have pinned back with professional bliss the ears of technicians during studio playback of this Western epic. Certainly the ingredients are here for a jolly good time even when listening is confined to a no-nonsense home system. Alfred Newman's studio orchestra (fifty-two strings, eleven woodwinds, ten brass, six horns and seven percussion) and the Ken Darby Chorus with Debbie Reynolds as soloist put on a massive sonic display during the unfolding of five phases of American Western history. There is none of the usual rolloff at the extreme low end of woodwinds, brasses or strings in the course of the rousing or plantive folk tunes that form the basis for the score. Of the film's major action scenes staged for opulent Cinerama visual effect, only the battle with the Indians is suggested in the recording (they'd still prefer to sell tickets rather than albums) but the episodes available are more than enough to alter any opinions you may have entertained about sound track recordings heard in the home.

Nelson Riddle: Love is a Game of Poker
Capitol ST 1817

I must confess that I succumbed to a twinge of anticipation when I read the press release on Nelson Riddle's latest stereo album. Things had been pretty quiet in the record field in recent months but this Capitol release, Allah be praised, was going to change all that. The announcement, issued to all reviewers in Bulletin # 15 (dated January '63), stated that Riddle's latest disc employed "new recording techniques". Then, in a manner somewhat breathless for a label as conservative and well-established as this one, the bulletin continued "the large string orchestra has a shimmering quality and the chimes a brightness heretofore unknown in pop instrumental recordings." Also prominent in the release was the claim that Riddle had orchestrated the music especially for the "new audio dimensions." New audio dimensions? Wasn't this just the sort of thing that readers of this column would really go for? Things were looking up. When the album arrived, matters looked even rosier. There on the cover were the words "A New Sound Breakthrough." My last minuscule doubts dissolved at the sight of those words. This was it. My excitement was hardly diminished by the top paragraph on the other side of the jacket wherein I learned that "this new sound promises to literally fill your room with dynamic audio excitement." All these claims, mind you, were being parceled out by a company whose word I had never had occasion to doubt in the past and whose stereo discs have delivered honest, full-range sound even on the most searching sound system. In fact, the excellent reputation enjoyed by Capitol's engineering department throughout the industry makes it all the more depressing to have to report that the claims made for this record are just so much nonsense. There is no breakthrough here of any kind. All they've done is introduce an amount of reverb and frequency limiting that now puts Capitol on a par with the teen-age rock and roll labels. If you think Columbia has recently lowered its standards in the more obvious of their echoey and limited-range stereo "360 Sound" releases, wait til you hear Capitol's far more extreme move down the same road. Riddle's strings now have a whining quality, the brass a nasal one even when the response is rolled off steeply at 7,000 cycles. Capitol's front office may have the shadow of an excuse in the fact that this recording was produced for them by an outfit called Albums, Inc. One can only hope that this recording does not represent the sound we're going to get on Capitol's light releases in the future.

Stan Freberg: Madison Ave. Werewolf
Capitol T 1816

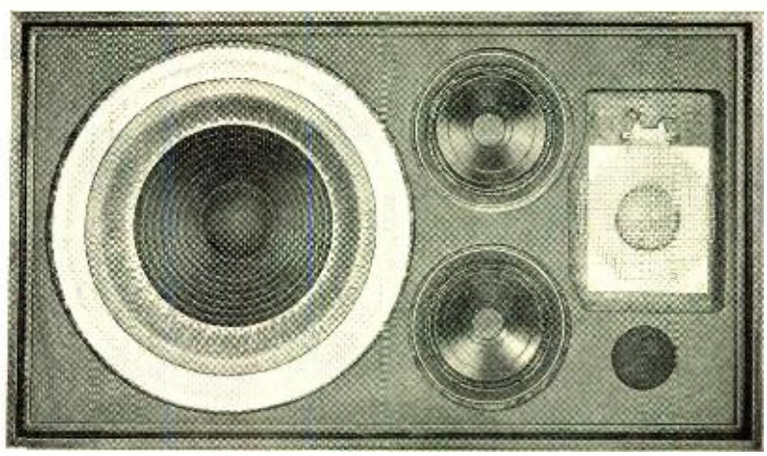
Dean Elliott: Zounds! What Sounds!
Capitol ST 1818

Humor based on the element of surprise in unseen sound effects runs through both of these new Capitol albums. Freberg's effort is a digest of material he aired during the fifteen weeks CBS had his comedy show on

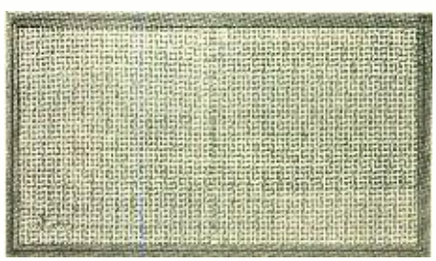
(*Continued on page 47*)

"Over-all, I would rate the XP-4A as one of the best, most truly musical reproducers available today."

—JULIAN D. HIRSCH *



*Noted equipment reviewer, in a lab report published in the December, 1962, HiFi/Stereo Review. Writes Mr. Hirsch: "Inside...the XP-4A is quite unlike any of the other speakers it resembles externally...proved to be an unusually wide-range, smooth system...the response was virtually flat from 5,000 cps to beyond the limits of audibility...Tone-burst tests showed very good transient response...In listening tests, the XP-4A...was almost neutral in character, very smooth and natural-sounding...had an especially fine and satisfying presence...a healthy amount of undistorted output in the 30-to-40-cps range...The XP-4A is priced at $199.50."†



Larger photo shows speaker with grille cloth removed; smaller photo with grille cloth in place.

FREE! $1.00 VALUE! The new 1963 edition of The Fisher Handbook, a 40-page illustrated guide to stereo, complete with specifications on all Fisher components, including loudspeakers. **ALSO:** Free reprint of the Hirsch report on the XP-4A.

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THE XP-4A LOUDSPEAKER BY FISHER

† SLIGHTLY HIGHER IN THE FAR WEST. EXPORT: FISHER RADIO INTERNATIONAL, INC., LONG ISLAND CITY 1, N. Y. CANADA: TRI-TEL ASSOCIATES, LTD., WILLOWDALE, ONT.

AUDIO ETC.

Edward Tatnall Canby

BIG BLUE FLASH

Partly thanks to concentration on my Other Self, as conductor of a choral group called the Canby Singers which gave its big concert-of-the-year recently, I have a barrel of unfinished audio projects under way, none of which can make the deadline right now—and a blanket apology is issued to those who patiently await each new issue of AUDIO to see whether Canby has *finally* got around to . . . well, 'nuff said. I habitually bite off more than I can chew.

Meanwhile (as the news broadcasters say), batches of interesting letters keep coming in to me and I've made a vow to give them the play they deserve in this department—which is, after all, a two-way, three-way street, between equipment makers, readers and myself, as m.c. I'm saving up a batch having to do with the many-sided implications in my "Back to the Factory" article, published in the March issue. (I get the pleasant letters; the gripes go direct to the editor mostly!) And there has been healthy comment on my comments concerning the Crown 800 recorder, in April. But first . . . the Big Blue Flash.

Over my coffee the other day (this is an aside) I was absorbing a "fifteen minute" news broadcast—a minute of news, then two commercials, maybe three, etc. The announcer, as usual, broke one short news segment with his familiar "More news after this message. in JUST . . . ONE . . . MINUTE. That's my signal for a quick fade-down and a look at my electric clock, to count off a minute and ten seconds.

I didn't have to, this time. Long silence. No commercial. After at least fifteen heart beats of soundless agony, the announcer came back again, all joviality. "BUT FIRST . . . back to the news!" says he. And back he went. Good commentary, I thought, on the present-day use of simple words like "first," in this time of slanted, motivated, addled-up English. (End of aside)

So, first . . . let me relay a succinct explanation of my unusual tuner explosion of awhile back, that occurred while I was innocently trying to record stereo off the air via a highly respectable tuner, audio control unit, and stereo tape deck. Everything was going along just fine and had been for quite awhile; I'd been taking down this and that, sampling here and there, had tried both speeds on the tape deck to see how much difference it made (that is, when I remembered to change the equalization switches)—when suddenly the tuner blew up with a flash, which I caught out of the tail of my eye.

Seemed to come from the vicinity of the antenna connections. Suspicious smudge nearby. Reception down to almost nothing; one faint station still audible. Rest of system OK.

I was astounded. Nothing remotely like this had ever happened to me before. How in the devil had a large charge got itself into *that* vicinity?

The antenna was perfectly OK. Had my rotator somehow got entangled with it? No—the rotator uses only some 30 volts, anyhow. Maybe there was a short in my famous power cord rat's nest. (Too many standard-length power cords all plugged into proximate receptacles in a confined space.) Was a cord frazzled and maybe shorted to the antenna leads, also coming in nearby? Nope. Rat's nest A OK. (But I did clear it up a bit, then and there, via one of those plug-in strips for accommodating a lot of power cords.)

So I got out my neon light test probe, one with two leads (some have only a single "nose") and approached the antenna cautiously with one leg, touching the other to the chassis. Lo and behold—a faint little pink glow. Barely anything. *That* couldn't have done it? I tried an electric lamp bulb across the same; it didn't light. A flashlight bulb wouldn't, either. No appreciable current, not much voltage. Nowhere near enough to blow the antenna matching coil, which is what had happened.

But howcome there was even a small "leakage-type" voltage on the antenna? Best theory, as per one of my assistants who hastened in to help, was that it is induced, half-wave, from the not-so-distant incoming a.c. power wires at one side of my house. So—no solution to my main problem, the big blue flash that killed my tuner dead.

Boy—*was* I going to be careful for awhile! I kept the rotator unplugged, just in case. Nothing whatsoever was connected to the antenna leads. No shorts in it; the lead-in was only a year old and looked perfect, even if it had been encased in solid ice for a couple of months last winter, up on the roof. Ice was gone. Roof was dry.

Well, eventually and by sheer accident I discovered the trouble source. I had left those dangerous, doubtful antenna leads unconnected, waving loose. But to see what might happen, I stuck the test probe with one leg on the antenna leads (twisted together) and the other touching the chassis. I figured I'd keep an eye on events. Pretty soon—it happened. The neon suddenly lighted up bright pink. No question this time—it was straight, unadulterated a.c., full power. And just at that moment in my excitement I jiggled something, the probe-leg attached to the antenna slipped down a half-inch and just barely brushed against the chassis. BAM!! Out went a 20-amp fuse in the cellar.

Luckily, no harm done this time. Nothing was connected to the antenna. Small burnt spot on the chassis, neatly melted.

By this time I was treating those innocent dipole leads like extensions of a railroad third rail. I expected coronas and streams of sparks to jump from my roof any night. Nothing—I repeat, *nothing*—was hooked to the antenna except the very proper 300-ohm plastic lead-in strip. And here was a hefty fuse, all charred and scarred.

Sheep and Foxes

By this time, my readers will have divided neatly into the audio sheep and the audio foxes. The sheep are mumbling in bewilderment—hey, I'd better-try-a-probe-on-MY-antenna—jeepers—*20 amps!* Quick, mama, throw the master switch. The foxes, having already figured out exactly what happened, are stroking their foxy lapels with a slavering grin.

I had found the source, if not the cause. The foxes will now feel even foxier. It was the tape-lifter in my tape deck.

The great antenna flame had jumped *when the tape recorder was in fast-forward or rewind motion.* Not at any other time. Only then was the tape-lifter solenoid actuated.

Not even every time I rewound or fast-forwarded. That is why it took me so long to pinpoint the basic fault. Indeed, for a good while after the fuse obligingly blew and was gingerly replaced, I could not get any reaction at all in the neon probe (now carefully strapped down so it wouldn't short again), though I pushed all the tape recorder buttons and roared a whole roll of tape back and forth several times. But eventually it happened again, harmlessly and revealingly. No two ways about it. Push the tape recorder into rewind and, five feet away, the *unconnected* antenna leads, via the probe, suddenly gave with bright pink. Push the stop button and the pink went out.

I am at this point positively relishing, with cruel delight, the shiverings of every sheepish fan who can't imagine (as I couldn't) what dreadful misconnection could have done this bit of charge-transference—from inside the tape recorder to a *disconnected* antenna feet away. (I'm assuming, of course, that *you* are the fox.) Fortunately, as I say, one fox wrote me a succinct letter that told me positively what my assistant and I had begun to figure out for ourselves already. So I hereby quote from foxy Mr. Fred C. Hervey of Chilton, Wisconsin.

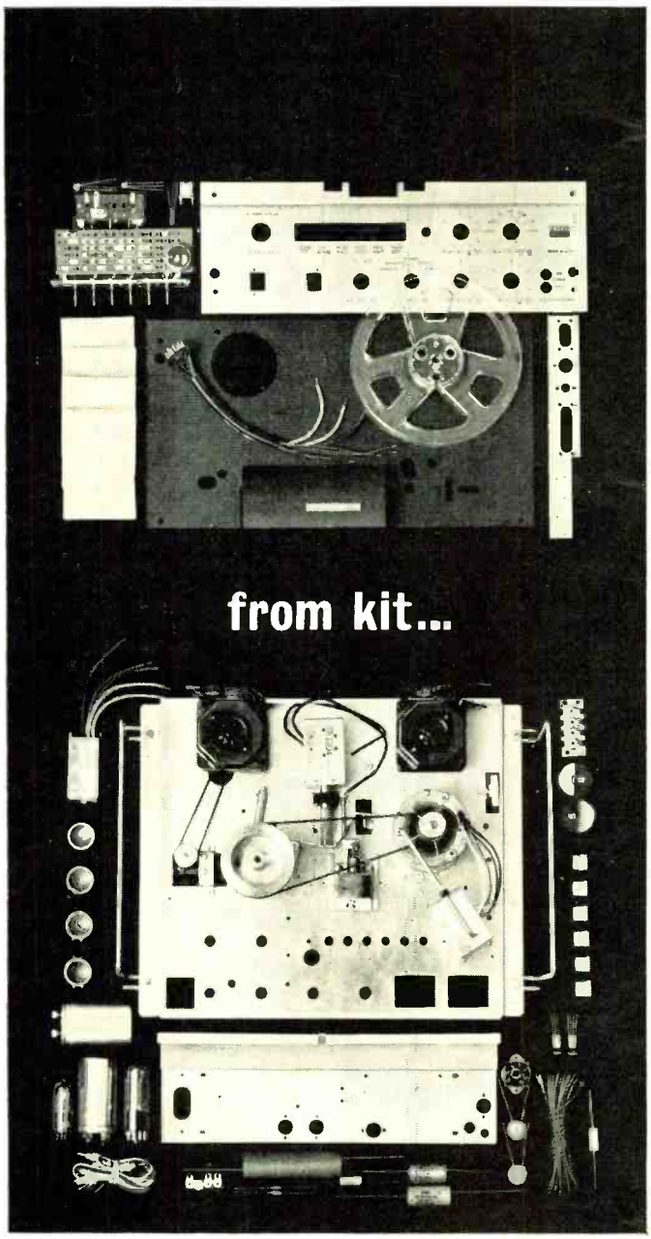
Sneak Circuit

"Dear Sir:

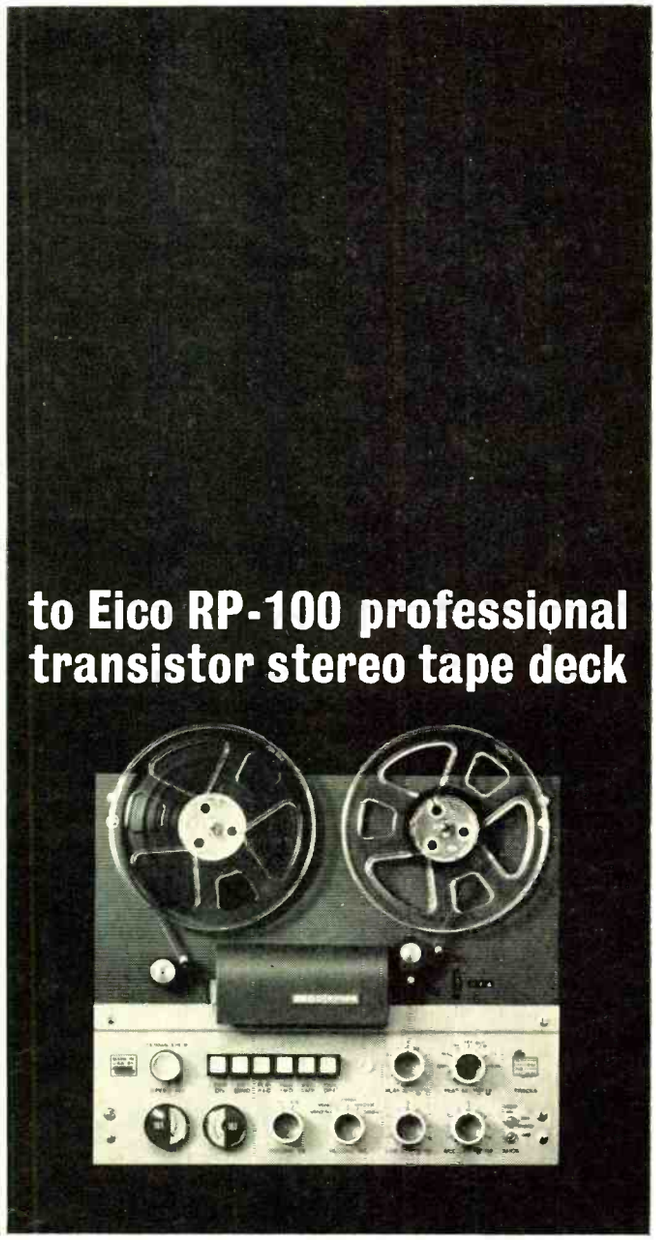
"You, sir, are without doubt the victim of a "sneak" circuit. (Your problem of an antenna that burns out antenna coils, fuses, etc.)

"I have no circuit available for your equipment, so I postulate thusly: A. Your 'ground' is floating. Equipment chassis ground, that is: i.e. there is no direct ground to a cold water pipe from, say, your preamp chassis. B. The antenna *is* grounded solidly. C. There is a condenser (*capacitor*) from one side of the tape-lifter solenoid to the tape deck chassis. All chassis are connected together by the audio cables. Now, therefore: the path for the ground current is from the tape deck to the preamp or amp control and to the FM tuner through the shields of the cables and thence to "real" ground through both antenna lead-in wires in parallel, through the folded dipole or dipoles to the center boom, thence to ground through the mast and heavy ground wire. I am assuming that either the anti-spark capacitor of the tape lifter is shorted (likely) or, failing that, the a.c. circuit that controls the solenoid and energizes it is grounded either through a defective solenoid or switch-contact insulation. It should not be very hard to find with an ohmmeter."

The foxy gentleman is right, right, and right. I haven't yet got inside the tape recorder to see if his last points are valid—but one of them is bound to be. My ground



from kit...



to Eico RP-100 professional transistor stereo tape deck

(and you save $100)

Just pushing the start button tells the quality of the EICO RP-100. Instantly, tape flows with the smoothness and precision you would expect only in a studio console. Hit the stop button: D.C. brakes halt the tape with hairbreadth accuracy. Rewind—and watch a full reel whizz through in less than a minute. Aside from the decisive snap of the solenoid controls, all runs silently—thanks to rugged construction. No mechanical whirring and buzzing obtrudes on the music. And the solid heavy-gauge chassis maintains vital mechanical tolerances under heavy use.

You can't top the RP-100 for versatility: 4-track or 2-track, stereo or mono, with each channel separately erasable, 2 speeds (7½ and 3¾ ips), monitoring directly from tape, sound-on-sound recording, facilities for mixing two inputs with separate level controls for each channel, and for recording two programs simultaneously.

. . . and as for quality factors: 3 motors—hysteresis synchronous capstan drive—transistorized electronics to eliminate hum and microphonics—automatic tape lifters—automatic shutoff—3 precision-lapped shielded heads adjustable in all planes—narrow-gap (0.0001 inch) playback head for maximum frequency response—consistency of high frequency response improved by hyperbolic-ground heads—separate record and playback amplifiers—high-torque tape start for precise cueing and editing—jamproof speed shift—dual recording level meters—non-critical bias setting—record safety interlock—rapid loading in sweep-line path that assures tight tape wrap-around on heads, no need for troublesome pressure pads—permanent bearing lubrication—digital tape index.

And the sound? Frequency response 30 to 15,000 cps ± 2 db at 7½ ips with 55 db signal-to-noise ratio. At 3¾ ips the frequency response is 30 to 10,000 cps ± 2 db with 50 db signal-to-noise ratio. Wow and flutter are below 0.15% at high speed, under 0.2% at low speed.

Summing up: *"THE EICO RP-100 will do as good a job as many recorders costing up to twice as much, and it is probably more flexible than any of them."* That's the unbiased test report of Hirsch-Houck Laboratories, published in Hi-Fi/Stereo Review. As a semi-kit the EICO RP-100 is **$299.95.** You can also buy it factory-wired for **$399.95.** Even then it's unmatched for the money. See the superb RP-100 and the complete EICO line of high fidelity components at dealers everywhere. For FREE 32 page catalog, 36 page Stereo Hi-Fi Guide (enclose 25¢ for handling & dealers' name, write: EICO ELECTRONIC INSTRUMENT CO., INC., 3300 Northern Blvd., L.I.C. 1, N. Y. A5T

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is floating, what with new equipment being plugged in and out every other day most impermanently. My antenna *is* solidly grounded, I now realize; only a year or so ago I had a lightning protection job done on the house, a sure double-check.

The astonishing thing is that this has been the case (the antenna was always grounded) for some nine years! Never until this moment had I had any "floating ground" trouble. I have used many an FM tuner, many a tape recorder, and not one had heretofore blown up. Never so much as a *little* blue flash, not to mention a 20-amp fuse-blow.

Do all our beginner-readers realize that a roof-top dipole antenna is and should be grounded at the "center tap"—and that this does not, as one might think offhand, "short the antenna to ground"? Seems odd, when you first come to it. That's why, I guess, I took so long to figure out that my trouble was not in the antenna itself at all. Natch, just as any soul might, I began by assuming that there was "a.c. on the antenna." Nope—there was "ground" on the antenna, and rightly so. The a.c. jumped *to* the antenna, not off of it, if one can speak in such a loose fashion of 60-cps power oscillations.

Well, were *you* a fox? Or just a shoop?

* * *

Our foxy friend Mr. Hervey goes on with some practical ideas that are too good to pass up here. He says, first—and I agree with him dolefully (but probably won't do much about it)—"Tie every last piece of equipment together (chassis and frames) with Belden flat braid—½-inch or ¼-inch wide, and then run a solid, heavy ground wire from the preamp chassis to a cold water pipe, making sure of a good electrical connection." Fine idea, and the worst that you can do henceforth is to pop a fuse.

He adds "a good low-resistance ground will also cut hum down to a minimum if the shield connections on the "comes-from" end are disconnected at the plug, connecting only the center conductor at the "sending end" of all cables and getting the circuit ground through the heavy braid." Now that, it seems to me, is a solid idea and ought to be tried. Push the RCA-type plugs only part-way in, leaving the collar unconnected. (You can do this with helpful results even without a Belden-braid ground on most two-cable stereo connections. You'll get a squawk when you pull off *both* collars; just loosen one of them, on one channel. That makes one less potential ground-loop. Of course you should also have the heavy ground as recommended by Mr. Hervey. Let that take care of the works, and avoid all sorts of ground trouble, from hum to blue flames.)

Hervey goes on to suggest—a fertile source of ideas, this man—that an excellent lightning-protection "extra" is a pair of small fuse holders at a "handy point on the baseboard near where your 300-ohm antenna line comes in." Run the antenna leads through two small fuses, around 1 amp. Lightning will neatly vaporize them, but a potentially heavy charge that can get through quickly while the lightning is ionizing the air in the arrestor gap has been stopped before it blows out coils, transformers and what-not. You leave the regular arrestor in the circuit, of course—to take care of the rest of the lightning, once the gap has been bridged, a couple of milliseconds after things have begun to pop. Don't—he warns—use a chassis-mounting fuse holder. Use the "bread-board" type fuse holder, a bakelite board with two fuse clips. Amen, I guess. I would not have known the difference.

Funny thing: I've never popped anything yet via lightning, though we have some lovely storms around my place in summer. Nevertheless, I think I'll get some Belden braiding and some of those 1 amp fuses. You'd better, too.

I felt a bit less unhappy about my blue flash when I read from Mr. Hervey that I ought to—since "sneak circuits" occur in the finest engineering circles, like say, in a radio station where he worked. Seems there is a 6000-volt shorting bar in biggish transmitter systems that shorts the plate-supply circuits to ground when the transmitter is shut down. That is—after the a.c. power for the big d.c. power supply has been cut off. Well, this station got itself a little sneaky ground in, of all things, a pilot lamp, which somehow kept the relay circuit from turning off the a.c. When the shorting bar dropped down that day, as Mr. Hervey succinctly puts it: "WHAM!!"

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THIS MONTH'S COVER

This month we visit Bobby Hackett, an outstanding cornet jazz artist, shown at home with the recording and playback equipment he uses to improve his professional performances as well as for just plain music listening. His equipment consists of three Tandberg tape recorders, including the new Model 62 half-track; EMI "Studio Monitor" speakers with built-in amplifiers (25 watts each); Marantz preamplifier; Altec lipstick mikes; Capps condenser mikes; AKG and Koss headphones; Fairchild 412 turntable with an Ortofon cartridge; and a Fisher FM-1000 stereo tuner. The photograph shows him playing his Shilke custom-made cornet.

Bobby makes "on-the-spot" recordings of his performances during engagements in night clubs, music halls, and other entertainment centers. He says, "Live recordings during a night-club performance are not at all disturbing to the audience. Usually they are intrigued by the operation of the equipment and often ask to listen to the recording. They find it extremely entertaining to listen to the tape through headphones and are fascinated at the clear reproduction of the performance which they have just heard 'live'."

Generally, he takes the recorded tape home to the well-equipped "Hackett Sound Room," where he carefully evaluates the different arrangements which have been recorded. In order to disassociate himself from the amplifiers, tape recorders, loudspeakers, wires, and such, he closes his eyes, faces the wall and then listens supercritically to every instrument in his quartette. If he hears any sound or mood in the playing which should be corrected, he makes notes, and at the next practice session the change is made. This appraisal has proven so helpful in polishing his material to achieve the perfection he desires that the procedure has become indispensable to him.

For the past twenty years, Bobby Hackett has been a successful jazz artist. He performs with his quartette, which consists of his cornet, piano, bass, and drums. He appeared with Benny Goodman, as a soloist, in the first Jazz Concert at Carnegie Hall. Last year, he appeared again with Benny Goodman in the first Jazz Concert at Lincoln Center. He has also performed with Louis Armstrong at the Town Hall in New York. Bobby Hackett's records are available under the Columbia, Capital, and Epic labels. He is featured in the well-known "mood" albums which were introduced by Jackie Gleason.

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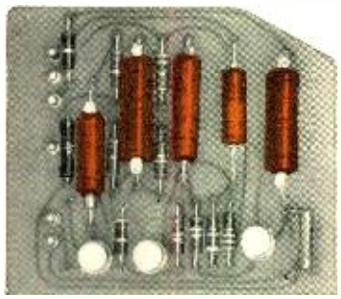


...a straight wire with gain. *"A major breakthrough in the application of semi-conductors to high-fidelity sound... Citation A literally has flat response to beyond 1,000,000 cycles and distortion that is non-measurable... Superb response characteristics not matched by any known preamplifier... A unit that should meet the demands of the most critical listener and audio perfectionist... It suggests that... a sound path could be set up that approaches the classic goal of amplifier design* ***... a 'straight wire with gain'."***

EQUIPMENT REPORT — HIGH FIDELITY MAGAZINE

For the full text of the High Fidelity report, write Dept. A-5, Citation Division, Harman-Kardon, Inc., Plainview, N. Y.

harman kardon

EDITOR'S REVIEW

THE "BEST"

AT THE RECENTLY-CONCLUDED High Fidelity Show in Los Angeles we had the opportunity, and pleasure, of talking with many of our readers and with consumers in general. For the most part we enjoyed the conversations but we must admit we were rather surprised at the many requests to answer that old saw, "Which is the best . . .?"

We were surprised because we had thought that it would have been laid to rest by now—really there isn't one "best" which is best for all circumstances, in spite of what we are led to believe by product-rating organizations.

For example, consider the case of FM tuners. In EQUIPMENT PROFILE this month we described a situation where a particular technical attribute (capture ratio) may be more important to the user than other attributes which are usually given more attention. Thus one could very easily fall into the trap of establishing a scale of values wherein this particular attribute is given less weight than others, and on the basis of this scale of values selecting a "best." The end result would be, if consumers continue to let these rather absolute ratings influence them, that a number of consumers will not get the performance they want.

Actually, we can't really blame the product-testing groups for this state of affairs; it wouldn't continue if the people who used these services didn't allow them to continue. Certainly we would admit it is much easier to let a laboratory (or anyone else) do our thinking for us than going through the tedious process of investigation and analysis necessary to determine what are our individual needs. Taking the easy route however, involves the type of danger we have mentioned; you may end up with a costly piece of equipment which doesn't do the job.

We should mention that product-testing laboratories can fill an important function if they stick to product testing, without trying to answer questions that really can't be answered—such as "Which is the best . . .?"

OLD HAT

Another question which consumed much of our time concerned receiving FM stereo. Actually many of the questioners didn't realize they were talking about this problem, they thought their tuners were defective because stereo reception was quite noisy while mono reception was fine.

Again we were surprised, we thought that it was old hat by now.

Anyhow, for those with new hats, stereo transmission always results in less signal into the tuner than mono transmission, the exact amount less varying from ⅔ to ½. For this reason, a signal may be perfectly adequate in mono, but inadequate for stereo.

In order to solve this problem one usually has to examine the antenna performance, and upgrade it to provide more signal. Thus, for example, if you are using a line cord antenna, try an indoor one; if you are using an indoor antenna try one outside; and so on.

There are some short cuts, but these require a little bit of experience and common sense. (One of the short cuts might be to consult a nearby neighbor who has solved the problem.) By the time you have gone through one or two failures, as we all have, you will probably qualify for an old hat.

MORE OLD HAT

Another problem we encountered in the old hat department was where to start in setting up a new stereo system. It seems that in California, at least in the Los Angeles area, there is a large group of people who have not yet converted to stereo, and they are just now considering it.

Actually the answer sounds simpler than it really is. Invariably we counselled the questioner to start with coupling the speakers to the room acoustics and then work back to the amplifier, preamp, and so on. Sounds simple, but we must admit that it isn't an easy job to match speakers to a room or, conversely, match the room to the speakers. This is an area where one should take advantage of any experienced (in this area) friend you might have. Or better yet, go to an audio consultant who specializes in acoustics. In the long run this may pay off more in satisfaction than other procedures which are, at the time, less costly.

