AUDIO
JULY 1971 60c
The Authoritative Magazine About High Fidelity

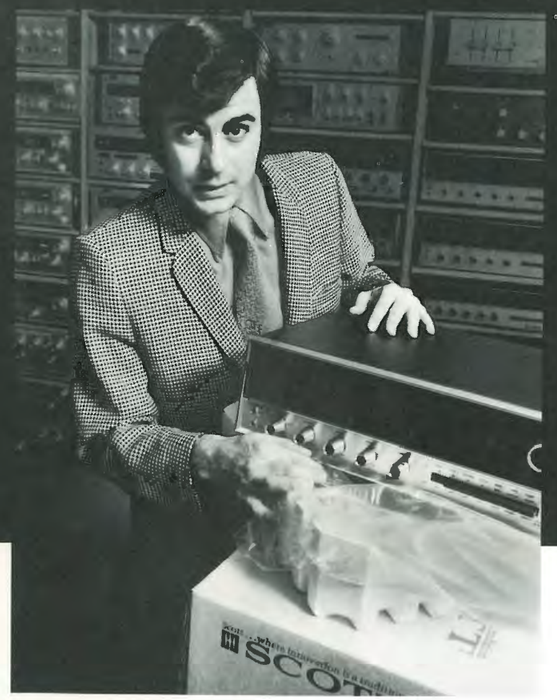
WHYTE Looks At SURROUND SOUND

A Buyers Guide To MICROPHONES

The Case For CONDENSER MICROPHONES

The EASTMAN STUDIO WORKSHOP

If exceeding its performance claims makes a receiver great... the Scott 387 is about the greatest.



For months we've been telling you what a great performer the 387 AM-FM stereo receiver is. Now a respected independent test laboratory report* shows how conservative our performance claims really are:

Characteristic	Our Data Sheet Claims	H-H Lab Report
Continuous power (RMS) both channels driven	55 watts into 8 ohms 85 watts into 4 ohms	67 watts into 8 ohms 100 watts into 4 ohms
Harmonic distortion	0.5% at rated output	Below 0.1%, 1-60 watts Below 0.25%, 0.1-65 watts
IM distortion	0.5% at rated output	Well below 0.5%, 0.1-65 watts; under 0.5% from 25-20,000 Hz at 55 watts, and under 0.2% over most of that range.

The report says the 387 has "one of the most powerful amplifiers ever offered in an integrated receiver". Add to this all the other innovative features such as Scott's exclusive "Perfectune" indicator, permanently aligned FET front end, full complementary output stage, solderless "tension wrap" connections, and you've got a receiver which is unsurpassed in the $399 price class. Ask your Scott dealer for a demonstration of the 387 receiver today.

*Hirsch-Houck Lab report appearing in Electronics World, May, 1971

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Good 16-track masters don't just happen.

Unless the Dolby System is used, the final stereo master may be only marginally quieter than an 8-track stereo cartridge.

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The Dolby System eliminates all this. The noise level of a Dolby recording, even when it is reduced to stereo from sixteen tracks, can easily be better than that of a two-track original recording on the same kind of tape without the Dolby System. At the same time, print-through and cross-talk are also reduced by 10 dB, keeping stereo placement exact and silent passages velvet quiet. Sessions move faster because setting up pre-equalization is unnecessary. Instead, equalization can be worked out during mixdown without affecting the sixteen-track original and without watching the second hand of the clock as session time ticks away. Nor is there need to ride gain on dead channels during mixdown to keep out noise; the Dolby System takes care of that.

The Dolby System makes recording and reduction easier and faster, with time for more attention to creative values, less to technical problems. It makes good engineering 10 dB better.

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AUDIO

Successor to RADIO, Est. 1917

July 1971 — Vol. 55, No. 7

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Coming In August

***Special Tape Cassette Number**—Review of the top cassette units.

***Tape Recorder Maintenance,** Part 8 of H. W. Hellyer's series.

Equipment reviews include:
Pioneer 9000X receiver
TEAC 7030 SL tape recorder

LATE FLASH

Teldec Video Discs

Reports from Germany indicate that Teldec will be demonstrating a color version of the high-speed video discs at the Berlin Radio Fair in August. Playing time is five minutes but an automatic magazine which holds 24 will go a long way towards solving *that* problem. The discs are loaded in the magazine in their sleeves to avoid hand contact. No details of bandwidth, etc. are available but it is claimed that definition is comparable with broadcast programs.

About the cover: (mi'kra-fon) *n.* an instrument whereby sound waves are caused to generate or modulate an electric current. . . . The photograph shows 14—count 'em—ranging in price from $9.95 to about $400.00.

Audioclinic

JOSEPH GIOVANELLI

6 db High-Pass Filter

Q. I am using a stereo amplifier (Scott LK72) for a "booster amp," (fed by two Shure M68's). I would like to insert a filter, preferably in the tape monitor circuit, so that it could be easily switched out. I would like to have it roll off at about 300 Hz, at the rate of 6 dB per octave.—Henry F. Fuss, Springfield, Mass.

A. The filters you wish to insert in the tape monitor position of your amplifier can be made by using a capacitor of the appropriate value, connected between the "tape out" and "tape in" jacks. The value would probably fall in the range of 0.001 μf. I suggest a frequency run so that you can be sure that it starts rolling off at the desired point. You will probably find that you are down a db at 1 KHz. Significant rolloff, however, does not take place till 300 Hz and below, once you have chosen the correct capacitor. Of course, one capacitor will be required for each channel.

Disc Processing

Q. I have a question about disc pressing. I read an article where it was stated that the process of making the finished pressing is from tape to lacquer to master, to mother, to stamper to final disc. Why are not the pressings made from tape, to master, to final disc? Would not there be more quality this way than in the first type of production?—Louis Hone, Montreal, Canada.

A. I think that a part of the confusion here is in the use of terms. I shall describe briefly record processing using the terms as I use them in my work.

The master tape is first cut onto a lacquer disc, which is usually called the master. This disc is then plated. The metal is then stripped from the lacquer. The result metal part is a negative of the original lacquer grooves. This metal part is known as a "strikeoff." We then plate this strikeoff, and strip the new metal part from the negative. This results in a positive once again, just like the lacquer, but this time in metal. This part actually can be played, but with special precautions which will not be discussed here. (If you ever obtain such a part, do not play it; your stylus may be damaged.) This positive is known as the "mother." We take this mother and obtain another negative, called a "stamper" because it goes into the press and actually stamps out the finished disc. If this stamper wears out, as it will after a few hundred discs have been produced, it is replaced by another stamper, made from the same mother. Many stampers can be made from the same mother. If anything did happen to the mother, then another mother could be made from the strikeoff. The strikeoff can be used to make quite a number of mothers, though this is seldom necessary.

The strikeoff could be used to stamp out records. This is done often when only a small number of discs is required. This latter arrangement, then, does not obviously lend itself to quantity record production.

I believe that what I have just described is what you proposed in your question. You may ask at this point why you can't simply make a new strikeoff from the lacquer. Sometimes this is possible, but there is a good chance that this new strikeoff will be noisy or even be scratched. Removing it from the lacquer is a very delicate process because of the extremely soft material of which the lacquer is made.

The article you read was correct. However, where the article refers to a lacquer, I use the term "master" or "master disc." Where the article referred to a master, I generally call this part a "strikeoff."

Blend Control

Q. Can you suggest a "blend" system to be used with a Mac MX110 tuner-amplifier?—Henry F. Fuss, Springfield, Mass.

A. I suggest that you use a 2 megohm potentiometer connected as a rheostat, wired across the two output terminals of your preamplifier. Decreasing the resistance of this pot will blend the channels.

Probably the action of this control will take place at its low resistance end. If this proves to be the case, use a pot having a lower resistance.

Once you have arrived at a pot setting which produces the blend you wish, you can substitute a fixed resistor of proper value. I think, however, that you should consider using the pot at all times because the amount of blend required varies from one program source to another.

If you have a problem or question on audio, write to Mr. Joseph Giovanelli at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. All letters are answered. Please enclose a stamped self-addressed envelope.

Tape Guide

HERMAN BURSTEIN

Head Wear, Equalization, and Large-Reel Adapters

Mr. Donald Mahler, of the Dept. of Education, Humboldt State College, Arcata, Calif., comments on items which appeared in TAPE GUIDE in February and March of this year:

Head Wear, Feb., *I do a fair amount of commercial recording, as well as considerable private work, using a number of recorders of various makes. In my sad experience, as little as five or six hours of bad tape can ruin a set of heads, with or without pressure pads, and on machines costing $1500 as easily as those costing $50. For some time I used to check new tape a short ways from the outside end, using an inexpensive magnifying glass under a table lamp, but after getting poorer and poorer tape from domestic makers—I've simply standardized on Sony and BASF because of their non-abrasiveness (especially Sony) and most of all consistency.*

Equalization, March, *The simplest way to obtain magnetic phono equalization for a tape recorder input (if it does not have such a circuit or it is already hooked up to another item) is to use the inexpensive Sony passive (non-powered) adapters. These work very well on virtually all recorders through the microphone inputs, are very small, and I believe still cost only about $6.00 per pair.*

Large reel adapter, March, *The normal quarter inch tape recorder using reels up to 8¼ inches is actually using 8mm movie film reels—as far as original design, width, and center hub are concerned. The 400 foot 8mm movie reel became the seven inch tape reel (and in fact I sometimes use regular 8mm reels and plastic cans in place of so-called tape supplies). If Mr. Siegal, who asked the question, will search in large camera stores, especially those with lots of old stock, he should have no trouble finding 800 or 1200 foot 8mm movie reels which will work nicely on his Revox. He should, however, avoid the painted steel ones because of the magnetism and static electricity they tend to collect.*

Drop Out

Q. I have a problem that I really don't quite understand. I suppose the term for it is "drop out." I thought at first that my tape deck was at fault, but upon further investigation and some reading I have discovered that this is a characteristic of magnetic tape. Realizing this, I decided to do all recording at 7½ ips, allowing the tape imperfections to pass over the heads more quickly. This, however, does not alleviate the problem. I go through all the rigors of a real tape enthusiast (which I am) by cleaning the heads thoroughly, setting correct levels, etc., but nothing seems to help. I am a great fan of classical music, and I can't stand to have it distorted. I also enjoy listening with earphones, but they just make the problem more pronounced. Is there a tape that will give me good results?—Richard Wieand, APO, San Francisco, Calif.

A. I am afraid that your description of the problem of drop out is too sketchy for me to comment on extensively. True, all tapes exhibit drop out. The high quality tapes tend to do so less than those of lower quality. In today's state of the art, drop out tends to be unnoticeable when using high quality tapes with high quality tape machines at speeds of 7½ ips, although drop out may be detectable by meter or oscilloscope or on listening to a single, steady tone. Use of wider tracks (e.g. half-track rather than quarter-track) reduces the problem, because tape imperfections tend to average out better over a wider track.

Possibly your machine has a fault resulting in symptoms akin to drop out. The policy of AUDIO magazine prohibits me from recommending specific items of audio equipment, including tapes.

Visible Magnetic Images

Q. Some time ago AUDIO *mentioned developing the magnetic image in a tape recording to produce a visible image. Could you tell me what the material is which accomplishes the developing and where I could obtain it? I have a problem with crosstalk in my tape recorder and feel that this might be useful in checking the cause.*—Irving Menchik, Brooklyn, N.Y.

A. You are probably referring to Magna-See made by Reeves Soundcraft Corp., 302 E. 44th St., New York City.

If you have a problem or question on tape recording, write to Mr. Herman Burstein at AUDIO, 134 North Thirteenth Street, Philadelphia, Pa. 19107. All letters are answered. Please enclose a stamped, self-addressed envelope.

What's New in Audio

Heath Stereo-4 decoder

This is the kit version of the Electro-Voice Stereo-4 decoding system, which adds and subtracts the original two channels electronically to provide four-channel reproduction. Savings over wired price are about 50 percent. Price: $29.95.

Check No. 4 on Reader Service Card

Sinclair IC amp-preamp

Audionics, Inc. offers the Sinclair Radionics IC-10, an integrated circuit amplifier-preamplifier on one monolithic silicon chip. Output is rated at 5 watts rms at 8 ohms at 28 V d.c., while a response of 5 Hz to 100k Hz ± 1 dB is claimed. Rated noise is -70 dB. Single unit price: $12.00.

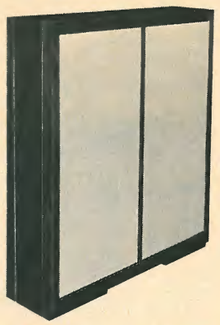
Check No. 10 on Reader Service Card

Shure preamplifiers

The Models M64 and M64-2E stereo preamplifiers provide voltage gain, equalization, and choice of impedances necessary to operate magnetic phono cartridges and tape playback heads. Both models have a single slide switch for selecting equalization for phono, tape, or flat. Price: $34.00

Check No. 12 on Reader Service Card

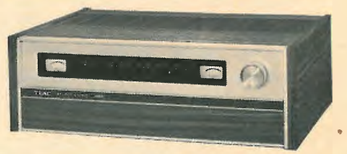
Wright electrostatic speakers



Dayton Wright Assoc. offer the XG-8 series of full-range electrostatic speakers. Eight drivers are used without crossovers to operate from 32 Hz to 19 kHz. The purchaser has the choice of using either the ST-300 matching stereo transformer unit, which will handle 350 watts/channel, or the 27014A stereo power amplifier/graphic equalizer, with an output of 60 watts rms/channel. Basic unit size is 40 in. W. x 48 in. H. x 6¾ in. D. Prices begin at $1175 for the basic XG-8, the ST-300 transformer system is priced at $525.

Check No. 14 on Reader Service Card

TEAC component line



Previously emphasizing recorders, TEAC has now introduced a six item component line including a basic amplifier, an integrated amplifier, speaker system, AM/FM tuner, three-way crossover, and a performance indicator. The tuner (shown) incorporates a five-gang tuning capacitor and three FETs. Price: $349.50.

Check No. 18 on Reader Service Card

Eico environmental lighting

Color organs, strobe lights, "pop-op" lights, and sound-light translators are available in kit and finished forms from Eico Electronic. High reliability solid state design includes isolated transformers, parallel lamp configuration, and external color controls. Color organ prices begin at $29.95.

Check No. 20 on Reader Service Card

BEHIND THE SCENES

BERT WHYTE

FOUR-CHANNEL sound has been on the audio scene for several years now, and although much confusion still exists about many aspects of this controversial subject, some guidelines have been established. For example, up to this time, *true discrete* four-channel stereo can be heard only from the tape format. It is also well established that in the true classical sense, the purpose of four-channel stereo is to capture concert hall ambience and enhance the acoustic perspective. Although strictly an artificial phenomenon with no counterpart in live music, pop four-channel sound of the equal amplitude "surround" variety is an accepted fact. Even though the pop four-channel sound is a contrived product, the result of mix-downs from 8- or 16-track recordings, it nonetheless appears in the form of a *discrete* "in-line" tape recording. While there is admittedly a dearth of both pop and classical four-channel recordings, what is available has been demonstrated at many hi-fi shows and in a large number of audio salons. There is little question that these demonstrations have had tremendous impact on those who have heard them, and have established four-channel stereo as a major step forward in audio and a very desirable product.

The trouble is of course that desirable though four-channel stereo may be, it is, in the present tape format, a bit rich for most pocketbooks. As avid a tape man as I am, I have to agree with those who state that four-channel stereo will never "get off the ground," unless it appears on disc and can be broadcast on FM. While this is unquestionably sound merchandising policy, there is a big technological "if" in this attitude. To wit: How are we going to record four-channel stereo on a disc?

As most readers of this column are aware, there are quite a few companies working on the problem, among them Columbia, Nippon Columbia, JVC, Electro-Voice, Sansui. No, I have not forgotten Peter Scheiber and more about this pioneer in the field a little later. As you might expect, there has been a great deal of "jockeying for position" . . . claims and counterclaims . . . "ours is the best," etc. The New York "rumor mill" has been particularly active on the four-channel disc, and it has been hectic "running the rumors to ground," and sifting fact from fancy. Out of this welter of confusion, a trend seems to be developing. However, before drawing any conclusions, I think it would be interesting to review the various approaches to the four-channel disc that have been undertaken up to now.

Ideally, of course, we would like a discrete four-channel stereo disc, with complete independence between the channels. Some wild things have been proposed to accomplish this. For example, one idea was a throwback to the Cook binaural disc of early two-channel days, wherein two channels were cut some distance apart on the disc and then reproduced by tandem parallel cartridges. In the four-channel version two standard 45/45 stereo grooves were to be utilized, reproduced with a double stylus pickup cartridge! Among many drawbacks of this system, the most objectionable was the reduction of playing time. The JVC four-channel stereo disc can be said to be of the discrete type. In this system a four-channel source is fed into a matrix circuit converting the sound into sum and difference signals. The sum signal is cut as a direct signal and the difference signal is converted to a frequency and phase modulated signal of up to 45 kHz and recorded over the direct signal. In reproduction, a "decoder" box containing an RIAA equalizer, high and low pass filters, detector and matrix, furnishes the correct four-channel stereo output signals. Crosstalk is 20-25 dB, roughly the same as in conventional two-channel stereo. Thus in practical terms . . . the JVC disc produces discrete four-channel sound. All in all, a pretty impressive accomplishment. However, critics of the JVC system point out the following problems: 1) A special phono cartridge with response beyond 45 kHz is required to play the disc. JVC has a unit of their own and claims this is not a major point. Most U.S. pickup manufacturers seem to agree that producing a cartridge with such a response is well within present technology. 2) A special cutting stylus would be necessary to cut such high frequencies on a vinyl disc, modifications would have to be made in the cutter head and amplifier. The criticism is that signal-to-noise ratio would suffer and be no better than 50 dB. And indeed, JVC claims the S/N as "over 50 dB." On the other hand, JVC seems to have anticipated the cutting problem by running the cutting

lathe at reduced speed so that they are not running the modulated signal higher than 16.6 kHz. 3) Even with modern pickup arms operating at one gram, record wear would soon erase the ultrasonic groove modulations, destroying separation. JVC claims the disc can be played 1000 hours without erasing the high frequencies. At this point there is no statistical evidence to support this claim. It is worth noting that some time ago scanning electron microscope studies of stereo record grooves showed significant deterioration of high frequencies after relatively few plays. In any case, trouble could certainly be anticipated in the playback of the disc with the relatively heavy and crude pickup arms on record players in use by the general public. There have been other criticisms, but the foregoing are those most often mentioned. I have heard the JVC disc, and it seemed to work as advertised. But it was a very superficial exposure and the program material was limited. To do justice to the system and to reach a meaningful evaluation, one would have to live with it for a while. In sum, the JVC four-channel stereo disc has tantalizing potential, but it would appear that there are problems to be resolved if there is to be any possibility of industry acceptance.