IT TAKES SOME READERS LONGER

A few weeks ago we received a letter which questioned an equation we had presented in one of our previous issues. After we checked out the equation—he was right, we had erred—we noticed the date of the issue in which the error had appeared; August, 1947. (At that time we were known as AUDIO ENGINEERING.) In keeping with our policy of correcting mistakes as they crop up please take out your August, 1947, issue and make the following correction on page 38 on the graphical solution for minimum-loss pads. The formula for R_2 should be

$$R_2 = Z_2/a = Z_2\left(\frac{Z_1/Z_2}{Z_1/Z_2 - 1}\right)^{1/2}.$$

MORE-RECENT CORRECTIONS

The following corrections concern the April issue (1963, that is):

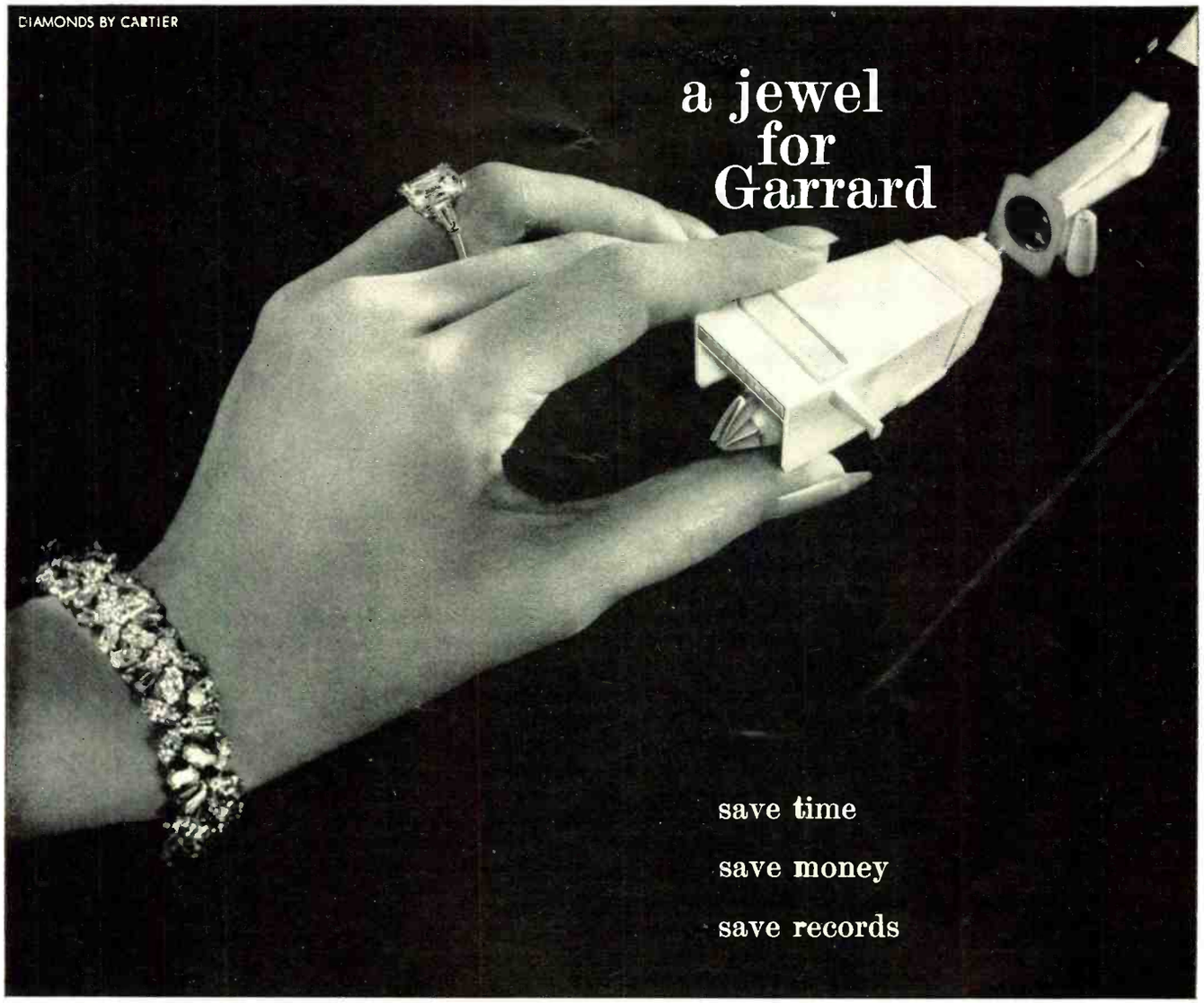
Page 21, add dot where lead from emitter of Q_2 crosses lead from D_1 to C on SW_2.

Page 32, *Fig.* 2: 470k (two places) should be 47k.

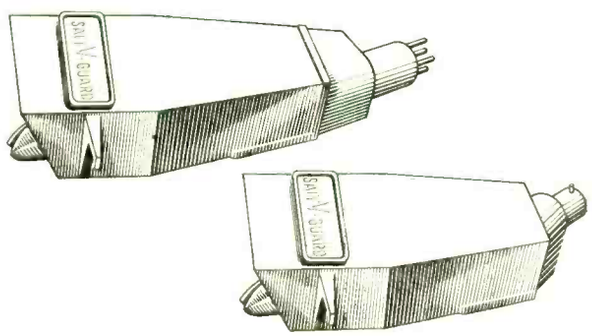
Page 70, *Fig.* 8 and *Fig.* 9 should be reversed.

CONGRATULATIONS—

To Electro Voice for receiving a Certificate of Merit award from the Academy of Motion Picture Arts and Sciences for the significant advances made to the industry by the 642 microphone. Normally we do not think of microphones as contributing greatly, but the industry does. This is the first time a microphone has been so honored in 22 years.



Plug-in head assemblies with pre-mounted cartridges for Type A and Model AT6 Garrard Automatic Turntables.



Choose the **right** pickup for your Garrard installations — choose a Pickering — the new U38/ATG and the famous U38/AT are both available premounted in Plug-in Heads for Garrard Type A and Model AT6 Automatic Turntables.

FEATHERWEIGHT OPERATION — for maximum record protection, 1 to 3 grams tracking (recommended 2 grams) — where environmental conditions permit light tracking forces.

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Includes U/38 Stereo Fluxvalve Cartridge (premounted) with D3807ATG **SAFE V-GUARD®** "Floating Stylus"

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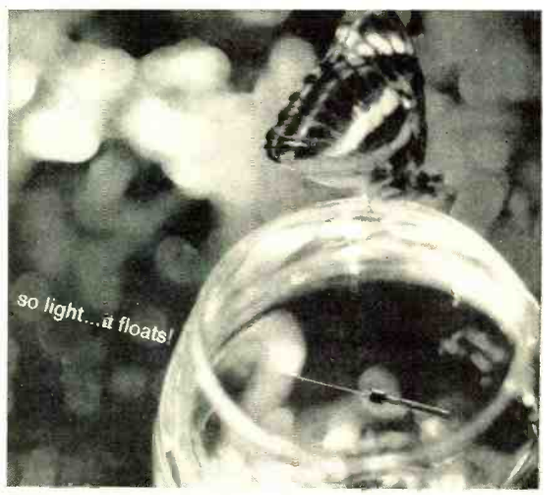

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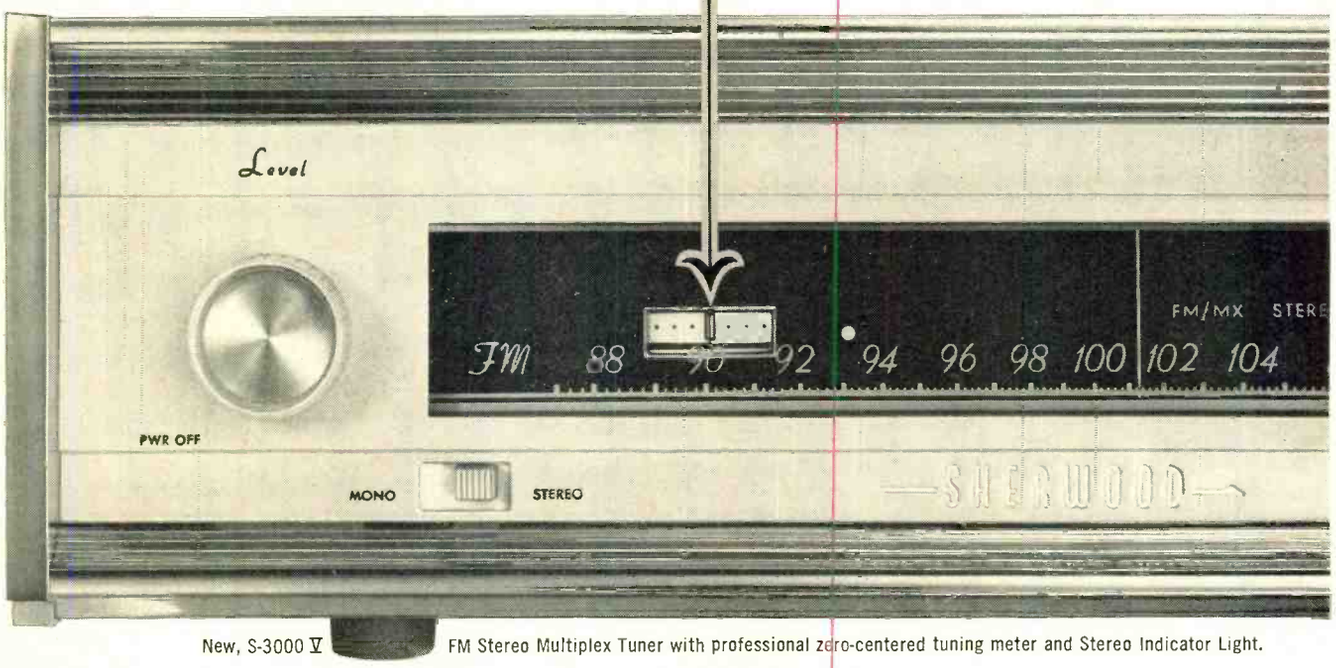
Why Sherwood "zeroed-in" on the problem of tuning accuracy



New, S-3000 V FM Stereo Multiplex Tuner with professional zero-centered tuning meter and Stereo Indicator Light.

The wider band requirements for the stereo information now being multiplexed on FM channels has made precision tuning a factor more-important-than-ever in FM reception.

Tuning eyes are good. Peak meters have value. But, these are yesterday's achievements applied to today's and tomorrow's needs.

This is why Sherwood engineers have incorporated a professional, zero-centered meter in the new S-3000 V Tuner. It tells when you are exactly on frequency. No guesswork. No maybe's. Only assuredness!

What difference does Sherwood professional zero-centered meter tuning make?

Quite a lot. It makes possible accurate, first-attempt tuning. You will find it isn't necessary to tune and then step back to listen and verify whether you tuned in correctly.

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Added to the professional accuracy of zero-centered meter tuning, Sherwood gives you a "can't-be-fooled" Stereo Indicator Light. Stereo broadcast identification is instant and positive.

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Other value features of the S-3000 V

- **Superb sensitivity:** 1.8 μv (IHFM) for —30 db. noise and distortion.
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- **Flywheel tuning:** made with turntable accuracy for smoothest, fastest tuning.
- **Dial spread:** communications-type 20% longer scales provide professional accuracy.
- **Price:** $165.00 (less case).

If you want a component that combines tuner and 80-watt stereo amplifier in one compact chassis . . . see the new S-8000 III FM Stereo MX Receiver. Has zero-centered professional tuning meter and Stereo Indicator Light. Price: $319.50 (less case).

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High-Quality Transistorized Tape Recorder Amplifier

LEE BEEDER*

Combining standard GE and Nortronics circuits into a workable record/playback amplifier system, this project becomes one which will provide the tape recordist with professional-type operation and performance.

THE TAPE-RECORDER ELECTRONICS described in this article uses thirteen transistors, including two power transistors for the bias.

The following features—which read something like the features of a large console—are incorporated:

1. Separate recording amplifier with front-panel-adjustable recording equalization. Also, switch-selected equalization for a speed of 3¾ or 7½ ips. (This could easily be changed to 7½ and 15 ips if desired.)
2. Separate playback preamplifier with front-panel-adjustable equalization. Also has switch-selected equalization for 3¾ and 7½ ips.
3. Push-pull bias with bias-set control and a control allowing balancing of the bias wave form.
4. Monitor amplifier that also drives a small VU meter. This amplifier, through a jack that disconnects the built-in VU meter, also drives a large standard VU meter. This allows a VU meter to be used on a 3-foot extension, if desired.
5. A signal recorded at 0 VU, when played back, gives an output of +4 VU (1.228 volts) with additional gain available.
6. A signal recorded at 0 VU gives an output of +4 VU (1.228 volts) from the monitor amplifier as the signal is being recorded. Thus, input and taped signals are monitored and played back at the same levels. Comparisons of the two are easily made.

The equalization circuits used are comparable to those used with vacuum tubes so that almost any recording head may be used: you are not limited to the low-impedance heads customarily required with transistor circuits.

Battery power can be used if desired, which could be valuable in some instances.

The recorder, which was constructed for the purpose of making high-quality recordings, is not complex or difficult to construct since the various small amplifiers can be built on separate small terminal boards.

The chassis on which the amplifier is built is 3 × 5 × 9½ inches which, though small, allows ample room. The chassis for the a.c. power supply is 3 × 4 × 5 inches.

* *185½ S. Virgil, Los Angeles 4, Calif.*

Fig. 1. Front-view of chassis.

General Description

The circuit, shown in *Fig.* 2, is set up for a two-head deck. However, if a tape deck with three heads is used a couple of minor changes must be made. First SW_{2c} becomes a separate SPDT switch, SW_4, with the two positions of this switch marked INPUT and TAPE. Second, connect the playback and record heads directly to their respective amplifiers.

Now with SW_2 in the RECORD position, you can compare the input signal to the recorded signal on the tape by simply throwing SW_4 to the desired positions for monitoring before. For playback, SW_4 must be in the TAPE position, of course.

With some playback-only heads (which normally provide a higher output than record-playback heads) it may be possible to eliminate Q_{10} completely and take the output directly from C_{29}. If there is any doubt, however, just follow the schematic as shown.

The circuit is rather straightforward and no problems have arisen in more than two years of heavy operation. One change was made since the original design will explain the appearance of a large audio choke in the accompanying photographs, while the schematic shows no such component.

When originally constructed in 1960, an output stage was used which was covered by a pending British patent. This circuit required a large-value audio choke. I photographed the amplifier as construction proceeded, but later I asked permission to use the output stage in the article, but I received no reply. So, I simply changed the circuit to the simple one-transistor Nortronics-type output stage. This proved to be preferable to the more elaborate stage.

Figure 1, in which this choke can be seen, shows a front view of the chassis with the components mounted and gives some idea of the appearance of the unit, while *Fig.* 3 shows the bottom of the unit. The bias transformer and the two power transistors Q_5 and Q_6 are mounted on the rear panel of the chassis as is R_{34}. Extreme miniaturization was not attempted; but most of the available space was quite well utilized. Layout, parenthetically, is something like calculating a chess combination. You have to look ahead far enough to be sure that the ranks and files will be open when you need them. So apropos of this, be

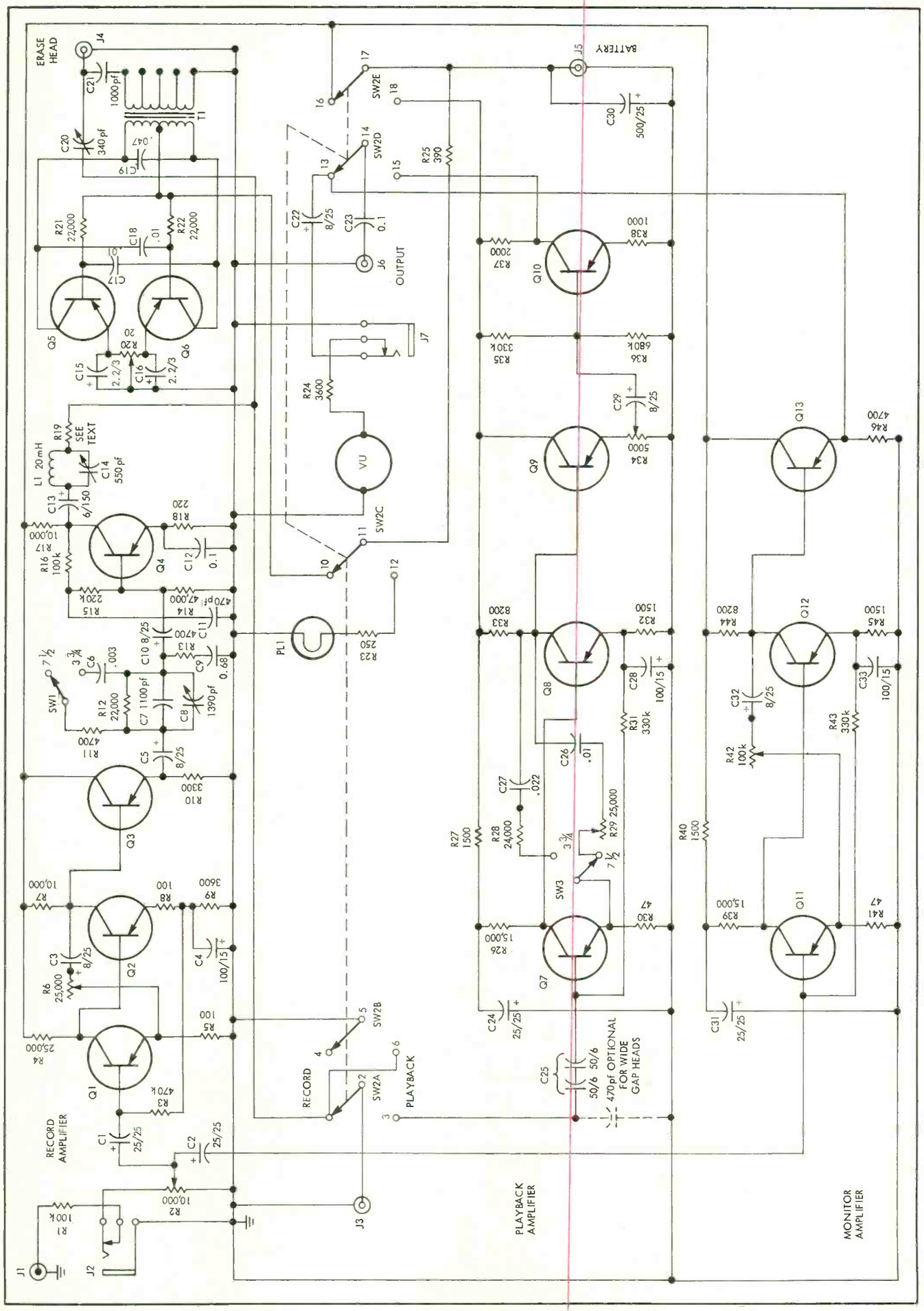


Fig. 2. Schematic of record, playback, and monitor amplifiers.

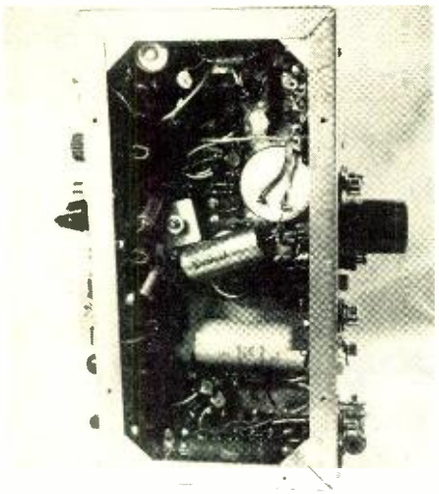


Fig. 3. Bottom view of chassis.

sure that you have an idea of where everything is going before you start drilling holes.

Figure 4 shows the power supply—so simple that no further explanation need be made—and *Fig.* 5 shows the schematic.

Circuit

And now, to return to a brief description of the circuitry: the input signal is fed through either the microphone jack J_2 or the line jack J_1 to the volume control, R_2. From there, after the recording level is set, the signal goes to the recording amplifier and to the monitor amplifier. The monitor amplifier has a flat response from 20 to 20,000 cps. This ensures that the monitored signal will sound just like the input signal, since the distortion of the monitor amplifier is quite low.

R_{12}, C_7, C_8, R_{13}, and C_9 give the NAB equalization at 7½ ips. C_8 is adjustable and allows tailoring the response at 10,000 cps.

For 3¾ ips R_{11} and C_6 are switched into the circuit. Q_4 is the output stage. L_1 and C_{14} form a bias trap through which the signal is fed to the recording head.

The value of R_{19} will depend on the inductance of the recording head. I used a record play head with an inductance

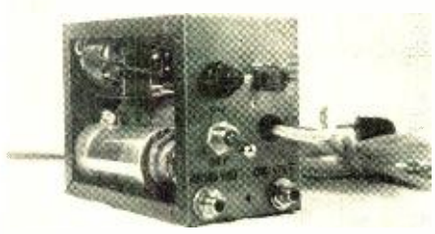


Fig. 4. Front view of power supply chassis.

of about 400 mH. For this value, 22,000 ohms is correct. For heads of higher inductance the value must be increased. For record-only heads the value can be lowered if, as will probably be the case, the inductance is lower than 400 mH. For 100 mH, 5100 ohms is suggested as a value for R_{19}.

The bias circuit of Q_5 and Q_6, and the bias transformer T_1, were developed by Nortronics, a company that makes recording heads and accessories. The transformer is a boon to experimenters as there is nothing attractive in laboriously handwinding a transformer, hoping it will oscillate in a given circuit when completed.

At first, I used tube bias with the recorder, but this circuit performs so well that I changed to it. The transistorized bias supply is much handier. It supplies a more than adequate current, and the frequency is also adjustable from 60 to 100 kc. C_{19} determines the bias frequency. A value of .05-μf gives 60 kc, .03 gives 80 kc, and .02 gives 100 kc.

The secondary of T_1 is tapped so that an erase head of practically any impedance can be used. The circuit will supply enough current for two erase heads and two record heads. If you should want to construct two bias circuits, however, they should be synchronized by connecting the high-impedance taps of the two secondaries together through a .02-μf capacitor.

On PLAYBACK the signal is fed to Q_7 from the head. It is equalized by the feedback networks from the collector of Q_8 to the emitter of Q_7. It is sometimes necessary to shunt C_{26} with a resistance of about 680k ohms, sometimes not. You can check this when setting up the recorder.

Q_9 is an emitter follower that drives the output transistor Q_{10} and isolates the equalizing circuits.

Critical Components

First, R_{31} and R_{43} should be selected to give a −2 volt reading at the collectors of Q_7 and Q_{11} with a supply of −18 volts. This value will probably be somewhere between 200k and 400k ohms. However, 330k ohms always seems to be quite suitable. You can use two 9-volt batteries if you want to select the values more carefully. This is vastly easier to do than to wait until the amplifier is completed.

C_{13} and C_{25} are two capacitors that must be checked with care. If either has any significant leakage the head will become magnetized. For C_{25} I used two 50-μf, 6-volt tantalum capacitors in series, which gives perfect safety. C_{13} is a paper capacitor with a voltage rating of 150. This solution, while completely effective, is just a touch expensive as these premium capacitors are more costly than the ordinary—and possibly leaky—electrolytics.

Low-noise resistors are preferred for R_6, R_{26}, R_{39}, R_5 and R_{41}. If you feel like

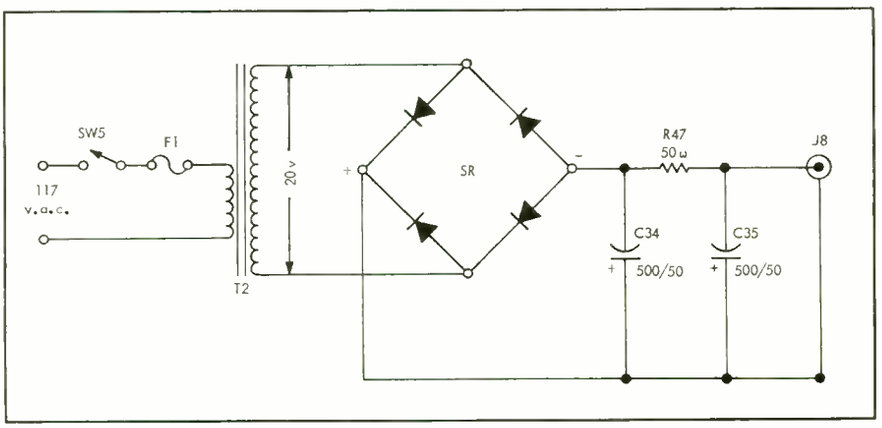


Fig. 5. Schematic of power supply.

one of the last of the big spenders you might consider making some of the following low-noise: R_7, R_{33} and R_{44}.

The power-supply voltage required will vary with the erase head. With my erase head the schematic values give −15 volts. Thus, it might be necessary to adjust the values of R_{25} or R_{47}, but this is an extremely simple task.

The pilot light PL-1 is operative on PLAYBACK. In this way the current consumed by the light brings the voltage to the correct voltage needed by the playback amplifier. This voltage is not really critical, I've at various times used from less than 15 volts to slightly more than 21 volts.

J_8 on the power supply feeds jack J_3 on the recorder. To operate on bat-

(*Continued on page 51*)

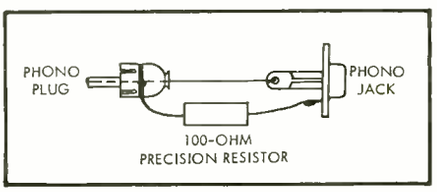


Fig. 6. Connector for measuring head current.

An All-Electronic Method for Tuning Organs and Pianos

A. M. SEYBOLD*

The first part of this series (February, 1963, issue) presented design and construction details for the electronic tuning equipment, as well as instructions for tuning the system to the American musical standard. This part discusses tuning of keyboard instruments to international musical standards, and presents construction details for a second model of the tuning oscillator. This second version of the electronic tuner offers the reader an extremely versatile instrument which, in addition to its musical applications, can also be used to measure audio frequencies. A final part will discuss frequency standards, the tuning of instruments to non-standard frequencies, and the construction of an inexpensive secondary frequency standard.

BESIDES SIMPLICITY AND ACCURACY, the electronic tuning system offers a degree of flexibility which is particularly useful in the tuning of pianos and organs using any of the musical standards found throughout the world. With the 27.5-cps oscillator described in the first part of this series (which for simplicity we will call Part I), the reader can readily tune a keyboard instrument to the French, English, or American musical standard. The only information needed for this tuning is given in Table I. This table of frequencies is based on an equal-tempered scale, and is applicable for the three most popular musical standards: the American standard 440-cps "*A*" adopted by the American Standards Association in 1936; the French 435-cps "*A*" adopted internationally in 1895; and the 439-cps standard used in England since 1891. The chromatic scales given in the table contain half-tones that are proportional to each other by a ratio of one to the twelfth root of two.

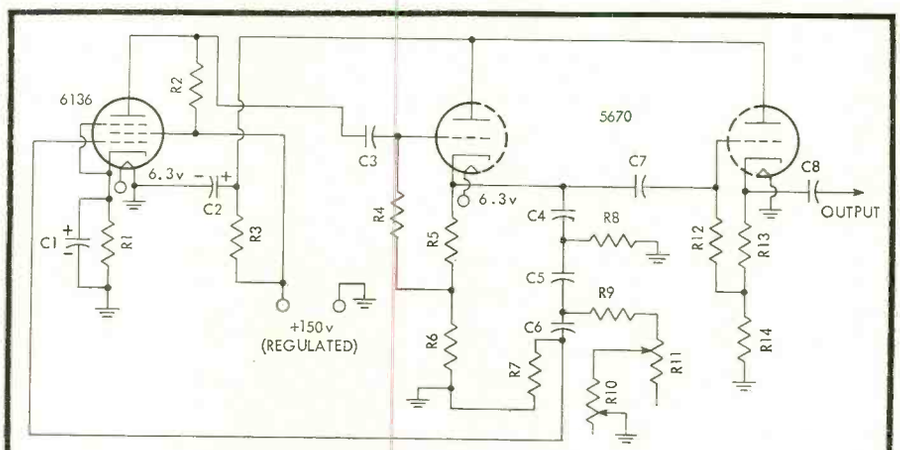
The details of tuning to standards other than 435, 439, and 440 cps will be discussed in the third article. The present discussion involves tuning to the same pitch by which the musical tuner is calibrated. In tuning an organ to the French standard, for example, the electronic tuner is first calibrated to the standard "*A*" of 435 cps. This calibration requires the use of a conventional tuning fork as a reference and a dial setting of 36.0 on the tuner. With this setting, the 27.188-cps oscillator frequency is then located. (This frequency corresponds to the figure shown for the French "*A*" in Table I.) After this step, the procedure for establishing a calibration curve based on 435 cps is the same as that described for the 440-cps curve in Part I.

After the 435-cps French standard calibration curve is constructed, the dial readings are determined from the curve for $G\sharp_4$ at 27.372 cps, $A\sharp_4$ at 27.110 cps, and the remainder of dial readings through D_6 at 27.325 cps.

The same procedure is used to establish a calibration curve for the 439-cps English standard, and to determine the dial readings for each tone on the scale. The same steps described in Part I for tuning to the American standard are also used for the French and English standards.

20-cps Tuner

Up to this point in the discussion, all tuning operations have been performed by means of an oscillator which operates in the vicinity of approximately 27.5 cps. This oscillator contains one vacuum tube, is stable and accurate, and meets all the requirements of a precise tuning system. The tuning device discussed in the remainder of the article matches the performance of the 27.5-cps oscillator, but has the added advantage of serving as a frequency reference for most of the audio spectrum. This tuner, which uses two tubes, is a 20-cps oscillator incorpo-



PARTS LIST

C1 1000 µf, 15 v ELECTROLYTIC	R5 220 ω, 1 w
C2 16 µf, 450 v ELECTROLYTIC	R6 820 ω, 1 w
C3, C7 0.1 µf, 600 v	R7 390,000 ω, 1 w
C4, C5 0.012 µf, 600 v MYLAR	R8 360,000 ω, 1 w
C6 0.01 µf, 600 v MYLAR	R9 180,000 ω, 1 w
C8 0.33 µf, 600 v	R10 20,000 ω, WW POT.
R1 330 ω, 1 w	R11 50,000 ω, WW POT.
R2 10,000 ω, 1 w	R12 560,000 ω, 1/2 w
R3 2200 ω, 1 w	R13 1000 ω, 1/2 w
R4 560,000 ω, 1/2 w	R14 33,000 ω, 1 w

Fig. 1. Circuit diagram for the 20-cps electronic tuner. The location of the components is not critical, but R_7 through R_{11} and C_4 through C_6 should be placed where heat from the tubes is not excessive.

* *Electron Tube Division, Radio Corporation of America, Harrison, New Jersey.*

TABLE I

CALCULATED FREQUENCIES FOR THREE MUSICAL STANDARDS

Tuning Data for the 27.5-cps Oscillator

Note	A = 440 cps American Standard			A = 439 cps English Standard			A = 435 cps French Standard		
	Actual Frequency	Mult.	Ref. Freq.	Actual Frequency	Mult.	Ref. Freq.	Actual Frequency	Mult.	Ref. Freq.
A 3	220.000	8	27.500	219.500	8	27.438	217.500	8	27.188
G#4	415.305	15	27.687	414.360	15	27.624	410.585	15	27.372
A 4	440.000	16	27.500	439.000	16	27.438	435.000	16	27.188
A#4	466.163	17	27.421	465.104	17	27.359	460.866	17	27.110
B4	493.883	18	27.438	492.760	18	27.376	488.271	18	27.126
C5	523.251	19	27.540	522.062	19	27.477	517.305	19	27.227
C#5	554.365	20	27.718	553.105	20	27.655	548.066	20	27.403
D#5	622.254	22.5	27.656	620.840	22.5	27.593	615.183	22.5	27.341
E5	659.255	24	27.469	657.757	24	27.407	651.763	24	27.157
F5	698.456	25.5	27.390	696.869	25.5	27.328	690.519	25.5	27.079
F#5	739.989	27	27.407	738.307	27	27.345	731.580	27	27.096
G5	783.991	28.5	27.508	782.209	28.5	27.446	775.082	28.5	27.196
D6	1174.659	42.5	27.639	1171.989	42.5	27.576	1161.310	42.5	27.325

rating a cathode-follower stage. This latter feature helps to isolate the oscillator from any load that might be applied. In addition, the 20-cps tuner is designed so that it may be checked against both 60- and 50-cps a.c. line frequencies.

Figure 1 shows the circuit of the 20-cps oscillator. Triode unit B of the 5670 double triode serves as the output cathode-follower. Because of this isolation stage, the oscillator can be calibrated while connected to the vertical terminals of an oscilloscope and then used in the horizontal circuit without readjustment. (The one-tube oscillator does not have this degree of isolation, but can maintain excellent stability as long as it is fed into the same load resistance.) The oscillator stage uses a 6136 premium tube designed for mechanical and electrical stability. Triode unit A of the 5670 isolates the plate circuit of the 6136 from the phase-shift network and at the same time connects the 6136 plate circuit to a constant high-impedance load. (This load, the grid circuit of the output cathode follower, has negligible influence on the oscillator frequency.)

Resistors R_{10} and R_{11} control the frequency; they function as discussed in detail in Part I. As in the single-tube circuit, slight modifications of the values of R_7, R_8, and R_9 may be necessary to adjust for normal component variations. In addition, adjustments may be needed to permit R_{10} and R_{11} to operate in the correct range of control at 20 cps.

An accurately divided dial face (shown in *Fig.* 3 of Part I) is needed under the pointer of the dial for R_{10}. A similar dial face can be used for R_{11} if the tuner is to be used for laboratory frequency measurements, or if frequency ranges wider than those used for tuning are required. Otherwise, a simple knob can be used on the shaft of R_{11}.

The power supply for the 20-cps tuner is the same as that used for the 27.5-cps tuner. As described in Part I, the power-supply components are mounted on a separate chassis to reduce the heat in the oscillator section. The oscillator plate voltage is supplied by an 0A2 voltage regulator tube which provides the regulation necessary for oscillator stability. Although the 0A2 is a relatively low-impedance device and can adequately control the oscillator circuit, its impedance is not low enough to maintain isolation between the two cathode-follower stages and the oscillator. Therefore, an RC filter (R_3 and C_2 in *Fig.* 1) is used to eliminate coupling between the plates of the oscillator and the cathode followers.

TABLE III

CALCULATED FREQUENCIES FOR THREE MUSICAL STANDARDS

Tuning Data for the 20-cps Oscillator

Note	A = 440 cps American Standard			A = 439 cps English Standard			A = 435 cps French Standard		
	Actual Frequency	Mult.	Ref. Freq.	Actual Frequency	Mult.	Ref. Freq.	Actual Frequency	Mult.	Ref. Freq.
A 3	220.000	11	20.000	219.500	11	19.955	217.500	11	19.773
G#4	415.305	21	19.776	414.360	21	19.731	410.585	21	19.552
A 4	440.000	22	20.000	439.000	22	19.955	435.000	22	19.773
A#4	466.163	23.5	19.837	465.104	23.5	19.792	460.866	23.5	19.611
B4	493.883	25	19.755	492.760	25	19.710	488.271	25	19.531
C5	523.251	26	20.125	522.062	26	20.079	517.305	26	19.896
C#5	554.365	28	19.799	553.105	28	19.754	548.066	28	19.574
D5	587.329	29.5	19.909	585.995	29.5	19.864	580.655	29.5	19.683
D#5	622.254	31	20.073	620.840	31	20.027	615.183	31	19.845
E5	659.255	33	19.977	657.757	33	19.932	651.763	33	19.750
F5	698.456	35	19.956	696.869	35	19.911	690.519	35	19.729
F#5	739.989	37	20.000	738.307	37	19.954	731.580	37	19.772
G5	783.991	39	20.102	782.209	39	20.057	775.082	39	19.874

Calibration

Calibration of the 20-cps oscillator is similar to that described for the 27.5-cps unit. A steady 220-cps "*A*" from an organ is used to construct the calibration curve. There are 11 sine waves in the pattern at 20.000 cps; at various points on either side of this 20-cps point on the curve, the count is taken with a stopwatch or second hand of a clock. The frequencies needed for tuning musical instruments to the American standard scale range from 19.700 to 20.150 cps. A sample set of curves is shown in *Fig.* 2 and 3. (For best accuracy, two sheets of graph paper such as K & E 359–14 are used to expand the scale.) On the dial, 52.0 was selected as the calibration point for 20.000 cps.

To review the procedure for the reader, I will describe how one point on the curve is established. (The determination of all points on the curve was described in detail in Part I.) Proceed as follows: First, the 52.0 dial setting is checked to make sure that a synchronized pattern containing 11 sine waves is produced. A 220-cps "*A*" is played, and the tuner range knob is adjusted for exact synchronization. Then the dial is set at 1.0 division. The number of shifts at the end of the sine-wave pattern on the scope are counted for 30 seconds, and the frequency is calculated. At a dial setting of 1.0, 99 shifts in 30 seconds would be 99/30 or 3.3 shifts per second. With 11 sine waves in the scope pattern, the frequency difference in cycles per second would be 3.3/11 or 0.300. Thus, at a dial setting of 1.0 division, the frequency is 20.000–0.300 or 19.700 cps.

Similar points taken at 10- to 15-division intervals on the dial are plotted on two sheets of graph paper; the resulting curve is almost a straight line, and serves as the calibration curve for the device. This curve will be slightly different for each tuner; *Figs.* 2 and 3 represent the curve for the tuner built by the author.

Table II contains data obtained from the calibration curve for tuning organs to the 440-cps American Standard. A similar table incorporating dial settings from one's own calibration curve should be kept with the 20-cps tuner. The step-by-step procedure for tuning the reference octave from $G\sharp_4$ at 415.305 cps to

TABLE II
TUNING PROCEDURE FOR 20-CPS OSCILLATOR

TUNE	Vernier Dial Setting	Sine Wave Pattern	Multiplier	Reference Frequency	Actual Frequency	Notes
Range Dial	*	1	22	*	*	Set vernier dial as temperature chart indicates
—	52.0	1	22	20.000	440.000	This vernier dial setting (52) is the 440-cps reference
A 4	52.0	1	22	20.000	440.000	Tune A4, but from here on A4 is not to be retuned
G#4	14.3	1	21	19.776	415.305	
Check	52.0	1	22	20.000	440.000	Retune the range dial if necessary
A#4	24.8	2	23.5	19.837	466.163	
B 4	10.6	1	25	19.755	493.883	
C 5	72.7	1	26	20.125	523.251	
Check	—	1	—	—	—	If retuning is necessary, check A#, B, C
C#5	18.3	1	28	19.799	554.365	
D 5	37.5	2	29.5	19.909	587.329	
D#5	64.1	1	31	20.073	622.254	
E 5	48.4	1	33	19.977	659.255	
Check	—	1	—	—	—	If retuning is necessary, check C# through E
F 5	45.0	1	35	19.956	698.456	
F#5	52.0	1	37	20.000	739.989	
G 5	68.9	1	39	20.102	783.991	
Check	—	1	—	—	—	If retuning is necessary, check F through G

G_5 at 783.991 eps is given in the table. For instruments requiring the tuning of octaves above and below the reference octave, Part I should be reviewed.

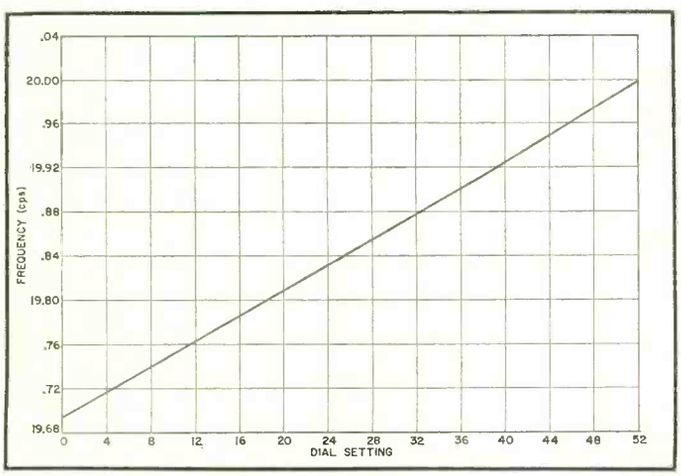
When the 20-eps oscillator is used for English or French standard *"A"*'s, Table III should be used for the calibration and tuning reference frequencies. The procedure for calibrating to the English standard is as follows: First, A_4 on the organ is set at 439 eps by means of a tuning fork. Then A_3 is set at 219.5 eps by zero-beating it with A_4. Note A_3 is then played and, with the oscillator dial set at 52.0 divisions, the range knob is rotated until a pattern containing 11 sine waves is synchronized on the oscilloscope. By means of a stop watch, the dial is then calibrated from 1.0 to 80.0 divisions, and the results are plotted on a calibration curve. This curve is then used to establish the dial reading that provides the 19.731-eps reference (from Table III) for $G\sharp_4$. In the same manner, dial indications for tones $A\sharp_4$ through G_5 are determined from the calibration curve. These figures should then be compiled as a permanent reference source, and used whenever an English standard is involved.

Tuning Accuracy

The foregoing discussion has presented devices and procedures for an accurate tuning system. The remainder of the article describes an analysis of the accuracy of the system. With this analysis, it is possible to anticipate what errors will occur when this method is used to tune instruments to standards other than the American, French, and English.

First, the accuracy with which the dial could be reset to the same frequency was checked. Repeat readings were obtained by means of the oscilloscope which determined synchronization each time the dial pointer was returned to the same division mark on the dial. This test proved that no error could be found in resetting the dial to "whole-number" divisions. Then checks were run on estimated return points between whole numbers. By estimating tenths of divisions it was found possible to return to within ± 0.1 division of a predetermined number. Thus, the frequency deviations in the vicinity of 20.0 eps were found to be in the order of ± 0.0006 eps or an error of ± 0.003 per cent. Another source of error is the "rounding-off" of the third decimal place in the frequency of the 20-eps oscillator. All of the rounding-off errors fall between ± 0.0021 per cent, the average being ± 0.001 per cent.

An error of less than 1/100th of a semitone (or "one cent" in organ terminology) is an objective of tuning systems. This magnitude of error is 0.059 per cent, and is quite acceptable, although a good musician-piano tuner can exceed this accuracy. For instance, tuning D_4 from A_4 by ear requires a beat-note count of 10 beats in 10 seconds. This beat note can be considered as the beating of the 2nd harmonic of 440 eps (880 eps) with the 3rd harmonic of 293.664 eps (880.992). The difference is 0.992 beat per second, or approximately 10 beats in 10 seconds. A normal error in



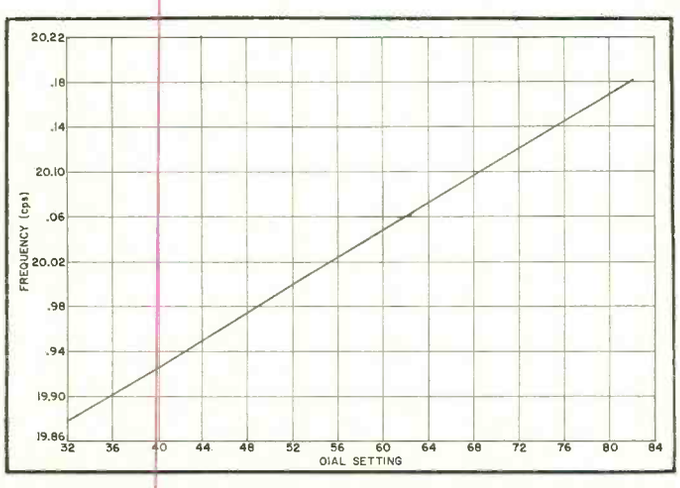
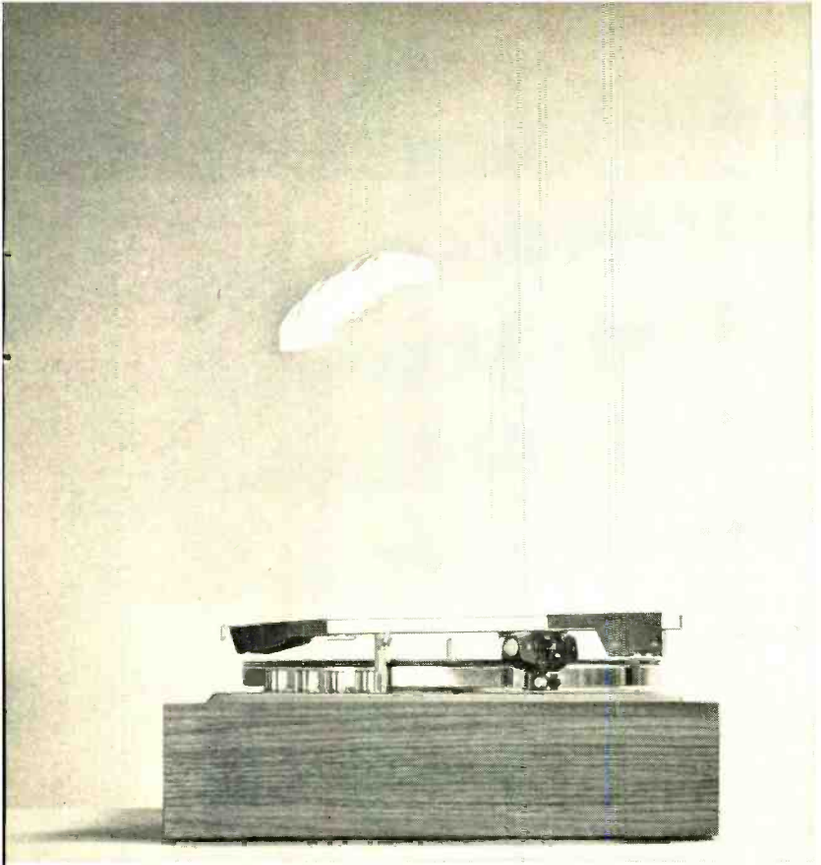
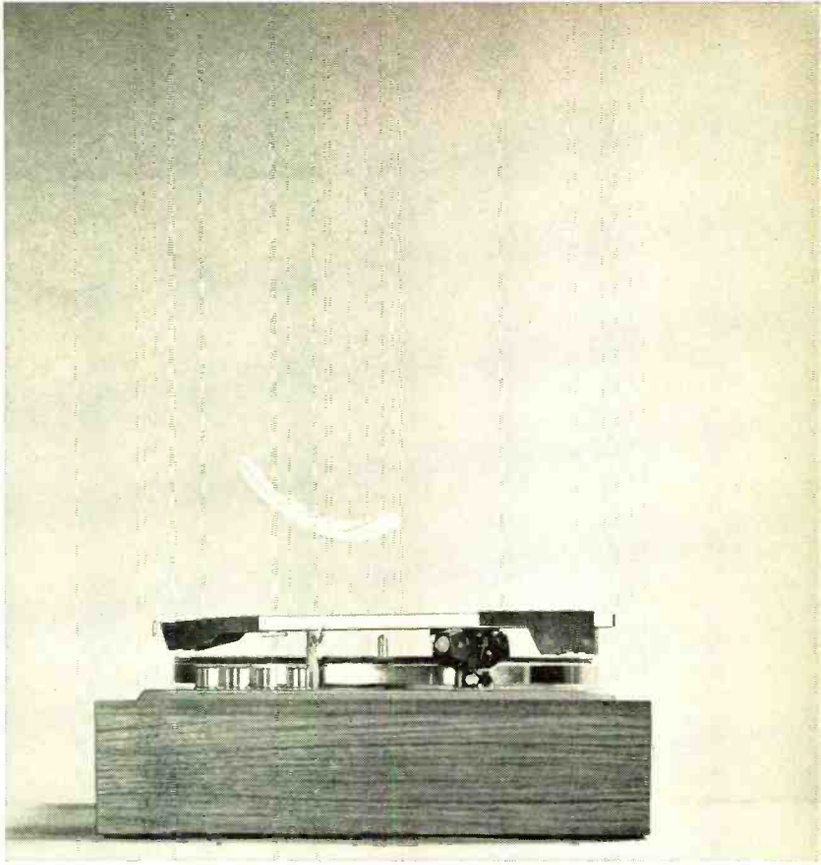
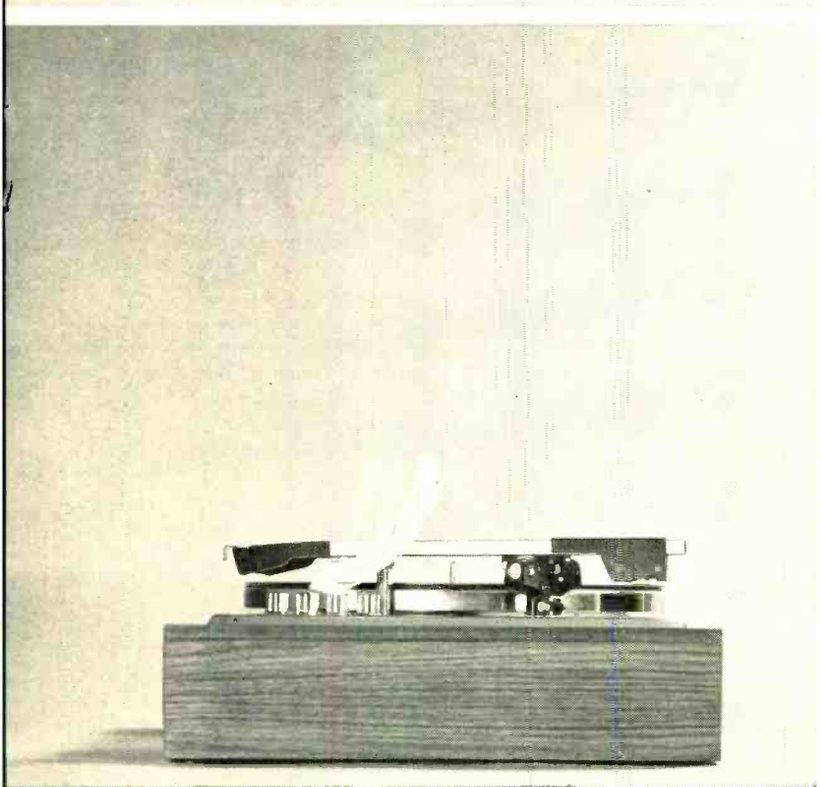
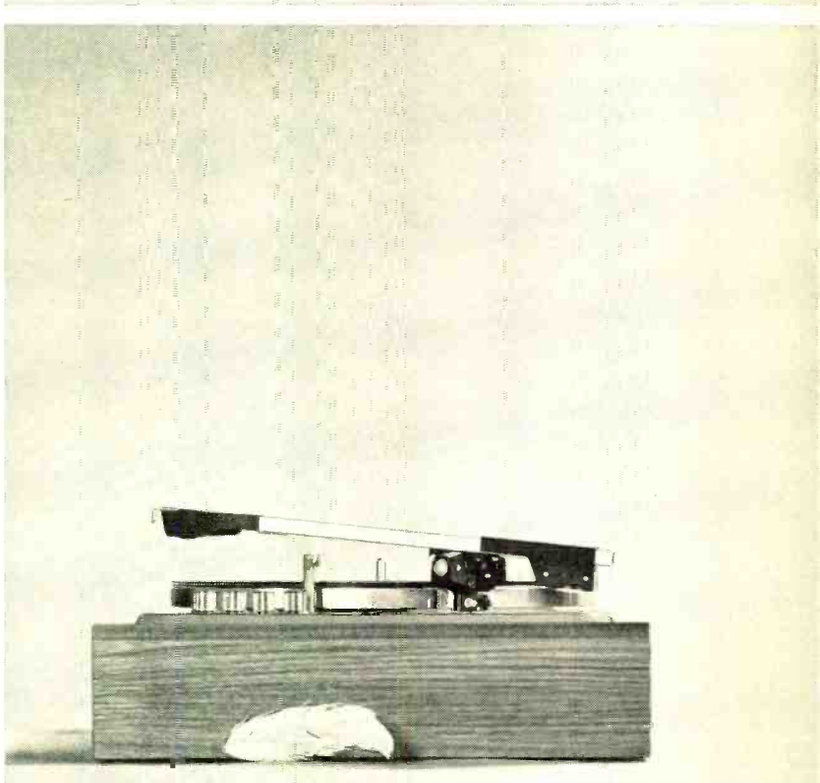


Fig. 2 (left). Colibration of the low-frequency end of the oscillator dial. Fig. 3 (right). Calibration of the high frequencies. Individual models of the tuner have similar, but not identical, curves to those shown here and in Fig. 2. As a result, each unit must be calibrated separately as described in the text.









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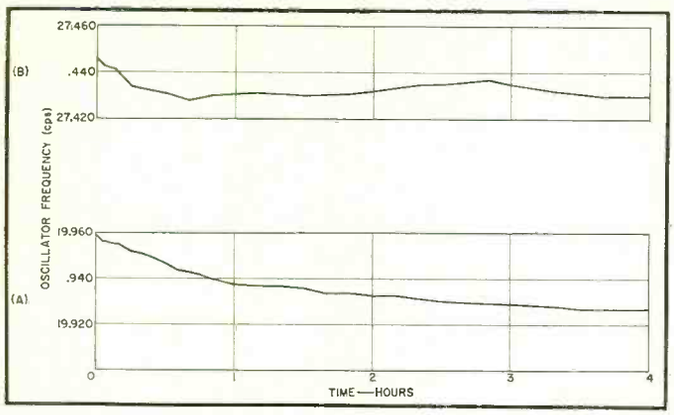


Fig. 4. (A) shows that the 20-cps tuner changes frequency from the time it is turned on until it approaches temperature equilibrium; (B) shows the behavior of the 27.5-cps oscillator. The rate of frequency drift was required to determine tuning accuracy.

estimating or counting the 10 beats can be expected to be one-half beat out of the 10, so that the 3rd harmonic of D_4 is set at 880.942 cps instead of the 880.992 cycles desired. When D_4 is being tuned, this 0.05-cps difference represents a 0.0166-cps error at 293.664 cps, or an error of 0.005 per cent. The dial-reading error of 0.003 per cent for the electronic tuner, therefore, is less than the error expected of musicians, and is considerably lower than the error of many tuning systems and the "one-cent" level of mechanical devices.

In the evaluation of all possible sources of error in the electronic tuning system, one of the questionable items is the use of the sine-wave trace as a synchronization indicator. The spot where the return trace breaks into the start of a sine wave is very clear on the cathode-ray tube. When this spot stands still, synchronism has been reached (however, the degree a spot moves when it is thought to be stationary determines the real accuracy).

To evaluate the sine-wave trace as a synchronization indicator, the author ran a test with a 440-eps signal synchronized on the scope by the 20-cps tuner. This test produced a regular pattern with 22 sine waves. The frequency of the 20-cps oscillator was varied until motion of the starting point was just visible. The crawl of this pattern was timed, and it was found that one complete sine wave shifted past the end of the pattern in 60 seconds (0.0166 shift per second). The number of shifts (0.0166) divided by the number of sine waves (22) equals 0.00075 cycles, the change in frequency. At 440 cps, a change in frequency of 0.00075 cps represents an error of 0.00017 per cent. Because the pattern motion producing this error is readily discernible, the contribution of synchronization technique to system error is negligible.

The frequency drift of the tuning oscillator was studied by the author to determine its influence on tuning accuracy. Oscillator frequency is shown as a function of time in (A) of *Fig.* 4. After an initial warmup of one hour, the average slope of the curve is 0.00007 cycle per minute, which represents an error of 0.00035 per cent. This error is small compared to the dial-reading error of 0.003 per cent. The interval of one minute is conservative; it takes much less time to tune a note to synchronism on the scope.

The section of the frequency-drift curve having the steepest slope indicates a maximum shift of 0.0002 cycle per minute. This shift is quite small and is equivalent to an error of only 0.001 per cent in one minute. An even smaller error could be expected if silver-mica capacitors were used for C_4, C_5, and C_6 instead of the Mylar units. (B) of *Fig.* 4 shows the frequency-drift curve of the one-tube tuner which uses silver-mica capacitors. As shown, the maximum slope is 0.0002 cycle per minute, or a 0.0007 per cent error caused by frequency drift. With either oscillator, this type of error is also minimized by periodic resetting to the reference *"A"*.

Reference Frequencies

In addition to the small errors discussed above, the relationship between the reference frequency and tuning error should be considered. When the 60-cps line is used to establish *"A"* in the organ being tuned, an exact 220.000-cps or 440.000-cps tone cannot be expected. *Fig.* 5 shows actual a.c. line-frequency variations observed during an 8½-hour period; the variations are averaged over one-minute intervals. *Figure* 6 shows the line frequency averaged over six-second intervals at one point during the 8½-hour period. Spot checks taken at other times indicate that the greatest deviations to be expected are in the order of ± 0.2 cps.

Obviously, a 60-cps line cannot be used as an absolute standard; however, it can be used to establish a frequency within reasonable tolerances. For example, *Fig.* 5 shows the greatest deviation for the 440-cps tone referenced to the local a.c. line was 60 ± 0.2 cps times 7.3333, or from 441.466 to 438.533 cps. For any application where the frequency need only be known within 0.33 per cent, the 60-cps line is entirely adequate. Actually, an accuracy of ± 0.1 cps can be expected for all but a few minutes during peak load shifts, so the frequency reference is within ± 0.16 per cent of the nominal value. This error is generally exceeded by that of low-cost tuning forks.

It must be remembered, however, that once *"A"* is set in the organ, it should *not* be rechecked against the a.c. line and expected to be found in synchronism. Æ

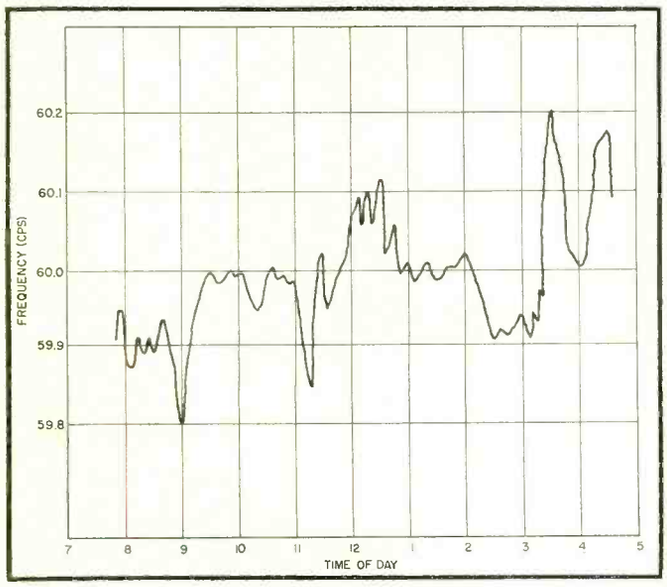
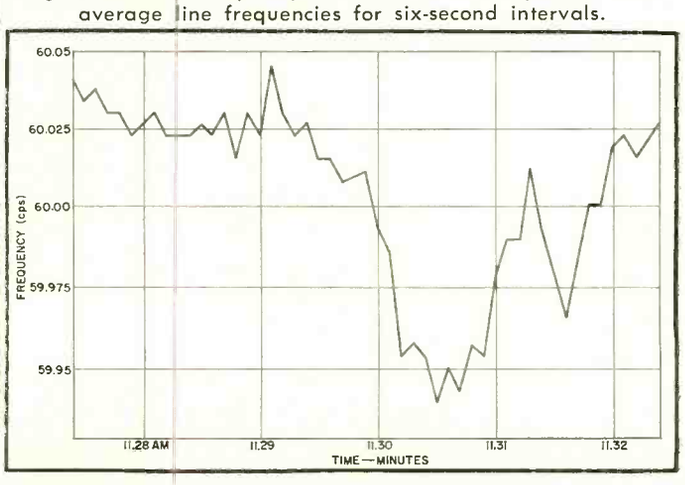
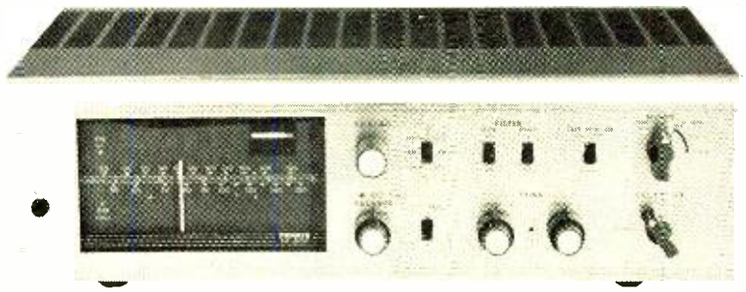


Fig. 5 (left). Measured frequency variation of a 60-cps line; points on the curve represent average values for one-minute intervals. Frequency variation was less than 0.1 cps for 75 per cent of the time, and less than 0.05 cps for 50 per cent of the time.

Fig. 6 (below). Frequency variation of a 60-cps line with average line frequencies for six-second intervals.



NEW PRODUCTS



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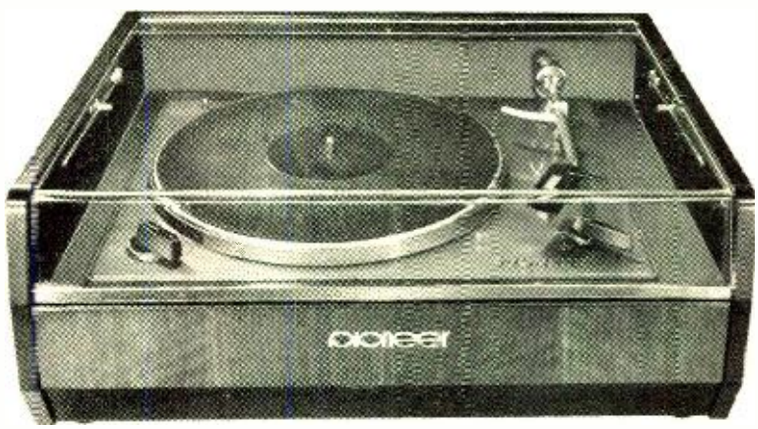

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Checking Frequency-Compensating Circuits

MANNIE HOROWITZ

Tone controls, scratch and rumble filters, and loudness contour networks all alter the "flat" response of an amplifier to satisfy a particular purpose. In order to check a particular amplifier for one of these functions it is necessary first to understand the purpose.

HIGH-FIDELITY AMPLIFIERS are usually equipped with an ample quantity of frequency-discriminating functions. These include some type of variable bass- or treble-compensating network as well as loudness controls and scratch and rumble filters. Each designer of audio equipment has his own prejudices as to the relative need for each of these functions. Some engineers feel that any deviation from a perfectly flat frequency response is a deviation from "true" high fidelity. Others have made a life study of frequency-compensation requirements and have designed complex networks to suit their research conclusions. In this article, four groups of these functions will be considered: The tone control, scratch filter, rumble filter, and loudness control.

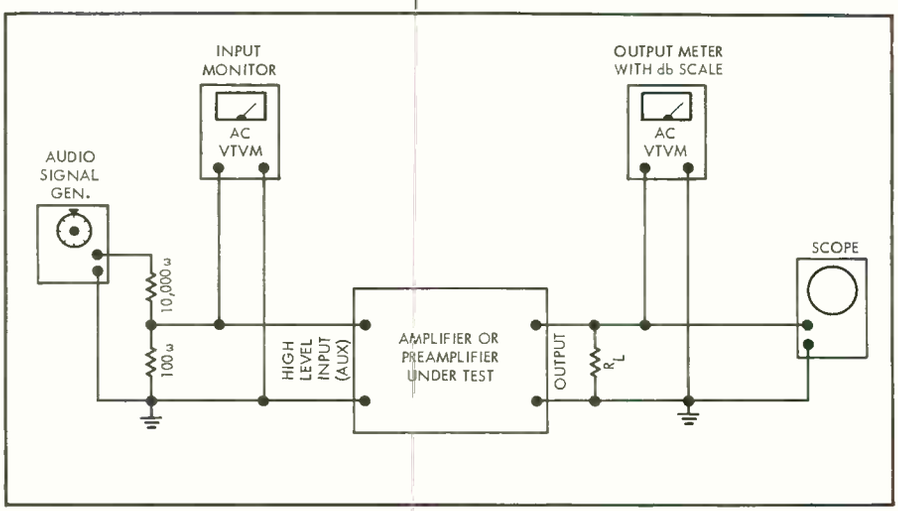

Fig. 1. Test circuit. R_L is equal to the characteristic load resistance at the output transformer of the power amplifier. Do not use a resistor when testing a preamplifier.

The Tone Control

Every high fidelity amplifier has at least one such control while most have two. The primary function is to compensate somewhat for room acoustics. Many audiofans use these controls to satisfy various secondary functions—compensate for a poor phonograph cartridge, get a booming bass, produce a piercing "high fidelity" treble, reduce turntable rumble, reduce record scratch or tape hiss, and so on.

A complete set of tone controls should provide, in varying degrees, five groups of frequency characteristics. The four most obvious are bass and treble boost and cut. The fifth, and most important, is a flat frequency response. While most controls will give adequate boost and cut, many will not have one definite position where the frequency response is held to within ±1 db over the entire audible spectrum.

The setup shown in *Fig.* 1 can be used to test the tone controls. This is identical to the circuit described in previous articles discussing measurement of frequency response in the amplifier and preamplifier sections. Little need be said here concerning the circuit. A few words on application should be repeated here to prevent fallacious readings.

First, all level controls on the amplifier under test must be set at maximum to prevent the frequency-response curve from being influenced by any stray capacitances inherent in these controls.