All of the other four-channel discs proposed by the companies mentioned, are variations on the matrix theme. All of them use the encoding concept of a complex mixing (matrixing) of the four-channel discrete stereo source to two channels, and then decoding back up to four channels. The trouble is that no matter how clever the matrixing, the decoded channels are not truly discrete. Does this matter? Let's put it this way . . . for the dyed-in-the-wool, "golden-eared" audiophile, he would probably reject the system out of hand. For the less technically sophisticated it will be musically acceptable. While for "Joe Doakes," the man in the street, it is doubtful that even if he was given an A-B comparison, he would be able to differentiate between the discrete tape source and the nondiscrete disc. As always, big company inertia can raise hob with new developments, and of the companies with plans for a four-channel disc, it would appear that Electro-Voice is a few jumps ahead of the competition. Their closest rival until recently was Peter Scheiber. As noted, many of the matrix systems have similarities. Such was the case with the Electro-Voice system and that of Mr. Scheiber, and most likely to avoid patent difficulties Electro-Voice has acquired the rights to Mr. Scheiber's system. Mr. Scheiber and Advent (with whom he had an association at the time) gave one of the most honest demonstrations of four-channel sound I have ever heard. There was no "fudging" or "gimmicking" whatever . . . as we were offered direct A-B comparisons between discrete four-channel stereo tape and the *same program* on a Scheiber encoded four-channel disc. Relatively few of us were able to judge between tape and disc. The clue that you were hearing the disc was that after the fullness of the tape, the sound of the disc seemed to "collapse" toward the middle and front of the room and sounded almost like an out-of-phase condition. Without the A-B tests, the sound of the disc was impressive. The very sophistication of the Scheiber system, in a way worked against the inventor. Mr. Scheiber incorporated in his system a diagonal (left front/right rear and right front/left rear) automatic gain control function to enhance the separation between the four channels. A neat idea but it made the cost of his decoder unit fairly expensive. A criticism of the Scheiber system was of its mono playback on FM, with a purported loss of nearly 8 dB in level. In all fairness, this was reported on his earliest versions of his system, and I believe that some corrections were made in subsequent versions.

The Feldman four-channel stereo disc system which was bought by Electro-Voice, has many advantages and almost none of the drawbacks of other matrix systems. Directional effects are good, with adequate channel separation and low crosstalk. There is less loss in monophonic FM reception than in any other system. Not the least of the advantages is that Electro-Voice has managed to get the decoding circuitry reduced to a monolithic IC. Mounted in a neat box about half the size of a cigar box, with appropriate input and output receptacles and switching facilities, they have the cost of a decoder down to $59.95. Furthermore, it is available at many hi-fi dealers around the country. With this accomplished, Electro-Voice is pressing hard to get their system accepted as the industry standard. They have made good progress. At present, E-V has signed up 5 or 6 small record companies. The ubiquitous Enoch Light and his Project Three company are in the act. No less than 28 FM stations around the country have E-V encoders and are presenting four-channel broadcasts. Eight recording studios have encoders for four-channel disc production. I should have mentioned that the E-V system is considered completely compatible with present two-channel disc playing equipment and with FM broadcasting. Hence FCC approval and hence the 28 stations broadcasting in this mode. It is interesting to note that as more E-V encoded four-channel discs become available, FM stations will not have to use encoders at all. They will simply playback the record, broadcast it as usual and if the home listener has a decoder, he will hear the four-channel sound.

I have one of the E-V decoders and some test pressings of some Enoch Light four-channel stereo, encoded by Mr. Light and John Eargle of Mercury Records at the latter's studio. Mr. Eargle points out that the mixing/encoding for the discs differs from Mr. Light's previous mix of the same material for four-channel stereo tape, in that the type of mix, the pan-potting, etc. is specifically tailored to the characteristics of the E-V encoder. Mr. Eargle also noted that a big help in making a high quality encoded recording is that the mixing console enabled him to monitor the recording through the E-V decoder, as if he were listening to the finished product. Sort of a musical feedback loop! Unfortunately, because of the differences in the tape and disc mix, I was unable to conduct any A-B tests at home. The sound from the disc is excellent in the normal parameters of frequency and transient response. As far as the four-channel sound is concerned, with the "surround" type of pop material I was listening to, the directional effects were pronounced, and let's face it, that is the name of the game with this kind of music. I have played the E-V discs for some friends who are totally non-technical types —just people who enjoy music—and they were completely enthralled with the sound. I then played some of Mr. Light's four channel stereo tapes for them and got two reactions. One was that they seemed to think the tapes had "more brighter, sharper" sound (I think they really were referring to the greater fullness and distribution of the sound) and the other was that they preferred the disc because there was less hiss! And they were right about that, since the discs were quieter, and hearing hiss in back of you as well as from the front is most disconcerting.

Thus from "Mr. Average Man's" viewpoint the E-V discs are a success. As an old die-hard I still prefer discrete four-channel stereo, but if the encoded discs catch on and create a viable new four-channel market, it has to do some good for we crusty old types as well.

Perhaps there will be some dramatic breakthrough on four-channel stereo discs, but in the light of available evidence and the present blitzkrieg campaign, it looks like Electro-Voice may have caught the brass ring. Æ

Dear Editor,

More on Doppler

Dear Sir:

Recently your magazine has published several communications about frequency intermodulation distortion (FIM) in loudspeakers (Ref. 1-4). I have been interested in the subject for several years and have noted that discussions on the subjective effects of FIM generate more "sound and fury" than any other topic. I would like to present my thoughts on this subject and comment on some of these communications (Ref. 1-4) with the hope that this rather lengthy note will be interesting to other readers of your magazine.

As is well known, these distortion components are considered to arise from the classical Doppler effect (Ref. 5, 10) which has wide application in physics. One such example is astrophysics, where it has been used to interpret certain red shifts in light observed from deep space. In loudspeakers, Doppler distortion is recognized to be present even for ideal reproducers (Ref. 4). It is said to arise when a loudspeaker cone attempts to reproduce sound at two frequencies, f_2 and f_1, where f_2 is much larger than f_1. The higher frequency is then modulated by the motion of the driver at the lower frequency f_1. The nature of the distortion products arising from this effect is described by Terman (Ref. 6), Beers and Belar (Ref. 7) as well as others (Ref. 8a, b). It is shown that the frequencies of the FIM distortion components are the same as for normal amplitude intermodulation (AIM) products. The latter may arise when the motion of the speaker is not linearly related to the driving force, i.e. the voltage output of the amplifier. It is therefore perplexing to this reader why FIM is claimed to be less objectionable than AIM components with comparable magnitudes. From an analysis of the FIM frequency spectrum, Klipsch (Ref. 8a, b) shows that the principal FIM components have the frequencies $f_2 \pm f_1$ and that the remaining FIM components may be neglected to a good approximation. Klipsch also shows that the percentage of FIM distortion arising from these components is given by the equation of Beers and Belar (Ref. 7), namely

$$d = 0.033\ A_1\ f_2 \qquad (1)$$

where d denotes the percent of FIM distortion, A_1 the amplitude of the driver excursion at the modulating frequency f_1, and f_2 the modulated frequency. The question as to how significant FIM is, must therefore be related to, and discussed in terms of, realistic concert hall sound pressure levels, SPL, and driver amplitudes, A_1, needed to realize these levels in the "average" home. In addition it is also important to note how the magnitude of FIM compares with the magnitude of other forms of distortion at these output levels.

Experimental studies of Klipsch with direct radiator drivers suggest that FIM components account for approximately 10 percent of the total distortion products (Ref. 8b), but this fraction may be higher in those speaker systems where other forms of distortion are minimized. Klipsch notes however that FIM may only be approximately distinguished from AIM experimentally, and hence it is not clear what the measured data presented by Dr. Griener (Ref. 1) represent. If we take these values (Ref. 1) to represent total distortion and only consider the more realistic 0.1 acoustic watt output for a home environment, then we also expect that HD and AIM products will also decrease as the modulating frequency f_1 is increased. Dr. Griener's data in table II of Ref. 1 may reflect this result. With regard to the data in table II of Ref. 1, several questions come to mind: 1. Are the sound amplitudes of f_1 and f_2 the same? 2. Is the output at frequency f_1 equal to 0.1 watt and the output at frequency f_2 some small value? 3. Do the figures in table II represent total distortion of the driver from all sources? 4. Do the results with the 200 Hz crossover in table III represent distortion products of both drivers or only the driver reproducing the frequency f_2? Clearly this information is relevant if any conclusions may be drawn from these measured results. What is perplexing to this reader about the measured values (Ref. 1) is the following: If we compare the calculated FIM distortion for a 10 in. driver with 0.1 acoustic watt output as given by Mr. Allison (Ref. 2) with the corresponding results measured by Dr. Griener, it is seen that all the calculated results are *larger* than those measured. This observation is inconsistent with FIM theory which indicates that Doppler distortion should represent a lower limit for a speaker operating at a specified output level.

I would welcome it if both Dr. Griener and Mr. Allison would clarify these inconsistencies. It is possible that Dr. Griener's measurement setup for distortion discriminates against the FIM components $f_2 \pm f_1$ which may be sufficiently close to the fundamental frequency f_2 to be only partially resolved?

Mr. Allison dismisses the possible significance of FIM by comparing its subjective effect with that of mechanically induced flutter (Ref. 2) All may not be well with the analogy because the subjective effect depends upon music program material (e.g. try listening to a flute recording on even some good quality cassette decks) and may also depend upon the frequency of the flutter (Ref. 9). Klipsch (Ref. 9) describes a scheme for generating FIM distortion using a carefully prepared eccentric tape recorder capstan. He demonstrates that for sounds similar to those produced by an oboe, 0.35 percent rms flutter at 40 Hz is subjectively more unpleasant than at 20 Hz, which in turn is more objectionable than at 10 Hz. Although a trend is suggested, it would be dangerous to generalize these results to higher flutter frequencies, e.g. flutter at 100 Hz. However it is also open to question whether normal music program material would not mask the effects which are audible with the simple tones used in Ref. 9. This reader notes that findings using orchestral music are conspicuously absent from Ref. 9, even though the technique used by Klipsch, a proponent of FIM, could also be used with more complex music material.

Thus, discussions pro or con FIM noted by this reader in popular as well as in engineering publications have been less than convincing. Presumably with the sophisticated equipment available to AR, Inc., a definitive study of this topic could be made by Mr. Allison and for that matter by most manufacturers of loudspeakers. None appears forthcoming however and this suggests that FIM in small speaker systems may not be as insignificant as these gentlemen would like the consumer to believe.

In conclusion, I would like to comment on the article by Mr. H. A. van Hessen (Ref. 4). Surely, sir, you cannot be serious. The model which you suggest can be decomposed into two parts. In the first, the higher frequency f_2 is "encoded" by the motion of the microphone diaphragm at the frequency f_1 as the frequency f_2'.

$$f_2' = [1 + V_{mic.} \div C] f_2 \qquad (2)$$

where $V_{mic.}$ denotes the velocity of the microphone diaphragm at the modulating frequency f_1, and C the speed of sound. This corresponds to a case in classical Doppler theory where the sound source is stationary and the observer is in motion. In the second part, a stationary observer listens to a moving sound source (the speaker cone) reproducing the encoded frequency f_2. The stationary observer then hears a sound at the frequency f_2' which depends upon the velocity of the speaker cone $V_{speaker}$ and is given by the equation (Ref. 10)

$$f_2'' = f_2' \div [1 + V_{speaker} \div C] \qquad (3)$$

Upon substituting eq. 2 for f_2' in eg. 3 gives

$$f_2'' = [1 + V_{mic.} \div C] \div [1 + V_{speaker} \div C] \qquad (4)$$

Equation 4 shows that even for the highly idealized conditions which you describe, the frequency f_2'' observed is only equal to the frequency of the source f_2 when $V_{mic.} = V_{speaker}$. Expressed in another way, $f_2'' = f_2$ requires equal amplitudes of speaker cone and microphone diaphragm motion. Thus your proposition that "the loudspeaker merely de-Dopplerizes the pre-Dopplerized signal" indicates that for you realistic levels in the home satisfy this requirement. I will leave it to the reader to decide if your proposition corresponds with his sense of reality.

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REFERENCES

1. R. A. Greiner, AUDIO, (Dec., 1970).
2. R. F. Allison, AUDIO, (Mar., 1971).
3. A. Petite, AUDIO, (Apr., 1971).
4. H. A. van Hessen, AUDIO, (Apr., 1971).
5. Rayleigh, *The Theory of Sound,* (Macmillan Co., N.Y. 1940), Vol. II.
6. F. E. Terman, *Radio Engineering,* 3rd ed., 1947.
7. G. L. Beers, H. Belar, *Proc. IRE* 31, 132 (1943).
8a. P. Klipsch, *J. Aud. Eng. Soc.* 17, 1 (1969), b, 18, 29 (1970).
9. P. Klipsch, *J. Aud. Eng. Soc.* 6, 143 (1958).
10. A. B. Wood, *A Textbook of Sound,* (Macmillan Co., N.Y., 1955), 3rd ed., p. 370.

And More on Doppler

Dear Sir:

Well, your April issue has done it. I can't leave it alone; I will just have to add my two cents' worth to the growing "Doppler controversy."

Although I agree in general with Mr. van Hessen's conclusions, it seems to me that he is guilty of certain important oversimplifications.

His reduction of the situation to the church with a cellophane partition would be valid if the area of the speaker

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Dear Editor . . .

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diaphragm (and possibly the microphone) were equal to the area of his theoretical partition. Such a sheet, if it were transmitting one acoustic watt at 50 Hz, would have a total excursion of only about 0.001 inch if it had an area of 314 square feet. (I do not wish to argue whether one acoustic watt is a realistic figure or not; it is an easy one for calculation and the proportions will remain the same.) Reducing the size of the partition to the size of some "real" speakers we get the following approximations:

Speaker Diameter	*Excursion*
30"	0.1"
15"	0.4"
8"	1.4"

Figure 1 shows what I feel is a closer analogy to the actual situation. A reverse horn on the "input" side of the partition increases the velocity of the energy to be transmitted by the "real" small "partition." Figure 2 shows Mr. Klipsch's speaker system superimposed onto the same schematic scheme. On

Fig. 1—Reverse horn on "input" side.

Fig. 2—Fig. 1 with Klipsch speaker system superimposed.

the face of it, it would appear that the horn system is a quite valid method of restoring the original sound, given a small radiator. Of course, the original large partition could be simulated by an array of speakers or by a large area radiator such as an electrostatic.

Mr. van Hessen further states that in an ideal system the "loudspeaker diaphragm is moving exactly in step with the microphone diaphragm." As the figures show, the motions required to produce a given sound level vary greatly with the size of the diaphragm. If this ideal were realized, there would be a great discrepancy in frequency response between radiators of differing sizes. This is obviously not the case. The actual ideal situation would be more accurately expressed as the recreation of a sound field that is as nearly as possible a replica of that field intercepted by the microphone.

The amount of excursion required to radiate a given power at a stated frequency depends upon the acoustic impedance match, and particularly at low frequencies, this is related to the area of the radiator, by and large. Thus, for a horn or other large area radiator, which offers a quite constant impedance match over a wide range, we would see a quite smooth curve of driver excursion vs. frequency at the same acoustic level. This would be the case illustrated by Fig. 2. In Fig. 1, however, the curve of frequency vs. excursion would not be nearly so "natural," because the acoustic loading on the diaphragm varies considerably and somewhat erratically, so with a "flat" acoustic output we would expect larger low frequency excursions *relative* to high frequency excursions than would be the case with the horn-loaded system. This will make an objective difference in Doppler components certainly. However, the question remains: How significant are they?

In reality, Doppler distortion (which is sort of an "FM" distortion) seems to be far from an obvious effect to detect. Even in the case of the Bose 901, where full-range radiators are used, no undue high frequency distortion seems evident, although a preliminary calculation reveals that when radiating one watt at 50 Hz, the Doppler distortion at 10 kHz would be on the order of 47%!

Perhaps part of the answer is psychoacoustic, in that a case could be made for the presence of Doppler effects in "natural" sound. For example, there might be an objectively measurable difference in the sound of a 3 kHz organ pipe played alone as compared to the same pipe accompanied by a very low frequency pipe. In the last case, the 3 kHz tone might be very slightly frequency modulated because it would be propagated in air that has a real, though small, velocity component due to the low frequency radiation. We don't hear it, because it is a "natural" sound.

Perhaps, then, the question is not so much one of eliminating Doppler effects, but one of maintaining the proportions of such Doppler effects to levels below our psychoacoustic tolerance.

Inspection of the figures shows that the setup of Fig. 2 does much to maintain these proportions, but an additional consideration may explain why Fig. 1 is not as bad as it seems it should be. (Remember that "inaudible" 47% figure!) When we reduce the theoretical diaphragm from 314 square feet to a realistic size, we vastly increase the velocity (excursion) of the low frequencies. What is not often considered is that at the same time we also increase

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Editor's Review

THE WORD *microphone* was first used as far back as 1827 but it then described a kind of vibrational stethoscope invented by Wheatstone. It was given its present meaning some years later by Hughes because it seemed a more appropriate description of a telephone transmitter. Credit for the first microphone *per se* is usually given to Boursel who described his idea in 1851. But since he did not actually *build* one, honors must go to Bell for the magnetic type and Edison for the carbon principle, which of course is still used in present-day telephones. Other types patented in the mid-eighteen hundreds were rather more exotic and they included several employing liquid jets, at least two hot-wire thermal contraptions and one by Reis using a variable contact with a diaphragm made of—of all things—the skin of a German sausage! A far cry from the modern condenser unit with its gold-coated mylar diaphragm and controllable response patterns. . . .

Some 93 microphones are classified in the directory on pages 36 to 43, which of course is not by any means a complete list. Of these, 64 are dynamics, 25 condenser types, plus three ribbons and one crystal. Crystal microphones are now mainly used with inexpensive tape recorders and while they offer good value for money, they are generally inferior to other kinds. No less than 14 condenser models use *electrets* for polarizing voltage and the emergence of these fascinating devices has resulted in a serious challenge to the dynamic principle. This trend is discussed by Richard Fowl in his article on inexpensive condenser microphones on page 26.

Quadraphonic Confusion

Received on the same day: A booklet describing the Lafayette-Dynaco adaptor, a list of broadcasting stations and record companies using the Electro-Voice system, news from Fisher announcing their endorsement of the RCA Q-8 (4/8 track) tape system, from Los Angeles reports of a system called "Dual-Triphonic," and from Motorola a statement saying "the report that Motorola is abandoning the discrete 4/8 track system in favor of a matrix system is erroneous. We are completely convinced of the superiority of the discrete four-channel systems as contrasted with quasi systems which use synthesizers or matrix techniques. Our commitment to and confidence in the discrete concept is total." So there you have it. Rumors that Motorola is going to make phonograph records are untrue. . . .

Adding to the chaos are conflicting stories about the multitude of other synthesizers and reports about a compatible matrix system from a major record company! Yet another source of confusion is the claim that this or that phono cartridge is "ideal for four-channel sound." The truth is of course that *any* cartridge that gives good results with two-channel stereo will work well with Electro-Voice, Dynaco, or similar systems. The only exceptions are wide-band multiplex arrangements like the JVC which require a response up to 45 kHz.

Amplifier Power Output Or What's Watts

The Federal Trade Commission confirms that they are considering the views of AUDIO regarding the proposed regulation relating to power output of amplifiers. In brief, AUDIO supports the Institute of High Fidelity recommendations as opposed to the Electronic Industries Association's suggestions, but put forward an alternative proposal if a simple measurement is required. This involves a two-frequency (60 and 10,000 Hz) IM test which will then indicate distortion throughout most of the audio range as well as a meaningful power bandwidth figure. The EIA suggestion, offered in all seriousness, is to make power bandwidth disclosure optional and harmonic distortion figures are to be taken at 1000 Hz only. Furthermore, if the distortion is less than 5 percent, the actual figures need not be mentioned! The difficulty arises from the fact that members of the EIA are concerned with shall we say, less ambitious record players? as well as high fidelity equipment. Whether the Federal Trade Commission in its wisdom will come up with a regulation that will satisfy all parties remains doubtful to say the least.