Next, the output from the signal generator must be low enough so that the amplifier will not be overloaded at any frequency used in the test. As an example, an amplifier providing five clean volts at 20 cps should never be required to deliver more than this at any setting of the tone control. If 20 db of boost is expected at 20 cps in the maximum bass-boost position, set the output from the generator so that the amplifier can provide this boost without distorting. If the maximum undistorted output voltage from the amplifier is five volts at 20 cps, the reference level should be at most 20 db below this point, or 0.5 volts.

Finally, monitor the output from the signal generator using an a.f. voltmeter. This is important because the output from the generator may not be constant over the entire frequency range. The output from the amplifier should also be observed on a scope to be certain that the output meter is indicating a sinusoidal signal and not hum or a non-sinusoidal signal.

Bearing these precautions in mind, the various functions of the tone controls can now be checked.

Determine the maximum essentially-sinusoidal output from the amplifier at 20 and 20,000 cps. Choose a convenient voltage (or reference level on the db scale) 20 to 25 db below the lower of these two readings. This is the reference level. Now adjust the tone controls for the most linear output over the entire audio range, at this reference level. Draw this curve.

Note the amplifier settings for flat frequency response. Now set the bass control for maximum boost. Readjust the signal generator so that the output meter will once again read the reference level at 1000 cps. Draw the frequency-response curve using this 1000-cps level as the 0-db reference point. The curve should be checked from 20 to 20,000 cps to determine the effect of this control at all portions of the audio range.

Now take readings for some setting of the bass control midway between the flat response and maximum bass boost. Do the same for the maximum bass attenuation setting as well as some point mid-

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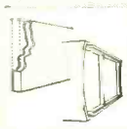

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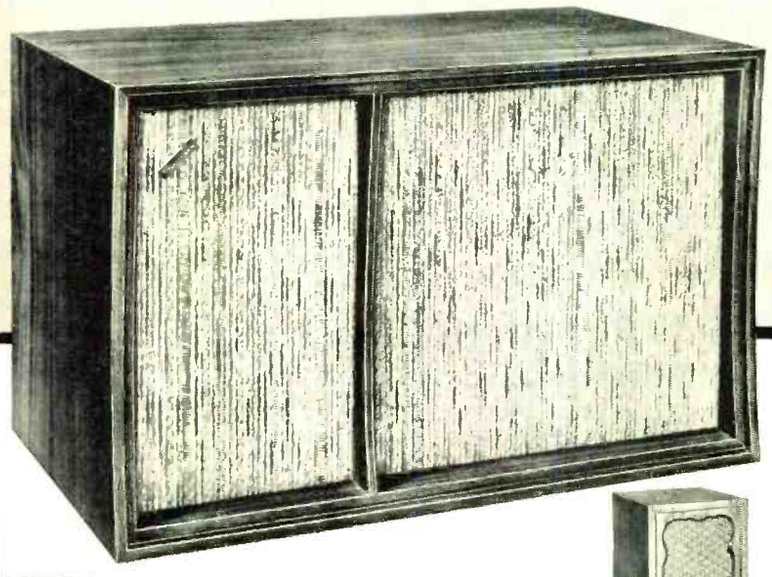

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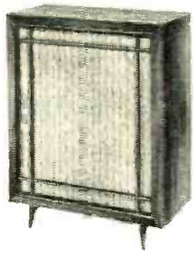

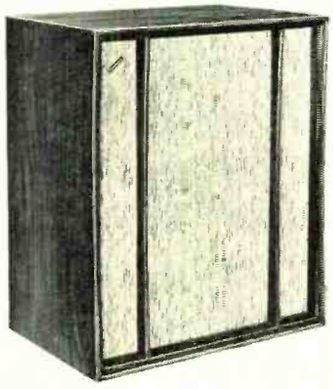

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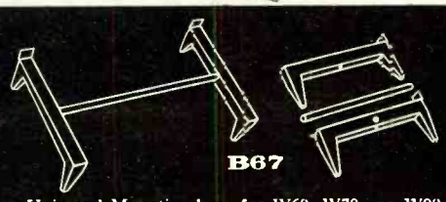

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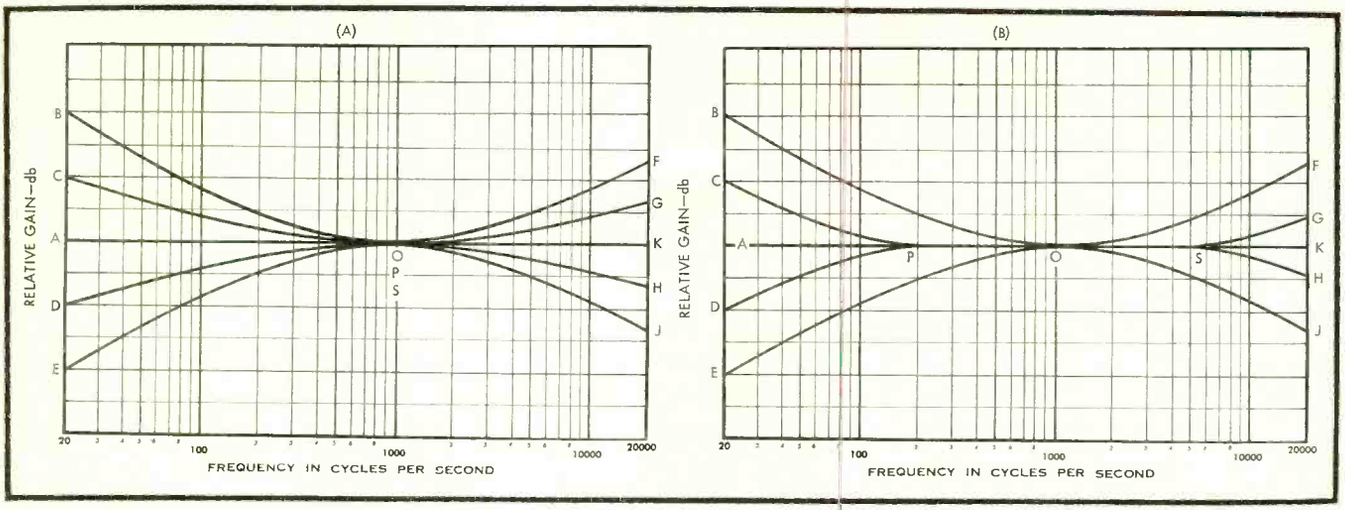


Fig. 2. Typical tone control curves resulting from: (A) A losser circuit, and (B) a Baxendall circuit. A-O-K is the "flat" line, B-O-K is maximum bass boost, E-O-K is maximum bass cut, A-O-F is maximum treble boost, and A-O-J is maximum treble cut. Other curves represent intermediate settings of the tone controls.

way between the flat response and maximum cut.

Repeat all four measurements for the various settings of the treble control. Each time check the response from 20 to 20,000 cps relative to the same 1000 cps 0-db reference level.

Two of the many possible sets of curves resulting from these tests are shown in *Fig.* 2. The curves shown in (A) are those usually provided by a losser-type tone-control circuit, while those in (B) are characteristic of the Baxendall-type feedback circuit.

In the Baxendall circuit, the curves for the extreme settings of the controls pivot around some mid-frequency, such as 1000 cps ("0" on the curve). At intermediate settings of the bass control, the curves start to rise and fall at some frequency less than 1000 cps ("P" on the curve) while the upper and middle frequencies are not affected. Similarly, the curves for intermediate settings of the treble control start to rise and fall at a frequency above 1000 cps ("S" on the curve). Only the extremes of the audio band are affected by this type of tone control network.

This is not the case with controls using the losser type of network. In this case, the curves pivot around a mid-frequency for all settings of the controls. Effectively, points "O," "P," and "S" merge to one point. The entire upper half of the band is affected when the treble control is adjusted and the entire lower half of the band is affected when the bass control is adjusted.

The Baxendall arrangement is most desirable in high-fidelity applications because it is more selective than the losser arrangement. In amplifiers where the frequency range is limited, the losser type of circuit is more desirable. In these cases, extremes of the audio range do not exist. The Baxendall circuit produces no noticeable effect for most of the range while the frequency variations caused by the losser circuit are usually quite obvious.

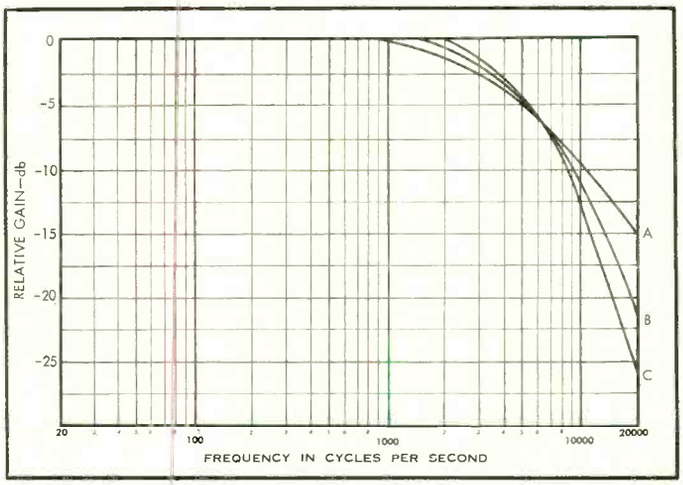


Fig. 4. Effect on amplifier of using (A) one, (B) two, and (C) three of the scratch filter sections shown in Fig. 3. All curves are 6-db down at 6300 cps.

The curve for flat response, "AOK," has been assumed perfectly flat. This is, of course, an ideal situation seldom obtained, especially with circuits of the losser type.

It has also been assumed that each control affects only a portion of the frequency range. The bass control should affect only the low frequencies while the treble control should affect only the highs. Actually this is only partially true. The suggested test for each setting covered the entire audible spectrum. This was done to check the effect of the controls at all sections of the audio range to determine the effects on the sections they should not control as well as the amount of control they do exert over the assigned portion of the spectrum. The amount the bass control affects the treble and the treble control affects the bass, is a measure of quality. Naturally the least effect is the most desirable.

Tone controls should not affect the average volume level. The 1000-cps reference level should remain unchanged whatever the setting of the controls may be. Any change from the predetermined reference level at 1000 cps is an indication of the quality of the particular circuit.

As a final thought, no distortion should be produced at any setting of the tone controls. The Baxendall type of tone control is reasonably distortion free. In a well-designed circuit, the losser type can also provide clean output.

Some "economy" arrangements, such as placing the tone controls in a feedback loop around the output transformer, gives satisfactory performance at flat response settings, but result in entirely too much distortion at extreme boost

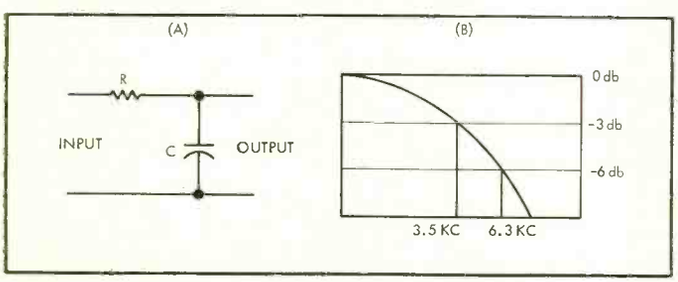
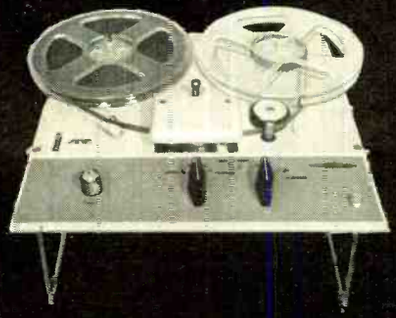


Fig. 3. (A) is the circuit for the scratch filter and (B) is the response of the amplifier with the filter.

3 FOR 4-TRACK BY HEATHKIT



4-TRACK STEREO TAPE PLAYER*

• Plays pre-recorded 4-track stereo or mono tapes through amplifier tape head inputs • Convert to recorder by adding electronics later • 7½ & 3¾ ips • Fast forward & rewind • 7" reels • Digital counter • Response 40-15,000 cps, ±3 db • Wow & flutter .2% or less at 7½ ips KIT AD-12, 16 lbs. no money down, $12 mo. $124.95

4-TRACK STEREO TAPE RECORDER*

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4-TRACK PORTABLE STEREO RECORDER*

• Includes all amplifiers & speakers • Records & plays 4-track stereo & mono tapes • 7½ & 3¾ ips • Bar-type level indicators • Mike & line inputs • Dual two-way speaker systems • Stereo headphone jack • Factory assembled case with lift-top lid and swing out detachable speaker wings KIT AD-72, 43 lbs., no money dn., $19 mo., $198

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positions. This can readily be verified in amplifiers using this circuit.

The Scratch Filter

Any filter placed in a circuit limits the full frequency range. Scratch filters are no different. A good filter is designed to minimize this factor.

Scratch noise from phonograph records and hiss from tape produce audible components, primarily in the upper frequency range. The convenience of this coincidence allows one filter to be designed to eliminate or minimize both types of interference by simply limiting some of the higher frequencies. A good filter will minimize only the highest frequencies. A poor filter will also attenuate the mid-frequencies.

The exact frequency at which the attenuation should be maximum to best eliminate noise is a variable often determined by the whim of the particular design engineer. For good noise suppression, this frequency must be down far enough to encompass the lowest noise frequencies, and it must be high enough so as not to eliminate any more of the high frequencies than is absolutely necessary. In this discussion it will be assumed that it is desirable to 6 db down at 6300 eps and have a 6-db-per-octave rolloff above.

Although it may be analytically difficult to calculate R and C from the 6-db point, it can be easily determined when the 3-db attenuation frequency is considered. From the curve in (B) of *Fig.* 3, the frequency at which the output has dropped 3 db is 3500 eps. Thus the product of R and C required to produce this curve is

$$RC = 1/(2\pi f) = 1/(2\pi \times 3500) \quad Eq.\ (1)$$

All of R and a portion of C are usually integral parts of the circuit (inherent tube capacitance and circuit resistance) in which the filter is to be included. Experimental methods must be used to determine the amount of C that must be added to the existing circuit to provide the 6-db cut at the predetermined frequency.

A close look at the curve in (B) of *Fig.* 3 shows up two major disadvantages of the filter. First, the high-frequency rolloff starts at 1000 eps—a frequency which we don't want affected to any noticeable degree. Second, at the highest frequency that must be attenuated by the filter, 15,000 eps, the gain is only down about 12.5 db. This rolloff is frequently inadequate. This information is redrawn as curve (A) in *Fig.* 4.

More networks of this type, with identical time constants ($R \times C$), can be added into the path of the signal to further attenuate the high frequencies. Curve (C) in *Fig.* 4 shows the result of three such networks in one amplifier. The rolloff starts at 2000 eps, an improvement of one octave over curve (A), and the gain is down 20 db at 15,000 eps, an improvement of 7.5 db. Although adequate, the three tandem networks add attenuation into the circuit with all the associated disadvantages.

A good compromise uses two such networks. Comparison of curves (B) and (C) in *Fig.* 4 indicates just how minor this compromise is.

Scratch filters (and the rumble filters discussed below) have frequently been included in feedback networks to provide an extremely sharp rolloff. Stereo amplifiers seldom, if ever, include these networks in feedback loops because of high cost as well as the dubious value.

The circuit in *Fig.* 1 may be used to test the filter network. First, adjust all controls on the amplifier for maximum flat response. Next, switch the filter into the circuit. Set the output from the signal generator so that the amplifier will reproduce 1000 eps at a level several db below its maximum output capabilities. Check the response from 20 to 20,000 eps to determine just how effective the rolloff filter is the frequency at which attenuation is 6 db, and just how the filter reshapes the portion of the studio spectrum it should not affect.

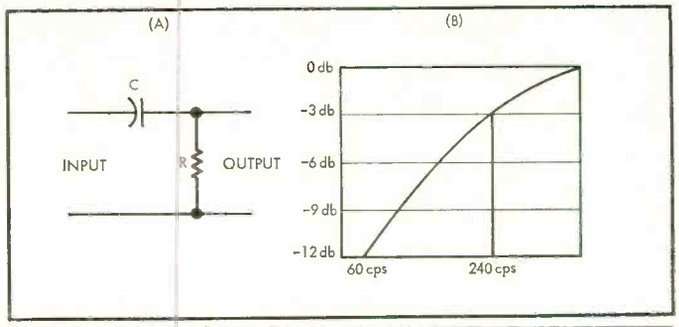


Fig. 5. (A) is the circuit for the rumble filter and (B) is the response of the amplifier with the filter.

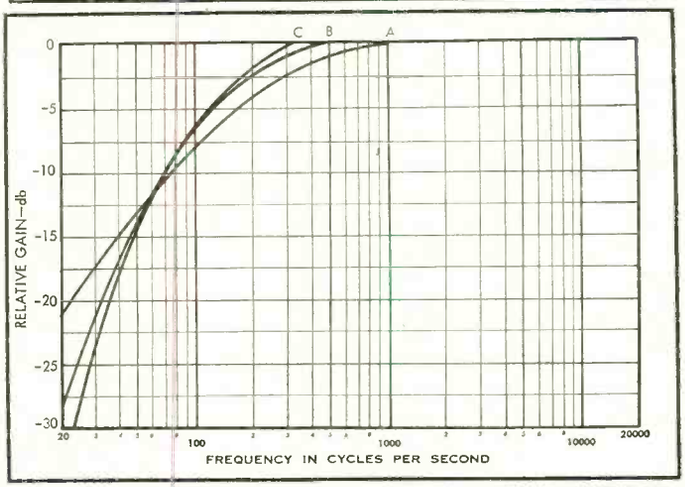


Fig. 6. Effect on amplifier of using (A) one, (B) two, and (C) three of the rumble filter sections shown in Fig. 5. All curves are 12-db down at 60 cps.

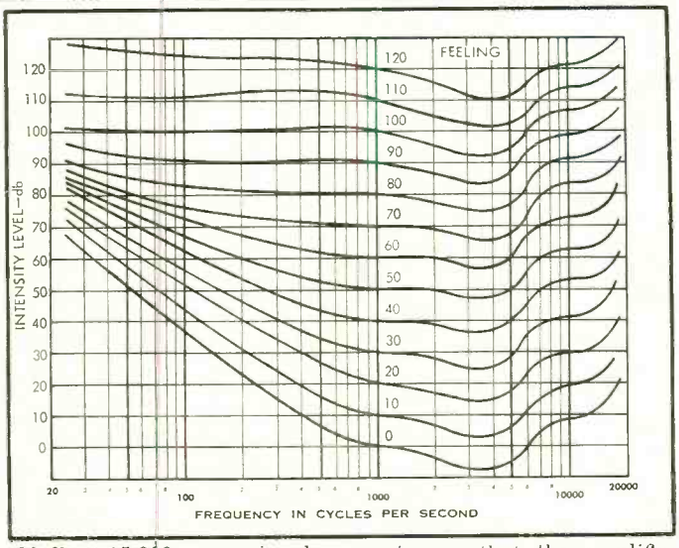
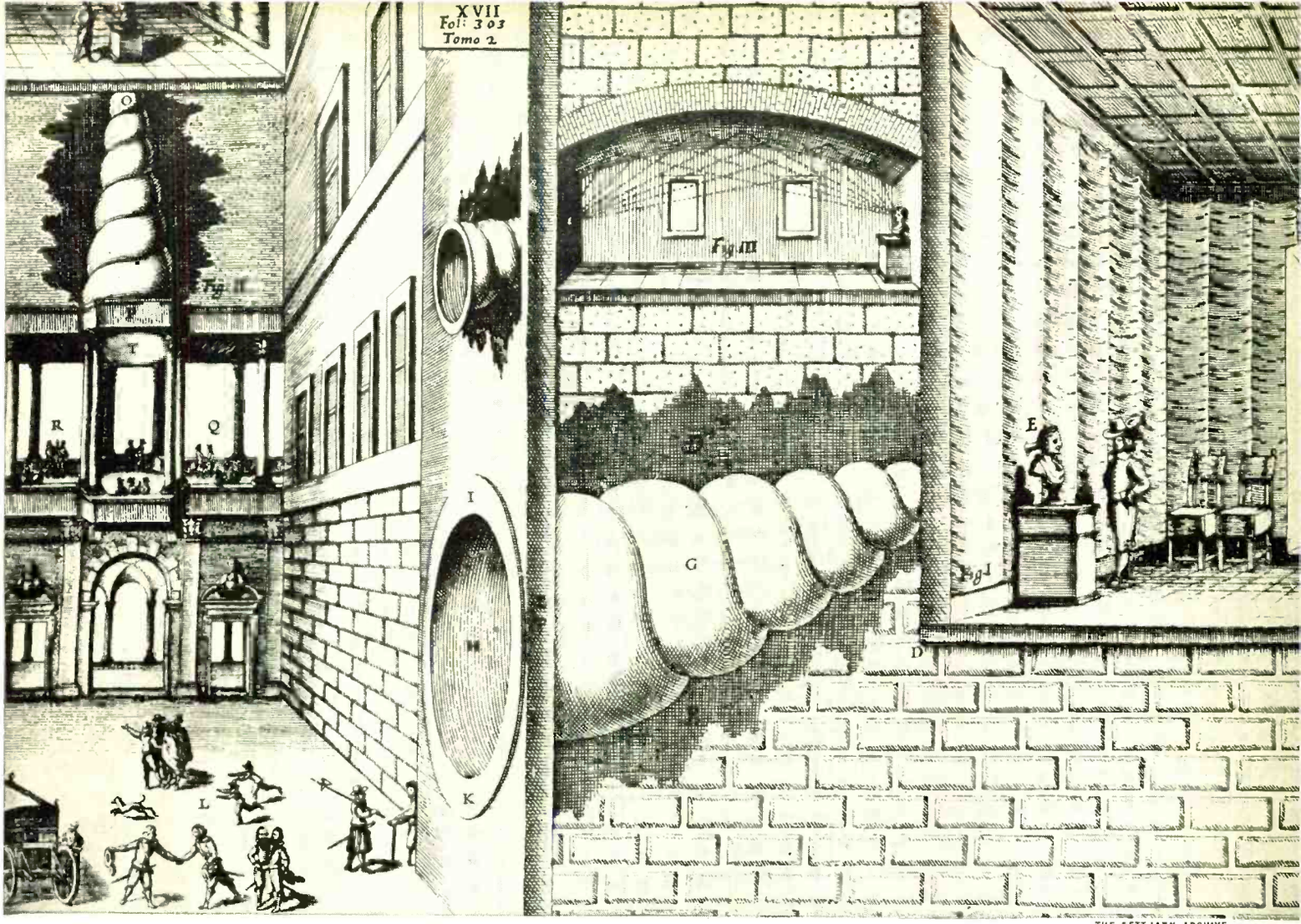


Fig. 7. Loudness-level contours (Fletcher and Munson).

The Rumble Filter

The rumble-filter network attenuates the low frequencies caused by rumble in the turntable. For a turntable with a two-pole motor, attenuation must be relatively high beginning at 60 cps. If the turntable uses a four-pole motor, attenuation should be concentrated from 30 eps down. In both of these cases, attenuation should be at least 10 db at the frequency indicated, and more at lower



THE BETTMANN ARCHIVE

It took 300 years to make Athanasius Kircher's dream come true.

Athanasius Kircher was a man of vision. Among his many accomplishments, this 17th Century scholar perfected the Aeolian Harp and invented a Tin Pan Alley dream—a composing machine. But his outstanding achievement...the Kircher Broadcasting System shown above, actually called for outsized cornucopias of sound built into walls. This system pioneered principles in use today.

The boldness, the vision of such a man, is truly epitomized today in the remarkable new instruments for high fidelity developed by University. In University's modern sound laboratories (what a treat they would be for Kircher) engineers devoted to the perfection of sound reproduction are creating extraordinary musical instruments. Consider the Classic Mark II. In according it top-notch rating, Julian Hirsch of Hirsch Houck Laboratories wrote: "In listening tests, it sounded very clean...there was an undercurrent of bass more often felt than heard that was completely lacking in some other quite good speaker systems that I compared to the Classic Mark II. Overall, the sound was beautifully balanced." The low frequencies up to 150 cps are handled through a 15-inch high compliance woofer in the tuned ducted port. An 8-inch midrange speaker covers from 150 to 3,000 cps, and above this, the superb Sphericon Super Tweeter takes over. Impeccable cabinetry, in oiled walnut. 35"w x 28¼"h x 17"d. $295. Hear it at your hi-fi dealer's or write for complete specifications and free Guide to Stereo High Fidelity. **University Loudspeakers,** Desk R-5, 80 South Kensico Ave., White Plains, New York.

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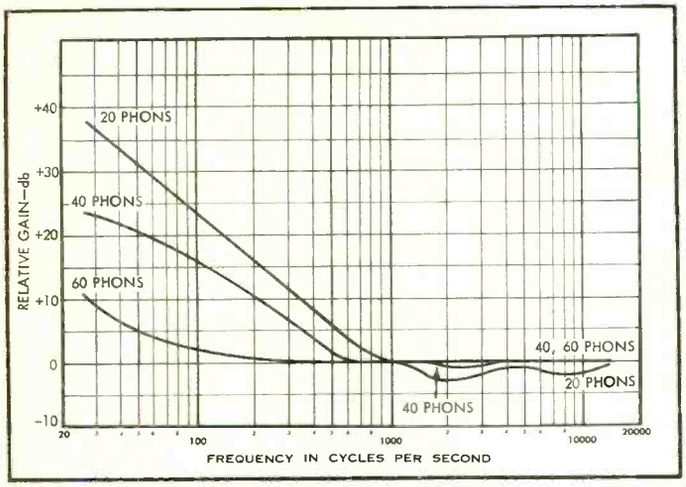

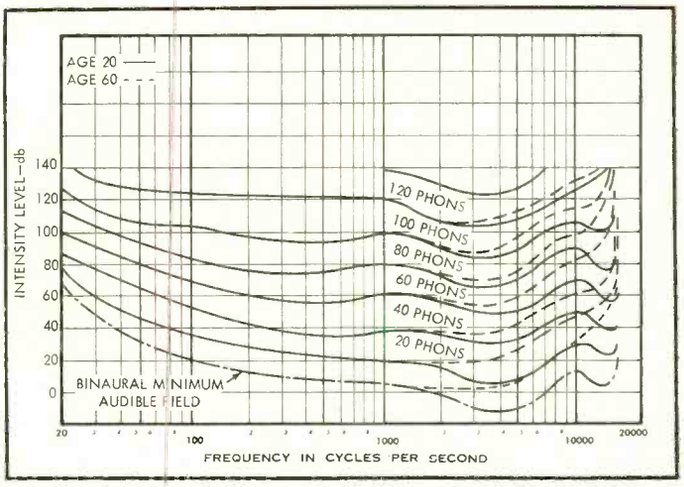

Fig. 8 (left). Compensation for Fletcher-Munson curves, 70 phons is standard playback level. Fig. 9 (right). Equal-loudness contours (Robinson and Dadson).

frequencies. In this discussion, we will consider 60 cps as the objectionable frequency. 12 db is assumed to be the required attenuation at this frequency.

The rudimentary rumble filter is shown in (A) of *Fig.* 5 and the response curve is shown in (B). The analysis is similar to the one for the scratch filter: For an attenuation of 12 db at 60 cps, 240 cps must be attenuated 3 db, and the product of R and C becomes

$$RC = 1/(2\pi f) = 1/(2\pi \times 240).$$

As before, it is obvious that one such section is inadequate; the attenuation is considerable at a relatively high frequency (1000 cps) and drops slowly (6 db per octave) below 60 cps. This is redrawn as curve (A) in *Fig.* 6. Curve (C) in *Fig.* 6 shows a more idealized case using three networks in the circuit, while curve (B), using two such networks, is a reasonable compromise.

Once again, the circuit in *Fig.* 1 may be used to test the response of a compensating circuit—this time, the rumble filter. The procedure and conclusions indicated under the scratch filter discussion apply here as well.

It should be noted that although 60 cps is the highest frequency considered in rumble-filter design, lower frequencies may also be generated and must be eliminated. Although elimination of rumble should not be the concern of an amplifier, it is important that rumble be eliminated. Excessive rumble can overload an amplifier or speaker, resulting in distortion at all frequencies.

Loudness Contour

Tones of identical sound level, but differing in frequency, do not sound equally loud to the human ear. Experiments have been performed to relate the apparent loudness to the actual relative sound intensity at all frequencies of the audio spectrum. The most commonly accepted results were compiled in the 1930's by H. Fletcher and W. A. Munson. The result of their research is shown in *Fig.* 7.

In common with most audio measurements, the curves are based on a 1000-cps reference frequency. With this in mind, let us study the curve marked "70."

Notice that 1000 cps is at a level marked 70 db. This 70 db is the zero reference level for this particular curve. At the higher and lower frequencies, the curve goes up. This means that at these frequencies, the sound pressure must rise if these frequencies are to *sound* identically loud as the 1000-cps note. The actual intensity must increase 10 db at both 60 and 15,000 cps if these frequencies are to seem equal in level to the 1000-cps signal. It must also fall 5 db at 4000 cps.

There are similar curves from "0" to "120." Each curve represents the equal loudness curve for different sound pressures with 1000 cps as the reference frequency. The equal loudness contours vary with the actual intensity of the sound. At low listening levels (curves marked "0" to "30") there must be a greater relative sound pressure at the low and high frequencies, if all frequencies are to seem equally loud, than is the case at loud listening levels (curves marked "70" to "120"). The loudness control is based on this fact.

Each curve depicting the equal loudness contour, is marked in units called "phons." The "phon" refers to an equal apparent loudness level. Even though the *actual* sound pressure varies several db over the frequency range, the rating in "phons" is identical when the *apparent* loudness is identical. The "phon" refers to the loudness contour curve while the db rating refers to the relative *actual* sound pressure.

The phon is identical to the pressure level in db at 1000 cps if the 0-db level is considered to be an intensity of 10^{-16} watts/cm^2. At frequencies other than 1000 cps, the phon varies from the intensity rating in db as the equal loudness contour curve varies around the 1000-cps level.

It is generally accepted for design purposes that music is played and recorded at the 70-phon level and played back in the home at the 40-phon level. If music is to be reproduced exactly as originally performed, the apparent loudness contour must follow the 70-phon curve. An amplifier with a flat frequency response will reproduce sound accurately only at the 70-phon level. But

(*Continued on page* 59)

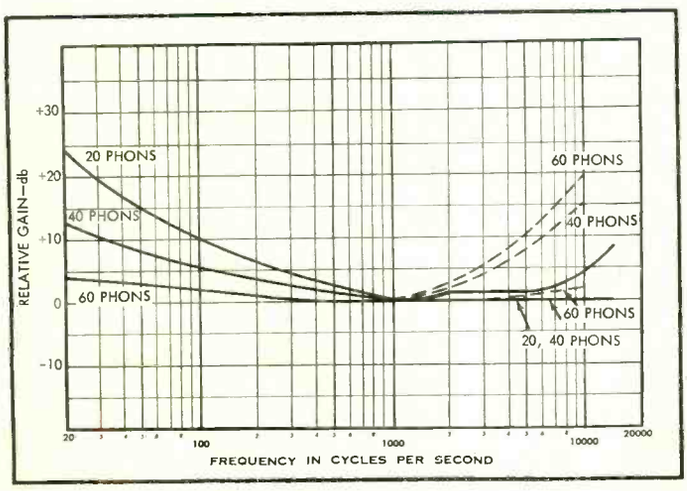

Fig. 10. Compensation for Robinson-Dadson curves. 70 phons is standard playback level (—age 20, --- age 60).

Buyer's Guide and Condensed Applications Chart—*Norelco*® 'CONTINENTAL' Tape Recorders

This condensed guide, prepared by the High Fidelity Products Division of North American Philips Company, Inc., offers the consumer the factual data he needs to select the tape recorder best suited to his specific requirements.

	Continental '100' Model EL 3585	**Continental '200'** Model EL 3541	**Continental '300'** Model EL 3542	**Continental '401'** Model EL 3534
PRIMARY USERS	The entire family—at work, at play, at home or away.	Serious music lovers with limited budgets.	Schools, churches, teachers of voice and music. Psychiatrists, speech therapists and recreation directors—and collectors of pre-recorded stereo tapes.	Professional musicians, studio recordists, serious music lovers, high fidelity enthusiasts, doctors, dentists, industrial sound installation contractors.
ESPECIALLY SUITABLE FOR	On-the-go, on-the-shoulder recording and playback — anything, anytime, everywhere.	Portable, high fidelity tape-deck applications. Portable public address.	Audio-visual and all specialized teaching applications; music program source for factory, office and home; portable P.A.	Professional-quality stereo recording, live or broadcast; space-saving hi-fi system control center and background music.
SPECIAL FEATURES	Battery-operated, 100% transistorized, feather-light. Records from any source. Tapes interchangeable with all 2-track 1⅞ ips recorders.	Stereo head output direct to external stereo preamp. Records sound-on-sound. Mixing facilities. Compact, lightweight, inexpensive.	3 speeds. Stereo head output for playback through external stereo preamp. Records sound-on-sound. Mixing facilities. Headphone monitoring.	100% transistorized. Completely self-contained for stereo recording and playback at all speeds. Dynamic stereo microphone. Multiplay permits sound-on-sound recording. 4th speed provides up to 32 hours recording time.
RECORDING CAPABILITIES	Monophonic 2-Track	Monophonic 4-Track	Monophonic 4-Track	Stereo and Mono 4-Track
PLAYBACK CAPABILITIES	Monophonic 2-Track	Monophonic and Stereo† 4-Track	Stereo† and Mono 4-Track	Stereo and Mono 4-Track
SPEEDS	1⅞ ips	7½ ips	7½, 3¾, 1⅞ ips	7½, 3¾, 1⅞, 15/16 ips
PLAYING TIME PER REEL	Up to 2 hrs. on a 4" reel	Up to 4 hrs. on a 7" reel	Up to 16 hrs. on a 7" reel	Up to 32 hours on a 7" reel.
WEIGHT	7 lbs.	18 lbs.	30 lbs.	38 lbs.
MANUFACTURER'S SUGGESTED LIST PRICE*	$129.50*	$179.50*	$269.50*	$399.50*

†Tape head output.

For complete technical data and detailed descriptions of Norelco 'Continental' Tape Recorders, write:

NORTH AMERICAN PHILIPS COMPANY, INC., High Fidelity Products Division, **230 Duffy Avenue, Hicksville, L. I., N. Y.**

**The unit prices stated above are for identification only and are not necessarily the regular or usual retail prices and are not to be represented as such.*

Knowledge and Skills Available upon Re-employment

ALBERT WOODRUFF GRAY*

It is generally understood that an employee cannot take information about secret processes from one employer to another, but he still retains many rights arising from his previous employment.

SUCCESSFULLY RESISTING for centuries efforts vainly made for both amendment and repeal, the age old statute, "Thou shalt not steal," still remains in full force and effect.

Only a few months ago a raid conducted by the police and detective forces of a city in New York on the premises of a corporation engaged in the manufacture and marketing of electronic equipment disclosed the illegal possession of lists of customers of competitors, confidential price information, and secret data relating to the needs of purchasers.

The raid also disclosed plating procedures that had been developed by the protesting company initiating this search, as well as plans and specifications, used in the production of these products, that had been illegally taken.

Here a production engineer, a salesman and a third employee who had for several years been in charge of production control had organized this new corporation and had taken with them from their former employer these records and data which had been entrusted to them in confidence.

When the action in which this raid was a part came before the New York court on an application for an injunction against a continued use of this material, it was said of the law governing activities such as had been disclosed by this raid.

"The fact that a trade secret is of such nature that it can be discovered by experimentation or other fair and lawful means does not deprive its owner of the right to protection from those who would secure possession of it by unfair means. The duty of an agent or employee not to use confidential information acquired in his employment in competition with his principal is implicit in the relation."[1]

Attention however was directed to the other side of the coin by the federal court in that state in which the misconception of the extent of these rights of an employer to restrain the activities of his employees in situations which such employees may subsequently accept, was made the subject of comment.

The employer in that instance, said the court, seemed to be under the impression that by mere force of the relationship of employer and employee an employer becomes the owner of everything invented by one of his employees. This conception goes far beyond what has been settled by the Supreme Court.

"There is some popular notion," continued the court, "that so far as concerns inventions, employees sell their brains to their employers, but that is not the law. On the contrary the Supreme Court has thoroughly established that while certain shop rights in inventions made by an employee while engaged in the work of his employment, may accrue to the employer, no title thereto passes unless there be a plain and unambiguous contract obligation by the employee to turn it over to his employer. Only by such a contract can title to the employee's invention be obtained."[2]

The law thus stated in relation to inventions is equally applicable to the skills and knowledge gained by an employee through his own efforts when not effected by contract provisions that may have featured in his relations with his employer.

You Can Take It With You—Sometimes

This boundary line that delimits the extent of the employer's ownership of information and skills acquired by an employee when such an employee seeks another job was set out in litigation before a federal court in New Jersey and a subsequent affirmance of that decision by the Court of Appeals a few months later.

For approximately six years a plastic machine manufacturer in Ohio had employed as an assistant to its president and in charge of sales a man who had used in his work production and other drawings and blueprints as well as customer lists and price data.

When that employee left and accepted a position with a competitor, this suit was brought against the second employer and the former employee for an injunction and damages. In that action it was contended that trade secrets and business know-how had been disclosed in breach of confidence by the employee.

From the refusal of the court to grant the injunction sought by this first employer an appeal was taken to the U.S. Court of Appeals. There in its affirmance of the judgment that court said,

"We have before us in this case two perfectly well established principles. One is that an employee after leaving the service of an employer may carry on the same business on his own and use for his own benefit the things he has learned while in earlier employment. If this were not so an apprentice who has worked up through the stages of journeyman and master workman could never become an entrepreneur on his own behalf.

"Any such system of quasi-serfdom has long since passed away. Necessarily the former employee may use what he learned in the former employer's business while engaged in business for himself or some business competing with the former employer.

"Equally clear is the proposition that the employee owes a duty of loyalty to the employer. He must not, while employed, act contrary to the employer's interests and, in general terms, owes a duty of loyalty as one of the incidents of the employer-employee relationship."[3]

And Sometimes You Can't

By the United States Supreme Court, in an opinion of Justice Holmes, was epitomized the essence of the distinction between a violation of the age old pre-

(*Continued on page 61*)

* *40 Washington St., East Orange, N.J.*

[1] Sealectro Corporation v. Tefco Electronics, 223 N.Y.S. 2d 235, New York, August 29 1961.

[2] U.S. Colloid Mill Corp. v. Myers, 6 Fed. S. 283, N.Y., Feb. 16, 1934.

[3] Midland Ross Corp. v. Yokana, 293 Fed. 2d 411, N.J., July 31, 1961.

The San Diego

Symphony Orchestra

listens to itself

AR-3's

During rehearsals members of the San Diego Symphony Orchestra pause now and then to listen to a taped recording of the passage they have just played.

AR-3 loudspeakers were chosen for the stereo playback system because of their lifelike reproduction of orchestral timbres. Any pseudo-hi-fi coloration here would defeat the purpose of monitoring.

AR-3's and other AR speaker models are often used professionally, but they are designed primarily for the home. Prices range from $89 for an unfinished AR-2 to $203-$225 (depending on finish) for an AR-3. A five-year guarantee on all models covers any repair costs, including freight.

A catalog and list of AR dealers in your area will be sent on request. We will also send a brief description and order form for two books on high fidelity published by AR.

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge 41, Massachusetts

HERMAN BURSTEIN*

(Note: To facilitate a prompt reply, please enclose a stamped, self-addressed envelope with your question.)

Standard Recording Characteristic

Q. Is there a standard recording characteristic for magnetic tape recorded at 7.5 or 3.75 ips? If there is, please advise me as to who makes a frequency-response test tape to this standard.

A. There are no official *recording* characteristics at any speed. Such standard characteristics—official or de facto—as do exist refer only to playback. These characteristics further specify that recording equalization shall be such as to achieve flat overall response within stated limits.

At 15 ips there is an official playback equalization characteristic, called the NAB curve. The same curve is also unofficially but widely employed at 7.5 ips. The NAB curve consists of bass boost commencing (up 3 db) at 3180 cps and leveling off (3 db below maximum boost) at 50 cps. This curve must be adjusted for any departure of the playback head from linear response at the very low and very high frequencies.

At 3.75 ips there is a suggested playback standard having a turnover frequency up 3 db) of 1326 cps and leveling off at 50 cps. A number of manufacturers are using 795 cps as a turnover frequency. The situation is still in flux at 3.75 ips.

At 7.5 ips, the most widely used test tape appears to be Ampex 31321-01. At 3.75 ips, it is Ampex 31331-01.

Random Low-Level Clicks

Q. On certain tapes in recording and playback I get random clicks. They are very low level and do not appear on the meter. But more significant is that even when the volume is at zero I get these clicks. Another thing: the only time I get them is when the tape is in play motion. In other words there are no clicks when the machine is in stop, rewind, or fast forward mode. I have checked the electronics sections by reversing the leads from the head to each channel of the stereo tape amplifier. The result of this test is that the trouble appears to be in the upper section of the record-playback head. Yet these clicks appear only on certain tapes. All my tapes are prerecorded. Some suggestions have been made to me concerning this problem: 1. A static charge builds up on the tape caused by very fast rewind and forward speeds and these charges cause the clicks upon contact with an improperly grounded head; 2. the head be painted with a metallic material (the paint used for printed circuit boards) 1/64 inch on either side of the gap so that all the laminations are grounded.

What do you think could be causing these clicks? Would painting the heads in the manner described cause any harm? Is there any other way to correct the problem?

A. It appears that your diagnosis is correct, namely that you have a defective head, one section of which is poorly grounded. Secure grounding of the laminations would probably eliminate the clicks. However, I cannot say for sure whether the grounding method you propose would be effective. I understand from one source that achieving a good ground is a somewhat ticklish proposition, and that if you don't know exactly what you are doing there is danger of ruining an expensive head. Thus it seems that the best advice I can offer is to have your tape recorder serviced by an authorized agency or by the factory.

Tape Hiss Trap?

Q. Tape hiss has proved to be an abomination to me as well as to some of my friends. What is the frequency range of tape hiss and can a trap be successfully designed to reduce this problem to a minimum?

A. Tape hiss covers the entire audio range and is pretty evenly distributed over the range, so that you cannot get rid of it by means of a filter for a specific narrow audio band. On the other hand, the ear is most sensitve to the hiss in the vicinity of 3000 cps. Therefore what you might do—as at least one manufacturer of special professional equipment has done—is to provide extra treble boost around 3000 cps in recording and provide corresponding de-emphasis of the 3000-cps area in playback. However, you must be careful not to introduce too much treble emphasis lest this cause excessive distortion.

Static-Like Tic

Q. My problem is a static-like tic at random intervals on playback only. The trouble has been isolated to the first two stages of the playback preamplifier, and exists only on channel 2 of my stereo machine. I would appreciate your answer to further troubleshooting for isolating this problem.

A. Determine whether the first or second stage is responsible by removing the first stage tube. If the trouble continues, the cause lies in the second stage; if it ceases, the cause lies in the first stage. Check the tube, resistors, and capacitors of the stage in question. You may have to check by substituting known good components for the ones presently in place.

Perfect "Off the Air" Tapes

Q. I like chamber music, and there is virtually none of it available on prerecorded tape, and a lot of it is broadcast here (Washington D.C. area) on live FM. So I record "off the air" with my tape recorder. But there are always defects—microphone failure at the source, hall reverberation, crosstalk on the telephone transmission lines from the hall to the station, audience noises, and often a very high noise level on the FM carrier itself. Naturally I can do nothing about any of these things. I now have 80 tapes that I have made that I thought were good enough to keep, but all without exception have defects of some kind or other that were in the signal received by my FM tuner. Actually, I have some pretty fine tapes (especially from the Library of Congress broadcasts, where the audience almost always waits to cough between movements), and my friends are always very flattering in their remarks when they hear my tapes, but I can hear the defects. How can I make a perfect tape?

A. Live performances are seldom if ever perfect, so I do not see why you should feel bad about your imperfect tapes, assuming that the defects in any one tape are on the whole minor and occasional. The trouble with high-fidelity equipment and source material is that one expects so much of them that the slightest departure from perfection is agonizing. You can listen to a $15 pocket radio and bask in the illusion of a live performance because you don't expect much of a cheap radio; your emotional attitude supports the illusion. But with high-fidelity equipment you go to the other extreme, listening more to the defects than to the substantially faithful recreation of the original sound. By "you," I mean all of us, of course.

Demagnetized VU Meter?

Q. The first time I demagnetized the heads on my tape recorder, I inadvertently had it turned on in the playback mode, with its two preamp level controls half on. I demagnetized the erase and record heads, and when I got to the playback head I noticed that the VU meters deflected sharply and realized that the preamp was on. I turned off the preamp immediately and proceeded with the demagnetization procedure. Since this occurrence I have used the tape machine for both playback and recording with no trouble at all. However, just for peace of mind, I would like to know if this mishap could in any way have damaged the playback head, VU meters, and such.

A. I am quite sure that no harm was done to the playback head or VU meters, especially since the incident you describe lasted briefly. A head demagnetizer is designed so that its magnetic field, while sufficiently strong to demagnetize the head, is not strong enough to harm the head. A true VU meter, or a substantially similar device, can continuously withstand a five-fold (14-db) voltage overload, and can withstand a 10-fold (20-db) voltage overload for half a second. Overload designates a voltage which drives the meter beyond 0 VU. The greatest chance of harm to a VU meter occurs if you try to demagnetize the heads with a bulk eraser and bring the latter close to the meter. The powerful field of the eraser can damage the meter.

Demagnetizing Playback Head

Q. Is it possible to run a small amount of a.c. current through a playback head to demagnetize it?

A. Yes. However, you are faced with the problem of gradually reducing this current to zero, because abrupt cutoff would magnetize the head. A head demagnetizer, available for a few dollars, is the best device. Æ

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

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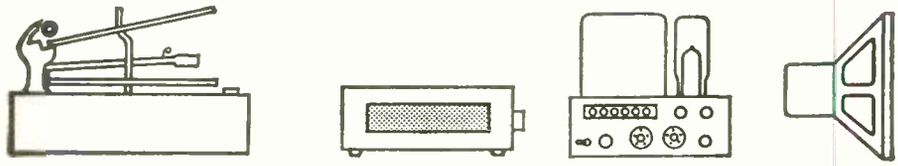


KNIGHT-KIT KP-70 STEREO RECORD/PLAY PREAMP KIT

Providing practically every function required from an amplifier to be used with a tape-transport mechanism, the KP-70 provides the advanced experimenter and tape recording enthusiast with a compact unit that is attractive in appearance and efficient in operation. Very few complete recorders offer the flexibility desired by the advanced recordist. Many offer *some* of the features, but only in the most expensive units is it possible to do all the things that can be done with the KP-70.

The real experimenter could probably design the equipment he needs, but he may not be able to construct it easily or of an appearance which is suitable. This is where any kit of this type shows up to advantage, since the design is done (and even if the user required some other features, he could easily incorporate them as he was building the unit), all the "hardware" is furnished, and the external appearance is usually quite attractive. From the standpoint of cost, even if all the components were obtainable from the jobber, they would total up to about twice the price of the complete kit. Printed circuit panels can rarely be obtained singly for specific requirements; knobs for dual concentric controls are hard to find; and small meters designed for a particular application are almost impossible. So, the kit's the thing.

The KP-70 comprises two playback amplifier channels, two record amplifier channels, a bias oscillator, the necessary controls and switches to permit operation, and a power supply. Each playback channel consists of the two sections of a 12AX7 followed by the gain control and one section of a 12AT7 with the output signal tapped off at its cathode and the monitor signal taken from the plate. The other section of the 12AT7 feeds the level-indicating meter. Feedback around the 12AX7 provides playback equalization, switchable to either 7½ or 3¾ ips. Record equalization is switched simultaneously.

Each record channel consists of a 12AX7 as a microphone preamp, mixing controls which permit combining microphone with a high-level input, followed by the two halves of another 12AT7 with record equalization built into the feedback loop around them.

The bias oscillator uses a 12AU7 in a push-pull circuit. A balance control allows adjustment for optimum wave form so as to keep tape hiss to a minimum. Silicon rectifiers are used throughout in the power supply, and all tubes except the bias oscillator are furnished with d.c. heater supply.

Referring to *Fig.* 1, the front panel controls, from left to right, are: the dual concentric playback level controls, record-playback-channel selector switch, AUX record level controls, and the MIC record level controls—the latter two also being dual concentrics. There are also four slide switches—monitor selection, from either source or from tape; MULT-NORMAL-ECHO switch, about which more later; equalization switch; and power switch. The monitor output jacks are at the left end of the panel and the microphone input jacks are at the right. The two channels are available separately for monitoring, but the upper jack is the double-circuit type so a single three-way plug may be used for the headphones.

Construction

The amplifier sections of the KP-70 are assembled on printed circuit panels, which simplifies the work considerably, resulting in a total construction time of 18½ hours. The playback section is at the left end of the unit, while the record section and the bias oscillator are at the center in the shield box; the power supply is at the right end. All external connections are made at the rear apron, except those for the microphones and monitor phones. The erase and bias adjustments are made with trimmer-type capacitors shown in *Fig.* 2 on the rear of the shield can, and the oscillator balance control is on the chassis apron. The shorted plug on the apron is a safety feature—when the unit is to be used for playback only for an extended period, this plug is removed, breaking the plate supply to the oscillator so that inadvertent operation of the selector switch cannot accidentally erase any of the recorded material. A switch at the top of the shield can connects the meter to its normal position or to the bias circuit for use in checking current. This is not used in setting up the preamp originally, but for subsequent checking.

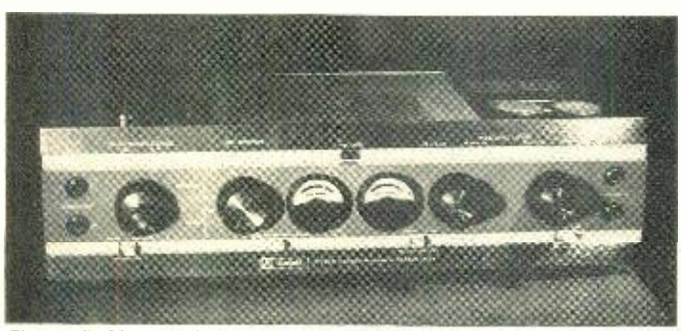
Performance

We had just recently converted an aged Presto RC-7 transport from mono to stereo, using a set of Nortronics stereo heads, and the KP-70 was put through its paces on this machine. The heads used were the 1451 (old number SEQ-4) for erase, 1053 (ASQ-4R) for record, and 1052 (ASQ-4K) for playback—the latter being chosen because of its low impedance and thus more suitable for transistor use, as was finally intended.

After complete adjustment of bias and erase currents, head height, azimuth, and so on, we made a series of measurements. Since the Presto works only at 7½ and 15 ips, we were unable to make measurements at 3¾, but the measured curves from the amplifier itself were as accurate as the 7½-ips measurements, so it is assumed that the tape performance would also be equivalent.

The playback response through the preamp, using the Ampex 31321-01 standard tape, measured within ±1 db from 50 to 12,000 cps at a S/N ratio of 56 db (the heads on the Presto are exceptionally well shielded), which is higher than the specifications. The measured bias oscillator frequency was 102 kc, which is desirably high. Recording from an external signal and playing back gave response with ±1 db from 50 to 15,000 cps. Record sensitivity measured less than 1 mv at the microphone inputs for full recording level, and 75 mv at the high-level inputs. Distortion through the record amplifier, tape, and playback amplifier was less than 2 per cent.

The MULT mode provides the sound-on-sound facility that seems to be so much in demand—although we have never found any need for it in our own experience—permitting the transfer of the recorded material on one channel to the other with the addition to another signal furnished externally. The ECHO mode feeds some of the recorded signal on the tape back into the record channels to give an echo effect without the need for any external patching. The amount of the echo is regulated by the playback control, with monitoring being available during the recording process to ensure the desired results.



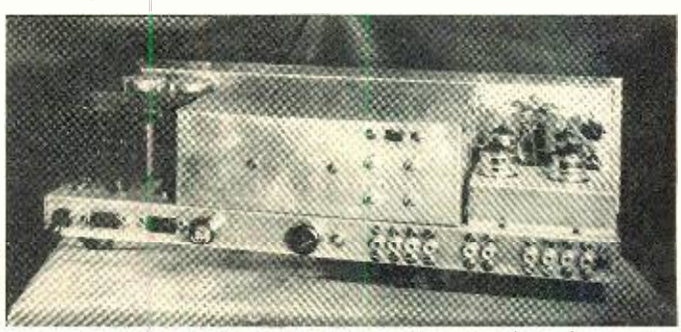


Fig. 1 (left). Panel view of the KP-70 record-playback stereo tape preamp. Fig. 2 (right). Rear view, showing the adjustments available for matching any head assembly.

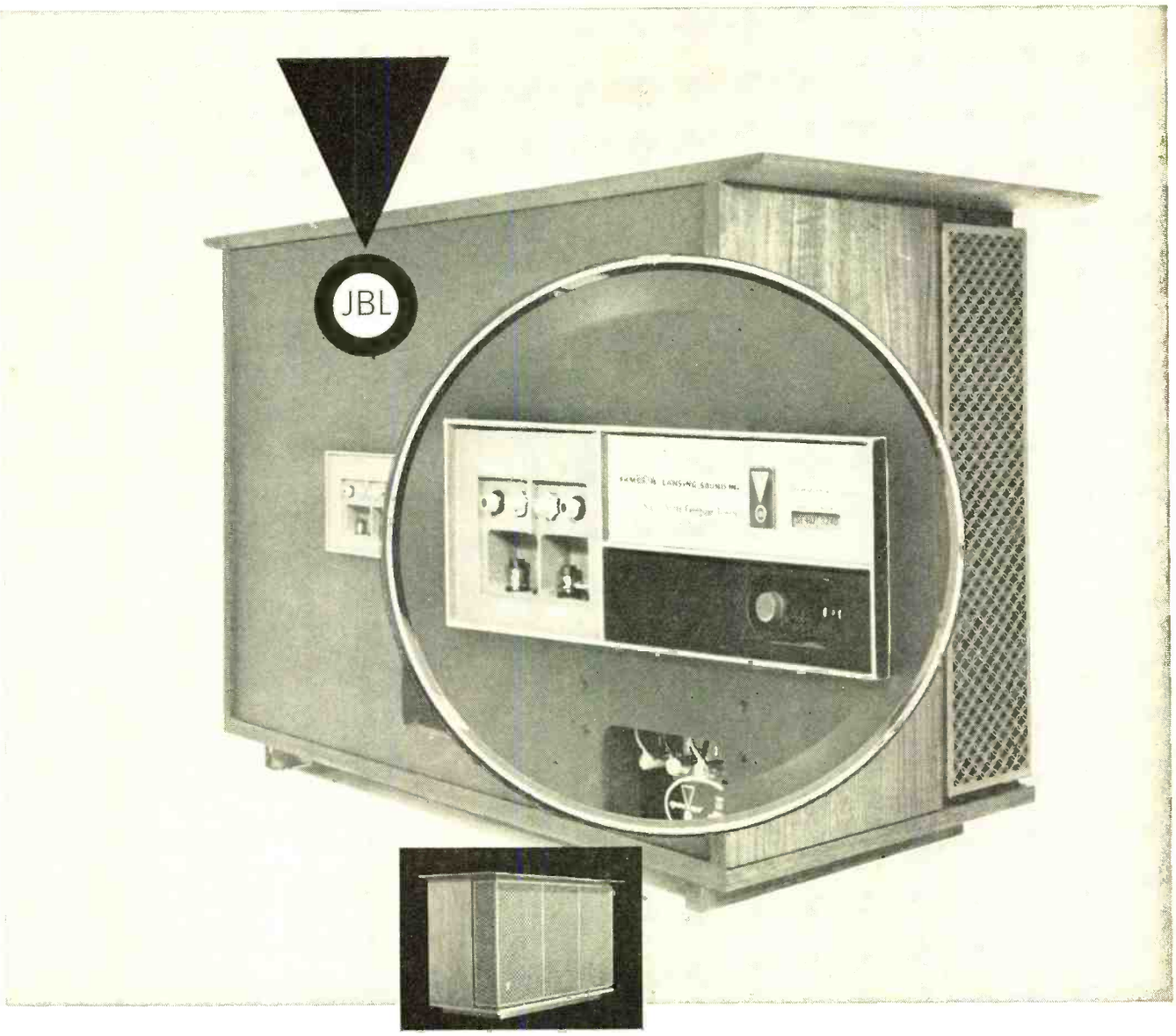


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Fig. 3. The Garrard line—left, the luxury leader, Type A; center, the compact AT-6; right, the economy model, Autoslim/P

The erase current supplied by the oscillator may be adjusted to accommodate all but the very low impedance heads used on a few makes of transports. A wide variety of adjustments make it possible to match nearly any erase head likely to be encountered. Bias current is similarly adjustable. The low-output, low-impedance head for playback (1052) would not be recommended for use with the KP-70, since its output is comparatively low, but even it is sufficient, though at practically full settings of the playback controls. With the 1050 or 1051, more output would be obtained.

For the recordist who wants flexibility and a preamp to go along with a three-head transport, this unit is definitely recommended. With a two-head transport, certain minor modifications must be made (provided by Knight-Kit on request). An attractive housing is available for the unit to provide a well-ventilated cover. Knight-Kits are, of course, products of Allied Radio Corporation. **E-14**

THE GARRARD AUTOMATIC TURNTABLES

Over the many years of hi-fi history, the Garrard line of record changers and turntables has maintained a considerable lead. And with recent years, when the term "record changer" has come into disrepute, to be replaced with the term "automatic turntable" this same lead has been maintained. Actually. the change of designation serves to differentiate the common "garden variety" changer from those which have been designed—and, more importantly, *manufactured*—to the highest quality standards.

The Garrards of today bear certain family traits which have been carried forward from year to year—not in a slavish resistance to change, but in gradual improvements, little by little. Were they to start with a brand-new design each year, they'd never get the bugs out. The Garrard leadership lies in infinitesimal improvements carried forward, continually "improving the breed."

Thus the Type A is the logical outgrowth from the RC-80, through the RC-88, (with an assist from the rare RC-98). The Type A retains all the tried and true features of its predecessors, each improved, still more improved, and then the improvements are improved upon. The second member of the line is the AT-6 (AT for Auto Turntable), which derives from the RC-121 and the more recent 210. Then comes the Autoslim/P, which might well be called the "economy" model of the AT-6.

The Type A

The time had to come when high-quality arms would be employed with automatic turntables. The Type A uses a dynamically balanced arm which is practically identical with the earlier separate Garrard arm, except for the variable-length and variable-angle features. The new arm is balanced just like so many professional arms, with a sliding counterweight. Then the desired stylus force is applied by a spring, with the fixing point of the spring being movable along a calibrated scale. And, of course, the arm employs a four-wire plug-in head.

A new Laboratory Series motor is used in the Type A—a four-pole model which is shielded both top and bottom so that the external a.c. field is reduced almost to zero. The duo-table—that's our term, not Garrard's—consists of the usual driven metal structure inside and a heavy cast platter outside, with a resilient foam "barrier" separating them to eliminate noise or vibration. Nor is the foam separator thick enough to introduce any flutter as do so many foam pads. The pusher platform still remains as the activator for the change mechanism, but the cycling time has been reduced to only seven seconds from the time the stylus leaves the record (at 33⅓ rpm) until it is down on the lead-in groove of the next one.

Last, but not least, is the change in appearance. The "sanitary" appearance of the recent white models always seemed to us to be slightly out of place in most hi-fi furniture. We have grown to accept various shades of gray as "professional," and there is no reason why a high-quality turntable could not be made in shades which would match conventional wooden furniture cabinets. At any rate, the new charcoal, black, and brushed aluminum results in a strikingly attractive unit—even though we think it would be still more attractive if some of the arm parts now in white were made charcoal.

The "old reliable" Type A is rather large, requiring a minimum of 16¾ in. width and 14⅛ front to back, with 6 in. above and 2⅞ in. below the top of the motor board.

We measured performance—primarily speed accuracy and rumble—using the new Shure M99 Gard-A-Matic head and cartridge assembly (to be profiled next month), and came up with a figure of −48 db S/N ratio, measured by NAB standard methods, which is as good as we have ever measured on any automatic turntable. Speed accuracy was within less than 1 per cent on all four speeds.

The AT-6

This model, somewhat less costly than the Type A, utilizes the center spindle drop system, a counterbalanced arm, and a complete restyling over its predecessor, the 210. Actually, in our opinion, if the AT-6 had the same type of rubber mat on the turntable, it would be more attractive than the Type A. It uses the same Laboratory Series motor and a simplified change mechanism which seems to employ many less parts than the A. It changes records in the same seven seconds, however. The counterbalanced arm is of a simpler design, but stylus force is set by a spring adjustment after originally balancing the arm and cartridge.

Speed accuracy was again within 1 per cent on all four speeds, and the rumble figure measured was −44 db—just slightly under the Type A. The AT-6 can be mounted in a smaller compartment, requiring a maximum of 15⅜ in. width, 13⅜ in. front to back, and 4⅞ in. above and 2⅞ in. below the motor board.

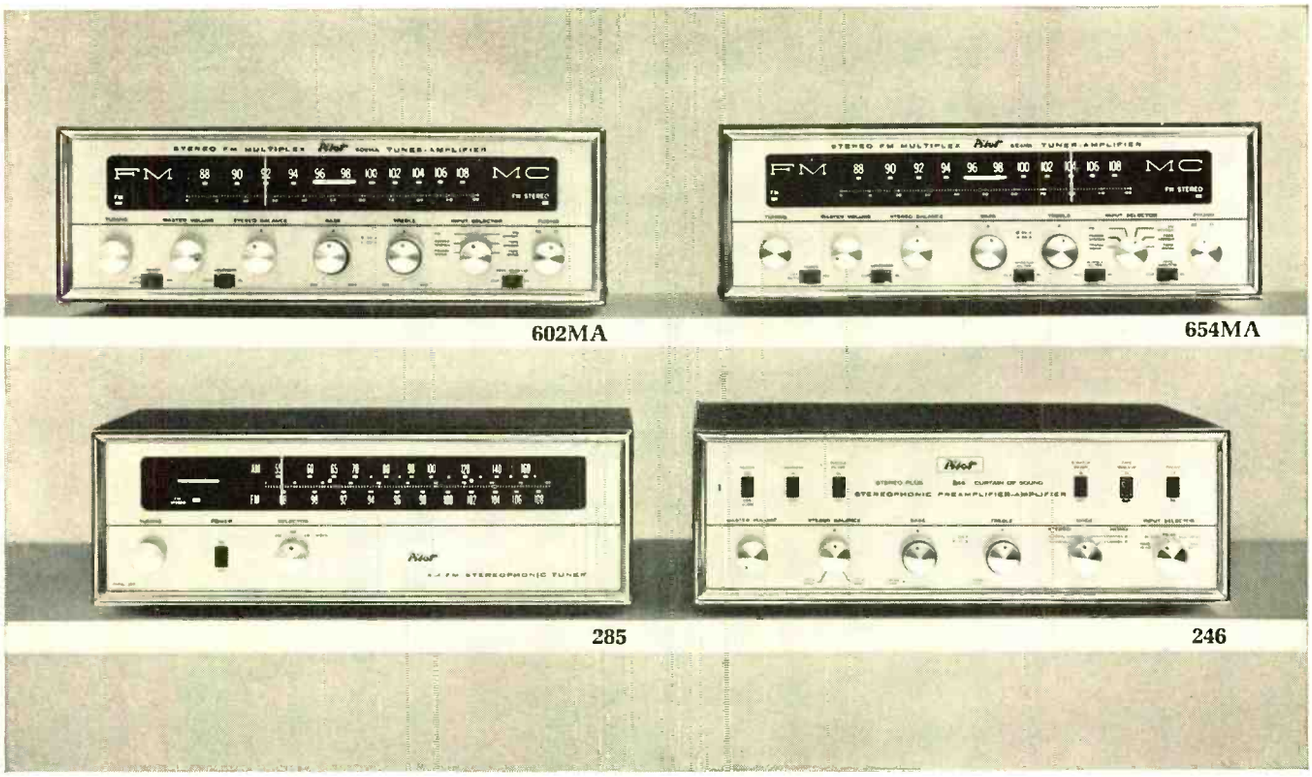
The Autoslim/P

The economy model of the line, this unit is similar in appearance to the AT-6, but uses a different motor and an arm which is entirely spring loaded—no counterweight. Aside from the arm, it looks just like the AT-6. and the mechanism is apparently identical except for the motor itself. Rumble on this model measured −42 db, and speed accuracy was still within 1 per cent. Mounting space required is 14¼ in. wide, 12½ in. front to back, and 4⅜ in. above and 2⅞ in. below.