Last month, I mentioned that Harold Weinstein, of Lafayette, was present at the Hearings. A rose by any other name etc., but I must apologize to Harold *Weinberg.*

Home Constructors

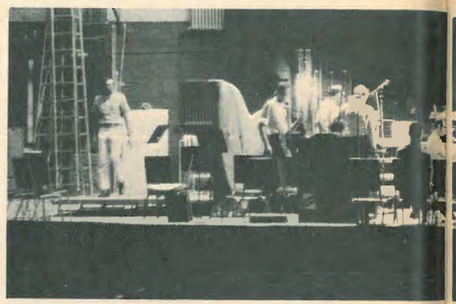
Take heart—a number of interesting projects are "on the stocks." They include a stereo preamp, two amplifiers, two equalizers, and an audio generator.

* * *

Here is an item of news which may have great Social Significance—although I am not certain what it really means. Here it is, as it came from the Penn Tool News Bureau, untouched by editorial scissors: "More than 40 percent of the hammers, screwdrivers, and handsaws sold for use in the home are being bought by women." Think about it. *G. W. T.*

Highlights of the Eastman Recording Workshop

Paul Dean



Microphones used at the Eastman Recording Workshop included a Neumann U-67 for the tuba in the brass quintet, a pair of AKG C-12As in a cross-cardioid setup for overall pickup of the quintet, and a AKG 451-E for the piano of the Arranger's Studio Combo. Dr. Donald Hunsberger, conductor of the Eastman Wind Ensemble, is shown at top and above, center, talking with a student and Phil Ramone (right), producer of Bert Bacharach's records.

Another article on this workshop, "The Recording Studio," by Dr. Donald Hunsberger, appeared in the June, 1970 issue of AUDIO. Further information can be obtained by writing the Eastman School of Music, Rochester, N.Y. 14604.

THE EASTMAN SCHOOL of Music drew 55 students for the 1970 Summer Session Recording Workshop. Engineers, producers, audiophiles, technicians, musicians, and amateur recordists, aged 18 to 65, were brought together to learn the most recent recording techniques and to meet the pros in the industry.

The Workshop opened with a welcome from David Greene, recording engineer and director of quality control for A & R Recording, Inc., who introduced his faculty colleagues: Phil Ramone, executive vice-president of A & R and producer of Bert Bacharach's record albums; Neil Muncy, engineer, console designer, and president of Suburban Sound, Inc., and Ros Ritchie, audio engineer and director of Recording Services Department at Eastman.

The Recording Workshop ran concurrently with the Arrangers' Workshop, which provided live recording sessions every day of the course. Therefore, by rotation of assigned activities, each student had an active part in all functions of actual recording sessions.

Preparations

The first "date" was with the Arrangers' studio combo, and the morning class prepared by discussing choice of tracks for the combo and selection of microphones. The console had a capacity of 16 positions. Under the direction of Phil Ramone and Dave Greene, the class plotted the positions on the blackboard and arrived at the following hypothetical setup:

1 Trumpet	9 Farfisa Organ
2 Trumpet	10 Piano
3 Trombone	11 Electric Guitar
4 Trombone	12 Regular Bass
5 Trombone	13 Fender Bass
6 Saxophone	14 Overhead (Drum)
7 Saxophone	15 Sock Cymbal
8 Saxophone	16 Bass Drum

On the Eastman Theater stage Phil Ramone supervised the microphone setup with selection from the available microphones: two Neumann U-67's, two Neumann U-87's, two AKG C-12's, two AKG 451-E's and 15 Shure SM-53's. Judicious miking was the objective, as the students placed booms and stands, giving special attention to the best position for pickup of the particular instrument. For example, an AKG 451-E was pointed into the second hole of the piano.

"Edsel Murphy's Law," as defined by Dave Greene, was definitely in action. The law states, "If anything can go wrong, it will!" And it did when more saxophones arrived than anticipated, resulting in the rearrangement of some positions.

While the mike setup was being made on stage, other students were preparing for the recording in the studio, which was located in the third floor of the building across the street from the Eastman Theater. Contact between the two points was maintained by phone and closed circuit TV. One student was in charge of the "take sheet," another acted as timekeeper, a third started the tape machines on cue, while still others hovered over the console as Dave Greene, engineer in charge, checked all positions for the "take." Two large speakers blasted the first notes as the band tuned up. Shortly, "take one" was ordered, and the recording session had begun.

The musicians were sight-reading the musical scores before them and required several "takes" for the entire arrangement. Soon the score took form and developed. Two Altec Voice-of-the-Theater speakers were provided on stage for playback.

The Arranger-Conductor

In the evening class after this first recording date, the students had the privilege to meet Manny Albam, the conductor-arranger who has been a guiding force in the Arrangers' Workshop. He emphasized the importance of playbacks:

"We 'shake down' the first tune; the next thing I want to hear as quickly as possible is a good sounding playback. . . . If that initial playback isn't a good, live-sounding thing and doesn't satisfy the musician, then the date starts to go downhill. Because if the musician isn't pleased, the date begins to sound like it's not fun, or it's not interesting, or the dynamics aren't right. Something is wrong, and you get an ordinary recording—not one that glows and glistens, has sparkle and whatever you want.

"I like to hear everything on the date, and there are few of us left who do it that way. I think that Burt Bacharach is another guy who brings in everybody. . . . You don't lay down a rhythm, and then go home and think about what the brass is going to do. Then bring the brass in, and bring the strings in, and rebuild the bass part; or redo one of the guitar parts, because it doesn't match what you had in mind for the brass. I want to hear it all at once, with or without the vocal. . . . We work hard, stay up nights, sometimes 72 hours in a row, to get a date done."

Microphones

Dave Greene, in presenting an enlightening discourse on microphones, described their history along with some of the problems encountered with the earlier models and how those problems are solved:

"Generally speaking, microphones are only as good as their environment. Acoustically speaking, you can't describe a microphone without talking about where it is and what's around it, for these factors will influence its operation. . . . Some of you were mainly interested in specific microphones and their uses. I guess the most commonly used microphone today—at least for studio operation—is the U-87 Neumann."

There followed a volley of student's questions, which Greene fielded with aplomb:

"Sock cymbal? I use a dynamic. Bass drum? You can use anything. I used an old ribbon mike on one date—they are fairly sensitive but also very rugged. It was an RCA 44-BX—an old, old, old thing but it worked very well. Ribbons are excellent for a bass drum. The trick about bass drums is that we

mute them by opening them up and filling them with shredded paper about half way; another way is an old quilt.

"There is one rule of thumb concerning microphones that is very important to remember from an audio standpoint: Never use two mikes to do the job of one, if at all possible. . . . Generally speaking, with regard to drums, the place to record them is overhead—and give that drum sound enough time to develop; keep it high, not very close. The basic microphone should be the overhead, and the others you should fill in to get presence and direction, especially if you are doing stereo. . . .

"Orchestra bells? Dynamics are excellent. Xylophones? You might like a condenser. Harp? There are two ways of miking a harp; condenser is very nice—you set it two feet away on the other side of the harpist. There's another way of doing it, which we found one day when we had a harp and a pretty heavy rock session, with brass, lots of loud brass. Coming up the back of the harp there are slots, and we taped an omnidirectional mike there. It worked great!

"Flutes? If you can spare the mikes, one for each player. Flutes, especially bass flutes—if they are played softly—have a great sound. For something like a flute or oboe a condenser is good. . . . Saxes? One dynamic mike for every two or three musicians. Again it depends on the number of mikes you can spare. They should be mounted low—on banquet stands or baby booms—and two or three feet from the instrument.

"Strings? Violins generate a sound that requires a live acoustic environment surrounding them. A small string section usually consists of four violins, one viola, and one cello. Large string sections can consist of 16 violins, four violas, and four celli. Setup depends on how the score is written—normally, two rows of mikes, three in a row, or could be 2-2-2. For small string sections, the first mike is placed about a foot from the first chair and two feet above the instrument, pointing at the second row. Condenser microphones are preferable, though dynamics do work. . . . Celli? They sit in a line and use one mike for two musicians—the mike placed at banquet stand height between both musicians.

"Vocal work? Condensers are most commonly used, but dynamics will do a surprisingly respectable job. If the vocalist sings off to the side of the mike, rather than directly into it, the 'popping' effect is reduced. The direction is across the front. . . . "

Recorder Alignment

Neil Muncy gave the class a wealth of information on variances which may occur in tape recorders. He demonstrated aligning the heads of a professional machine, using a signal generator and scope. A question was posed in reference to equalization and what occurs when the speed is doubled—e.g. from 7½ ips to 15 ips. Muncy explained:

"NAB playback equalization is the same for 7½ ips and 15 ips. However, losses in recording go down considerably at 15 ips, making a separate record equalization circuit for 7.5 and 15 ips essential."

On the subject of double speed tape copies, the point was made that most recorders don't have the frequency response required to pass a 30 kHz (15 kHz at 7.5 ips × 2) signal. The bias frequency is also not high enough to permit good reproduction on the copy. For voice work, where response and distortion are not of prime consideration, double speed copies may be made with acceptable results. Proper double speed copies must be made on equipment which is designed for this purpose—the high speed tape duplicator.

In covering the fundamentals of aligning tape machines, Muncy disclosed: "The NAB tape curve of 700 cycles is called the 'turn-over frequency.' All machines in this country use this reference of 700 cycles as a constant to establish equalization. A special alignment tape—Ampex makes one—is played back at '0' level. All machines are aligned according to this established signal, and therefore playback in the same way."

For illustration, the alignment tape was played back at different frequencies—the high end beginning at 15 kHz. The students could hear the signal, see the pattern on the scope, and visually compare the '0' relationship on the VU meter of the tape machine. As the test frequencies dropped to 12 kHz, 10 kHz, etc., the variances in the '0' reading indicated whether equalization and head alignment were correct. Muncy pointed out:

"Plus or minus 1 dB is probably the best you're going to do on a long term basis."

The students were impressed with the importance of tape recorder alignment—which is standard procedure in all professional studios and shares top billing on the list of *daily* maintenance with cleaning and demagnetization. When a new machine is purchased, it should be immediately checked for proper alignment. After 12 hours of use, the tape wear over the head establishes a microscopic groove; and if the head is slightly off, the groove will also be off for the life of the head and cannot be corrected.

The ReMix Room

On the fourth floor, above the studio, the faculty had set up an 8-track tape machine and a console with 8 channels in and two out. An Ampex 350 provided the delay from record to play, using a set of reverb springs, which gave an excellent reverb device to mix through the console.

The students practiced mixing live tapes of Bert Bacharach and other recent recordings, using sample tapes which were later checked by Dave Greene. The remix room was in constant use until the wee hours of each morning and a daily schedule was posted, so that each eager participant had a turn to practice mixing.

Signal Processing

Highlight of the Workshop was a lecture by John Eargle, chief engineer of Mercury Recording Productions, Inc., whose topics were equalizers, reverberation devices, and limiters. He began with a provocative question:

"Why put something on eight or 16 tracks if you aren't *really* going to make use of them later? If you are exercising this prerogative merely as an excuse to put off making a musical decision during a recording, this represents a 'reprieve.' If there is a justification for multi-channel recording, it is what it enables us to do after the fact.

"In the old days, when recording first got started, equalization meant to boost the high end when we recorded it, so we could crank it down on playback because of the noise characteristics of the medium. Since that time, the word has, by extension, come to mean: Taking what is basically a very pure sound out of a microphone or channel and manipulating the spectrum of the signal."

At this point, the lecturer circulated among the students some recording pages dating back to the early 1930s (one page was the "take sheet" of a recording of Tchaikovsky's *Sixth Symphony* under the direction of Dr. Serge Koussevitsky). The pages illustrated what the recording engineer of that day had to work with—the few variables limiting his final production. It was a sobering insight indeed, compared with the vast possibilities available to today's engineer.

Still delving into the past, Eargle traced the evolution of reverb from the early days—when they purposely avoided it—to the late 1930s and the great bands of that era, when some echo was first used on vocal parts. The war years, featuring vocal and choruses without instrumentalists, brought the doctoring of sound with reverb chambers and later in a more sophisticated

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way with springs and EMT reverb plates. In recent years there have been some interesting developments regarding echo. A slight time delay, just before the return of reverberation, gives a more natural sound.

Eargle explained, "What you are doing now is slightly akin to what happens in a big room. There are three sound fields that occur in a large room when a sound is emitted: one is the *direct field,* that reaches you directly and doesn't go through any bouncing; the second is called the *early field,* which consists of the first handful of initial reflections, which the ear can analyze (the ear can actually hear these early reflections); the third is the *grand mix* or *reverberant field* that is coming from all directions equally. . . ."

On quadraphonic sound and the role of time delay, Eargle said, "Creating artificial ambience is going to be a very big thing. Instead of having four monophonic happenings—one in each corner—we are going to have four acoustical happenings that we can control and manufacture. Part of this is going to be a very high quality time delay, and I don't mean taking some spare 4-track machine and running it 90 cycles a second, using a 30 ips capstan. I mean something that really lets you get down into very small bits of time delay, for example, 12 milliseconds. . . . The acoustical image that you get with time delay and reverberation is one of placing that voice in any acoustical environment you want to manufacture.

"To a very great extent, tape does its own kind of limiting of high frequencies. It is one of the most gently overloading media, and it has a cushion-type action. The opposite is true of disc cutting, and when an optical (film) recording overloads at the limits of the galvanometer action, it's catastrophic!

"Most limiters and compressors in current use have very fast attack times (the time it takes to go to a certain percentage of gain reduction action). Many of the FET style limiters can grab a wave of 15 kHz waveform and go into compression in a matter of 18 to 20 microseconds. For disc cutting, such a device as this is very important to prevent overloading and distortion. . . . One limiter, developed by Creatronics, in California, has an attack time of 18 microseconds and recovery time can be anywhere from 15 milliseconds up to 1½ seconds. Among its many uses are controlled distortion effects and elimination of leakage from other tracks in multi-track recording."

Eargle also described some of the exotic tools, such as Moog's voltage control low pass filter, and the resulting equalization effects.

Mobile Recording Studio

One of the most outstanding "live dates" of the Workshop was an evening involving the use of a commercial remote truck from Fedco Audio Labs, Providence, R.I. When the innocent-looking panel truck arrived, the studio-on-wheels revealed a fascinating recording potential to the students who inspected the interior and heard the engineer-designer describe the studio's capabilities.

Inside the truck were two 8-track tape recorders, custom-built by John Stevens of Burbank, Calif.; a custom console with 24 positions; four JBL 4310 monitor speakers, and a closed circuit TV. Interior basic equipment included a power conditioning system, to stabilize power supplies at any location, to alleviate rectifier noise, and operate without power change should line voltage fluctuate between 130 V and 105 V. Three cables ran from the truck into the building, one for power, one with 33 mike lines in it, and one for speaker lines, headphone lines, TV, etc.

The console was 16 mikes in, with 16 mike pre-amps, each with equalization and compression, and pan-pots for each of the 16 positions; 8 tracks out (with stereo mix made up as linear combination of either 8 outputs of the board, or four and two); equalization mix for the 16 inputs, plus the eight tracks, four tracks of echo, and solo. Echo was provided by four Fairchild spring sets, which were used very rarely and then only when making a two-track safety. Any input could feed any submaster; conversely any submaster could feed any input. With patching, this allowed six additional inputs.

Excellent communications were maintained by a talk-back system between the console and the engineer on stage with headphones and boom mikes. If hum developed, it could be located and corrected quickly. This compact, versatile vehicle was purposely designed to carry more equipment than could possibly be used for one date, thereby giving great flexibility in adjusting to any recording circumstance on location.

The Assemblage

To accomplish this second and unique live recording date, precise prearrangments were in effect. The mobile studio arrived first and very early, for the benefit of the students' inspection and enlightenment. Later, the Paul Winter Consort's panel truck, carrying the larger musical instruments, arrived from California, where one week earlier at UCLA, the Paul Winter Consort had been recorded by Phil Ramone, who had brought his recording to the Workshop and played it for the students at that morning's class.

The Paul Winter Consort arrived by plane from Arizona, where they had completed a date the night before using their small instruments. While unloading at the Rochester airport, their amplifier for electric acoustic guitar was dropped and broken, requiring hasty repairs. Nevertheless, the evening concert went smoothly and was enjoyed by a capacity audience.

The mobile studio was located on Gibbs St. in front of Kilbourn Hall. Inside at the console was Dave Greene, engineer in charge, running both tape recorders and monitoring with closed circuit TV. Up in the Eastman studio at the controls was a Workshop student, observed by an experienced TV sound engineer and other students.

The Paul Winter Consort

On the stage at Kilbourn Hall was the Paul Winter Consort—"A celebration in sound" (their publicity stated). "An ensemble of young musicians who are developing an original idiom of instrumental music and a new kind of theater-concert experience."

The six musicians rendered familiar classics, ethnic rhythms, and their own original compositions and improvisations, featuring oboe, sax, cello, English horn, acoustic and electric bass, portative organ, classical and 12 string guitars, lute, sitar (which took longest to tune), and a variety of folk percussion instruments.

During the performance, The Paul Winter Consort's engineer was located down front below the stage, operating their own sound system (four speakers: two for P.A., two aimed at the band). After the concert, a reception was held in the student lounge, where the Workshop students met and questioned the musicians.

Conclusion

Manny Albam gave this forecast to the Recording Workshop students:

"We say as much as we possibly can in class, with the idea that you will hear about one third of it or less. . . . But there is one thing that's going to happen. . . . At some time about three or four months from now, you'll be recording something and you'll say, 'Ah, *that's* what he meant!' And so take it all in now, as much as you possibly can, and it will begin to pop in a few months. . . . Without fail, I can almost guarantee that solutions to a lot of your problems are suddenly going to jump under your fingers, and you will go for the right switch at the right time!" Æ

The Case for the Condenser Microphone

A report by Richard Fowle*

"Incorporation of the electret capsule and the resultant increase in battery life, makes the use of superior condenser microphones as convenient as the use of dynamic microphones."

ACCURACY is the key factor in the design and performance of any audio component. There are many ways of measuring the deviation from absolute accuracy. *Total harmonic distortion, intermodulation distortion, frequency response, signal-to-noise ratio, phase response, impulse response,* and many more are terms describing the relative accuracy of a component. The aim of all these measurements is to show how closely the output of a device approximates the input to that device.

In studying the important characteristics of condenser and dynamic microphones, it quickly becomes apparent that a properly designed condenser microphone is *inherently more accurate* and thus better than a properly designed dynamic microphone.

A microphone is a device which converts acoustic energy into electrical energy. In other words, when sound of a given frequency and amplitude strikes the diaphragm of a microphone, alternating electrical current of equivalent frequency and amplitude is produced by the microphone. This transformation takes place in several well ordered steps, regardless of the type of microphone.

1. Acoustic energy (an alternating air pressure) strikes the diaphragm of the microphone.
2. The acoustic energy becomes mechanical energy as the diaphragm vibrates in accordance with the difference in pressure between front and rear sides of the diaphragm.
3. The mechanical energy (vibration) of the diaphragm is converted to electrical energy (alternating current) in accordance with the intensity and frequency of the sound pressure.