The Round-up

All of the Garrard models may be used either automatically or manually. All of them will play records manually, yet lift the arm and return it to the rest at the end of the record, and then turn the motor off, at the same time retracting the idler roller so as to avoid the formation of flats. The plug-in heads for the AT-6 and the Autoslim/P are interchangeable. All use the same plug for a.c. and ground leads, and all have phono jacks mounted on the chassis so the units may be removed or installed easily.

The main differences are in the finer points of performance. If low-frequency performance is extended to the practical maximum in a top quality system, only the Type A should be selected from the line; in a system where the advantages of a changer may be desired for a "second" turntable, the AT-6 should serve well. Where price is a factor, the Autoslim/P will give fine service at a minimum of outlay. **E-15**



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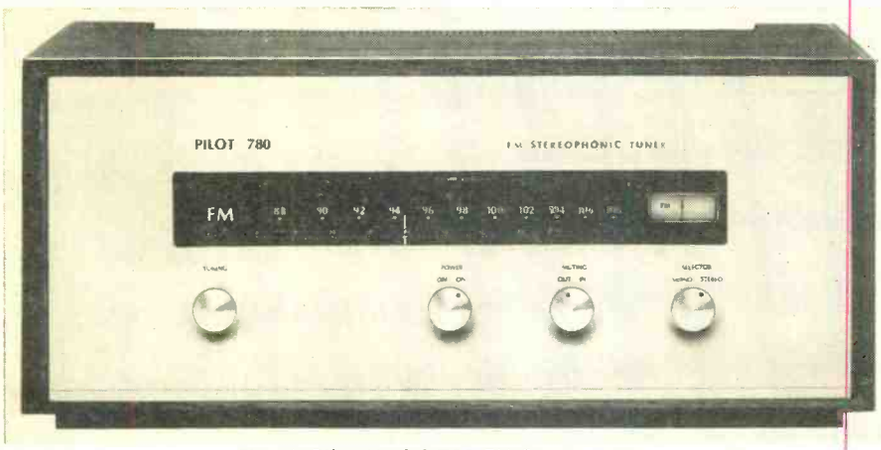


Fig. 4. Pilot Model 780 FM-Stereo tuner.

PILOT FM-STEREO TUNER MODEL 780

This latest offering from Pilot Radio represents a departure from their previous line on two counts: appearance and performance.

For some years Pilot Radio has been known for their "best buy" products—that is products which are rather modestly priced for the level of performance they provide. In the 780, the Pilot engineers have come up with a product that may well be a "best buy" because of its performance alone; certainly the 780 is in the front rank of FM-stereo tuners available today.

The other area of change noticeable in the Pilot 780 is its appareance; they have obviously decided that a more elegant front panel will be in keeping with the more elegant performance offered by this tuner. Thus they have taken a major step forward in appearance as well as performance. The gold-colored thick-aluminum panel is dignified and rich.

There are only four knobs on the front panel; power, muting, mono-stereo, and of course, tuning. Note that there is no control for a.f.c.; in fact a.f.c. is not used in the Pilot 780. We did not find it necessary even after tests which included operation for 8-hours-per-day over a period of a month. In fact, the 780 performed exceedingly well during and after this rather extensive use test; we had occasion to test it at the beginning and end of this period of use and found no change in performance.

One of the features of the 780 is the automatic stereo indicator and the circuit which automatically puts the stereo signal through if a stereo signal is being broadcast. All one need do is set the mono-stereo control to stereo (permanently if you wish) and whenever a stereo program is tuned in the 780 automatically does the rest, including lighting up the stereo indicator to tell you what it has done.

We need not describe the multiplex circuitry since it was fully detailed by the Pilot engineers who designed it (R. Shottenfeld and S. Abilock) in our December, 1961, issue. What we can say is that it was one of the first multiplex decoders to be available and that it has withstood the test of time with flying colors; it is an intelligent and, at the time, original design.

The rest of the FM circuitry—r.f. amplifier, oscillator, mixer, i.f. amplifier, and the detector—are rather usual and we will not spend space describing it. On the other hand it should be noted that the circuit is extremely well designed and executed, as the performance figures will bear out later.

There is one more noteworthy feature of the circuit which result in the rather startling capture ratio of 1 db. Actually we were unable to determine exactly how this was achieved on the basis of new circuitry because there just doesn't seem to be a specific circuit element to account for it. After speaking to the engineers, at Pilot, we gathered that this excellent performance is related to the manner in which the multiplex circuitry couples with the detector—more a constructional technique than a circuit element. In any case it works.

What a Tuner Should Do

A tuner should be able to take all signals, other than noise, that the antenna supplies to it, select the station you want, and send your selection to the preamplifier. It should be able to "defend" your station from interference by adjacent (in frequency and level) stations, and all other forms of signal which could encroach on the desired signal.

The first two characteristics are well known to the report-reading audiofan: sensitivity and selectivity. The last characteristic (really a group of technical criteria) is really not as well known although it may play an important part in the ability of the tuner to receive the signal you want, free from interference.

For example let us consider one of these criteria—capture ratio. In essence, this ratio tells us how close in level a nearby (in frequency) station may be and still be completely rejected by the tuner. A capture ratio of 10 db tells us that the adjacent station must be a certain degree lower in level to be completely rejected; similarly a capture ratio of 1 db allows an adjacent station to be much closer in level to the desired station. In other words, the lower the capture ratio, the closer an adjacent station may be and still be rejected.

Of course, we are not intending to convey the impression that the simplified explanation we have given is all that a tuner must do, but rather to give the outlines.

Performance

In view of the preceding discussion, the Pilot 780 exhibits exceptionally fine performance: IHF sensitivity of 1.8 μv, selectivity of 43 db, and a capture ratio of 1 db. Consistent with these results is harmonic distortion of only 0.2 per cent at 100 per cent modulation. In stereo, separation is better than 32 db.

We must repeat ourselves and point out that we checked the 780 both before and after some 240 hours of playing time and found performance to be unaffected by this amount of aging.

As a side note, we were able to pull in over 30 stations during the morning from our location some 35 miles from New York.

In sum, the Pilot 780 FM-stereo tuner is a first-rank performer which may be of unusually great value to those who live in areas where there is a need to prevent adjacent strong signals from interfering with reception. It is excellent in other areas too, of course. E-16

FISHER XP4A SPEAKER SYSTEM

In June of 1961 we had the opportunity of reviewing the predecessor of the XP4A, the XP4. At that time we went into some detail in describing the unique method of mounting the low-frequency speaker cone which eliminated the "basket" and instead made the enclosure part of the speaker structure. The result was to eliminate many of the unwanted sound peaks commonly resulting from reflections and resonances due to the speaker "basket." (For those who are unfamiliar with this term, "basket" is the technical word which describes the structural portion of most individual speakers which rigidly supports both the outer edge of the speaker cone and the

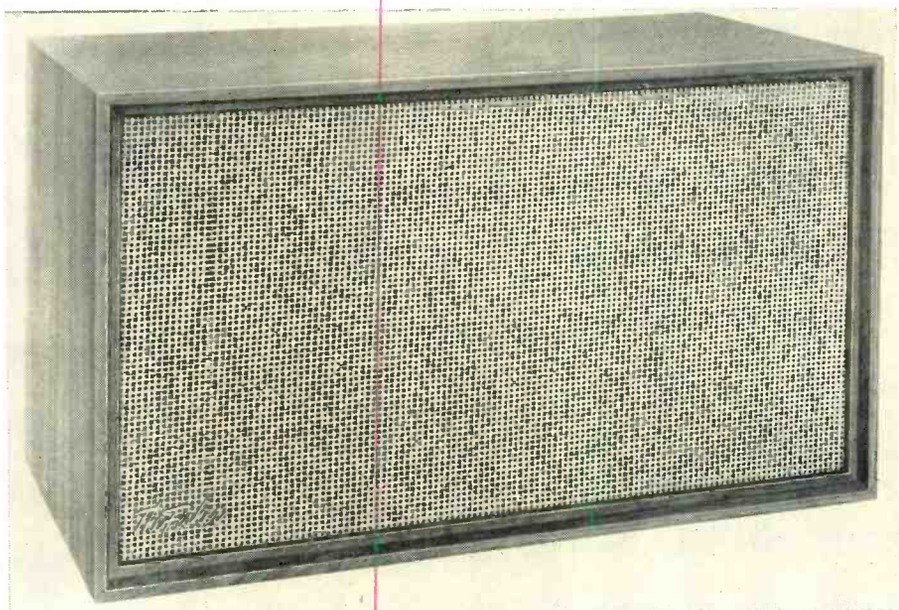


Fig. 4. Fisher XP4A Speaker System.

voice-coil centering device known as the "spider.")

The difference between the 4 and the 4A centers about changes in the woofer. Now the designer has come up with an improved, and truly novel, cone design plus a clever way of damping the motion of the speaker so that it will react more quickly and accurately to the electrical signals fed to it.

The technical description was given fully by designer W. Hecht in our February issue.

For those who did not read that article, we would like to point out that the designer gave a great deal of attention to a problem which is of great importance in using the speaker in your home: Acoustically balancing the four speakers in the system so that they all seem to project from the same plane. This is a rather tricky problem because of the varying efficiencies of the speakers used in the system. Acoustically, it is further complicated by the specific absorption properties of the room into which it will be placed. The latter problem is handled by providing controls, on the speaker, to adjust the relative levels of the midrange and tweeter. The former problem is handled at the factory. The reason we mention this factor is that we think that in this area of speaker balance the XP4A is much better handled than the XP4; we liked the XP4, but we must admit that the "A" version is a definite improvement.

Performance

Before listing the specific details, we will state that the XP4A is one of the smoothest and most accurate speakers we have tested for some time; it reproduces music as close to the original sound as we have heard in a system anywhere near its category.

Of course, when we say smooth, we mean as compared with other speaker systems—all speaker systems exhibit little valleys and peaks (little mechanical resonances) over their entire range so that what we are really saying is that it is free of *large* peaks and valleys. With this understanding, we can now say that the response of the XP4A is quite smooth from 40 cps to beyond audibility, rolling off at a slight slope from 40 to 30 cps. Actually, in spite of the rolloff, response in this area is quite clean and free of distortion.

In music-listening tests the Fisher XP4A was exceptionally unobtrusive, which, to our way of thinking, is the highest compliment one can give to any audio component. Consider it seriously if you are buying. **E-17**

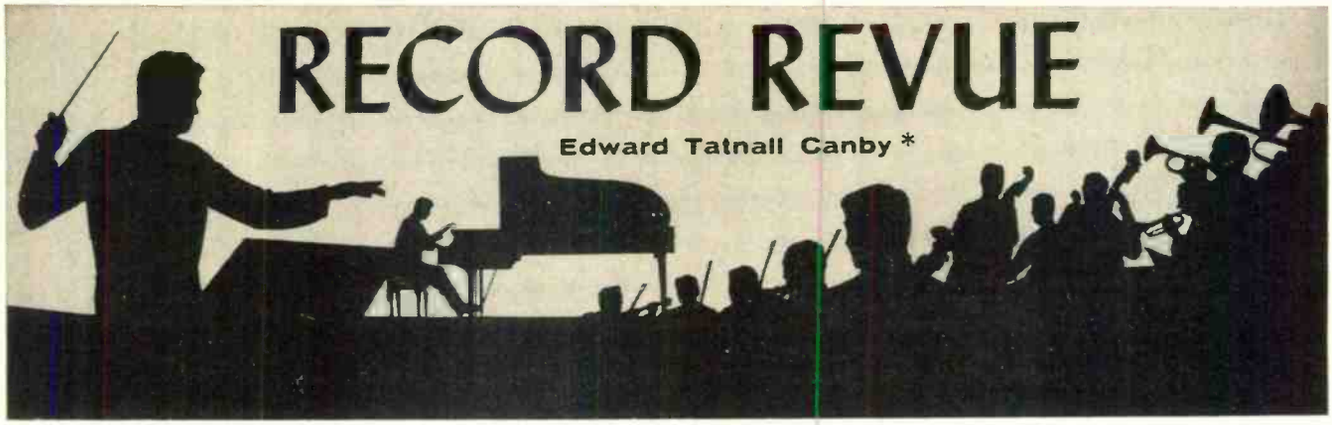
RECHECK OF TANDBERG 64 RECORD/PLAY RESPONSE

Shortly after our review of the Tandberg 64 appeared in the March issue, the accuracy of our measured record-playback response was questioned. The review indicated that at 7.5 ips response was down about 7 or 8 db at 20,000 cps (although only 2 db down at 15,000 cps); that at 3.75 ips it was down about 7 db at 10,000 cps; and that at 1.875 ips it was down 7 db at 5000 cps. Tandberg claims response within 2 db out to 20,000 cps at 7.5 ips, out to 10,000 cps at 3.75 ips, and out to 5000 cps at 1.875 ips. It was suggested that the tests might have been made with a bad tape or at too high a recording level so as to saturate the tape.

(*Continued on page 47*)

RECORD REVUE

Edward Tatnall Canby *



RRRRI-TSCHAHD THE SSSECOND!

The Hollow Crown. (The Fall and Foibles of the Kings and Queens of England.) Max Adrian, John Barton, Richard Johnson, Dorothy Tutin.

London OSA 1253 stereo

An excellent record! This is the disc version of the stage show presented in England and, recently, in America, a compilation of documents and accounts on the subject of British royalty for a thousand or so years. Most of it is "authentic"—old chronicles, the actual words of Kings and Queens, assorted commentary from the side-lines in various times. A gory, murderous, spicy, humorous collection, beautifully if fulsomely read by the well-known stage figures featured in the present production.

Incidentally, this offers an interesting example of our developing mores concerning permissible material in the various media: the most restricted is, of course TV, then radio and the films, whereas the most allowably liberal in range of expression is clearly the "live" stage—and, now, recordings, to match. A great deal of this material cannot properly be broadcast, though its racy flavor, of other ages, is entirely OK on the stage. And in the living room, so long as it's on a disc, not a TV screen. Just try Henry VII's special envoys' private report to the king on an eligible princess in Italy. She didn't make it, and you'll know why.

It should be noted that these famous actors do not even attempt to adapt their delivery to the close-up mike. They enunciate, one and all, with such prodigious force that preamps overload and loudspeakers spray showers of sibilants and transients! "*Rrrri*-tschahd the SSSecond!" Why not just Richard II? That sort of diction is indeed necessary on the stage, at a distance from an audience. The term "stage-whisper" was not invented for nothing. But in a recording, these people could well have forsaken their rigourous stage-habits for a slightly less exaggerated delivery. We're in the living room, after all, not in the theater.

ALL WITH PIANO

The Exciting Debut of Andre Watts. (Liszt: Piano Concerto No. 1; Les Preludes.) N.Y. Philharmonic, Bernstein.

Columbia MS 6458 stereo

Columbia is not an outfit to pass by a plum like this, dropped almost in its lap. Mr. Watts made his public debut, by subbing for the "scheduled pianist," who was indisposed. That pianist, if I remember, was another of Columbia's happy exploitations—Glenn Gould. Make way for youth!

At 16, Watts is all that a fabulous 16-year-old pianist could possibly be, and maybe a little more. He has the finger work entirely under control of course, but he also has a remarkably adult ear for the Liszt idiom and for most of the relatively grown-up harmonies, that take many of us many more than 16 years just to get used to by ear. He pedals more than usual—not less, like his elder brothers who splashed on the scene ten or fifteen years back. He plays quietly, lyrically, never pounds and bangs. No wonder they cheered.

In fact, the fellow is such a very honest young musician that his performance is clearly a very young man's concept, not subtle (though never unmusical), marked in fairly plain colors, not yet built into an over-all dramatic shape, not really putting out all the shades of meaning that can be found in a good and also mature performance. What else would you expect? Only publicity people think genius doesn't have to learn—it just explodes full-size overnight. It doesn't. Not even in a Mozart.

Noticeably closet-like, dull sound in the recording, made at Philharmonic Hall. Definitely, the hall has gone downhill since Columbia's excellent pre-opening takes during last year's "Tuning Week." Now it's Tuning Year, and we won't hear the end of it for a good while by the looks of things. Just listen to this and you'll hear what I mean.

Beethoven: Piano Concerto No. 5 ("Emperor"). Gina Bachauer; London Symphony, Skrowaczewski.

Mercury SR90321 stereo

Here is a wonderfully mature pianist! The "Emperor" has been recorded and played into the ground, and in spite of all the publicity, most pianists of the big-name sort simply cannot make the thing sound out any more. Most lesser pianists, on the other hand, find the work dramatically beyond their powers of projection. It's a tough piece to do.

And so this Gina Bachauer is worthy of all sorts of musical thanks. Her approach is big, dramatic, impeccably accurate and, most pleasing of all, lively and fresh. She puts on a big show, but it's not un-feminine at all. This is the first time I've really enjoyed the "Emperor" in recording for a long while. And the ever-accurate London Symphony under the unpronounceable young conductor seems to be in fine accord with the pianist herself.

Top prize in the Big League, I'd say, and more power to Mercury, which did this job American-style on 35 mm. (I.e., it isn't one of the Philips' records—the parent European company.) Our own Harold Lawrence was the musical supervisor.

Rudolf Serkin. Bartok: Concerto No. 1 (1927). Prokofieff: Concerto No. 4 (for the left hand). With Columbia Symphony, Szell, and Phila. Orch., Ormandy.

Columbia MS 6405 stereo

The two composers, two orchestras, two conductors, are brought together for a well-unified disc by the ever-dynamic, single-minded musicianship of Serkin, who dominates these recordings easily—not for himself but for the composers' sake. Perhaps Serkin is even more at home in these already-classic modern works, both of them formerly little known and both now coming into prominence, than he is in his more familiar role as interpreter of Beethoven, Brahms, & Co. If you have any yen for Bartok and Prokofieff, and especially, if you enjoy the tart acidity of the "modern" 1920's, you'll relish both sides of the LP. Both pieces are fine vehicles for Columbia's new-style big, close-up stereo hi-fi, the piano thundering right before your nose, the whole huge orchestra miraculously almost as close.

Chopin: Mazurkas. Malcuzynski.

Angel 35983 stereo

Lovely Chopin—limpid, beautifully phrased, marvelously subtle in its rubato ("rubber rhythm"), each of the Mazurkas—fifteen in all—a study in depth of a priceless aural tradition that goes straight back to Chopin himself and spans the generations of a century and a half of performers.

You can't write down directions for this sort of thing. You can't make it up out of your own mind. You can't learn it at all if you don't have the musical gift. Plenty of pianists don't. This one does, in a courtly, almost old-fashioned way. Astonishing, the variety of elegance and color he gets into a set of pieces every one of which is in the triple-time, somewhat waltz-like Mazurka rhythm!

If you're a pianist yourself, get this and spend hours with it and the printed music. Then see how good *you* are.

Prokofieff: Sonatas Nos. 1 and 2, Violin and Piano. Joseph Szigeti, Arthur Balsam.

Mercury SR 90319 stereo

As they get older, many famous artists break away, or are dropped, out of long-standing recording associations at the top level. Then—a smaller outfit snaps them up, to cash in before it is too late. Sometimes it doesn't work very well. Often it does. Mischa Elman has done some lovely twilight-glow fiddling for Vanguard. Horowitz is now retrospecting for Columbia. Here, the famous Szigeti, long a Columbia artist, makes a new start for Mercury. Pretty good, I say.

First—Szigeti was a close friend of Prokofieff, who sent him both of these Sonatas for a first American performance during the War years. Szigeti has lived with the music. Second, the oddly coarse tone and palsy-like slow vibrato that Szigeti developed after the war seems miraculously to have bettered; his playing is not exactly crystalline, but the sense of the music is reached with ease and the fast notes are all present. Artur Balsam makes an intelligent and cooperative accompanying pianist.

ANTIQUA

Pergolesi: La Serva Padrona. Anna Moffo, Paolo Montarsolo; Orch. Filarmonica di Roma, Ferrara.

RCA Victor LM 2650 mono

This classic little operetta, nothing but a sprightly musical dialogue between two singers with a bit of small-orchestra here and there, was an early pace-setter for the kind of musical effervescence we find in Mozart's "Marriage of Figaro" and Rossini's "Barber of Seville." These two soloists carry out the

fast-moving action-dialogue (part very fast musical recitative, part merry aria) with gusto and—for modern soloists—considerable accuracy. Both voices, of course, are much too big and close for the music; but then, this is always the case nowadays. Voices were different then, back in the early Eighteenth century, and so was chamber opera.

Check your copy for the printed libretto—it was accidentally left out of the package in the early shipments. You can get it from RCA if you find yours missing.

Monteverdi: L'Incoronazione di Poppea. Zareska, Mielsh, Buckel, Burgess, Santini Chamber Orch., Ewerhart.
Vox SOPBX 5113 (3) stereo

It is a curious thing that the Germans, with their dedicated sense of scholarship, usually do a far better job on older Italian music than the effervescent Italians themselves, who can't seem to get over Caruso and Puccini, not to mention Respighi. Provided, of course, that the German performers are good ones. These are.

This last opera of the great Monteverdi is done in a more-than-previously authentic form, with a number of contemporary instruments thrown in for good measure—viola da gamba, contrabass gamba, lute, theorbo, regal. Monteverdi wrote for a modern-style large orchestral ensemble but did not yet bother to be precise as to which ones he intended, as was still the custom in his day, the early Seventeenth century. So musicology, aided by a few actual listings of the instruments used on certain occasions, are free to build up their performance as best they know how. Nowadays, that means not "modernizing" but restoration to a reasonably plausible ensemble in the manner of the original.

Actually, the singers are the real problem—for the singing voice has changed more than the instruments. It's no good just to specify "soprano." You'll find a hundred different sounds from sopranos even today, and Monteverdi's sopranos singing with extreme accuracy, probably small volume and little vibrato, were utterly unlike ours. All you have to do is to look at the music he wrote to see how this must have been the case. Internal evidence.

The Vox performance, then, is a highly musical and good-hearted attempt to sing the music with modern-trained voices in an approximation of the original requirements, imaginatively if not literally. You'll find it easy on the ears, especially from the excellent Poppea, Ursula Buckel, but also from the others. It isn't the opera you're used to, this, and you'll have to take a lot of static recitative and many short little semi-arias. But the power of the old man will surely get you if you have patience. He was, as we should say today, the most.

Music at the Burgundian Court. Pro Musica Antiqua (Belgium), Safford Cape.
Vanguard BG 634 mono

The famed Belgian Pro Musica is now known widely for its particular style of presentation—an intimate, ingratiating and immensely musical rendition of works both for voices and instruments, mostly intermixed, the voices of a gentle and piercing beauty, the instruments always lively and full of rhythm, enterprising in their variety if not as sensational as those of the New York Pro Musica. There are five voices here and five instruments—lute, recorder, three viols. It is the lute with its authoritative intimacy that sets the tone of these performances, for no "big" and operatic-voiced singer can sing to the lute without drowning it out, ruining the musical atmosphere. These Belgian singers adapt themselves perfectly to it.

Medieval English Carols and Italian Dances. New York Pro Musica.
Decca DL 79418 stereo

Don't worry—you've never heard any of *these* unusual carols and they will do as well in May as in midwinter. So will the Italian dances.

The carols are genuine Medieval, complete with the lusty harmony of the period and decked out with the Pro Musica's collection of bells and drums and what-not—very festive. The singing tends, as always, to be intense to the point of semi-hysteria and one could wish this group might take a few tranquilizers before recording. Maybe they did—a few numbers are relatively slow and gentle. The Italian dances, played on the rising Pro Musica ensemble of old instruments, many of which are utterly "new" and strange to our ears, are liltingly rhythmic and utterly satisfying. No harmony—just an elaborately energetic pattern of pure dance-melody, colorfully orchestrated.

Instrumental Music of the Year 1600 of France, England, Italy & Germany. Concentus Musicus Ensemble (Vienna).
Vanguard BG 626 mono

This Viennese ensemble is of the old school of "old" music performing—gentle, rather elegant, with a touch of old-fashioned Nineteenth century Romanticism in it, quite appealing, and of a modest authenticity that sticks to long-standard "revived" instruments—viols, recorders—played with modern-style vibrato. No shawms, serpents, and what-not, as of the dynamic New York Pro Musica.

For some, all this may seem slightly stodgy; it is merely the authentic Viennese way of music-making, applied to an older repertory but genuine nevertheless and highly musical. Vienna's musical heartbeat is normally far slower than New York's; musical tranquilizers are un-needed thereabouts! Nicely close-up live recording.

Martini: Magnificat. Obrecht: Credo and Gloria from Missa Je ne Demande. Ockeghem: Credo sine Nomine. Renaissance Chorus of New York, Harold Brown.
Baroque 9003 mono

This unusual group, predominantly of young singers, does a splendid job on unusually early choral music—these men are two giants and one other important figure of the Fifteenth century. The records are released on a label created for the group, though now expanding towards other repertory. (Stereo releases will follow on these first recordings when demand warrants.)

The recording is made a bit difficult by a stylistic idiosyncrasy favored by this conductor—frequent swellings and dyings-away, crescendo and diminuendo. Choral music is always a strain on any recording system, with its misleadingly high-powered natural intermodulations between the many simultaneous vocal sounds, and the crescendi tend to make trouble here, if only because in the soft parts the level must be maintained and gain-riding is inadmissible beyond a very limited extent.

Try the Obrecht Credo on side 2, second band, for the liveliest music on this disc.

Rafael Puyana. (Picchi: Balli d' Arpicordo. Frescobaldi: Music for Harpsichord.)
Mercury SR90259 stereo

Rameau: Keyboard works, Vol 2. Albert Fuller, Harpsichord.
Cambridge CRS 1602 stereo

Two careful and conscientious harpsichord recordings, both very worthwhile for those who enjoy the unique harpsichord literature, so unlike that of the piano.

Mercury's Rafael Puyana features—as one must these days—a "new" discovery, the Dances for Harpsichord by the not very well known Picchi of the early 17th century. (His music, however, did make the basis for some of Respighi's lush "Ancient Airs and Dances" in the days before authenticism crept in.) The Picchi material is pleasant but not exactly harpsichord-shaking. It's worth a solid recording like this. More impressive, inevitably, is the music of the giant Frescobaldi, whose small pre-fugal keyboard works have fascinated musicians for several centuries. (I had to write compositions myself "in the style of Frescobaldi" as part of my musical training.)

Rameau is a later giant, whose learned and expressive harmonies exerted an enormous influence on music after his period, the time of Bach. Like Couperin, he is not really playable on the piano—too many elaborate ornaments, that cannot be ignored. Unlike pianists, most harpsichordists take it for granted that harp

sichord music should be played with the correct ornamentation, as of the period; Fuller has mastered this special art as well as anybody around—which means that for your listening, the Rameau flows effortlessly and gracefully, the ear-catching tunes not at all obscured by the tonal decoration. Copious fine-print notes by Fuller make good reading while you listen; similar notes by Puyana enliven the Mercury disc.

VERY SPECIAL

The Hoffnung Astronautical Music Festival, 1961.

Angel 35828 stereo

This giant and uniquely British musical satire-concert, involving the cooperation of the very top figures in British musical life, was first sparked in 1956 by the indefatigable Gerard Hoffnung himself, whoever *he* was. Well, if he existed at all, he is said to have died in 1959; good riddance because the Hoffnung idea would not be silenced and has got bigger and better! I missed the 1958 disc; I must say at once that the 1961 performance is generally on a much higher level of satire than the '56 model, which I found musically corny in spite of its Concerto for Vacuum Cleaners and what-not.

The uniqueness of these skits is, first their enormity. The kind of take-off that with us is done in high school skits, in home parties, cosy night clubs and homey TV shows, here sports a huge and top-flight orchestra, chorus, solo group in the high-toned surroundings of the Royal Festival Hall, with famous composers and performers all over the place. Uniqueness, too, resides in the almost exclusively "classical" point of view. Instead of taking off Elvis and Doris Day, Jack and Jackie or the latest in bearded folk, these skits hit Handel, Beethoven, Bach, 12-tone music, oratorio, plus a dig or two at electronic composition. You really must muster up your knowledge of musical styles and the classic repertory if you are to catch the subtleties that glare forth.

The high point, for me, was the utterly zany Beethoven "Leonora No. 4" Overture (there are but three in the catalogues). Much of it is agonizingly straight Beethoven, just as written, and one waits in horrible suspense for something perfectly dreadful to happen. Whole sections are blithely omitted, uncouth blats and blurps crop up innocently, fragments of other works appear out of the blue, weird harmony-changes and re-orchestrations parade forth, scandalously but dead-pan. The famous off-stage trumpet is heralded as per the score—and fails to appear; the orchestra makes another approach and the wrong theme is heard, faintly, in a hideous key. Finally, on Beethoven's own succeeding try, an enormous battery of trumpets breaks forth like the horsemen of the Apocalypse! Absolutely scandalous, and if you know your Leonora you'll be weak with shock at the end.

Another luffly bit of biting satire is the "12-tone" piece, with a vocal solo that jumps up and down laboriously in minor ninths, utterly without sense, but an accurate caricature of much contemporary vocal writing. Then, I enjoyed the faked "Bach chorale" hymns, with improbably sour harmonies. A long "Horrortorio," the marriage of Dracula and Frankenstein, left me cool though it hauls in everything from "Messiah" and "Marriage of Figaro" to Gilbert & Sullivan; yet I liked a musical missile launch, the confrontation of Volga Boat Song and Yankee Doodle and the longest, largest sheer crescendo anybody has ever heard in super-stereo. It comes, as you may guess, at the very end.

Rutgers University Music Dictation Series, Vols. 1–6.

Music Minus One (6 vols, Mono)

There's no better way to train the ear for music than via musical dictation. All good teachers use it; most intelligent musicians do it by themselves out of sheer habit. You hear music, you write it out in notes. I gave hours of dictation during my own teaching days, and took dictation as a student.

I wish that this worthy and expensive series, therefore, could fulfill its promise as a useful device for those interested in improving their ear for music. It doesn't, simply because its makers have shown a lack of imagination in transferring their material to the recorded medium and in foreseeing the probable audience that might acquire such records —at $50 the set.

What we have here is simply a literal transcription of a college dictation course, with formal spoken instructions and musical examples, played with extreme (though necessary) leisure. The atmosphere is as at any college examination, or weekly quiz—how well I remember the chastening hush, the discreet rustle in unaccustomed silence, the inevitable "gentlemen, please turn in your papers . . . at once." I had to do the formal act myself, and always longed to break the ice. Nobody breaks any ice here.

The narrator, to be sure, is perfectly pleasant, and he boasts an interesting (and entirely irrelevant) Scotch accent—I figure it must be Scotch-Canadian. But he is one of those who seem to think that people who listen to records (a) sit formally in rows, at attention and (b) are dreadfully hard of hearing. His pace is extremely deliberate, he chooses the longest words he can find, with never a one-syllable term when a polysyllabic one is available. His explanations are academic to the point of incomprehensibility—the account of sharps and flats in the common key signatures is surely the most linguistically elaborate ever perpetrated on an abashed listener! Moreover, the explanations in this series are merely rules, not explanations. They say nothing as to what a scale *is*, nor why, nor a key signature. There is not a thing an active mind can fasten upon, no mental stimulation, only rote.

Records *can* be informal—and informative too. They can move along at a brisk pace, and should. Music *can* be explained simply, without polysyllables, yet with profundity as well. I am sure that with commentary reduced to a pointed and informal outline of the essential subjects, the whole of this could be done in half as many sides at twice the value, and would appeal to a properly wide audience of intelligent listeners, including, perhaps, you and me.