From the above, it is apparent that the distortion may first occur in step 2, where a diaphragm is required to react with extreme accuracy to a constantly varying sound pressure.

The diaphragm of a condenser microphone is a circular piece of extremely thin (typically 0.00025 in. thick) plastic or metal which is supported at its edge. (See Fig. 1-A). The diaphragm of a dynamic microphone is also a thin plastic or metal sheet supported at its edge. The diaphragm of the dynamic microphone is connected at its center to a coil of wire which moves in a magnetic field whenever sound pressure strikes the diaphragm. (See Fig. 1-B).

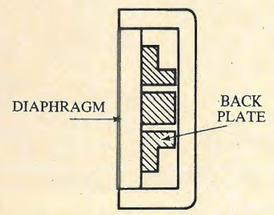


Fig. 1-A—Cross-section of a condenser microphone.

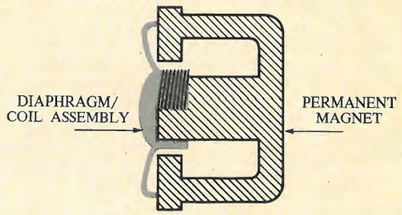


Fig. 1-B—Cross-section of a dynamic microphone.

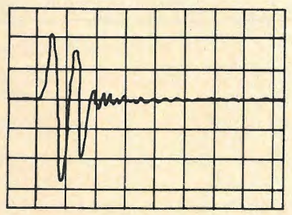


Fig. 2-A—Impulse response of a Sony condenser microphone.

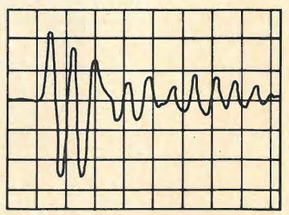


Fig. 2-B—Impulse response of a professional dynamic microphone.

*Sony Product Manager, Superscope, Inc.

The coil attached to the diaphragm of the dynamic microphone is required to convert the mechanical vibration of the diaphragm into electrical current, whereas the condenser microphone does not require a coil. By adding enormously to the mass of the vibrating system, this coil prevents the dynamic microphone from responding accurately to variations in sound energy. [1]

A simple experiment can be performed to illustrate and verify this effect. Two microphones are placed side by side, a $50 Sony condenser and a well-known $150 dynamic. A spark gap (as in an automobile spark plug) is used to produce a sound impulse. The output of both microphones is displayed on an oscilloscope. (See Figs. 2-A and 2-B.)

Once set in motion by the impulse, the high mass of the dynamic microphone diaphragm causes it to continue in motion (and thus produce output) despite the complete absence of sound. The low-mass diaphragm of the Sony condenser microphone ceases to move as soon as the sound stops. From this experiment it can be deduced that whenever there is a change in sound pressure, either in amplitude or frequency, the condenser microphone will respond quickly and accurately to the change while the dynamic microphone will adjust to the change more slowly.

The higher mass of the dynamic microphone's moving system also creates other problems, the most important of which is resonance. Any object possesses one or more resonances, as determined by the object's mass and other factors. Generally speaking, the larger the mass, the lower the resonance. [2]

In a microphone, the output will increase sharply at the resonant frequency of the diaphragm. Ideally, the resonance of a microphone diaphragm should be well above the audio frequency range in order to avoid an audibly peaked output. Only the very finest (and most costly) dynamic microphones have resonances restricted to the frequency range above 15 kHz because of the inherent high mass of their diaphragms. In contrast, the resonance of the low-mass diaphragm of a condenser microphone will be at an extremely high frequency, resulting in smooth, peak-free response throughout the audio range. [3]

The characteristics of condenser microphones will give the sound a natural quality which is unattainable with any but the most expensive dynamic microphones. Furthermore, in public address applications where feedback is a problem, a dynamic microphone will often cause feedback at its resonant frequency, thus reducing the maximum volume capability of the system. The smooth response of a condenser microphone will generally permit substantially higher volume levels before feedback occurs.

The low-mass diaphragm of a condenser microphone provides many advantages relative to the dynamic system. The sensitive condenser diaphragm will produce less harmonic and intermodulation distortion at a wider range of frequencies than the dynamic diaphragm. The condenser diaphragm is less sensitive to low frequency mechanical vibration transmitted through the stand and microphone case to the diaphragm. Finally, condenser microphones, with built-in pre-amps, generally have a higher output level than dynamic microphones. Therefore, the condenser microphone will produce an acceptable signal-to-noise ratio, even when used with less than ideal microphone preamplifiers. (See Figs. 3-A and 3-B.)

[1] As an analogy, take a baseball player and two bats. One bat weights 38 ozs., the other weighs only 28 ozs. The player steps to the plate with the heavier bat. The first pitch looks good so the player starts to swing the bat. In the middle of his swing, he realizes that the pitch is not a strike, so he attempts to stop his swing, but the inertia of the heavy bat causes it to continue forward, and a strike is called. The player then switches to the lighter bat and the same situation reoccurs. This time, as soon as the player attempts to stop his swing, the bat stops. In this example, it can be seen that the higher the mass of a moving object, the more the object resists a change in motion.

[2] As an example, take an empty 16 oz. glass and an empty 4 oz. glass. Strike both with a spoon. The larger, more massive glass will resonate at a lower frequency than the small glass.

[3] Although the problem of diaphragm resonance differs in cardioid microphones and omni-directional microphones, it is generally true that the frequency response curves of dynamic microphones show more peaks and dips as well as narrower bandwidth than those of condenser microphones because of the low frequency resonance of the dynamic microphone's diaphragm and its associated acoustic circuit. A detailed explanation of the factors involved is too complex to present here. Please see references 1 to 4 for information on this subject.

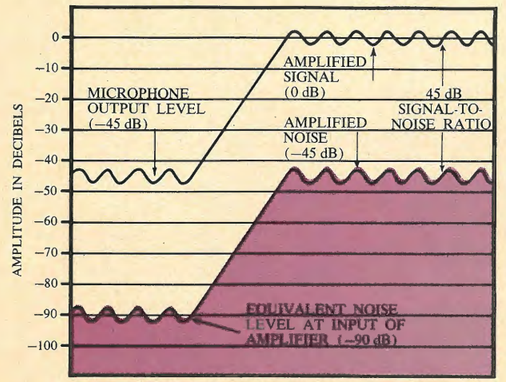


Fig. 3-A—Signal-to-noise ratio of a condenser microphone with an output level of -45 dB when used with a microphone preamplifier having a high noise level.

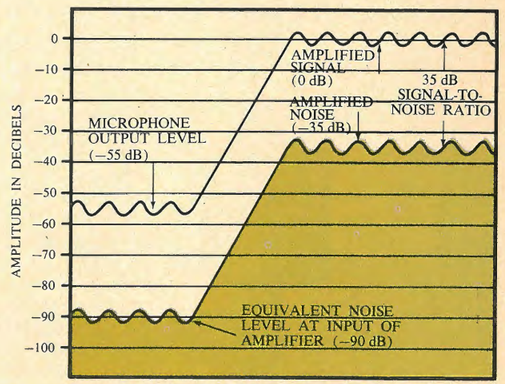


Fig. 3-B—Signal-to-noise ratio of a dynamic microphone with an output level of -55 dB when used with a microphone preamplifier having a high noise level.

After reviewing the preceding facts, which clearly indicate that the condenser microphone is technically superior to the dynamic microphone, a natural question is "Why do dynamic microphones out-sell condenser microphones by a margin of at least 10 to 1?" Up until now, three negative characteristics of condenser microphones have made these technically superior products unusable for all but the most professional applications.

First, since the condenser microphone is an electronic device (each contains an amplifier), a power source is required for it to operate. Originally, the amplifier used a vacuum tube and the microphone required three different voltages: 4 to 12 volts for the filament, B+ for the plate, and 64 to 200 volts to polarize the condenser capsule. As a result, a bulky, complex, and costly external power supply was required, with a huge multiconductor cable interconnecting the power supply and the microphone. See photos.

With the introduction of transistors, the power requirements were simplified, but the condenser microphone still required two voltages, 1.5 to 12 volts for the transistor amplifier, and 65 to 200 volts to polarize the capsule. A few

Sony C-37A and power supply (1955)

Sony C-37FET (1964)

Sony ECM-22

condenser microphones with self-contained battery power supplies appeared on the market, but battery life was still comparatively short. The majority of condenser microphones still required an external power supply. The microphones were still too complex for general purpose use.

In 1969, Sony Corporation manufactured the first electret condenser microphone, the ECM-22. The incorporation of an electret capsule [4] further reduces the power requirements. A single voltage, from 1.5 to 9 volts, is required. Since no high voltage is required for polarizing the capsule, battery life is extended (up to 1100 hours in the ECM-22; up to 15,000 hours in other Sony condenser microphones).

Each of these technical advances reduced the complexity of the condenser microphone, thus making it usable for a wider variety of purposes. The latest advance, the incorporation of the electret capsule and the resultant increase in battery life, makes the use of superior condenser microphones as convenient as the use of dynamic microphones.

Secondly, because the condenser microphone is very complex, it was also extremely susceptible to damage from shock, moisture, humidity, and heat. The reduced complexity of the modern condenser microphone design has resulted in a dramatic improvement in durability. Sony condenser microphones, for example, are extremely rugged and will withstand without any ill effects the normal accidents which occur, as for example, falling off a table. However, these condenser microphones cannot be used to hammer nails (a capability one well-known manufacturer of dynamic microphones claims for his product), since they are precision audio components and must be treated as such.

Finally, prior to 1969, the least expensive high quality condenser microphone cost over $200 with the majority of such microphones costing from $275 to $500 each. At these prices, the only users of condenser microphones were professional recording engineers, whose income depended entirely on the quality of their recordings, and acoustical engineers, who used condenser microphones for audio measurements which required greater precision and quality than any available dynamic microphone could provide. After designing the electret condenser microphone, Sony manufacturing engineers were faced with the task of producing these microphones at prices which were competitive with dynamic microphones. They were able to meet this challenge, and as a result, Sony condenser microphones are available at prices starting below $20.00. Each is a true condenser microphone, and thus incorporates all of the inherent advantages of even the most expensive condenser types. AE

The author has not stated some of the advantages of dynamic microphones which we hope to deal with in later articles.—Ed.

[4] A discussion of electret capsules, or of operating principles of condenser microphones, would be too complex to present here. Please see references 5 to 7 for information on these subjects.

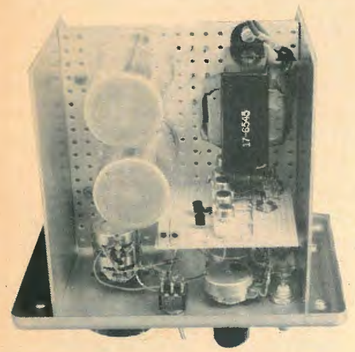
REFERENCES

1. L. E. Kinsler, A. R. Frey, Fundamentals of Acoustics, 2nd Ed. (John Wiley, New York, 1962).
2. H. T. Souther, "An Adventure in Microphone Design," *J. Audio Eng. Soc.* 1, 180 (1953).
3. R.H. Fisher, R. Booth, "Design and Development of Condenser Microphone," *British Kinematography Sound & Television* 50, 80 (1968).
4. H. F. Olson, "Directional Microphones," *J. Audio Eng. Soc.* 15, 420 (1967).
5. G. M. Sessler, J. E. West, "Condenser Microphones with Electret Foil," *J. Audio Eng. Soc.* 12, 129 (1964).
6. J. J. Noble, "Design Evolution of a FET Condenser Microphone System," *J. Audio Eng. Soc.* 15, 273 (1967).
7. P. V. Murphy, F. W. Fraim, "Electret Condenser Microphones of High Quality and Reliability," *J. Audio Eng. Soc.* 16, 450 (1968).

A Wide Range Audio Sweep Oscillator

MICHAEL LAMPTON

A USEFUL piece of test equipment for acoustical and electronic work is a sinewave generator capable of automatically performing a sweep of the entire audio spectrum. Such a sweep oscillator will reveal resonances and standing waves more quickly than the method of hand plotting data point-by-point: one need only listen for intensity peaks or watch a voltmeter needle to pinpoint frequency response problems. If a chart recorder is available, frequency response curves can be plotted automatically. The conventional Wien bridge oscillator, although capable of producing sine waves with very low distortion, does not maintain a precisely constant amplitude when swept, nor is its frequency electronically variable. The usual function generator circuits [1] provide accurate control of amplitude and frequency, but lack sufficient frequency range to span the entire audio spectrum without switching. This article will describe a simple sweep oscillator, suited for home (or laboratory!) construction, which will permit rapid testing and measurement of amplifiers, loudspeakers, and room acoustics.



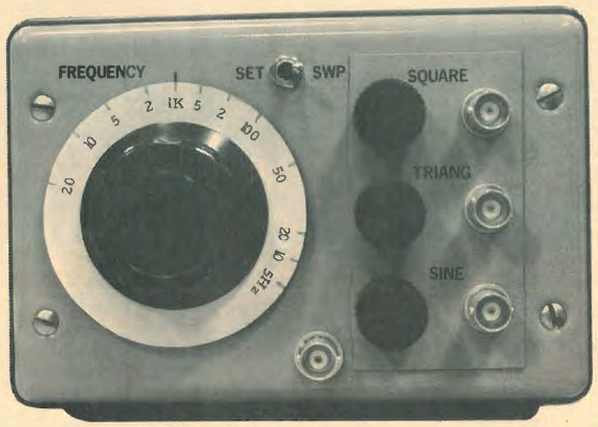
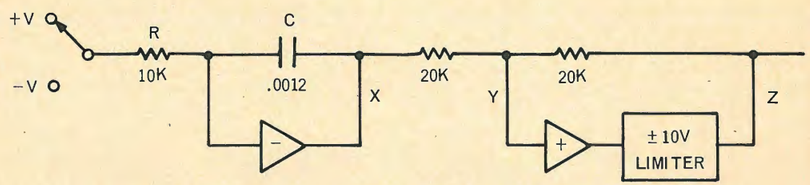


Fig. 1—Basic triangle generator circuit. The switch at left is controlled by the limiter. Triangle waves are available at point X and square waves at point Z.



The circuit to be described is based on the triangle wave generator shown in Fig. 1. In this circuit, two integrated-circuit operational amplifiers are cascaded. One of these has negative feedback applied to it by way of the capacitor C; it is an integrator whose input is either +V or -V depending upon the position of the switch. The other operational amplifier is supplied with positive feedback and functions as a sensitive voltage detector: when its input (point Y) becomes even a fraction of a millivolt negative, its output switches rapidly from the positive supply voltage to the negative supply voltage, and the limiter swings from +10 volts to -10 volts. To complete the feedback loop we stipulate that when the limiter output is positive, the switch will contact the +V input, and conversely a negative limiter output will cause the switch to move to the -V position. To follow its operation, suppose that point Y is indeed positive and Z is at +10 volts. A positive current flows into the integrator through resistor R, and voltage X moves negatively at a rate dX/dt = -V/RC. When X reaches -10 volts, Y reaches zero, whereupon the second amplifier, the limiter, and the switch change state. Since this reverses the drive to the integrator, point X now moves positively at a rate dX/dt = +V/RC. This state persists until X reaches +10 volts, where again Y = 0 and a new cycle begins. The resulting triangle wave at point X has an amplitude of 20 volts peak to peak and a frequency f = V/40RC; for the values shown in the figure, f = 2 kHz × V. The wide frequency range of this oscillator is made possible by the extreme voltage accuracy of modern IC operational amplifiers: an error of 1 millivolt is seen with this formula to correspond to a frequency uncertainty of 2 Hz. At the same time a full scale control voltage (V = 10 volts) corresponds to a maximum frequency of 20 kHz. The ratio of these frequencies, about 10000 : 1, illustrates the wide dynamic range of the basic triangle generator circuit.

This generator is then a linear voltage-to-frequency converter whose output is a fixed amplitude triangle wave. The complete design shown in Fig. 2 consists of this converter plus the additional circuitry needed to define the control voltage ± V, to perform rapid and accurate electronic switching of the integrator's input, to accurately limit the feedback voltage for amplifier A4, and to convert the triangle wave into an approximately sinusoidal waveform.

The frequency control voltage is initially established by the dual cascaded potentiometer VR1, when the frequency mode switch is in the position marked SET. The zener diode across VR1 permits good voltage stability at this point in spite of possible power supply variations. Both sections of VR1 should have an audio taper to spread out the first 0.1 volt (200 Hz) over the first 50% of dial rotation. A large dial is desirable for VR1 to permit accurate frequency calibration and easy reading. Amplifier A1 isolates the integrator load current from the potentiometer circuit. Amplifier A2 is connected as a unity gain inverter to generate the required negative voltage -V. Note that the large value capacitor C1 is held charged at +V by the potentiometer circuit as long as the mode switch remains in the SET position. When switched to the SWEEP position C1 is slowly discharged towards ground through the 100K resistor R1. This

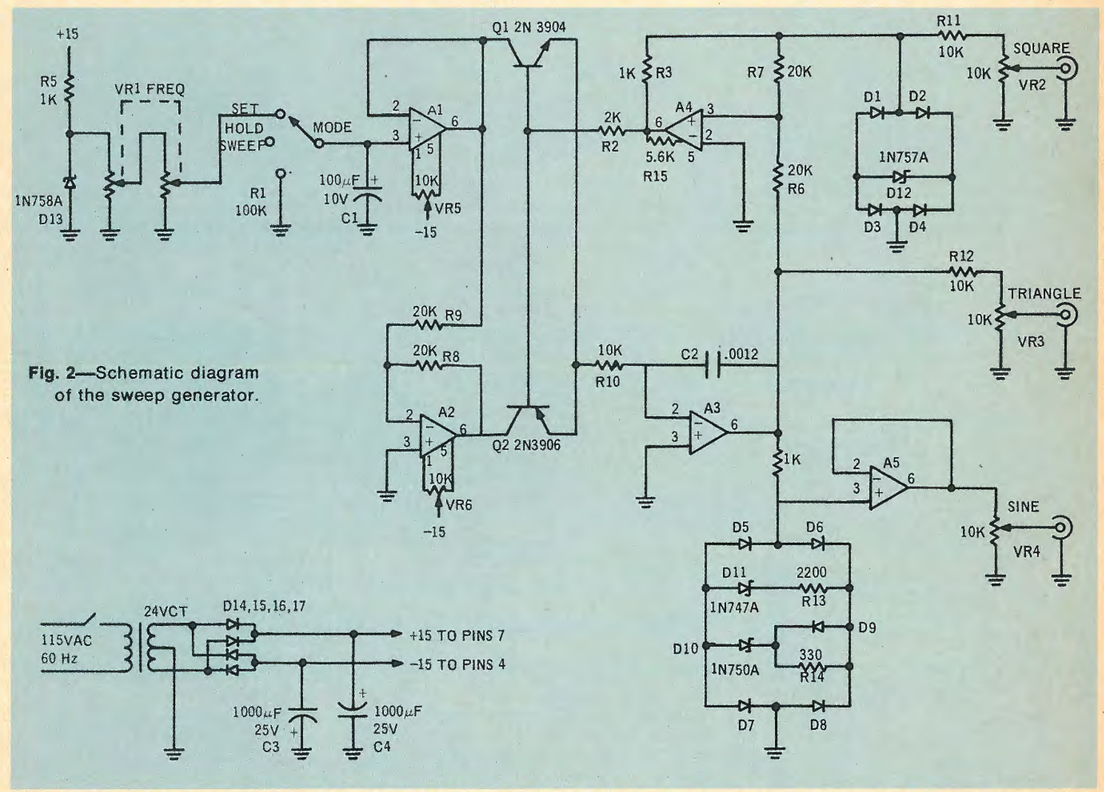


Fig. 2—Schematic diagram of the sweep generator.

discharge will be accurately exponential if C1 is free of leakage and dielectric nonlinearity (a high quality solid tantalum type is recommended). The values shown give a factor of two decay in voltage in 7 seconds, which corresponds to a frequency sweep rate of 7 seconds per octave or 23 seconds per decade. The network can of course be easily modified for other sweep rates. At any point, the sweep can be interrupted by moving the mode switch to the HOLD position; this feature is useful for sitting on a resonance identified during a sweep.

In order to achieve an exponential frequency sweep accurate down to a few Hz, the voltage sweep must be accurately exponential down to a few millivolts, both at the +V and the -V points. For this reason both amplifiers A1 and A2 are shown connected to the optional and otherwise unnecessary trimmer potentiometers. The trimmer VR5 at A1 should be set for an end-of-sweep frequency of about 1 Hz. The trimmer VR6 at A2 should be set for best triangle wave symmetry at frequencies below 10 Hz. These adjustments will interact somewhat, but need be made only once for a given pair of amplifiers. They should be set before the frequency dial at VR1 is calibrated since they do slightly affect the low end frequency calibration. For A1 a low bias current op amp is clearly desirable owing to the rather high impedance of the sweep network; the Motorola MC1456CG is recommended. For A2 any popular op amp will serve.

Transistors Q1 and Q2 form a pair of saturating switches employed in the inverted (common collector) configuration. Used in this way, they permit d.c. offset errors less than one millivolt to be achieved, as opposed to the 10 to 100 millivolts typical of the normal (common emitter) configuration.

The triangle wave generator consisting of A3 and A4 operates just as described previously. An important consideration in choosing an IC type for use as A3 is slew rate, i.e. the maximum speed with which A3's output voltage must change. For a 20 kHz, 20 volt p-p triangle wave, a slew rate of 0.8 volt/microsecond is required. This is well within the capabilities of the MC1456CG which will typically slew at rates as fast as 2.5 volt/microsecond. Although this same op amp type could also have been used for A4, better switching performance is obtained from an uncompensated IC such as the MC1439G. Its feedback voltage is symmetrically limited to ±10 volts by the 1N757A zener diode and associated rectifier bridge.

The triangle wave generated by this oscillator is converted into an approximately sinusoidal waveform by the nonlinear attenuator made up of the 1N747A and 1N750A zener diodes and their associated components. As the triangle wave rises past 4 volts, the 1N747A conducts through R13, which diminishes the rate of rise of the network's output voltage. Above 5.5 volts, the 1N750A conducts through R14,

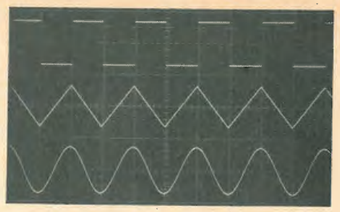


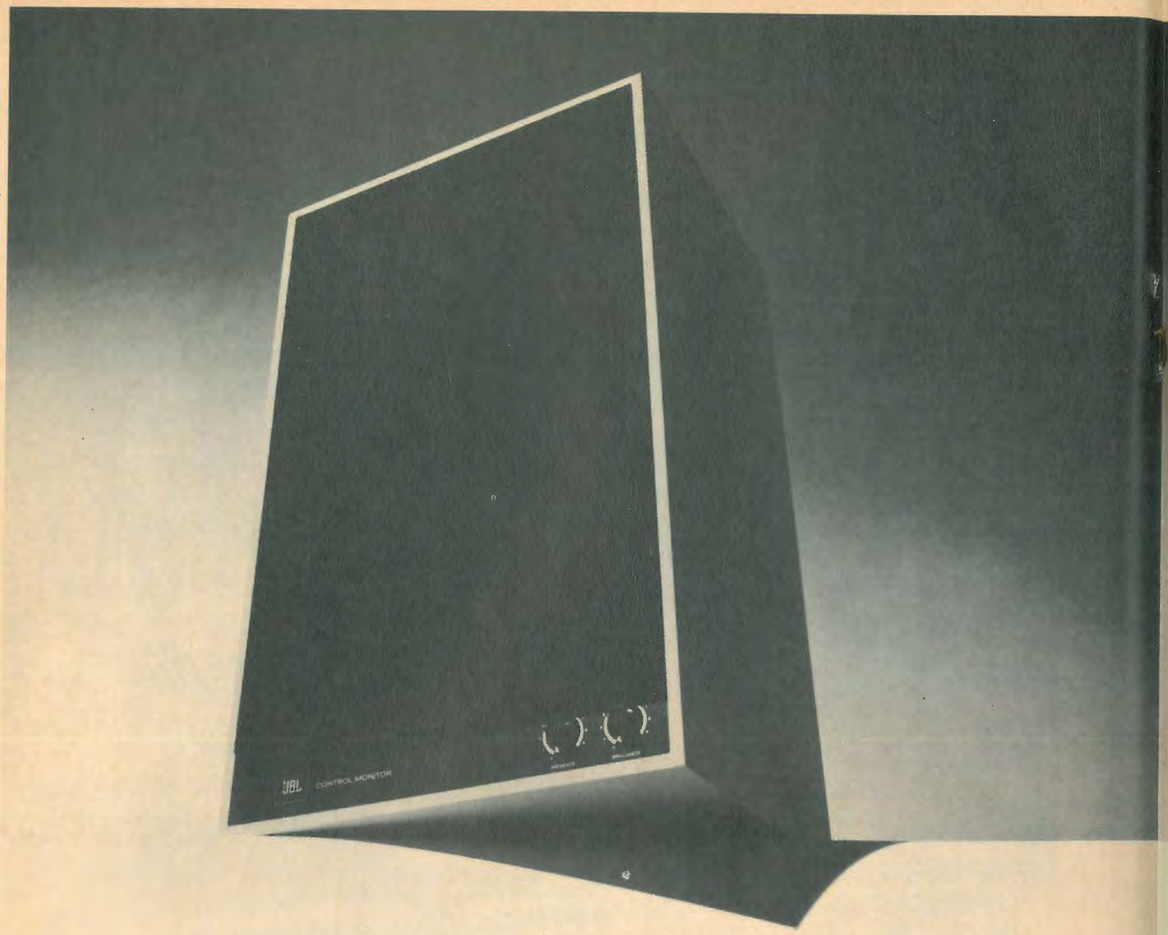
Fig. 3—Three simultaneous waveforms at 500 Hz, 1 volt/div. vertical, 1 millisecond/div. horizontal. Square-wave rise time is 0.2 μ sec.

which of course introduces further attenuation. Just beyond 6 volts the 1N750A directly clamps the waveform by way of the diode shunting R14. This nonlinear attenuation technique gives rather nicely rounded sine waves rather than sharp cornered polygons due to the gradual onset of conduction in low voltage zener diodes. Zeners are normally manufactured with a ±5% tolerance, and it may prove necessary to trim the circuit to achieve minimum

(Continued on page 59)

Parts List

Controls		**Diodes**	
VR1	Dual pot., audio taper, 10k + 10k	D1,D2,D3, D4,D5,D6, D7,D8,D9	1N914A
VR2,VR3, VR4	Audio taper, 10k	D10 Zener	1N750A
VR5,VR6	Trimpots, 10k linear	D11 Zenier	1N747A
Resistors		D12 Zenier	1N757A
R1	100k, ½ watt	D13	1N758A
R2,R3, R4,R5	1000 ohms, ½ watt	D14,D15, D16,D17	Silicon rectifiers, 100 P.I.V.
R6,R7, R8,R9	20k ohms, ½ watt	**Transformer**	
R10,R11, R12	10k ohms, ½ watt	115 V, 60 Hz,	24 V CT output (Triad F-45X)
R13	2200 ohms, ½ watt	**Op Amps**	
R14	330 ohms, ½ watt	A1,A2,A3,A5	MC1456CG
R15	5i.6k ohms, ½ watt	A4	MC1439G
Capacitors		**Transistors**	
C1	100 μF, 10 V, Tantalum, Sprague	Q1	2N3904
C2	.0012 μF	Q2	2N3906
C3,C4	1000 μF, 25 V	**Miscellaneous**	
		One 3-position, single-pole switch Three sockets	



Clark Kent.

The JBL 4310 is especially designed for mastering, control room installations, mix-down facilities, portable playback systems. It's full of good things like:

Wide range response. Full 90° dispersion for vertical or horizontal placement. Power handling capability, 50 watts program material.

Front panel controls for separate adjustment of presence and brilliance.

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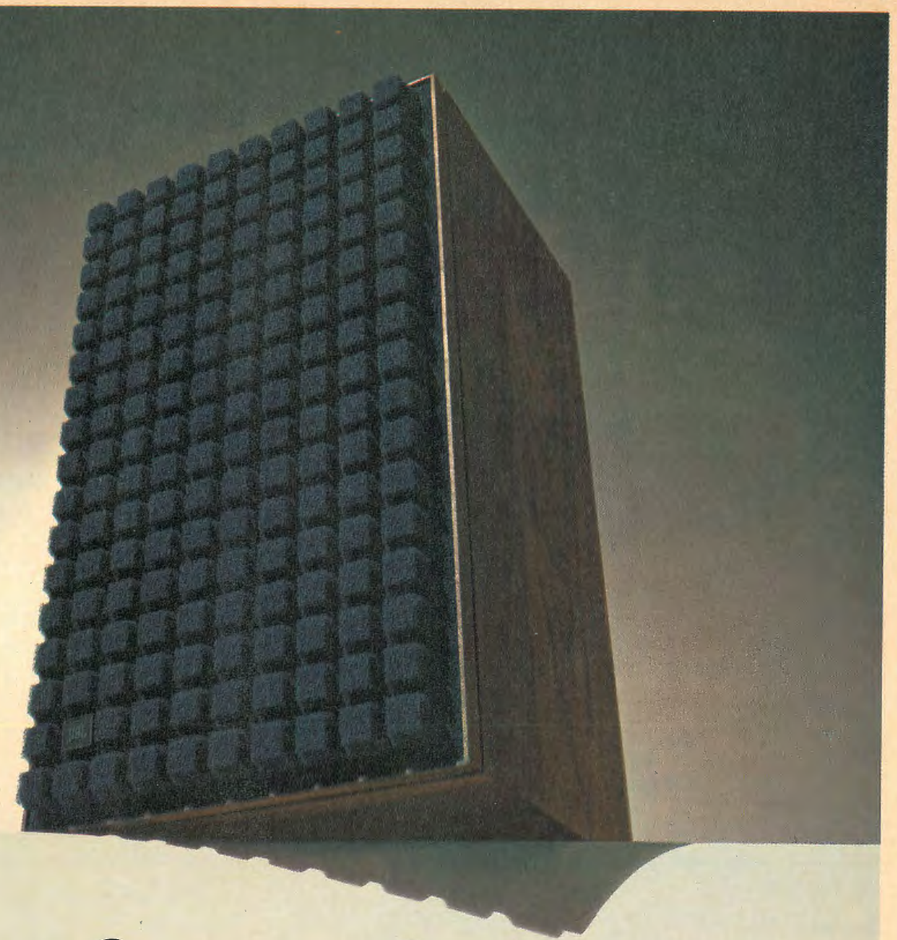
Now, guess what else the professionals have been doing with the 4310's for the last two years. You're right. They've been taking them home, using them as bookshelf speakers.

That's why we decided to get even.



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DIRECTORY OF MICROPHONE SPECIFICATIONS

Sennheiser MD 421

Readers should bear in mind that the specifications on the following pages are those supplied by the manufacturer and not the results of our tests or measurements. Obviously, due to space limitations, all the products of each manufacturer are not listed, but every effort has been made to give a representative selection.

Glossary

Electret—A plastic-chemical device which produces a relatively high voltage potential *with no current.*

Sensitivity—The standard Electronic Industries Assn. (EIA) ratings (SE 105) used are defined by "the ratio in dB relative to 0.001 watt and 0.0002 dynes per square centimeter of the electrical power available from the microphone to the square of the undisturbed sound field pressure in a plane progressive wave at the microphone position." Other standards commonly used are:

A) Volts in dB relative to 1 volt dyne per square centimeter,

B) Open-circuit voltage in dB relative to 1 volt per microbar, and

C) Power level in dB relative to 1 millivolt at 10 microbars. As a comparison, a typical microphone could measure -78 dB relative 1 V dyne cm2, have an open circuit voltage of 0.125 millivolts, power level of -57 dB, and an EIA rating of -150 dB approximately.

Directional Pattern—Figure 1 shows three common types. **A** is a cardioid; **B,** omnidirectional, and **C,** bi-directional. Note that radiating patterns tend to change with frequency.

Pressure Gradient—A microphone with both sides of the diaphragm open to the sound, thus responding to the *gradient* or *differential* pressure.

Variable-D—A microphone having more than one entrance to the rear of the diaphragm to reduce bass over-emphasis under "close mike" conditions.

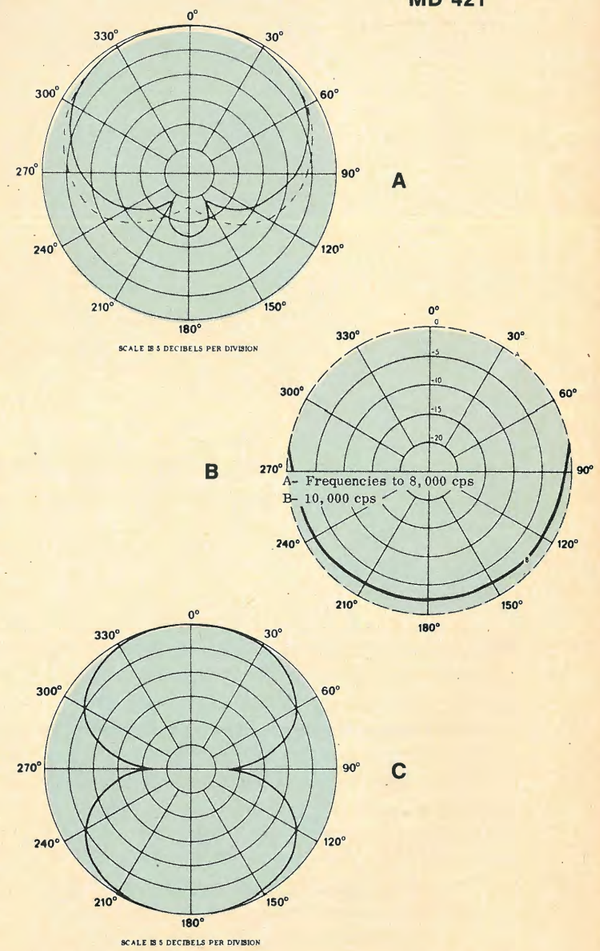

Fig. 1—Microphone response configurations. **A,** Cardioid; **B,** Omnidirectional, and **C,** Bidirectional.

AKG D-190E

MICROPHONES

Altec 650A

MANUFACTURER	MODEL	Directional Pattern	Operating Principle	Case Material	External Finish	Impedance, Ohms	Frequency Response, Hz to kHz, ± 7 dB	EIA Sensitivity, dM	Mic Connection	Cable Length, Ft.	Cable Plug Type	Dimensions, In.	Weight, Oz.	Mounting Method	Price	SPECIAL FEATURES
AKG	D-160E	Omni.	Dyn.	Metal	Satin	200	50-15k ±3	–148	XLR	15	Free	5⅞ x 1¾	7.5	⅝ x 27	60.00	With removable windscreen.
	D-190E	Card.	Dyn.	Metal	Satin	200	40-15k ±3	–149	XLR	15	Free	6¼ x 1½	6	⅝ x 27	50.00	Internally suspended capsule.
	D-200E	Card.	Dyn.	Metal	Chrome	200	30-15k ±3	–151	XLR	15	Free	7¼ x 1⅝	8	⅝ x 27	69.00	Two-way cardioid mic. Similar to two-way spkr.; woofer & tweeter w. crossover.
	C-451E	Vari	Cond.	Metal	Satin	200	30-20k ±2.5	–135	XLR	–	–	¾ x 4½	4.5	⅝ x 27	179.00	Modular system features: A) Interchangeable capsules. B) Phantom a.c. and d.c. powering.
ALLIED RADIO SHACK	Highball	Omni.	Dyn.	–	–	50-250 & 50k	50-15k	–	Cannon	15	Phone &Amph. MC1F	–	–	–	39.95	On-off switch, pop filter, windscreen, dual-Z.
	Highball-2	Omni.	Dyn.	–	Chrome	250 & 50k	90-11k	–	–	6	Phone	6¼ x 2¼	–	–	12.95	On-off switch, pop filter, windscreen.
	MC-1000	–	–	–	–	10k	100-10k	–	–	6	Phone	–	–	–	9.95	Pencil, with desk stand.
	Super Cardioid	–	Dyn.	Die-Cast	Chrome	600 & 50k	80-12k	–	–	6	Phone	–	–	–	17.95	On-off switch, mesh screen, with slide-on stand adaptor.
	Pro-100 Outfit	Omni.	Dyn.	–	–	250 & 10k	100-10k	–	–	2-20 &6	Phone	–	–	–	29.95	Complete outfit in fitted case: 2 mikes, cables, desk stands, slide-on wind screens, stand adaptors, lavalier cords.
ALTEC LANSING	650A	Card.	Dyn.	–	Satin Chrome	150-250; 20k	50-15K	–120	XLR	15	Phone	7¼ x 1¾	–	–	97.50	Bass roll-off sw., 400 Hz down, front-back disc. 20 dB Model 651AH, 20k ohms only, no roll-off sw., sgl. cond. cable.
	650 BH	Card.	Dyn.	–	Satin Chrome	150-250	50-15k	–120	XLR	25	Phone	7½ x 1¾	–	–	128.00	Incls. on-off sw. and bass roll-off sw. Model 650BL, same except cable fitted with XLR plugs.
ASTATIC	820	Omni.	Dyn.	Steel	Satin Chrome	150-40k	50-15k ±3	–158	Wired	18	Not Furn.	9 x ¾	17	⅝ x 27	79.50	820S, with switch, $85.00. Both available in gold for $5.00 additional.
	840	Omni.	Dyn.	Alum.	Satin Chrome	150	150-15k ±4	–153	Wired	30	Not Furn.	2⅝ x ¾	1¼	Lav., ⅝ x 27	85.00	840-S, with switch, $90.00. Both available in gold for $5.00 additional.
	850	Card.	Dyn.	Zinc	Satin Chrome	*	80-12k ±5	–147	Swcft. A4F	18	Not Furn.	1¼ x 6½–Ball-2	9½	⅝ x 27	95.00	850-S, with switch, $99.00. *Multi, Hiz 40k- LoZ 150.
	860	Omni.	Dyn.	Steel	Satin Chrome	*	50-15k ±3	–158	Wired	18	Not Furn.	¾ x 10–Ball-1½	18	⅝ x 27	89.50	860-S, with switch, Switchcraft A4F mic. con., $95.00. *Multi, HiZ.
	811	Card.	Dyn.	Zinc	Satin Chrome	*	80-12k ±5	–147	Amph. MC3M	**	Not Furn.	1¼ x 5½	13½	"G" Stnd.	75.00	*Multi, Hiz 40k; LoZ 150. **None, for "G" stand or "F" or "SC" adaptors.
	D-104	Omni.	Crys.	Brass	Bright Chrome	HiZ	100-5k ±5	–146	Amph. MC3M	5	Not Furn.	3 x 1⅛	14	⅝ x 27	31.00	AM communications.
COLLINS RADIO	M-21	Omni.	Dyn.	–	–	50-250	60-12k	–	–	25	–	⅜ x 2⅞	1½	Lav.	35.00	
	M-70	Card.	Dyn.	–	Gray	50 or 200	40-15k	–	–	20	–	1½ x 6¾	12	Desk Stand	57.50	
	M-80	Card	Dyn.	Zinc Alloy	Satin Chrome	150	50-15k	–	–	12		1⅝ x 6	14	⅝ x 27	44.50	
	M-90	Card.	Dyn.	Zinc Alloy	Satin	150	40-15k	–	–	20	–	2 x 6	20	⅝ x 27	57.50	