EQUIPMENT PROFILE

(*from page 43*)

With the same machine and with eight newly purchased tapes, new record-playback tests were made, completely supporting Tandberg's claims for 7.5 and 3.75-ips response but not the 1.875-ips response. Six of the tapes are brand names, four of these being 1½-mil acetate and two being 1-mil Mylar. Two of the tapes are unbranded, one having been purchased in an audio store and the other in a camera store; one of these is 1½-mil acetate and the other is 1-mil Mylar. The six brand names are identified here as Tapes A, B, C, D, E, and F. The unbranded tapes are identified as X and Y.

The recording level was 26 db below that which caused the magic eye to close at 400 cps. In machines having a VU meter it is customary to test response at a recording level 20 db below the 0-VU indication at 400 cps. This reading corresponds to about 1 per cent harmonic distortion. Magic-eye closure in the Tandberg corresponds to about 3 per cent distortion, which occurs at a recording level about 6 db higher. Therefore, to test the Tandberg 64 in a manner comparable with other machines, a recording level 26 db below magic-eye closure at 400 cps was used. Tests were made only on the right channel in view of the great similarity of response of the two channels.

Following are the results:

RECHECK OF TANDBERG 64 RECORD/PLAY RESPONSE

With 1000 cps as the 0-db reference frequency

	15,000 cps 7.5 ips	10,000 cps 3.75 ips	5000 cps 1.875 ips
Tape A	– 0.5 db	– 1.5 db	– 4.5 db
B	1.5	1.0	– 3.5
C	– 1.0	– 2.5	– 5.0
D	1.5	1.5	– 2.5
E	1.0	– 0.5	– 5.5
F	1.0	– 0.5	– 4.5
X	2.0	0	– 4.5
Y	– 1.0	– 3.5	– 7.0
Average	0.6	– 0.8	– 4.6

In addition, Tapes D and E were checked at 20,000 cps at 7.5 ips, and both showed response of about +1 db. Time did not permit the other tapes to be checked at this speed and frequency, but their performance at 15,000 cps indicates that all would have been essentially flat to 20,000 cycles. Further tests indicated substantial response to about 24,000 cps at 7.5 ips and to about 12,000 cps at 3.75 ips. **E-18**

LIGHT LISTENING

(*from page 8*)

radio in the summer of 1957. To no audiophile's surprise, the only episodes that are dated today are the two sketches kidding high fidelity wherein Freberg plays the part of Herman Horne, the authority to end all authorities.

Dean Elliott's excursion into the mad world of sound effects finds his big swinging band beating its way through a fantastic undergrowth of weird sounds. Dozens of wildly improbable effects show up in the rhythm, background and even melody of standard songs as sound effects editor Phil Kaye marshals his army of tapes. The cleverest effect is the use of melodic rain drops in the Elliott arrangement of *Rain*. **AE**

JAZZ and all that

CHARLES A. ROBERTSON

STEREOPHONIC

Gerald Wilson: Moment Of Truth
Pacific Jazz Stereo 61

The buoyant force of a growing corps of arrangers and composers is doing a great deal to offset the economic attrition which has deseiged big bands during the last decade. Youthful geniuses arrive to swell the ranks with astonishing frequency, and there is renewed activity on the part of weary warriors who learned long ago that genius and the ability to meet a payroll are two different things. Jazz publicists have manufactured too many geniuses in recent years for the term to mean much anymore, but the production of jazz scores has never before attracted quite so much brain power. No longer limited to charting paths for dancers only, the imagination can pursue strange rhythms, revel in orgies of sound, or wander down atonal byways. Among the veterans rejuvenated at the prospect of such freedom is Gerald Wilson, who uses Hollywood studios as a protective shelter while sharpening his wits by going on sorties with his own seventeen-piece band.

As a leader of troops in the field, Wilson combines the straightforward tactics of the swing era with the stealthy attack of today's schooled commandos. The strategy behind this double-pronged attack stems from factors which split his career into two parts. After early experience in and around Detroit, he played trumpet under such astute generals as Jimmie Lunceford, Benny Carter, Count Basie and Dizzy Gillespie. When the retreat of the bands turned to a rout in 1951, he left the music business for a year and settled in California. The slow journey back included writing assignments in television and movies, record dates accompanying vocalists, and culminated in a breakthrough last year with his band in the album "You Better Believe It!"

Not only does the band succeed in widening the breach in this second effort, but Wilson's plans for the assault are even more ambitious and daring. Like many of the newer jazz composers, he develops material and methods rarely considered in jazz during his younger days. Who can count the number of swing tunes based on a catchy riff and titled after street intersections, popular ballrooms, or a feminine name? Wilson writes about the fair sex, but the portraits are drawn from life and usually reveal some prized trait possessed by a member of his immediate family. He also treats such curious themes as bullfighting and the moment of truth, never forgetting an elementary lesson from the past. "While this is not a simple band and the harmony and structure of the material are advanced," he states in the liner notes, "the search is for simiplicity—but not simpleness."

There is ample evidence that Wilson remembers the lasting truths absorbed sitting beside the Lunceford sax section, from the clarity of a Sy Oliver arrangement, or listening to the great Ellington band of that period. These early influences serve quite effectively during the ballads *Josephina* and *Teri*, named respectively for his wife and a daughter. Wilson had little difficulty in achieving his aim of a distinctive sound on his last album, thanks to the blues playing of guest organist Richard Holmes. He hits the mark again with conventional instrumentation, as lead position goes to Joe Pass, one of the most exciting guitar soloists since Charlie Christain. Not far behind are Carmell Jones, trumpet, Teddy Edwards, tenor sax, and pianist Jackie Wilson, with the drumming of Mel Lewis urging everyone on. Modesto Duran joins in with conga drums to execute a stereo flanking movement on two Latin numbers. The striking cover photo of Wilson conducting shows how he commands the ensemble at crucial moments, and Lunceford would have every reason to be proud of the raw recruit of 1939.

Woody Herman: Woody Herman—1963
Philips Stereo PHS600065

Although this album was recorded in October, 1962, the updated title commenmorates Woody Herman's 25th year as a leader. As a matter of fact, several months of indecision intervened while members of the old Isham Jones band pondered over continuing to perform under their late leader's name. Enough regular hands to open up a new spread voted to ride along with Herman, who took charge and eventually adopted the brand "the band that plays the blues." Numerous Herds came later, but by and large the current group consists mainly of young mavericks who have yet to feel the heat of a branding iron. They still require plenty of territory to roam over, and Herman opens up the wide expanse of his years of experience. Besides corralling all fifteen members, this recording introduces several soloists of promise, and from now on Herman had better keep an eye out for rustlers. Prize specimens are Phil Wilson, a bold trombonist in the Bill Harris tradition, and a healthy and uninhibited tenor player named Sal Nistico. Even a seasoned range rider like Nat Pierce, pianist and sole survivor from previous outfits, cavorts joyously at the sight of so much new talent.

Aside from enthusiasm and instrumental prowess, the band boasts several thoughtful members who are fully capable of writing arrangements and fresh material. Nat Pierce comes through with three numbers, as might be expected, but Herman also gives free rein to Bill Chase, Gordon Brisker, and Jack Gale. The lone outsider is Tommy Newsome with a choice setting of Ellington's *Don't Get Around Much Anymore*. Chase, who shares trumpet honors with Paul Fontaine, contributes the ground-covering *Camel Walk*, with a descriptive vocal from the clarinetist-leader himself. To fill out the stereo picture there is Jake Hanna, one of the best drummers to spark a Herman band since Dave Tough held the post. The entire session sounds like history in the making, and the band can thank Herman for showing the way back to the blues of twenty-five years ago before moving ahead.

Glen Gray: Themes Of The Great Bands
Capitol Stereo ST1812

This sixth volume in the series "Sounds of the Great Bands" brings the total to a baker's half-dozen, as ten themes extracted from previous albums are included gratis on a bonus record. Glen Gray is well along on a second career of recreating the hit recordings of swing bands in today's sound, with the aid of a reconstituted Casa Loma orchestra drawn from Hollywood studios. When the project will end is anybody's guess, as a few themes still remain to be covered even after a dozen new additions. And if Gray ever starts on the popular bands, the prospects are virtually limitless.

Weary though individual members must become through constant repetition, every big band regards an identifying theme as its private domain and is always ready to fight off interlopers. The whole company snaps to attention when occasion arises for a full concert performance, and recordings are made to withstand the test of time and rival versions. But when the originals date back twenty years or so, time and stereo together are often enough to turn the balance in Gray's favor. This is particularly true of Jan Savitt's *Quaker City Jazz*, a real groovebuster even by current standards. Among the newly restored themes are Charlie Barnet's *Redskin Rhumba*, Glenn Miller's *Moonlight Serenade*, Les Brown's *Leap Frog*, and Tommy Dorsey's *I'm Gettin' Sentimental*. Clarinetist Abe Most executes a triple play by switching in stellar fashion from Benny Goodman to Artie Shaw to Woody Herman, while the trumpet stylings of Bunny Berigan and Erskine Hawkins are undertaken by Shorty Sherlock. Designed to give the fans a preparatory thrill, opening themes benefit immeasurably from the expansive dynamics heard here, and realistic stereo creates a warm glow of anticipation from the start.

Coleman Hawkins: Desafinado
Impulse ITC303 (4-track UST)

As the boss and senior citizen of the tenor sax, Coleman Hawkinh never becomes excited about new fads and is quite capable of taking the bossa nova in stride. He just polishes up his famed ballad style a bit, letting some of the luster rub off on such Brazilian goodies as *O, Pato, One Note Samba*, and *Um Abraco No Bonfa*. If Stan Getz sounds like sparkling champagne on *Desafinado*, then Hawkins flavors it with the mellow tone and relaxed glow of aged dark rum or old port. He alone has the dignity and aplomb to risk the conviviality of *I'm Looking Over a Four Leaf Clover*.

Manny Albam charts the way as musical coordinator, which probably means that he talked Hawkins into the idea as well as picking the tunes, writing the arrangements, and contributing *Samba Para Bean*. Holding to the principle that the music calls for a strong guitar lead, he assigns the role to Barry Galbraith and adds the rhythmic support of Howard Collins. The theory yields dividends for stereo listeners, and the interweaving of two guitar voices is especially attractive on the four-track stereo tape, engineered by Rudy Van Gelder. Willie Rodriguez and Eddie Locke handle the percussion parts, with an assist from pianist Tommy Flanagan on claves, and bassist Major Holley completes the septet.

Kenny Ball: Recorded Live!
Kapp KTL41049 (4-track stereo tape)

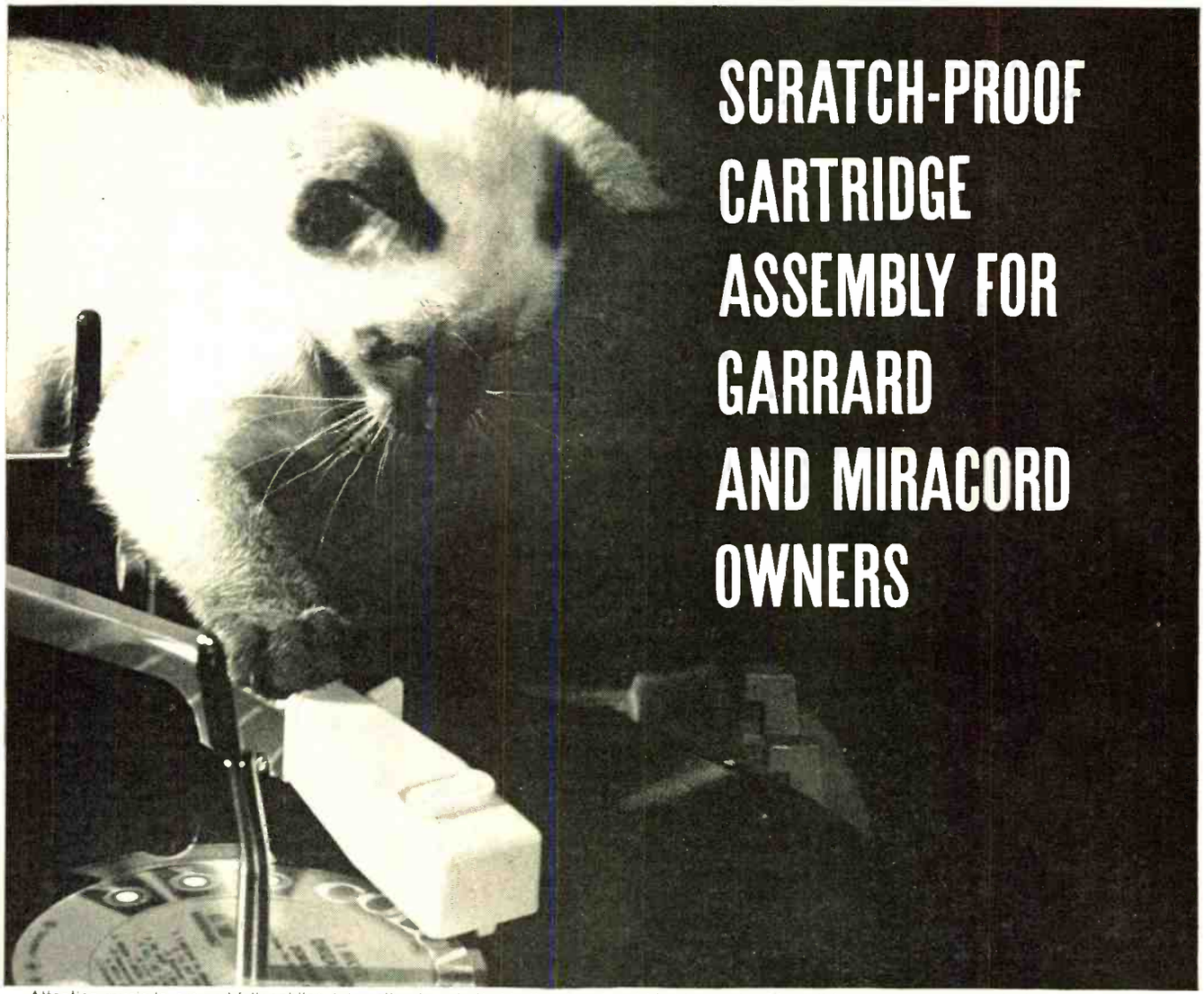
Whether Britishers are serious or lighthearted about Trad jazz, they are always enthusiastic and willing to pack a hall on a Sunday to greet Kenny Ball and his jazzmen. A capacity audience of 2500 persons crowded into the Empire Theatre, Liverpool, to hear this concert on April 1, 1962. The lack of similar box-office response in this country is no April Fool's joke. Four-track stereo tape, however, provides one of the most desirable seats in the house and by-passes the local custom of queuing up. As befits the happy occasion, the leader and Paddy Lightfoot distribute a larger vocal ration than usual, even inviting the guests join in on *I Shall Not Be Moved*. They engage in a rousing duet on *Swing Low, Sweet Chariot*, and Ball refers to paddlewheelers traveling "down the Mersey-sippi" on *Basin Street Blues*. Amongst all the foolery, purists will find a few solemn and sobering moments on *Old Miss Rag, Kansas City Stomp*, and *Saturday Night Function*.

Cal Tjader: The Contemporary Music Of Mexico And Brazil
Verve C281 (4-track UST)

This music is sophisticated enough to hold the attention of devotees of serious contemporary music, yet jazz and folk enthusiasts will be intrigued by the primitive and authentic ring of unadorned melody in infectious rhythms. No matter how worldly Latin composers become, it seems that they will always retain these native characteristics, along with an emotional frankness not always disclosed by their counterparts in other climes. While the performance results from the current interest of jazz musicions in Latin American

new from SHURE

originators of scratch-proof high fidelity tone arms



SCRATCH-PROOF CARTRIDGE ASSEMBLY FOR GARRARD AND MIRACORD OWNERS

Attention music lovers and felinophiles; interesting to note that both cat and cartridge have retractile styli for gentleness and protection from scratching

GREATER RECORD AND NEEDLE PROTECTION . . .
FINER RECORD REPRODUCTION

Now, owners of Garrard Laboratory® Type "A" and AT-6 and Miracord Model 10 and Model 10H Automatic Turntables can assure themselves unprecedented and unparalleled record and needle protection, and highest sound quality simply by plugging in the Shure Stereo Dynetic GARD-A-MATIC "floating" cartridge assembly. Nothing else to buy . . . no wiring, no soldering, just plug in.

Ingenious GARD-A-MATIC cartridge inside a special tone-arm shell ends scratching due to dropping the tone arm or accidentally dragging it across the grooves . . . records stay new, sound new. Needles last longer—can't be damaged by pressing arm on record. Does away with tone arm "bounce" from floor vibrations, etc. Even plays warped records. And, the performance characteristics are those of the famed Shure Stereo Dynetic cartridges.

SPECIFICATIONS

Frequency Responses:	From 20 to 20,000 cps
Output Voltage:	6 millivolts per channel
Channel Separation:	more than 22.5 db at 1000 cps
Recommended Load Impedance:	47,000 ohms
Compliance:	20.0 x 10^{-6} cm per dyne
Tracking:	1.5 to 3.0 grams
Inductance:	600 millihenries
D. C. Resistance:	750 ohms
Stylus:	.0007" diamond
Stylus Replacement:	N99

MODEL M99/A. Fits Garrard Laboratory® model "A". Includes tone arm head, factory mounted cartridge, .0007" diamond. **MODEL M99/AT6.** Fits Garrard AT-6. Includes tone arm head, factory mounted cartridge, .0007" diamond. **Model M99/M10.** Fits Miracord Models 10 or 10H. Includes tone arm head, factory mounted cartridge, .0007" diamond. **MODEL N99.** Replacement stylus assembly, .0007" diamond.

SHURE Stereo Dynetic® GARD-A-MATIC T.M.

Patented and Patents Pending

CARTRIDGE ASSEMBLY

WRITE FOR DETAILS TO: SHURE BROTHERS, INC., 222 HARTREY AVE., EVANSTON, ILLINOIS

music, the purpose this time is peaceful research rather than forceful expropriation.

The two groups under Cal Tjader go beyond surface manifestations to investigate primary sources, and any jazz experience simply makes the task that much more easier. The vibist was introduced to the Mexican songs of Mario Ruiz Armenhol by Clare Fischer, who also assists as pianist and arranger, and the voice of Ardeen deCamp weaves gracefully together with an octet on five titles. Guitarist Laurindo Almeida and a woodwind quintet join an expanded rhythm section when the quest turns to Brazil and the bossa nova. Much of the material is new to this country, and the vibes and extra percussion contrast brightly with the woodwinds on four-track stereo tape.

MONOPHONIC

Charlie Parker: The Happy "Bird"
Charlie Parker Records PLP404

If the stature of Charlie Parker has diminished since his death in 1955, a large part of the blame rests with the posthumous appearance of numerous albums which he would never have approved for release. Also at fault is the growth of a legend based on the least attractive aspects of his personality. Too many recent accounts leave the impression of someone who never enjoyed a happy day in his life, and the authors would probably insist that the quotation marks in the album title are placed around the wrong word. Everything about this informal session is bright enough to cut through the foggy notions closing in around the great alto saxist's bid for immorality, from Parker's original conception of the Vincent Youman's tune which sets the theme to the sound quality. Perhaps quotes should go around the billing "Unprecedented Hi-Fidelity," but the enthusiast who taped the proceedings did a fine job considering the circumstances. Several of Parker's rediscovered tapes and concert performances on the market are less well recorded.

The gathering took place at an after hours club in Boston called Christy's on April 12, 1951, with various sidemen moving on and off the stand at will. Among the luminaries in attendance was the late Wardell Gray, who left those parts a short while later to reside in California, and his impassioned solos on tenor sax are punctuated by encouraging shouts from the audience. As Gray's recordings are in short supply, a good share of the purchase price is likely to be amortized by his work on *I Remember April*, and *I May Be Wrong*. An incomplete personnel listing includes Charlie Mingus, Roy Haynes, Dick Twardzik and Walter Bishop. The missing names, along with the evening's full story, may be forthcoming when this release jogs someone's memory. Equally welcome would be news of additional tapes of the event. **Æ**

LETTERS

(*from page 6*)

$$R_s = \frac{750 \times 10^{-6}}{C_1}$$

$$R_2 = \frac{R_s}{6.88}$$

$$C_2 = 2.92\ C_1$$

This extremely simple input network results in much less electrical loss of gain than that used for full RIAA magnetic compensation and keeps us out of noise and hum problems in the amplifier, due to the much larger signal on the first control grid (75 to 100 millivolts). Further, the ceramic cartridge cannot pick up inductive hum and reasonable extra cable length cannot do more than slightly lower the cartridge output.

As might be expected, the use of any

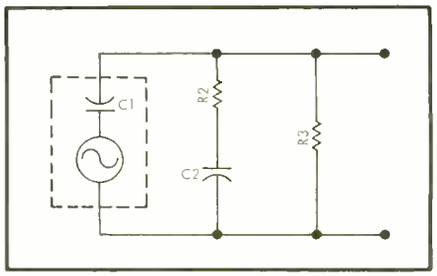


Fig. 1

ceramic cartridge having the "built-in" mechanical rising response with the above circuitry will result in the characteristic tipped-up response and coloration. Even if the response is carefully equalized down "flat" by altering the circuitry, the "ceramic sound "will remain, since its source is *mechanical.*

THEODORE LINDENBERG,
Director of Engineering,
The Astatic Corporation,
Conneaut, Ohio

TAPE AMPLIFIER

(*from page 19*)

teries, the electronics is powered through J_5 with the correct number of C or D cells.

The recorder consumes approximately 4.5 mA in playback and 120 mA in record. The bias oscillator requires 110 mA. These values are the most that the unit will consume with the most inefficient erase heads

When manufacturers make available d.c. tape decks of good quality it will be possible to use this set of electronics and be completely freed from confining your recordings to spots near an a.c. line outlet.

Operation

When construction is complete, plug in the heads and adjust the power supply so that the erase head receives the proper voltage. The erase record currents, can be checked with an adapter such as the one shown in *Fig.* 6. Insert the adapter between the amplifier and the head and compute the current by Ohm's law after reading the voltage across the 100-ohm precision resistor. Thus, the current in mA is numerically equal to 10 times the voltage.

Next, adjust C_{14} to give the lowest value of bias voltage at the collector of Q_4.

The next step, after plugging the adapter into the record head lead, is to set the bias by varying C_{20}. It is preferable to record a 500-cps tone at a low, say, −15 VU level and increase the bias setting until the playback level rises to a peak then falls about ½ db.

Now, switch to PLAYBACK and thread an Ampex 5563 standard alignment tape (7½ ips) on the deck. Set R_{34}

to give +4 VU (1.228 volts) output at J_6 when the 0-VU tone on the tape is played. Then, set R_{29} to give flat response at 10,000 cps. If response at 50 cps is somewhat high, shunt C_{26} with a resistor ranging in value between 500k ohms and 1 megohm. This completes the setting of the bias and playback sections. Switch to the RECORD position for the final settings.

Record a 250-cps tone from an audio oscillator onto a fresh—or degaussed—roll of tape so that playback of the tone gives a +4 VU output at J_6. This is the 0-VU recording level. When this is found set R_{42} to drive the pointer of the VU meter to 0 VU or 100 per cent.

Flat response at 10,000 cps can be obtained by varying the setting of C_8.

Now, the machine is ready for use. The tape deck will largely determine the quality you can obtain. With a good deck it is extremely difficult to tell any difference at all between the recorded signal and the input signal from a good FM tuner. Tapes made on this recorder can be played back on any NAB-equalized equipment. And, of course, NAB tapes can be played on the equipment.

Also, unlike tube equipment that requires a fair amount of maintenance, this unit has proven to be trouble free. Dependability, by the way, is one of the characteristics that makes professional equipment so expensive. To get that kind of dependability is so small a unit is very welcome.

Performance

The writer has operated the recorder many hours during the last two years and performance is unchanged. Performance was stable even when the unit was operated on days when the temperature went above 90°. It has been used for tape duplication and for portable applications. For the latter, the input signal can be monitored at J_6 through a set of headphones. Æ

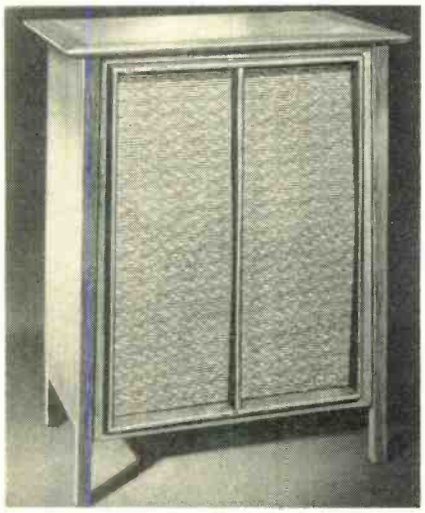
PARTS LIST

C_1, C_2, C_{21}, C_{31}	25 µf, 25 v, electrolytic, Sprague TE-1207
C_3, C_5, C_{10}, C_{22}, C_{29}, C_{32}	8 µf, 25 v, electrolytic Sprague TE-1203.5
C_4, C_{28}, C_{33}	100 µf, 15 v, electrolytic Sprague TE-1162
C_6	.003 µf, 200 v, tubular, Sprague 6PS-D30
C_7	1100 pf, mica, Sprague MS-211
C_8	Arco 308 trimmer, 1390 pf max
C_9	0.68 µf, 25 v, ceramic, Sprague 5C12
C_{11}	470 pf, mica, 5%, Sprague MS-347
C_{12}	0.1 µf, 200 v, tubular, Sprague 2PS-P10
C_{13}	6 µf, 150-v, paper, Sprague type 121P. See text
C_{14}	Arco 304 trimmer, 550 pf max
C_{15}, C_{16}	2.2 µf, 3 v, ceramic, Sprague HY-150

C_{17}, C_{18}, C_{26}	.01 μf, 200 v, Sprague 2WF-S10
C_{19}	.047 μf, 200 v, Sprague 2WF-S47
C_{20}	Arco 303 trimmer, 340 pf max
C_{21}	1000 pf, mica, Sprague MS-21
C_{23}	0.1 μf, 50 v, ceramic, Sprague 5C50
C_{25}	Two 50-μf, 6-v tantalum capacitors in series, Sprague type 150D. See text
C_{27}	.022 μf, 200 v, paper, Sprague 2WF-S22
C_{30}	500 μf, 25 v, electrolytic, Sprague TVA-1209
C_{31}, C_{35}	500 μf, 50 v, electrolytic, Sprague, TVA-1315
F_1	½-amp fuse
$J_1, J_3, J_4, J_5, J_6, J_8$	Phono jacks, Switchcraft 3501FR
J_2, J_7	Single contact mic jack Switchcraft C-12A
L_1	20 mH coil, Miller 691
PL_1	pilot light, Dialco 101-3830
$Q_1, Q_2, Q_3, Q_4, Q_7, Q_8, Q_9, Q_{10}, Q_{11}, Q_{12}, Q_{13}$	2N508 transistor, General Electric
Q_5, Q_6	2N1501 power transistor, Minneapolis-Honeywell
R_1, R_{16}	100 k ohms, ½ watt, 10%
R_2	10,000-ohm pot, audio taper
R_3	470 k ohms, ½ watt, 5%
R_4	25,000 ohms, ½ watt, 1% low noise
R_5, R_8	100 ohms, ½ watt, 5%
R_6, R_{29}	25,000-ohm pot, linear taper
R_7, R_{17}	10,000 ohms, ½ watt, 5%
R_9, R_{24}	3600 ohms, ½ watt, 5%
R_{10}	3300 ohms, ½ watt, 5%
R_{11}, R_{13}, R_{36}	4700 ohms, ½ watt, 5%
R_{12}, R_{21}, R_{22}	22,000 ohms, ½ watt 5%
R_{14}	47,000 ohms, ½ watt, 10%
R_{15}	220 k ohms, ½ watt, 10%
R_{18}	220 ohms, ½ watt, 5%
R_{19}	4700 to 22,000 ohms, ½ watt, 10%; see text
R_{20}	20-ohm pot, linear taper
R_{23}	250 ohms, 10 watts, wire-wound
R_{25}	390 ohms, ½ watt, 10% or see text
R_{26}, R_{39}	15,000 ohms, ½ watt, 1%, low noise
$R_{27}, R_{32}, R_{40}, R_{45}$	1500 ohms, ½ watt, 10%
R_{28}	24,000 ohms, ½ watt, 5%
R_{30}, R_{31}	47 ohms, ½ watt, 5%
R_{31}, R_{43}	330 k ohms, ½ watt, 10%, or value selected; see text
R_{33}, R_{44}	8200 ohms, 1 watt, 10%
R_{34}	5000-ohm pot, audio taper
R_{35}	330 k ohms, ½ watt 5%
R_{36}	680 k ohms, ½ watt, 5%
R_{37}	2000 ohms, ½ watt, 5%
R_{38}	1000 ohms, ½ watt, 10%
R_{42}	100 k-ohm pot, linear taper
R_{47}	50 ohms, 10 watts, wire wound, or value selected; see text.
SR	selenium rectifier, 1200 mA, full-wave bridge. Intl. Rect. M1B
Sw_1, Sw_3, Sw_4	SPDT slide switch
Sw_2	6PDT rotary switch, Mallory 3163J (if SW_4 is used, Mallory 3142J, 4PDT)
Sw_5	SPST slide switch
T_1	bias oscillator transformer, Nortronics T60-T2
T_2	small filament transformer, 115-volt primary, 20-volt secondary; Triad F91X
VU	small VU meter, such as Lafayette TM10, with standard VU meter characteristics

NEW PRODUCTS

● **Three-Way Speaker System.** Another "Classic," the "Dual-12," joins the family of high-quality speaker systems produced by University Loudspeakers of White Plains, New York. Descendent of the "Classic Mark II," the "Classic Dual-12" is styled in the same tradition, but designed for those who want the quality of the Mark II in a less costly and more compact form. Instead of the conventional three-speaker arrangement (12-in., 8-in., and tweeter), the Dual-12 has been equipped with two 12-in. speakers, plus a super-tweeter. A 12-in. woofer provides distortion-free reproduction of the ultra-



low frequencies; a 12-in. woofer/mid-range reinforces the woofer. To provide high-frequency response to 22,000 cps (measurable to 40,000 cps), the Dual-12 has been equipped with University's finest super-tweeter, the Sphericon. Continuously variable brilliance control allows user to tailor high-frequency response to his room acoustics, and a three-position "presence" control to select the user's personal "presence" preference. The Dual-12 is only 23¾-in. wide, 31½-in. high and 15½-in. deep. Price is $229.50. University Loudspeakers, 80 South Kensico Avenue, White Plains, New York. **E-1**

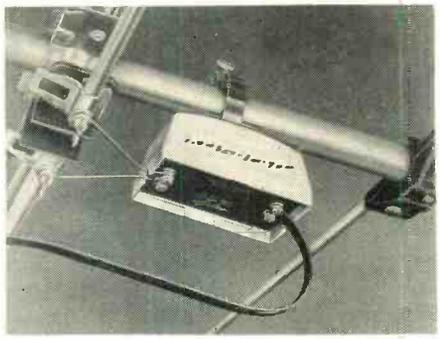
● **Two-Speed Turntable.** Acoustic Research announces a two-speed (33⅓ and 45 rpm) version of the AR turntable at $68. This unit is identical to the single-speed AR turntable except for its two-step drive pulley. Speed is changed by lifting off the outer platter and moving the belt from one section of the pulley to the other. Owners of the single-speed AR turntable may order a conversion kit (shown), which

will convert their turntable to the two-speed model, for $6 postpaid. This kit consists of the two-step pulley, a 45-rpm spindle adapter, and instructions for installation. The parts are of aluminum, machined to an accuracy of 0.0005 in. The conversion is a relatively simple job and should take less than one minute. Orders for the conversion kit, together with $6 in cash, money order, or check only, should be sent to Acoustic Research, Inc., 24 Thorndike Street, Cambridge 41, Massachusetts, **E-2**

● **Bulk Tape Eraser.** A Bulk tape eraser, Model 55-03, has been developed by Roberts Electronics for use on reels up to ten inches in size. Highly efficient and extremely simple to use, the new Roberts Model 55-03 completely erases, in seconds,

an entire reel of tape, reducing background noise levels of the tape far below that of normal tape recorder erase heads. An important accessory for the serious audiofan, Roberts bulk tape erasers are priced at just $24.50. Roberts Electronics, Inc., 5978 Bowcroft Street, Los Angeles 16, California. **E-3**

● **Transistor Antenna Amplifier** .The Winegard Company announced the introduction of a new low-cost antenna amplifier, the "Red Head," with a suggested list of $29.95. This model RD-300 has a high-pass interference filter, built-in two-set coupler and is fully a.c. with no polarity problems.