(Continued on page 40)

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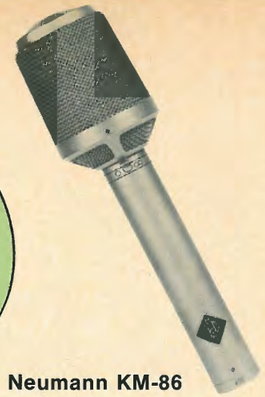
MICROPHONES



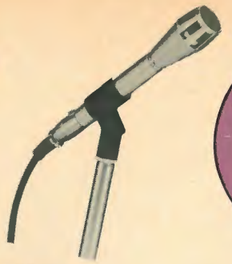
E-V RE20

Neumann KM-86

(Continued from page 37)

MANUFACTURER	MODEL	Directional Pattern	Operating Principle	Case Material	External Finish	Impedance, Ohms	Frequency Response, Hz to kHz, ± 7 dB	EIA Sensitivity, dM	Mic Connection	Cable Length, Ft.	Cable Plug Type	Dimensions, In.	Weight, Oz.	Mounting Method	Price	SPECIAL FEATURES
ELECTRO-VOICE (General Purpose)	664	Card. (Var. D)	Dyn.	Diecast Zinc	Chrome, Gray or Gold	150 & HiZ	60-15k	–149 –151	E-V QC3M	15	None	7⅛ x 1¼	26	⅝ x 27	57.00	Variable-D cardioid; resp. independent of distance; on-off switch.
	674	Card. (Var. D)	Dyn.	Diecast Zinc	Chrome	150 & HiZ	60-15k	–151 –152	EV QC4M	15	None	7¼ x 1¼	18	⅝ x 27	61.35	As above, w. 3-pos. bass-tilt sw. for control of room rumble.
	676	Card. (Var. D)	Dyn.	Diecast Zinc	Chrome	150 & HiZ	60-15k	–151 –152	EV QC4M	15	None	7¼ x 1¼	12	300 Std. Adapt.	61.35	As above, without on-off switch.
	670	Card.	Dyn.	Alum. Alloy	"Top Brass"	150 or HiZ	60-14k	–150	XLR	15	Swcft. A3F	7¼ x 1½	6	301 Std. Adapt.	45.90	Emphasizes low freq. when used close up. 670V has vol. control, $50.10.
	621	Card.	Dyn.	Metal	Satin	200 or HiZ	150-12k	–	–	–	–	5¼ x ⅞	6	Desk Std. Adapt.	19.95	Emphasizes low freq. when used close up.
	1711	Omni.	Electret Cond.	Alum.	Anod., Enamel	150	60-15k	–142	–	18	Swcft. A3F	–	4½	312A Clamp	58.50	Has on-off switch on barrel.
	1751	Card.	Electret Cond.	Alum.	Anod., Paint	150	60-15k	–137	–	18	Swcft. A3F	8 x ⅞	4½	312 Clamp	60.00	
	651	Omni.	Dyn.	Delrin	Flat Black	50-250	60-10k	–	–	–	XLR	–	–	–	60.00	Extremely lightweight assembly mounts to eyeglass frame or headband. RE51, with cough button, $80.40.
ELECTRO-VOICE (Professional)	RE-20	Card. (Var. D)	Dyn.	Steel	Fawn Beige Matte	50, 100, 150	40-20k	–150	Swcft. A3M	18	Not Furn.	8½ x 2 ⅛	26	Adapt.	272.40	Very wide range; uniform polar curve.
	RE-16	Card. (Var. D)	Dyn.	Steel	Fawn Beige Matte	150	80-15k	–150	Swcft. A3M	18	Not Furn.	7⅛ x 1⅜	8	Adapt.	176.70	Super effective pop filter similar to RE-15.
	RE-15	Card. (Var. D)	Dyn.	Steel	Fawn Beige Matte	150	80-15k	–150	Swcft. A3M	18	Not Furn.	6½ x 1¼	6	Adapt.	169.80	Super-cardioid; max. rejection at 150 deg., uniform response at all angles.
	RE-55	Omni.	Dyn.	Steel	Fawn Beige Matte	150	40-20k	–149	Swcft. A3M	18	Not Furn.	10½ x 1¼	8½	Adapt.	141.30	Extremely smooth response; suitable as secondary calibration standard.
INGENUICS	Environ	*Omni.	Dual Dyn.	Alum.	Black Anod.	250 or 50k	40-15k	–	None	10	–	8 x 3 "T" Shape	12	–	189.00	*Switchable dual mode, super omni and noise cancel.
LAFAYETTE	99-45973	Omni.	Dyn.	Chrome	Chrome	250 or 50k	50-15k	–56	–	4½	Phono	6⅛ x 4½	24	⅝	17.95	Wide range freq. from two indep. cartridges, Lo/Hi.
	99-46203	Omni.	Dyn.	Satin Chrome	Satin Chrome	250 or 50k	100-10k	–	–	20	Phono	6½ x 2⅛	32	⅝	15.95	Dual impedance; ball screen anti-wind pop.
NEUMANN	KM-88	Omni. Fig. 8, Card.	Cond.	Metal	Satin Chrome	200	40-16k	–140	Cannon	25	Cannon	5¾ x ⅞	3.5	⅝ x 27	336.00	3 pattern, switchable; with 10 dB overload protection switch. Uses nickel membrane capsules.
	SM-69 FET	Dual Omni, Card., Fig. 8	Cond.	Metal	Satin Chrome	200	40-16k	–131	Cannon	33	Cannon	10 x 1⅞	16	⅝ x 27	880.00	Dual 3-pattern mic. for stereo miking in either X/Y or M/S mode.
	U-87	Omni., Card., Fig. 8	Cond.	Metal	Satin Chrome	150/250	40-16k	–137	Cannon	25	Cannon	8 x 2¼	20	⅝ x 27	359.00	Studio std. for close miking int. compartment for batt. oper.; switchable 10-freq. & 10 dB overload protection.
	KM-86	Omni., Card., Fig. 8	Cond.	Metal	Satin Chrome	200	40-20k	–137	Cannon	25	Cannon	7⅛ x 1⅜	7⅛	⅝ x 27	344.00	3-pattern, switchable with 10 dB overload switch for close-up recording.
	KM-84	Card.	Cond.	Metal	Satin Chrome	200	40-20k	–137	Cannon	25	Cannon	8 x 2⅛	3	⅝ x 27	265.00	Reqs. batt. or a.c. supply; flat freq. resp. on or off mike; 10 dB overload sw. for close-up use; accessories available.
	KM-83	Card.	Cond.	Metal	Satin Chrome	200	20-20k	–137	Cannon	25	Cannon	4⅞ x ⅞	3	⅝ x 27	236.00	As above.
	KM-85	Card.	Cond.	Metal	Satin Chrome	200	40-20k	–137	Cannon	25	Cannon	4⅞ x ⅞	3	⅝ x 27	265.00	As above with spec. 10-freq. roll-off for PA use.

Shure 585SA



Shure SM60

MICROPHONES

MANUFACTURER	MODEL	Directional Pattern	Operating Principle	Case Material	External Finish	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	EIA Sensitivity, dM	Mic Connection	Cable Length, Ft.	Cable Plug Type	Dimensions, In.	Weight, Oz.	Mounting Method	Price	SPECIAL FEATURES
PML (Ercona)	TC 4 US-V	Card., Omni., Bi-Dir.	Cond.	Metal	Satin Chrome	50 or 200	30-20k	–172	Tuchel	20	None	5¾ x 1	5	⅜ x 27	350.00	Studio FET mic, a.c. power supply.
	EC-71	Card.	Cond.	Metal	Satin Chrome	30-50, 200, 600	40-18k ±3	–164	PREH	12	None	2¾ x 1	1⅛	⅝ x 27	109.50	Micro min. cond., a.c. or d.c. power supply.
	EK-71	Omni.	Cond.	Metal	Satin Chrome	30-50, 200, 600	40-18k ±3	–164	PREH	12	None	2¾ x 1	1⅛	⅝ x 27	99.50	As above.
	D-44	Card.	Dyn.	Metal	Black, Grid	200	60-16k	–165	Att.	12	None	5	4.7	⅝ x 27	34.95	Avail. w. on-off sw., 30-ft. cable, 200 ohms bal. or HiZ at $39.95.
RCA BROADCAST SYSTEMS	77-DX	Omni., Card., Bi.	Ribbon	Metal	Chrome	30, 150, 250	35-18k ±5	–150	–	30	Not Furn.	11½ x 3¾ x 2½	48	½ or ⅝ x 27	224.00	Three-position voice-music switch and directional pattern choices.
	BK-5B	Uniaxial Card.	Ribbon	Metal	Low Luster Gray	30, 150, 250	30-20k ±4	–151	–	30	Not Furn.	7 x 1⅜	27	½ or ⅝ x 27	172.00	Extremely smooth response. Can be boom mounted.
	BK-6B	Semi-direc.	Dyn.	Metal	Low Luster Gray	30, 150, 250	60-15k *	–159	–	30	Not Fum.	2½ x 1	2.3	Lanlard	95.00	*Lavalier mike with countoured response.
	BK-12	Semi-direc.	Dyn.	Metal	Bronze Epoxy, Matte Gold	30, 250	60-18k	–159	–	30	Not Furn.	1½ x ¾	0.71	Tie Clip	85.00	*Lavalier mike with contoured response.
	BK-14	Omni.	Dyn.	Metal	Satin Chrome	30, 250	40-20k ±5	–154	–	30	XLR	8 x ⅜	4	⅝ x 27	149.00	Extremely smooth response. Wind and pop resistant. Handheld or stand mounting.
	BK-16	Omni.	Dyn.	Metal	Satin Nickel	30, 250	40-20k ±5	–154	–	30	XLR	8 x ⅜	3	⅝ x 27	139.00	Extremely smooth response. Handheld or stand mounting.
	BK-1A	Omni.	Dyn.	Metal	Low Luster Gray	30, 150, 250	50-15k	–146	–	30	Not Furn.	7⅜ x 1⅞	18	Ball & Socket ½" Thread	95.00	Insensitive to wind and mechanical vibrations.
	SK-30	Omni.	Dyn.	Metal	Midnight Blue	30, 250	50-14k	–149	–	20	Not Furn.	4½ x 1½	8	⅝ x 27	22.00	For handheld, stand-mount or gooseneck-mount applications.
SENNHEISER	MD 211-U	Omni.	*	Metal	Dull Chrome	200	40-20k ±2.5	–149.3	XLR	15	XLR	⅞ x 5	5	Stand or Boom	153.00	Very flat frequency response. *Pressure transducer.
	MD 415	Card.	*	Metal	Gold	200	60-15k ±2	–	Tuchel T3260	18	Din.	1⅜ x 6	11	Stand or Boom	152.20	"Pop," resistant. *Pressure gradient transducer.
	MD 421U	Card.	Pres. Grad.	Synth. Fiber	Dull Gray	200	30-17k	–148.5	XLR	15	XLR	7 x 1⅞ x 1¾	14	Stand or Boom	123.20	Continuous bass roll-off attenuator.
	MD420	Close Talk	Pres. Grad.	Metal	Lt. Dull Gray	200	200-10k	–146	Tuchel T-3080	15	Tuchel T-3080	1½ x 5¼	4	Stand or Goose Neck	68.00	Noise-cancelling mic.
	MK12	Omni.	Cond.	Metal	Gray	10	20-20k	–121.5	Att.	15	Min.	½ x 1½	3.2	Tie Clip	210.00	Lavalier type.
SHURE (General Purpose)	585SA	Card.	Dyn.	Diecast Zinc	Chrome	Hi	50-13k	–153.5	Amph. MC1F	15	Not Furn.	6⅜ x 2 1/16	13½	Adapt.	45.00	Unisphere A; also avail. in low-Z model 585SB.
	588SA	Card.	Dyn.	Diecast Zinc	Chrome	Hi	80-13k	–155	XLR	15	Not Furn.	6½ x 2 1/8	12	Adapt.	39.00	Unisphere B; also avail. in low-Z model 588SB.
	515SA	Card.	Dyn.	Diecast Zinc	Black Chrome	Hi	80-13k	–154	–	15	Not Furn.	6½ x 1½	15	Adapt.	27.00	Unidyne B; also avail. in low-Z model, 515SB.
	579SB	Omni.	Dyn.	Diecast Zinc	Chrome	Lo	50-15k	–151	XLR	20	Not Furn.	6⅞ x 1 9/16	5½	Adapt.	45.00	Vocal sphere.
	548	Card.	Dyn.	Diecast Zinc	Black & Chrome	Hi Lo	40-15k	–151	XLR	15	Not Furn.	6⅛ x 1 9/16	9	Adapt.	69.00	Unidyne IV; also avail. w/mag reed sw as model 548SD.
	565	Card.	Dyn.	Diecast Zinc	Black & Chrome	Hi Lo	50-15k	–150.5	Amph. MC4M	15	Not Furn.	6 x 2	11	Adapt.	64.80	Unisphere I; also avail w/mag reed sw as model 565SD.
	545	Card.	Dyn.	Diecast Zinc	Black & Chrome	Hi Lo	50-15k	–151	Amph. MC4M	15	Not Furn.	5 13/16 x 1¼	9	Adapt.	57.60	Unidyne III; also avail. w/mag reed sw as model 545SD.
	55SW	Card.	Dyn.	Diecast Zinc	Chrome	Hi, Med, Lo	50-15k	–151.5	Amph MC3M	15	Not Furn.	7 13/16 x 3 1/16	26	⅝–27	58.80	Unidyne II with on/off sw.
SHURE (Professional)	SM33	Super Card	Ribbon	Diecast Zinc	Gray Enamel	30/50 150/250	40-15k	–148	XLR	20	Not Furn.	8 x 1⅛ x 1 7/8	26	⅝–27	150.00	Wide-range response.
	SM53	Card.	Dyn.	Alum.	Matte Metallic	150	40-15k	–151	XLR	20	Not Furn.	7 1/16 x ½ 1½	8	Adapt.	153.00	Eff. rejection of unwanted sounds; mech. noise isolation; rolloff sw.
	SM58	Card.	Dyn.	Diecast Zinc	Gray Enamel	30/50 150/250	70-16k	–148	XLR	20	Not Furn.	6½ x 2	15	Adapt.	96.00	Built-in wind and pop filters; shock-mounted cartridge.
	SM60	Omni	Dyn.	Alum. & Steel	Matte Metallic	150	45-15k	–153	XLR	20	Not Furn.	6⅛ x 1 7/8	6	Adapt.	49.20	Clean natural reproduction.