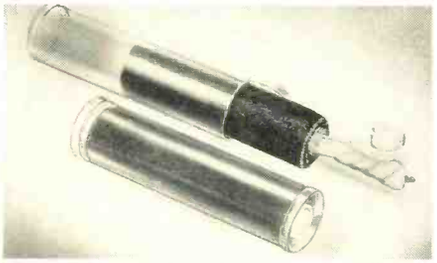


It is recommended by the manufacturer for areas where all signals are less than 20,000 microvolts. The "Red Head" has a bright red amplifier housing for lasting product identification. Winegard Company, Burlington, Iowa. **E-4**

● **Equipment Cabinet.** The new Audio Originals Model 404 features two large sliding drawers instead of doors; one drawer with board for changer/turntable and the other for records or tape recorder. Drawer fronts are available with either

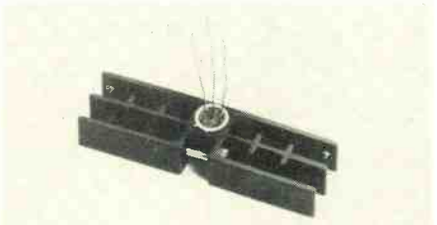
cane cloth or matching wood veneers. Equipment is mounted above the drawers, as shown in photo. The cabinet is made of genuine hardwoods in oiled walnut or fruitwood finish. It is shipped knocked down and assembles in a matter of minutes. Price is $99.50. Audio Originals, 474 South Meridian Street, Indianapolis 25, Indiana. **E-5**

● **Record Cleaner.** The new record "Preener" by Cecil E. Watts is an unusually simple device which thoroughly cleans records. Consisting of a roll of "plush" material with an inner foamed-plastic wick, the "Preener" uses plain water as the wetting agent, with the major



cleaning being done by the "plush." The center wick is dipped in water and placed in position; then the "Preener" is held against the record for two or three rotations. The "Preener" is intended to keep new records "new." Elpa Marketing Industries, Inc., New Hyde Park, N. Y. **E-6**

● **Printed-Circuit Board Transistor Heat Sink.** The Model 2704 is the latest model in Astro Dynamics' line of small, light, natural-convection heat sinks which provide the maximum ratio of heat dissipation to



volume occupied. The 2704 heat sink will accommodate both the TO-5 and TO-9 transistor cases. Mounting holes for other transistors are also made to customer specifications. Astro Dynamics, Inc., Northwest Industrial Park, Burlington, Mass. **E-7**

● **Stereo Phones Control Center.** Easily attached to amplifiers or speakers, the Sharpe CB-1 stereo headphone control center features: Left and right volume controls; speaker on-off switch; two phone jacks; and a blend control which allows

the mixing of two input signals from full separation to monophonic output. This allows the CB-1 to double as a low-impedance audio mixer. For example, music played through Channel A could be mixed with a voice played through Channel B. Sharpe Instruments, Inc., 965 Maryvale Drive, Buffalo 25, N. Y. **E-8**

● **Linear Potentiometers.** Gotham Audio Corp. has introduced its "Preh" model deposited-carbon linear-motion potentiometers designed to permit restyling of products in keeping with the current trend towards easier-to-see and easier-to-operate controls. The units are available in single or dual elements, linear or logarithmic taper, tracking or reverse motion, and in values from 1000 ohms to 5 megohms with tolerances a slow as ± 5 per cent. For special applications the unit is available in a constant-impedance bridged-T configuration. Gotham Audio Corp., 2 West 46th St., New York 36, N.Y. **E-9**

New Super-Sensitive SCOTT FM Stereo Tuner

Multiplex Version of the Famous 310 Tuner Selected for "Telstar" Experiment

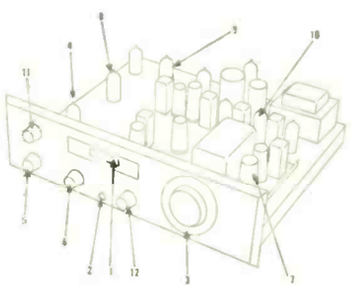
Now the world famous 310 tuner is fully equipped for Stereo Reception. The 310 is considered the most outstanding FM tuner available. It is used for commercial applications and critical broadcast relay work throughout the world. Its extreme sensitivity, selectivity and low distortion make it the logical choice for the most critical installations. The new 310E is equipped with the famous Time-Switching multiplex circuitry, pioneered by Scott, and universally accepted as the best way for achieving optimum stereo separation. Here is a tuner of broadcast quality, suggested for use in critical reception areas where its extreme sensitivity, excellent capture and low distortion are required. It is also recommended for the audio enthusiast who requires the very finest tuner possible at the present state of the art.

310E Technical Specifications

IHFM Sensitivity 1.9 microvolts; Drift .02%; Capture Ratio 2db; Selectivity (adjacent channel) 50 db; FM Detector Bandwidth 2 mc; FM Limiting Stages, 3; FM IF Stages, 4; Frequency Response (± 1 db) 30 to 15,000 cps (IHFM limits); Harmonic Distortion less than 0.5%; Spurious Response Rejection 85db; Separation 35 db. Controls: Main Tuning, Interstation Noise Suppressor, Level, Sub-Channel Filter. Size in accessory case: 15½W x 5¼H x 13¼D. Price: $279.95 *

310E FM Stereo Tuner Outstanding Features:

1. Sensitive illuminated tuning meter for optimum orientation and station selection. **2.** Convenient front-panel recorder output jack. **3.** Laboratory-type precision vernier tuning control. **4.** Auto-Sensor circuitry for fully automatic operation. **5.** Mode Control with these positions (FM Monophonic, FM Stereo, FM Stereo Automatic). **6.** Interstation noise suppressor. **7.** Silver plated RF Cascode front end. **8.** Scott's unique "Time Switching" multiplex circuitry. **9.** 2 megacycle wide-band detector. **10.** Three limiting stages, assuring fully quieted performance on even the weakest signals. **11.** Power/Filter (with these positions: Off, On, Sub-channel Filter, Stereo Filter). **12.** Stereo Threshold.



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Address _____

City _____ Zone ___ State _____

Send name and address of interested friends.

ABOUT MUSIC

Harold Lawrence

Time-Beating—Plain and Fancy

"He used to suggest a *diminuendo* by crouching down more and more . . . When the volume of sound grew he rose up as if out of a stage-trap, and with the entrance of the power of the orchestra he would stand upon the tips of his toes almost as big as a giant, and waving his arms, seemed about to soar upwards to the skies."

The podium choreography described above suggests Leonard Bernstein, the late Dimitri Mitropoulos, or perhaps Danny Kaye. Actually, it is an eyewitness account of Beethoven conducting his own music nearly 150 years ago. The composer's approaching deafness, his intense feelings about his own compositions, a recalcitrant band of players—these factors might explain the violence of his movements. The sad truth is that the musicians paid little attention to Beethoven, but kept their eyes instead on the concertmaster, who dispensed cues and set tempi with a vigorous nod of the head or a wave of his bow. In fact, "the orchestra had to have a care in order not to be led astray by its master," one player reported. But even with perfect hearing, an impeccable baton technique and a proficient ensemble, many a conductor has felt it necessary to literally throw himself into his work, a spectacle that has caused many a critic untold esthetic anguish.

Conducting and Showmanship

Podium manners became a topic of discussion from the time the conductor left the relative obscurity of his seat at the keyboard in order to rise to the head of the orchestra, in plain view of the audience. Whether he liked it or not, he was now in show business. The public carefully scrutinized this new breed of musician; they inspected his attire, noted his walk to and from the podium, and studied his profile.

Although conductors were to become as celebrated in the late 19th century as were singers and instrumentalists, they were bitterly resented at first by both the public and the critics. As late as 1841, a German critic questioned the need for the baton-wielding conductor, who "beats time with aching arms, and quite unnecessarily too, for the opera would go on like clockwork quite as well under the guidance of the prompter without any time-beating. The fine *Herr Kapellmeister* is nothing but an ornament, and we have sometimes observed that when the orchestra is getting into difficulties he quietly lays down his baton, blows his nose, and then waits until the concertmaster has rescued it from its perilous situation by the vigorous use of his violin. Then as if nothing had happened, he gracefully resumes his time-beating."

From the vantage point of his seat in the orchestra, Moritz Hauptmann (a musician who played under Louis Spohr) focused his objections on the baton: "The cursed little white stick always did annoy me, and when I see it domineering over the whole orchestra, music departs from me; it is as if the whole opera exists merely for the sake of beating time to it."

More than a baton was needed to establish the conductor's absolute sway over his orchestra. The new maestro wielded power by means of a commanding presence, unequivocal bodily movements, and a rocklike faith in his interpretive abilities. Orchestral direction moved from mere time-beating to conducting in the modern sense through the work of Weber, Berlioz, Spohr, Mendelssohn and Spontini.

Of Weber's orchestra in Dresden, Berlioz wrote: "[He] had it trained so well that he would sometimes beat the first four bars in the *allegro* of the *Freischütz* overture, and then allow the orchestra to go on alone up to the pauses near the end." The late Sir Thomas Beecham could be called a latterday Weber. At one of his last recording sessions for E. M. I., the British conductor had just finished rehearsing an excerpt from *Eugen Onegin*. He then put down his baton, sat back in his chair, folded his arms, and jovially addressed his orchestra: "All right gentlemen, play it!" They did and without so much as a downbeat.

No less economical in his movements than Weber was a Bérlin conductor of the mid-19th century who attacked those "charlatans who fight and use their arms like the sails of a windmill; I lead my *Academie* with my right forefinger." Fritz Reiner, a modern Zelter, holds the baton between thumb and third finger and executes minuscule movements.

Another restrained conductor was Richard Strauss, who couldn't be both-

ered with using more than one arm: "The left hand has nothing to do with conducting. The best place for it is in the waistcoat pocket, except at the most to give an occasional hint to damp the tone down, or some insignificant sign; but for this an imperceptible glance is really sufficient."

Although Mendelssohn was not a one-handed conductor, he belonged to the company of "quiet" leaders. "It must be supposed that he in any way courted notice by his behaviour at the desk," reported Hiller. "His movements were short and decided, and generally hardly visible, for he turned his right side to the orchestra. A mere glance at the first fiddle, a slight look one way or another, was sufficient."

Weber, Mendelssohn, and Strauss were examples of conductors who used economical gestures, and were interested primarily in results from the men in front of them. Some other equally gifted men of the podium were at least as concerned with the effect upon those seated *behind* them. Spontini was one of these, a superb showman. He would arrive "with his aristocratic demeanour, dressed in a dark moss-green coat, his breast covered with orders" (Carse, *"The Orchestra from Beethoven to Berlioz"*). Wagner described Spontini's ebony and ivory-knobbed baton and how he "manipulated it in a way to show one plainly that he looked on the baton as a marshal's staff, not for beating time with, but for commanding." In private life, Spontini dazzled Clara Novello, who visited his Berlin home in 1837 and described it as "a gallery of portraits of himself, alternating with sonnets in his praise, busts of himself, etc., all the way to his own sort of throne room, where he sat on a raised dais in a armchair with his portraits, busts, medals, and sonnets all round him."

Conductors like Musard and Jullien carried the theatrical element of their profession to an extreme degree. It was reported the Musard would on occasion "throw away his baton, smash his stool, walk to the edge of the platform and fire a pistol into the air." The irrepressible Jullien was the rage of Parisian ladies for his stunning sartorial qualities, his elegant moustaches and wavy black hair. Between pieces, he would rest on stage in a "lustrous fauteuil," next to his "golden music stand," and would never conduct a Beethoven symphony without first donning immaculate white gloves. Critics invariably spent more words on Jullien's personal traits, clothing, and furniture than on his music-making, although he was a conductor of undeniable gifts.

Between the one-handed Strauss and the flamboyant Jullien lies a world of conducting styles and attitudes. Throughout the years, conductors have turned out numerous tracts on the art of conducting, but they are principally of theoretical interest. In the final analysis, it makes little difference whether a maestro wiggles his right forefinger or tries to leap into space to produce the desired result. Æ

NEW LITERATURE

● **Stereo Record.** H. H. Scott announces a free stereo recording explaining and demonstrating FM stereo (multiplex). This 7-in. plastic record enables the listener to hear an actual FM-stereo broadcast "off the air." There is a complete explanation of important technical specifications with demonstrations of what each specification means and how it affects FM-stereo reception. A copy of the recording is available free by writing to H. H. Scott, Inc., Department P, 111 Powdermill Road, Maynard, Mass. **E-10**

● **Stack Switch Catalog.** Switchcraft announces the publication of their latest catalog of Stack Switch Components and Assemblies for the industrial electronic industry. The new catalog, S-308, features new general purpose stack switches which are made up of an actuator spring and various contact springs. These assemblies are available in many different circuits, contacts and actuator spring forms. The catlog also illustrates the most commonly used stack switch components for computers, telephone relays, micro-miniature switching and various other control devices used in industrial commercial, home entertainment and government applications. Catalog S-308 has been designed to be used as a guide to engineers on all types of stack switches; the catalog, contains engineering considerations, design suggestions, specifications and mechanical drawings on each component. Switchcraft, Inc. 5555 N. Elston Ave., Chicago 30, Illinois. **E-11**

● **Voltage Control Handbook.** General Radio Company, West Concord, Mass., has published a 40-page "Handbook of Voltage Control with the Variac Autotransformer." Contents include principles of autotransformers, descriptions and diagrams of many Variac circuits, and information on the use of auto-transformers for incandescent and fluorescent dimming, for maintaining color temperature in photography, and for various laboratory, heating, and motor speed applications. Over 80 circuit diagrams, charts, and photographs are included. Copies of the Handbook are available free on request from General Radio Company, West Concord, Mass. **E-12**

● **Index to Record Reviews.** The Polart 1962 "Index to Record Reviews" is an index which shows where and when a particular recording, disc or tape, was reviewed in 1962. Monitoring such publications as *Atlantic Monthly,* AUDIO, *Harpers,* and an even dozen more, the index makes it easy to find the most recent review of your favorite composer. In addition to a composer listing, there are listings of artists in the Collections and Pop and Jazz sections. Subjects and shows are listed under Miscellaneous and Shows. All categories are repeated in the Tape section. Price is $1.50. Polart, 20115 Goulburn Ave., Detroit 5, Mich.

● **RCA Battery Manual.** A new 64-page "RCA Battery Manual," specially prepared to assist the designer, application engineer, experimenter, and student. Compiled by RCA engineers, the booklet contains the latest technical information on the company's carbon-zinc, mercury, and alkaline-type dry cells and batteries for industrial and consumer-product uses. This new comprehensive booklet gives the electrical and mechanical characteristics for each RCA dry-cell and battery type including: dimensional outlines, terminal connections, applications, and performance criteria. It also includes a classification chart to aid in the selection of a battery type for a particular application. The "RCA Battery Manual" has an optional list of 50 cents and is available from authorized RCA Battery distributors or from Commercial Engineering, RCA Electron Tube Division, Harrison, N. J.

CHECKING COMPENSATING CIRCUITS

(*from page 32*)

music is reproduced in the home at the 40-phon level. The loudness control is used to reshape the 40-phon curve so that the relative intensity level will follow the contour of the 70-phon curve.

In the reshaping process, 1000 eps is still the reference frequency. At 60 eps, the 70-phon curve requires an increase of 10 db in actual intensity. On the 40-phon curve, the increase in actual intensity required at this frequency is 30 db.

Putting this in another way, if two signals, one at 1000 eps and another at 60 eps, were reproduced at identical intensity levels of 70 phons, the 60-eps note would sound 10 db lower than the 1000-eps note; the 60-eps note would sound 30 db lower than the 1000-eps note if reproduction were at the 40-phon level. In order to make reproduction at the 40-phon level sound as if it were at the 70-phon level, the actual intensity of the 60-eps signal must be 20 db (30 – 10 db) higher in intensity than the 1000-eps signal.

The difference between the two curves similarly has to be reproduced at all frequencies: At 200 eps, the difference is 14 – 4 db, or 10 db; at 10,000 eps, the difference in 12 – 12 db, or 0 db at 3000 eps, the difference is (– 3.5)—(– 3) db, or – 0.5 db. An exact loudness contour compensation curve for making the 40-phon level sound like the 70-phon level is shown in *Fig.* 8. The compensation curve required for doing same to the 60-phon level (for people who like their hi fi very loud), and to the 20-phon level (for those who use their equipment at very low levels), is also shown.

It is quite simple to provide these equal-loudness contours in the amplifier by proper circuitry. At least one of these, at about the 40-db level, is frequently found in audio amplifiers. But how valid are any of these compensations.

To determine this, let us turn to curves by Robinson and Dadson, shown in *Fig.* 9. These were determined at a much later date than were the Fletcher-Munson curves. They also show the effect of the listener's age on these curves, where the ability to hear high frequencies falls off with increased age.

The compensation required for the Robinson-Dadson curves is shown in *Fig.* 10, as interpolated from *Fig.* 9. Again they are referenced to a 70-phon performance level. Note that with the Robinson-Dadson curve, less loudness compensation is required than with the Fletcher-Munson curve. The former also requires treble boost.

Which set is correct? Which set should be considered the standard when designing for the loudness contour? Nobody knows.

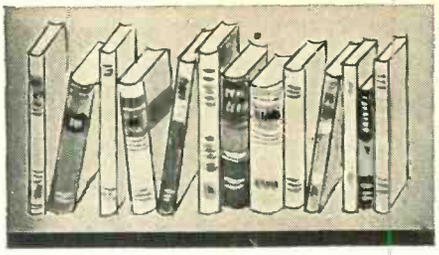
Each set of curves is the result of a statistical study. The Robinson-Dadson set may be more accurate due to the use of better techniques and equipment since this set is more recent. But who can really tell? The sample of people at one test may have had different hearing characteristics than the sample at the other test. The physical and mental health of the two groups of people may have been significantly different. Both these factors would affect results.

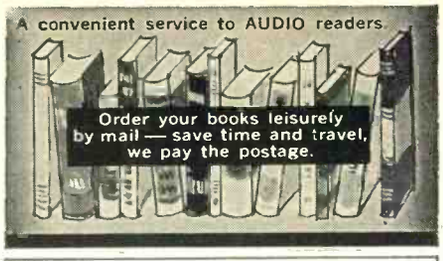
Other considerations also must be taken into account. For one, the response to pure (sinusoidal) tones used in either test is probably unlike the response to complex musical tones. Equal-loudness contours are affected by the relative direction of the sound source to the individual.

These factors are pointed out and both sets of data are presented here to emphasize the impossibility of setting any meaningful standard contour curve for loudness compensation at this time. It is a highly subjective variable. Best personal compensation can be attained when each individual sets the tone controls to best suit his own hearing and particular room acoustics.

It should furthermore be remembered that 70 db is the average loudness level *near the orchestra.* A distance away, the level changes, and so does the equal-loudness contour curve. The curves for those sitting at the rear of the concert hall differ from the curves for those in the expensive seats. Just what the listening level and associated contour curve is, is thus determined by the distance from the orchestra. The curve one prefers is a subjective matter, and should not be dictated by the whim of an amplifier designer. Each curve at each level is correct.

Whatever type of loudness compensation is provided for on the amplifier, it may be checked with reference to a 1000-eps 0-db level, using the circuit in *Fig.* 1. All controls on the amplifier must be set for a flat response. The loudness control can then be switched into the circuit and the effect on the frequency response may be checked. No stage in the amplifier should be overloaded at any time during the test. The entire audio range should be scanned and the curve plotted. Just which set of data your curve should be compared with is your choice. Æ





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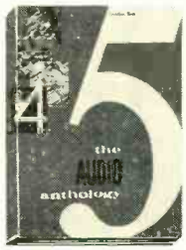

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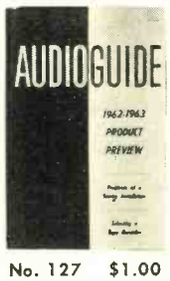

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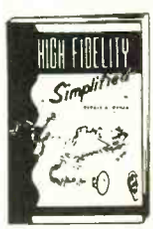

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TRADE SECRETS

(*from page 34*)

cept against stealing and the use by an employee of abilities he has acquired through innate intelligence and effort.

There a suit had been brought to prevent the disclosure by a former employee of a process for the production of artificial leather. The employee admitted his intentions to manufacture this product but denied that in doing so he was violating the law or illegally using any trade secrets of his former employer. In its decision that court said,

"The word *property* as applied to trade marks and trade secrets is an unanalyzed expression of certain secondary consequences of the primary fact that the law makes some rudimentary requirements of good faith. Whether this employer had any valuable secrets or not the employee knows the facts, whatever they are, through a special confidence that he accepted. The property may be denied but the confidence cannot be.

"Therefore the starting point for the present matter is not property or due process of law but that the employee stood in confidential relations with his employer, or one of them. These have given place to hostility and the first thing to be made sure of is that the employee shall not fraudulently abuse the trust reposed in him."[4]

Trade Secrets—Whose?

By the Pennsylvania Supreme Court two controversies of this character have recently been decided. In both instances that court characterized the information of which an employer is justified in insisting on its sanctity and the information that must of rights be the stock in trade of the employee in earning his living, whether that be done with one employer or another.

A university graduate who had specialized in analytical chemistry had been employed by a manufacturer, spending approximately half of his working time in the company's laboratory and the remainder appraising and ordering the necessary materials and ingredients for his employer. After several years in this position he accepted employment with a competitor and suit was brought by the first employer in which it was charged that the employee had disclosed formulas and processes that were trade secrets that had been entrusted to him in confidence.

Refusal of the Supreme Court of that state to permit the issuance of an in-

[4] E. I. DuPont de Nemours Powder Co. v. Masland, 244 U.S. 100, May 21, 1917.

junction against this employee at the instance of the first employer clearly outlined the law governing such situations as it is today.

"We are thus faced with the problem of determining the extent to which a former employer without the aid of any express covenant can restrict his ex-employee, a highly skilled chemist, in the uses to which this employee can put his knowledge of formulas and methods he himself developed during the course of his former employment because this employer claims these same formulas, as against the rest of the world, as his trade secrets.

"In this era of electronic, chemical, missile and atomic development many skilled technicians and expert employees are currently in the process of developing potential trade secrets. Competition for personnel of this caliber is exceptionally keen and the interchange of employment is commonplace.

"One has but to reach for his daily paper to appreciate the current market for such skilled employees. We must therefore be particularly mindful of any effect our decision in this case may have in disrupting this pattern of employee mobility, both in view of possible restraint upon an individual in the pursuit of his livelihood and the harm to the public in general in forestalling to any extent widespread technological advances.

"The principles outlining this area of the law are clear. A court will protect an employer from the unlicensed disclosures or use of his trade secrets by an ex-employee provided the employee entered into an enforceable covenant so restricting his use or was bound to secrecy by virtue of a confidential relationship existing between the employer and employee.

"Where, however, an employer has no legally protectable trade secret and the employee's aptitude, his skill, his dexterity, his manual and mental ability and such other subjective knowledge as he obtains while in the source of his employment, are not the property of his employer and the right to use and expand these powers remains his property unless curtailed through some restrictive covenant entered into with his employer."[5] *Æ*

[5] Wexler v. Greenberg, 160 Atl. 2d 430, Pa., May 4, 1960.

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FOR SALE: Ampex stereo head assembly for 351-2. Two-track erase, record, and playback heads. $275. Condition: like new. J. M. Edelman, M. D., 4550 North Boulevard, Baton Rouge, Louisiana.

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FOR SALE: Concertone Model 63 two-track stereo with record and playback preamplifiers, 7½ and 15 ips. With 7- and 10-inch reels plus VU meter. Originally sold for $755, asking $295. with case. Franart Audio, 131 Mac Dade Blvd., Collingdale, Pa.

MORE CLASSIFIED ON PAGE 63

Industry Notes...

• **Empire Expands Sales Staff.** Herb Horowitz, president of Empire Scientific Corp., announced that two men have been added to its sales staff: Dan Anderson, appointed factory salesman, and Dan Natter, appointed national sales manager. Natter was formerly with North American Philips.

• **Citroen Changes Name to Freeman Electronics.** Citroen Electronics Corporation has changed its corporate name to Freeman Electronics Corporation to avoid confusion with companies in other fields. The corporate trademark crest adopted by the company will remain the same so that brand identity is continuous. The name change will be carried through gradually over a six-month period and literature and advertising will carry both names until the Freeman Electronics image has been established.

• **Stanton Sets '63 Goals.** The Pickering Company, in their new program to expand national sales, has announced the appointment of new sales representatives in two. key markets—Chicago and Seattle. Karet-Schulman Co., Inc. will serve dealers in Chicago area and the Seattle-based William R. Lanphear Company is handling the Stanton/Pickering lines in the northwest. According to Walter O. Stanton, Pickering President, the naming of new reps in these markets is another step in an over-all program. The firm will also develop new outlets for its tone-arm cartridge, and turntable lines, and provide effective, unique sales aids for new and existing dealers. Details are to be announced.

• **University Forms Applied Research Department.** University Loudspeakers announced that the establishment of their new Department of Applied Research has led to organization changes involving their engineering staff. Sumner S. Averett, formerly Special Products Chief Engineer, has been appointed to the position of Manager of Engineering. University's Department of Applied Research will operate under the direction of Victor Brociner as Manager of Research. Mr. Brociner, a leading pioneer in the areas of high fidelity design and manufacturing, has moved to this assignment from the position of Director of Engineering, a position now discontinued.

• **Weingast Chairman, Sparer President.** The Board of Directors of Pacotronics, Inc., Glendale, L. I., electronics firm, today announced the election of **Solomon Weingast** as Chairman of the Board. At the same time, it was announced that **Sol Sparer** had been elected President and Chief Executive officer of this manufacturer of electronic test equipment and kits, electrical indicating instruments, stereo-high fidelity component kits, and stereo speaker systems.

MORE CLASSIFIED

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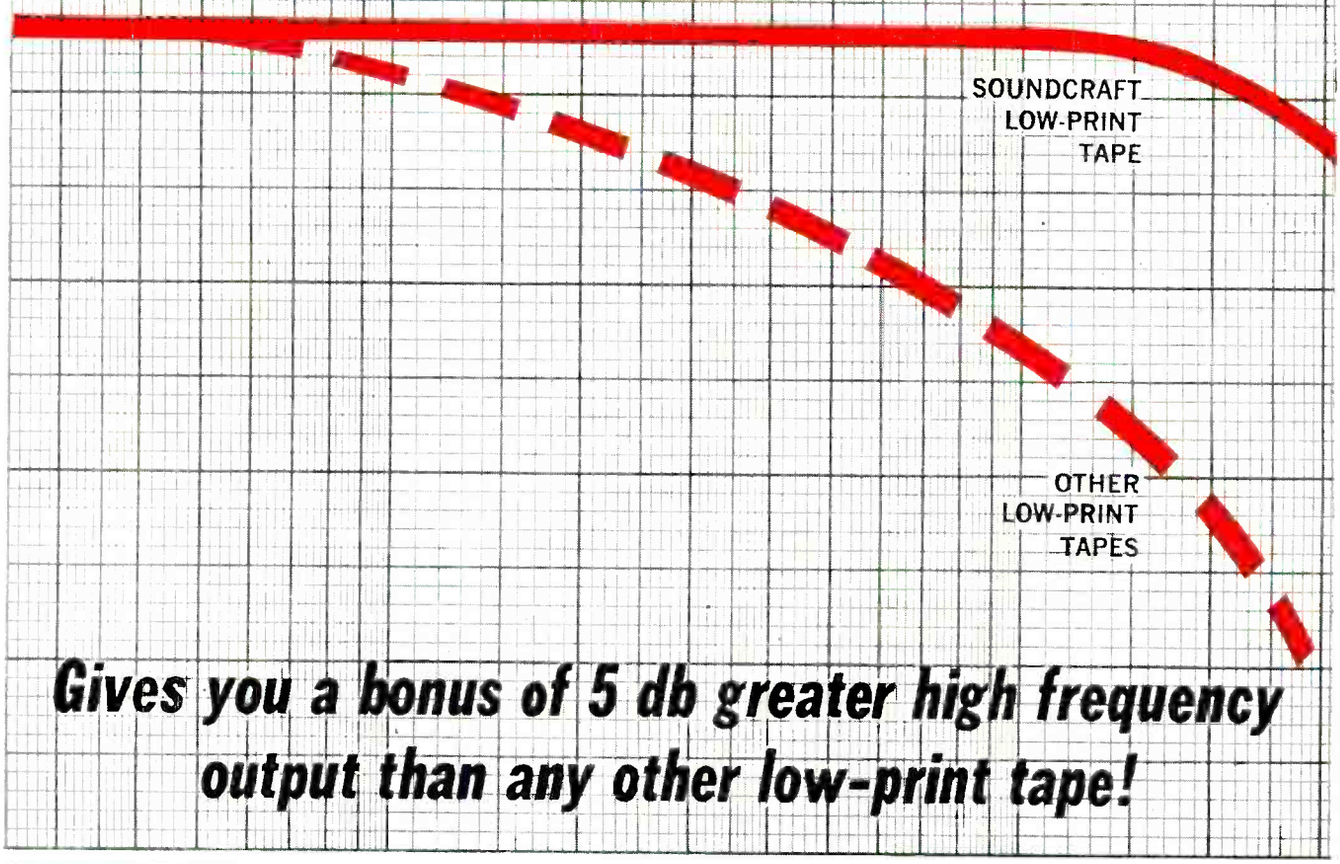

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Now, for the first time — a professional low-print mastering tape you can intersplice with standard mastering tapes because **its output characteristics match these tapes!** To achieve this, Soundcraft has provided this tape with a high frequency boost . . . 5 db more output than other competitive low-print tapes . . . to assure you of master recordings with lower background noise and wider dynamic range. All this, in a tape that offers 8 db better print-through than standard mastering tapes. No static noise, no editing squeal. Exclusive Soundcraft manufacturing processes help to produce a physically perfect tape — among these:

- **Micropolishing®** for mirror-smooth defect free surface, perfect high frequency response without break-up.
- **Precision-slitting** for complete absence of edge burrs and skew.
- **Chemical balance** of base material and oxide coating to prevent cupping.

And two more Professional Tapes to improve your recordings:

SOUNDCRAFT HIGH OUTPUT MASTERING TAPE— Provides optimum combination of high output, high signal to noise and low distortion characteristics — resulting in wider dynamic range for your critical master recordings.

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How far can the E-V 644 Sound Spot reach to pick up useful sound? Only you can answer that question. Because the range of any microphone is limited by how and where it is used. But we can safely say that the 644 will reach farther than any other PA microphone.

Some 644 users report an increase in distance of up to four times what they could achieve with ordinary cardioid microphones. Particularly in large churches, auditoriums and amphitheaters. You may get a bit less—or possibly even more when acoustics permit.

Whatever the distance, you'll hear clearer, more realistic sound than you ever thought possible, with less feedback (even when speakers must be located close by). You may well pick up an extra 6 db sound level with complete stability—often the margin between success and failure.

The reason for the greater reach of the 644 is the slender tube in front. Its slotted-line construction narrows the effective acceptance angle to about 90° at the front (compared with up to 180° or more with most cardioids). This reduction of reverberation, noise, and unwanted sound at the sides and rear is achieved without limiting frequency response. The 644 is peak free from 40 to 12,000 cps. And the output from the Acoustalloy® diaphragm of this rugged dynamic unit is a solid -53 db.

The 644, with its exclusive E-V slotted-line, is the "little brother" of the famous E-V 642 and the 7-foot long E-V 643 microphones in use in every national TV network and most major movie studios. All are the result of constant work with professional sound engineers throughout the world.

The next time you are hamstrung for distance in sound reinforcement, recording, or PA, reach for an E-V 644 Sound Spot. It outdistances every other microphone in solving the toughest problems in sound. Just $110.00 list (less normal trade discounts). Electro-Voice, Inc., Dept. 532A, Buchanan, Michigan.

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