Sony SCM19B

Sony C-37P

University 5000

Turner 600

MANUFACTURER	MODEL	Directional Pattern	Operating Principle	Case Material	External Finish	Impedance, Ohms	Frequency Response, Hz to kHz, ± dB	EIA Sensitivity, dM	Mic Connection	Cable Length, Ft.	Cable Plug Type	Dimensions, In.	Weight, Oz.	Mounting Method	Price	SPECIAL FEATURES
SONY/ SUPERSCOPE (General Purpose)	ECM-16	Omni.	Electret Cond.	Alum.	Nickel Satin	600	50-13k	–149.8	Att.	6	Mini	1 1/16 L x 5/16 D	1.09	Tie Clasp	34.95	Operates on-internal battery. Small size permits tie-tack mounting. Battery included.
	ECM-19B	Card.	Electret Cond.	Alum.	Nickel Satin	250	50-12k	–145.6	Att.	9	Mini.	6 L x ⅜ D	4.4	Adapt.	34.95	Includes desk stand., Stand. adapter. battery.
	ECM-21	Card.	Electret Cond.	Alum.	Nickel Satin	50/250/ 600	50-12k	–145.6	Att.	19	Not Furn.	6⅛ L x ⅜ D	5	Adapt.	54.95	Includes desk stand, stand adapter, windscreen, battery. May be wired balanced or unbalanced.
	ECM-22P	Card.	Electret Cond.	Alum.	Nickel Satin	250/600	40-15k	–146.6	Can. XLR	20	Not Furn.	7⅝ L x 1 D	4	Adapt.	99.95	Includes stand. adapter, windscreen, battery, features low cut filter, external phantom power capability.
	ECM-99	Dual Card.	Electret Cond.	Alum.	Nickel Satin	600	50-12k	148.6	Att.	10	Dual Mini	7 1/2 L x 1 11/64 D	10	Adapt.	44.95	One-point stereo operation with two cardioid microphones at 160° angle in single housing.
SONY/ SUPERSCOPE (Professional)	ECM-50	Omni	Electret Cond.	Alum.	Nickel Satin	50/250/ 600	50-16k ±3	–147.0	Att.	10	Can. XLR	23/32 L x 27/64 D	3.66	Tie-Tack	129.95	Includes tie-tack, lapel, and pocket mounting clips, battery, windscreen. Features extremely small size, smooth, natural response.
	ECM-51	Omni.	Electret Cond.	Alum. & Brass	Nickel Satin	50/250/ 600	50-16k ±3	–147.0	Att.	10	Not Furn.	7¾ – 17½ L x 17/32 D	4	Adapt.	129.95	Includes battery, windscreen, case. Features adjustable length, small size, smooth natural response.
	ECM-53	Card.	Electret Cond.	Brass	Nickel Satin	50/250/ 600	40-16k ±3	–147.0	Att.	10	Can. XLR	2 13/16 L x 1 9/16 D	7.8	Built-in Stand Mount	149.50	Includes windscreen, battery, carrying case. Features built-in Gooseneck for desk and floor stand mounting.
	ECM-377	Card.	Electret Cond.	Brass	Gray Enamel	200	20-20k ±3	–141.8	Att.	19	Not Furn.	–	16	Built-in Stand Mount.	195.00	Includes carrying case, battery. Features internal/external (48 volt phantom) powering, 2 low-cut filters, built-in shock mount.
	C-37P	Card./ Omni	Electret Cond. Switch.	Brass	Gray Enamel	250	30-16k ±3	–141.5	Att.	20	Can. XLR	7⅞ L x 1 23/32 D	18	Built-in Stand Mount	295.00	Includes carrying case, cover. Features switchable directivity, 48 volt phantom power capability. Built-in shock mount, 3 low cut filters.
	C-77	Super Directional	Electret Cond.	Alum. & Brass	Anodize	50/250/ 600	40-12k	–143.8	Att.	3	Can. XLR	22.5 L x 2 D	39	Built-in Stand Mount	495.00	Includes handle, boost/monitor amp/windscreen/ case. Features super-directional response at all frequencies, internal battery power.
	C-500	Card.	Electret Cond.	Brass	Nickel Satin	250	20-20k ±3	–141.8	Att.	19	Can. XLR	–	34	Built-in Stand Mount	395.00	Includes response graph, carrying case, cover. Features 48 volt phantom power capability. Built-in shock mount, 2 low-cut filters.
TURNER DIV. (Conrac Corp.)	500	Card.	Dyn.	Alum.	Satin Chrome	Comb. Hi & 150	40-15k ±3	–151	Swcft. A4F	20	Not Furn.	1 17/32 x 6 1 13/16	12	⅝ x 27	60.00	Available with rotary on-off switch, model S500, and in match pairs for stereo.
	600/602	Card.	Dyn.	Alum.	Satin Chrome	600-HiZ; 602-150	50-15k ±3	–151	Wired in	12	Not Furn.	1⅝ x 6	14	⅝ x 27	39.00	
	700	Card.	Dyn.	Alum.	Satin Chrome	HiZ & 150	50-15k ±3	–151	Swcft. A4F	20	Not Furn.	1⅝ x 6	14	⅝ x 27	57.00	701 available in high impedance only with MC IF con. & 12' cable with 280 phone plug attached at 39.00
	2203/ 2266	Card.	Dyn.	Steel	Satin Chrome	2203, 150; 2266, HiZ	50-15k ±3	–157	Swcft. A3F	20	280 Phone-plug	¾ x 6	8	⅝ x 27	54.00	High impedance unit (2266) supplied packed in permanent carrying case.
	2300/ 2302	Omni.	Dyn.	Steel	Satin Chrome	2300, HiZ 2302, 150	50-15k ±3	–157	Swcft. A3F	20	None	¾ x 6	8	⅝ x 27	45.00	With on-off switch.
	35/35A	Omni.	Dyn.	Alum.	Paint	*	50-12k ±3	–161	Wired	25	None	⅜ x 2¼	1	**	35, 42.00 35A, 48.00	*35, comb. Hi & Low; 35A, 150. **Lavalier assembly.
	S2850	Card.	Dyn.	Cyco-lac	Black	HiZ & 150	70-12k ±3	–161	Wired	12	¼" Phone Plug	1⅛ x 5 7/8	8	⅝ x 27	26.40	With on-off switch.
	2811/ 2812	Omni.	Dyn.	Cyco-lac	Black	2811, HiZ 2812, LoZ	70-10k ±3	–161	Wired	12'	*	1⅛ x 4	3	**	12.00	Universal cassette recorder replacement. *Audio mini plug & remote control phono plug. **Comb. lav. & desk.
UNIVERSITY (Altec)	5000	Super Card.	Dyn.	Diecast Alum.	Satin Chrome	200-30k Bal.	25-20k	–120	Term	15	Not Furn.	7½ x 2⅛	12	SA-10	59.37	Also avail. w. sw., Model 5100 w. amp. con.; Model 5020 integ. swivel & amp.; Model 5050 shock-mtd. cartridge.
	6000	Card.	Dyn.	Diecast Alum.	Flat Black	150 Bal.	50-15k ±4	–151	Term.	15	Not Furn.	3⅜ x 1	5	SA-10	41.75	
	2000	Omni.	Dyn.	Zaniak 3	Acrylic Silver Gray	50-20k Bal.	50-14k	–143	Term	15	Not Furn.	6 x 1⅛	16	SA-10	32.96	All mics supplied w. SA-10 std.; adapt. may be attached to stand or hand held; also available with switch.

Equipment Profiles

- Nikko TRM-1200 Amplifier 44
- Garrard Zero 100 Turntable 46
- Acoustic Research FM Tuner 49
- Realistic Sound Level Meter 51

Nikko Model TRM-1200 Stereo Preamp-Amplifier

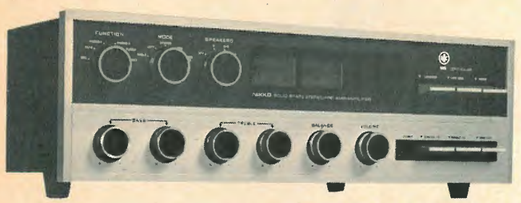


Fig. 1—Rear panel layout.

MANUFACTURER'S SPECIFICATIONS

IHF Music Power: 130 watts @ 4 ohms; 120 watts @ 8 ohms. **RMS Power:** 45 watts per channel @ 8 ohms, single channel driven; 40 watts per channel @ 8 ohms, both channels driven. **THD:** 0.3% at rated output, 0.1% @ 1 watt. **IM Distortion:** 0.3% @ 30 watts; 0.1% @ 1 watt. **Power Bandwidth:** 15 Hz to 30 kHz (-1 dB, 0.5% THD). **Frequency Response:** Power amplifier section, 13 Hz to 50 kHz ± 1 dB; Aux. Input, 20 Hz to 40 kHz ± 1 dB. **Input Sensitivity:** Mic, Phono 1 & 2, 2 mV; Tuner, Tape & Aux, 220 mV. **S/N Ratio:** Mic, 70 dB; Phono 1 & 2, 70 dB; Tuner, Tape & Aux., 85 dB. **Tone Control Range:** Bass, ± 12 dB @ 70 Hz; Treble, ± 12 dB @ 10 kHz. **Rumble Filter:** -6 dB @ 70 Hz. **Scratch Filter:** -10 dB @ 10 kHz. **Damping Factor:** 15 @ 4 ohms; 30 @ 8 ohms. **Dimensions:** 15¼ in. W. x 4½ in. H. x 12¼ in. D. **Suggested Retail Price:** $249.95.

The sudden interest in "separate" amplifier components just as the industry became convinced that the integrated receiver would dominate the field forevermore has prompted many manufacturers to offer amplifiers and tuners in just about every price category. The latest integrated amplifier entry from Nikko Electric Corporation of America is their moderately priced but impressive looking Model TRM-1200. The most impressive aspect of the front panel of this unit is the pair of illuminated VU meters at the center of the upper portion of the panel. The gold anodized and black panel also includes a six-position selector switch, a mode switch (with settings for RIGHT, LEFT, STEREO, REVERSE, and MONO L+R), a speaker selector switch (with positions for one or both pairs of speakers and OFF position for headphone use) and three piano-key switches for LOUDNESS COMPENSATION, TAPE MONITOR and POWER. The lower section of the panel includes separate BASS controls for each channel, separate TREBLE controls for each channel, BALANCE, and VOLUME controls. A stereo headphone jack and three more piano-key switches are slightly recessed in the lower right corner of the front panel. These last three switches introduce scratch and rumble filters and bypass the tone controls.

The rear panel is laid out in orderly fashion. The a.c. line cord is of the interlock type, so that removal of the amplifier's cover automatically disconnects the line cord from the amplifier. Three circuit breakers of the "push to re-set" type are accessible at the rear panel. They are located in the transformer primary circuit and in the two speaker output lines. Two convenience outlets (one switched, one unswitched) are also located in this section of the rear panel. Speaker terminals are well isolated by barrier strips and, although each terminal screw head is slotted, the sides of the screw-head are knurled and easily turned by finger pressure. Thus no tools are really needed to connect the speakers. A pair of jumper cables connect the preamp outputs to the main amp inputs and, with these jumpers removed, this unit can really be used in any way that a separate preamp and basic amplifier might be used. A center channel output jack is also provided, but a third monophonic power amplifier would be needed to utilize this feature for a middle channel arrangement. Two adjusting potentiometer shafts are available for calibrating the front-panel VU meters, about which more will be said later. In addition to the usual input and tape output jacks, there is a tape record and playback socket, wired in accordance with the DIN (Foreign) standards, and a pair of microphone jacks. Having the mic jacks on the rear panel may be a bit of an inconvenience for some people if the amplifier is to be custom installed, but the feature is a welcome addition, which all too few of today's amplifiers and receivers can boast. We would have preferred to see the input jacks on the front panel for easier access. A grounding terminal and a "speaker compensator" switch complete the rear panel layout. The latter feature is new to us on integrated amplifiers and it will be discussed later.

Figure 2 shows the internal layout and construction of the Nikko TRM-1200 amplifier. The low level preamp stages are fully enclosed in a shielded metal structure for minimum hum pickup. Driver transformers used in the power amplifier section are toroidally wound for extremely accurate balance between secondary sections.

The low level preamplification (for phono and mic inputs) is accomplished by means of IC's, with appropriate equalization components externally wired. Amplification of preamp output signals as well as high level input sources is accomplished by a pair of d.c. coupled NPN transistors in each channel, followed by a Baxandall feedback tone control state for bass and treble control action. This latter state is completely by-passed when the front panel tone control switch is moved to the OUT position. Each power amplifier channel consists of three d.c. coupled stages (the last two of which are in emitter-follower configuration) followed by the driver transformer and a pair of NPN power output transistors. The latter are powered by negative and positive 35 volts d.c. so that the center take-off point to the loudspeakers requires no isolating coupling capacitors. While there are no adjustments for d.c. balance or biasing, we found the d.c. potential at the speaker take-off points to be so low

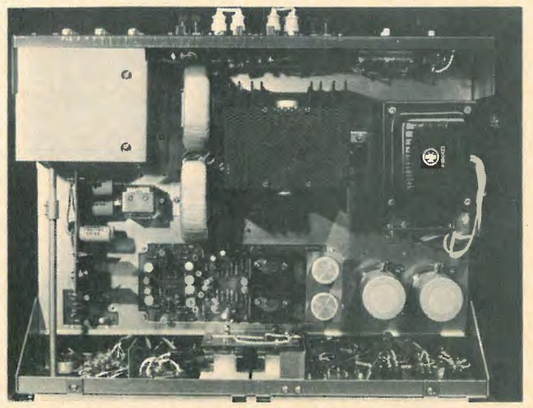


Fig. 2—Top view of the Nikko TRM-1200.

as to be insignificant, indicating that the output pairs have been well matched.

The pair of d.c. coupled NPN transistors in the earlier stages of the preamplifier serve a second purpose. A frequency-sensitive feedback loop with a crossover frequency set at about 150 Hz is introduced when the "speaker compensator" switch is moved to the ON position. This portion of the circuit (for one channel only) is shown in the partial schematic of Fig. 3. With lower frequencies applied, the 0.15 μFD capacitor no longer acts as a short-circuit and the 22K resistor across it is introduced into the feedback network, decreasing total feedback around the pair of transistors and increasing gain at low frequencies. The circuit differs from the normal bass control in that the crossover frequency has been specifically set to boost the lower bass region only, to raise the lowest octave or two.

Measurements

With both channels driven, we reached rated distortion (0.3%) at an output power of 37 watts per channel. At 40 watts output (still with both channels driven) THD reached 1.0% exactly. With only a single channel driven, rated distortion was reached at 47.5 watts, a bit better than claimed. All power output levels below 28 watts per channel were reproduced with 0.1% distortion or less. As for IM distortion, 47.0 watts was developed before the IM figure reached 1.0%. At 1 watt output per channel, IM measured somewhat less than 0.2%. The THD and IM characteristics of the amplifier are plotted in more detail in Fig. 4. Power bandwidth is 1 Hz to 32 kHz, as plotted in Fig. 5.

Tone control action and filter characteristics are plotted in Fig. 6 and are seen to correspond closely to the published specifications. The loudness-contour action, taken at -30 dB from maximum volume setting, is also shown in this figure, as is the bass boost action of the "speaker compensator" circuit described earlier. With tone controls deactivated, frequency response in the AUX position was uniform within 1 dB from 9 Hz to 35 kHz. With tone controls introduced and set at mechanically flat position, uniform response within 1 dB was again excellent, extending from 10 Hz to 25 kHz.

Residual hum and noise measured -65 dB on phono, referred to a 2 mV input for full output. Referred to a more usual 5 mV, this figure would increase to over 70 dB, a really excellent reading for such low level circuits. Mic hum and noise was down 70 dB while TAPE and AUX inputs measured a hum and noise level of 85 dB below full output.

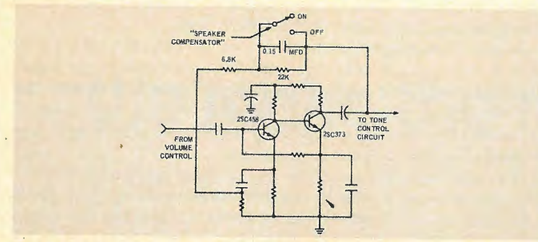


Fig. 3—Voltage amplifier stages of Nikko preamp section (one channel shown) includes feedback network to boost bass frequencies below 150 Hz.

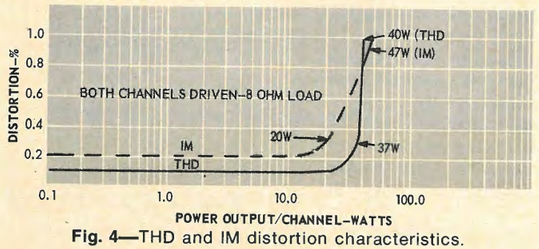


Fig. 4—THD and IM distortion characteristics.

Use and Listening Tests

When the amplifier is first turned on, there is a four second time delay which prevents "pops" to the speakers—a very welcome feature, especially on an amplifier having such excellent low-frequency power response. To the right of the illuminated VU meters, the position of the selector switch is indicated by illuminated lettering. In trying out the VU meters, we discovered that they are really more flexible than is indicated in the instruction manual. By means of the rear calibrating potentiometers, we were able to set the meters so that "0 VU" corresponded to any power output level from 1 watt to full-power output. The instructions make no mention of this useful adjustment feature.

The amplifier sounded very clean with all the recorded music we used in our tests (which now includes some of the "multimedia" Stockhausen works that really demand dynamic range and good transient response from all elements of the reproducing system). Power output was adequate for two sets of low-efficiency systems and there was no evidence of "break-up" during loudest recorded passages.

We also tried the "speaker compensator" but, with our high quality speaker system, we found the lower bass emphasis to be a bit too much at our listening levels and in our particular listening room. As we switched the tone control circuits in and out, there was absolutely no audible difference (either in gain or in tonal effects), confirming the precision of the Baxandall circuitry used when the tone controls are "in-circuit." Since the VU meters are larger (and probably more accurately calibrated) than those normally found on home tape recorders, we found using the TRM-1200 for recording work (with its microphone inputs in use, instead of those on our tape recorder) to be very convenient and effective. We checked the circuit breakers by placing momentary shorts across the speaker terminals and found them fast-acting and fool-proof. Upon pressing the re-set buttons, the four second time delay is still in effect, however.

The Nikko TRM-1200 has so many other worthwhile features typical of the "new breed" of separate solid state amplifiers that, at its "under $250" price, it offers excellent value, even if you evaluate amplifiers purely on a "dollars per watt" basis. *L.F.*

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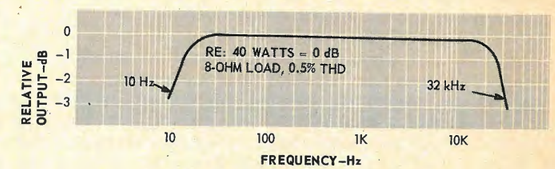


Fig. 5—Power bandwidth.

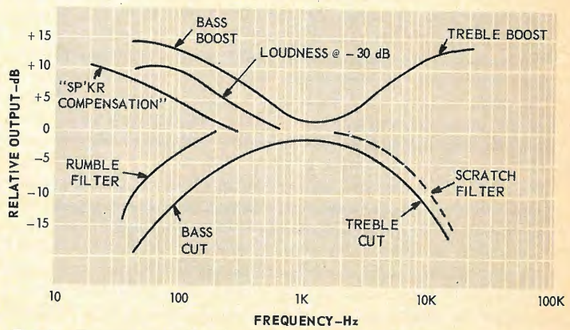


Fig. 6—Tone control, loudness, filter, and speaker compensator characteristics.

Garrard "Zero-100" Automatic Transcription Turntable

MANUFACTURER'S SPECIFICATIONS

Speeds: Two—33⅓ and 45 RPM, each variable approx. ± 3%. **Wow:** Better than 0.10% rms. **Flutter:** Better than 0.05% rms. **Rumble:** Negligible. **Motor:** Two-sections—4-pole induction for starting torque and synchronous for constant running speed. **Pickup Arm:** Counterbalanced, with sliding weight to adjust stylus force; head pivots laterally as it tracks a record to maintain negligible tracking error; magnetic anti-skating system calibrated for both conical and elliptical styli; head adjustable for 15-deg. vertical tracking angle for either 1 or 3 records; lever-controlled lift, with viscous-damped lowering. **Power consumption:** approx. 9 watts. **Dimensions:** 14¾" w., 13¼" d., 6¾" h. **Weight:** 11½ lbs. **Price:** $189.50. Optional extras: mounting base with or without cover; record-platform extension to play six 7-in. small-hole records; record spindle adapter to play up to six records with large center holes automatically.

Incorporating practically every known plus feature in one automatic turntable, the new Garrard Zero-100 unit introduces for the first time in an automatic a zero-tracking-angle device on the arm which causes the head to maintain practically perfect tangency to the record groove at all diameters. It is well known that a minimum tracking angle is one of the desiderata in any record-playing mechanism, but on all conventional arms, the tracking angle will vary from a value of as much as +4 deg. at the outer grooves to -1 or -2 deg. somewhere between the start and the finish, then rise again to a value of perhaps +1 or +2 deg. at the innermost grooves.

Arms have been introduced that corrected this problem, but they were only for single-play turntables—never before on automatics. The importance of a near-zero tracking error is attested to by the number of such arms that have been on the market in the past and which no longer are. A little study of the problem of perfect tangency will convince anyone that a solution by the parallelogram method is possible. The principal reason the earlier "parallelogram" types were not successful is that the increased number of bearings caused too much friction. Now with the availability of improved types of free-rolling bearings, the same principle has been worked out with complete satisfaction.

A simple list of all the "Zero-100" features should serve to spotlight the changes that have been incorporated in this model of the Garrard. We will elaborate on them later on:

15-deg. vertical tracking angle adjustment.
Sliding-weight stylus-force adjustment—easy to adjust as little as one-tenth of a gram.
Magnetic anti-skating control.
Spring-loaded tonearm safety restrictor (lock).
Long-taper variable speed control.
Illuminated stroboscope, with two bands of lines, one for each speed.
Rotating manual spindle.
Proven "Synchro-Lab" motor—combination of induction and synchronous types.
Lightweight, balanced, full-diameter platter.
Safe 2-point record support.
Handsome combination of chrome, brass, and plexiglas for tonearm mounting.
Adjustments for arm lowering position, lifting height, and lifting-height restriction.

All of these features combined into one automatic turntable make news, even though some are found on other units. Only in the Zero-100 are they all put together. Taking them individually, we first come to the vertical tracking-angle adjustment. This is a simple lever which has two positions marked "M" and "A". In the "M" position, the cartridge head is set for a 15-deg. tracking angle on a single record, played Manually. In the "A" position, the cartridge is tilted slightly so it is at the proper 15-deg. angle for the third record of a stack of six, the maximum number that may be stacked on the machine.

The stylus-force adjustment is by means of a sliding weight on the arm, which is first balanced with the weight at "0" and then the weight is moved to the desired stylus force. A movement of 1⅛ in. varies the stylus force by only one gram, so an accurate setting can be made to any desired amount up to three grams or even down to one-quarter of a gram.

The anti-skating control involves no mechanical linkage to the arm. A simple slide on the fixed arm mounting serves to place a shield between a fixed magnet and one mounted on the movable gimbal which supports the arm. Separate calibrations are provided for conical and elliptical styli.

While most turntables have a lock to hold the arm on its rest, it is usually a solid one, and lifting the arm could cause damage when it is supposedly locked. On the Zero-100, the lock is sufficiently firm, yet if the arm is lifted when locked, a restraining spring gives slightly to remind you that it was locked, suggesting that you release it.

The variable-speed device on modern turntables usually employs a tapered spindle on the motor shaft against which the idler wheel is moved up or down to provide the speed change. If the taper is steep, the idler contact with the shaft can vary, causing an unwanted wow. In the new Garrard, the tapered shaft is long, with a gradual taper that ensures good contact and allows a more accurate setting of the speed. The two speeds are indicated by a built-in stroboscope—a series of lines in the usual fashion, but placed on the underside of the platter, illuminated by a neon bulb, and viewed by a series of mirrors from the top of the unit. The two bands of lines allow accurate setting for either speed. We consider a built-in strobe highly important when variable speed is offered.

The rotating manual spindle is now common on high-quality turntables and is now a part of the Garrard. The "Synchro-Lab" motor, a unit which employs both an induction section and a synchronous section, makes for the best of two worlds—quick starting, and constant speed. The platter is non-ferrous, and is

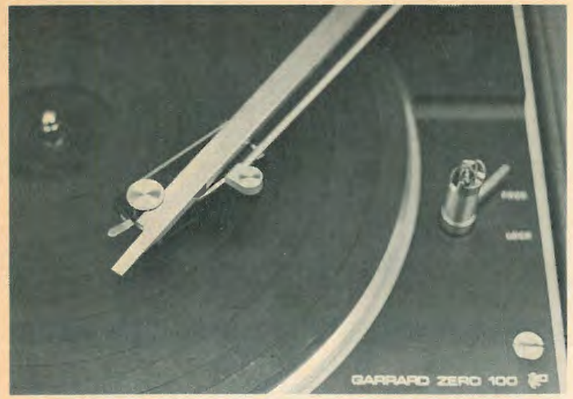


Fig. 1—When the arm is near the center grooves of the record, the angle is changed by the controlling tubular component at the right. This part is pivoted on the rear of the head and provides practically perfect tangency throughout the entire record.

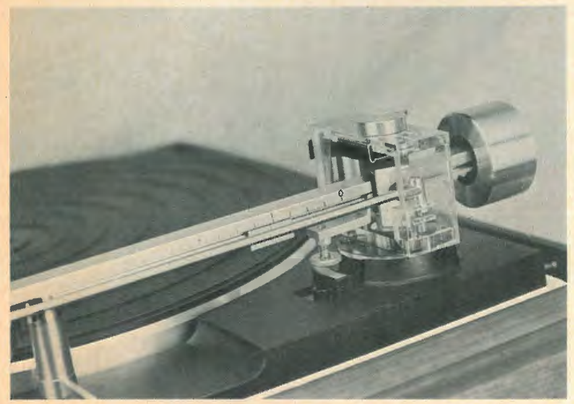


Fig. 2—The plexiglas arm-mounting structure accommodates the anti-skating magnets and the indicator for proper setting. The sliding weight under the arm moves 1⅛ in. for a change of 1 gram in stylus force. The counterweight is brass.

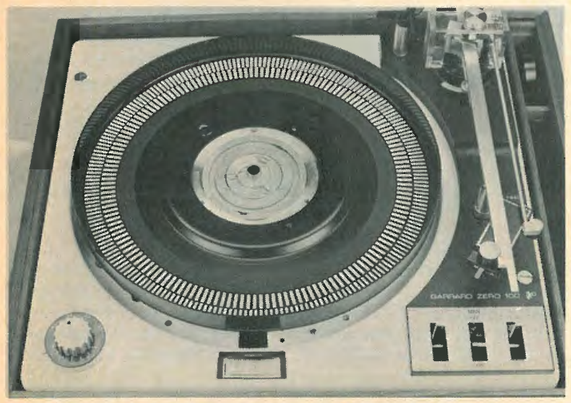


Fig. 3—With the platter removed and inverted, the two bands of stroboscope lines are seen on the underside of the platter. They are illuminated by a neon bulb and viewed through a mirror visible through the opening directly in front of the platter.

a lightweight component with a full rubber surface for the disc, providing damping needed to support the entire record surface.

In the Zero-100, Garrard retains the reliable two-point support for the stack of records. Once the stack is placed on the automatic spindle, a plastic clip steadies the stack, yet allows the bottom record to drop gently to the platter on a cushion of air.

The tonearm pivot mounting uses a gimbal for the two bearings, and it is in a strong plexiglas structure which mounts the anti-skating magnet. Another magnet is mounted on the gimbal. and a shield may be interposed variably between the two magnets to adjust the amount of compensation applied. An indicator on the shield shows the settings suggested for both conical and spherical styli, with the calibration such that the setting is made to the value of stylus force applied by means of sliding weight on the arm. The arm structure accommodates a variety of adjustments for setdown position and for lifting height, together with another to permit adjustment of the amount of lift so as to clear records remaining on the spindle.

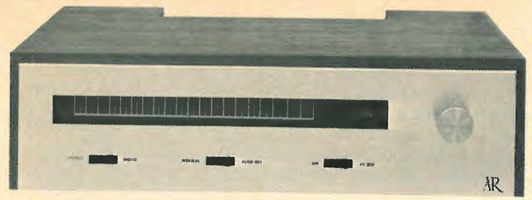
The speed control remains similar to that on the SL-95 series, in that the control has four positions—one for 45 rpm, 7-inch records, and three for 33⅓, with setdown positions for 12-, 10-, and 7-in. discs. Under the knob is the vernier speed adjustment which provides approximately 3 per cent increase or decrease in the normal speed.

The operating controls also are similar to the SL-95B—three tabs: automatic start, stop and reject; manual motor start; and cue, for lifting and lowering the arm.

Performance

The Zero-100 performed just about as we expected after reading the specifications. Wow measured .08 per cent—that is in the band from 0.5 to 6 Hz. Flutter, in the band from 6 to 250 Hz, measured .03 per cent, both of which are excellent. The variable-speed control gave a range of a little better than ±3 per cent on 33⅓ rpm, and a little less than that on 45 rpm. No change in speed was noted over a line-voltage range from 85 to 135 volts, but the expected change came when the line frequency was varied, due to the synchronous section of the drive motor.

While the skating of the arm should be much less pronounced with the near-zero tracking error, it can be shown that some skating tends to exist, but the amount is certainly less than that with conventional arms. This is probably the reason why the magnetic anti-skating feature works so well, and we could certainly see for ourselves that there is a difference in the sine wave shown on the scope when the anti-skating compensation is set properly. Similarly, using the same cartridge on a conventional arm and on the Zero-100 arm, a difference could also be observed on the scope. For all our performance measurements, we fitted a Stanton 681-EE cartridge which tracked perfectly at ½ gram, less than the pressure Stanton recommends. At 1 gram, it was less sensitive to floor vibrations, and at 1½ grams, not at all. Signal to noise ratio measured 41 dB unweighted, or with the standard "A" weighting, 56 dB, using the CBS BTR-150 broadcast test record, which also supplied the 3000-Hz signal for the wow and flutter measurements. Arm resonance was measured at just under 10 Hz, and the change cycle required only 10 seconds from the completion of the last groove on one record to the setdown on the outer grooves of the next. Thus the Garrard Zero-100 is certainly the finest in a long line of automatic turntables which have been around for over 50 years. And as usual, each new model contains improvements over its predecessors, with constant research which strives to better performance, appearance, and reliability. We think you will like it. *C.G. McP.*



Acoustic Research FM Tuner

MANUFACTURER'S SPECIFICATIONS

IHF Sensitivity: 2.0 microvolts or better. **S/N Ratio:** 65 dB. **Distortion:** Less than 0.5% IM or THD, Mono or Stereo. **Drift:** 50 kHz maximum. **Frequency Response:** 20 Hz to 15 kHz ± 1 dB, Mono or Stereo. **Capture Ratio:** 2.0 dB or less. **Selectivity:** 55 dB or more. **Image Rejection:** Better than 70 dB. **IF Rejection:** Better than 100 dB. **Spurious Response Rejection:** Better than 90 dB. **AM Suppression:** 55 dB or better. **Stereo FM Separation:** 40 dB minimum at 400 Hz, 30 dB minimum at 10 kHz, 35 dB minimum at 50 Hz. **Output level:** 1.0 volt rms for 100% modulation. **Dimensions:** (with wood cover): 15¾ in. W. x 4½ in. H. x 9⅞ in. D. (less wood cover): 15⅛in. W. x 4-5/16 in. H. x 9⅞ in. D. **Suggested Retail Selling Price:** $210.00 (optional oiled walnut cover, $15.00 additional.)

As was the case with previously reviewed AR electronic products such as their Model AU integrated amplifier and their Model AAU receiver, the new AR FM tuner seems deceptively simple on the outside, as can be observed from the front view. Frankly, we think AR may have gone a little too far in what seems to be a "cut the front frills to the bone" styling of their electronic products. The flat gold-anodized front panel has a simple unframed rectangular cutout for the dial scale area which also includes a stereo indicator light and a center-of-channel tuning meter. Three two-position rocker switches located below this area serve as MONO/STEREO, MUTE ON/OFF and POWER ON/OFF switches. To the right of the long, narrow dial scale opening is a tuning knob, coupled to an effective flywheel—and that's it.

While we are certainly against needless frills and useless controls and gadgets, the AR front panel seems so devoid of latter day component styling that we are frankly concerned that the prospective buyer, accustomed to external elegance, may pass by this fine-performing tuner. We could be wrong, of course. Many, many years ago we can remember a competitor's FM tuner that was laughingly known in the trade as the "crying tuner" (because its face looked like it was in a perpetual state of sorrow). The fact is that it sold like crazy and the owners of that then "upstart" company must have "cried all the way to the bank."

The rear panel is made of black plastic and contains a screw-terminal strip for antenna connection, a group of four output jacks (two can be fed directly to your amplifier, the other pair might be connected directly to a tape recorder input), all of which are controlled by a level control, and a fuse post. One item that perplexed us is the removable line cord. We have seen removable line cords used in connection with line-connected "hot" chassis equipment where, for the sake of consumer safety, the line cord (known to the TV trade as a cheater cord) is permanently affixed to the back cover, so that when it is removed, the line cord comes with it and the set cannot be operated in this open state. In the case of the AR tuner, however, the line cord does not come loose with removal of the cover—nor would it have to, since the AR tuner is a *perfectly safe* transformer-operated chassis, whose highest internally exposed d.c. voltage is a mere 20 volts, which couldn't even give you a tickle if it were inadvertently touched.

The output jacks are all color-coded, in keeping with AR's previous format of color coding all their input and output jacks and interconnecting cables (when supplied) to facilitate quick interconnection with other components.

An internal view of the chassis is shown in Fig. 1. Visible just below the flywheel is the sealed, imported front-end whose circuit details are not shown on the schematic diagram which accompanies the unit. All of the rest of the circuitry is contained on a single large p.c. board which occupies fully two thirds of the remaining chassis area. A 4-pole linear phase crystal filter is featured in the i.f. section, as are two RCA CA-3012 integrated circuit amplifiers. No interstage tuning adjustments are required (hence, no realignment is ever necessary), and a well balanced Foster-Seeley discriminator is used as a detector circuit. No less than 13 bi-polar transistors are used in an optimumly designed multiplex circuit, followed by a pair of emitter follower output stages, which provide an output impedance of less than 1 Kohm. Critical r.f. and i.f. stages are powered from a voltage-regulated supply.

Measurements

Important mono performance is shown graphically in Fig. 2. We measured IHF sensitivity as just a bit better than claimed—1.9 microvolts. Signal to noise was 75 dB, considerably better than the minimum guaranteed by AR. Noteworthy are the excellent limiting characteristics of the tuner (at 2 microvolts, full level audio was recovered), and the steepness of the "residual noise" curve caused a noise reduction of 50 dB below full output at a mere 3 microvolts of input signal. At 5 microvolts of input signal, noise reduction was already 60 dB—a figure deemed highly acceptable in some tuners even with a signal input of 1000 μV. Total harmonic distortion was, indeed, just a shade below 0.5% for full modulation and, since AR quoted the same figure for THD in stereo, we measured it and found it to be exactly 0.5% (not shown in the figure).

Overall stereo separation is just about the best we have ever measured. While many tuners and receivers have boasted separation figures of 40 dB at mid-band frequencies, tuners which are able to maintain at least 30 dB of separation over the entire audio range are a rarity. The AR tuner does it, with some room to spare at the low end at that. Results are shown in Fig. 3.

Capture ratio was measured at 1.8 dB, while alternate channel selectivity measured closer to 60 dB than the 55 dB minimum claimed by the manufacturer.

Listening Tests

Calibration of the AR tuner is absolutely linear, that is, the distance between each MHz along the dial scale is equal. Furthermore, markings are available at each half of a Megahertz. With such well defined calibration, accuracy of the dial pointer had better be pretty good—and it was. About the only fault we could find with the listening performance of the AR tuner is the fact that the stereo indicator light has a tendency to become

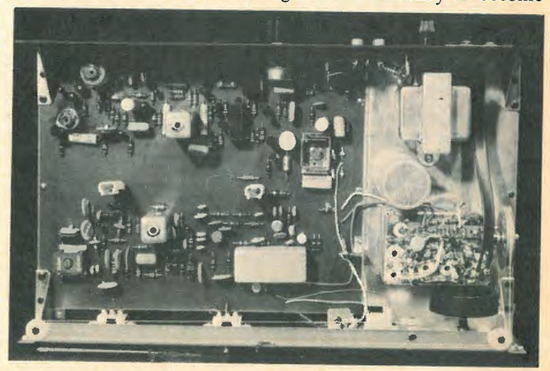


Fig. 1—Internal view of the AR FM tuner.

illuminated between stations, when interstation noise is present and the mute control defeated. Center-of-channel indication on the tuning meter was precise and corresponded exactly to best audible reception (and measured reception, as well). With the mute control on, stations below a threshold of 5 microvolts are blocked, and this is somewhat of a pity, for there were stations which were received with less than 5 microvolts of signal strength which, nevertheless, provided sufficient quieting for comfortable listening but would not come through with the mute control in the active position. While this speaks very well for the sensitivity of the tuner, we rather wish that a tuner in this price class had provided a customer muting threshold adjustment so that one might have quiet between stations *and* weaker station reception at the same time.

As for station statistics, this one really pulled them in—58 *usable* signals in our metropolitan New York suburban location, with 38 of them in stereo. We do use an outdoor, multi-element rotatable antenna in all our tests, however. There was no evidence of adjacent channel interference nor could we encounter any conditions akin to overload distortion. Interestingly, with the mute control active, the number of stations received was reduced to 47, which means that 11 of the previously acceptably received stations were coming in with signal strength of *less than five microvolts.*

While we may differ with AR's styling philosophy, we certainly can't dispute the fact that they have come up with a tuner that does just about everything a good FM tuner should do, and if $210.00 is about what you've set aside for the FM tuner portion of your separate components system, you would do well to audition this new entry from Acoustic Research. If nothing else, it confirms the old saw about "not judging a book by its—dress panel." *L.F.*

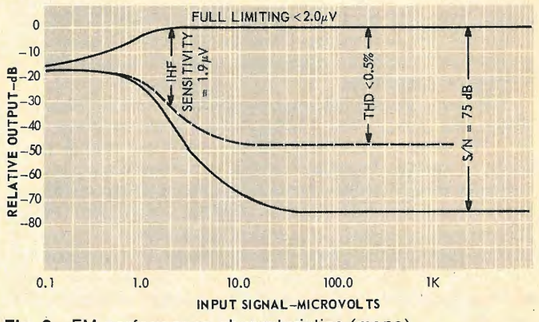


Fig. 2—FM performance characteristics (mono).

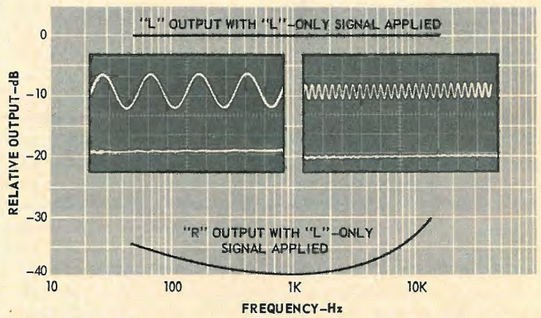


Fig. 3—Stereo FM separation characteristics. Inset photos show left and right output signals at 100 Hz and 10 KHz with left signal only applied. Upper trace is left output.

Check No. 52 on Reader Service Card

Realistic Music/ Sound Level Meter

MANUFACTURER'S SPECIFICATIONS Range: 60 to 116 dB in 5 ranges. **Accuracy:** ± 2 dB at 114 dB sound pressure, referred to 0 dB = .002 dynes per square cm. **Meter Ballistic Characteristics:** Fast to ASA standards, slow for average levels. **Output Jack Voltage:** 1 volt min. @ 1 kHz, with response of 40 to 14,000 Hz ± 2 dB, with less than 2% distortion at 1 kHz, 0.5 volt output, fed into a load of 10 Kilohm minimum. **Battery:** 9 volt (Realistic type 23-469). **Microphone:** Dynamic, monodirectional, becoming slightly directional with increase in frequency. Diameter and depth similar to Western Electric type 640AA. **Price:** $39.95.

Here's a really handy gadget which, at toy prices, fulfills a longstanding need for a sound level meter for amateur use. This product of Allied/Radio Shack, manufactured in Japan, really works like its informative booklet says it should. At $39.95, it ought to find a home in every audiophile's and musician's bag of useful accessories.

The main reason that the sound level meter is not widely used by amateurs is that it has been too expensive to buy. Even the least expensive sound level meter which meets applicable USASI standards costs $200.00. It evidently costs money to make an instrument stable, reliable, rugged, and accurate. What no one thought of—until now—was to reduce the capabilities of the standard sound level meter and make one without pretense to precision and stability, a handy-dandy, cheap (inexpensive isn't the word) little gadget for everyone to play with to his heart's content. The funny thing is that except for dynamic range and of course price, this one is not very far from the big, expensive models.

A word about range. Most sound level meters work from around 50 to 140 dB SPL and one can understand why it is expensive to provide accurate, low noise, distortionless, repeatable wide frequency ranges through a 90 dB dynamic spectrum. The Realistic Music/Sound Level Meter's lowest range is labelled 70 dB and the meter's scale markings are such that one can read down 10 dB from that, as well as 6 dB up from "0" on each scale. On the uppermost, the 110 dB range, then, we can measure as high as 116 dB. Unless one needs to measure the noise of a jet engine, this upper limit is high enough and the 56 dB dynamic spectrum is wide enough in covering the main range of interest to hobbyists wanting to know how loud their system or instrument is playing.

Besides the five position range switch, or attenuator, the unit has a five position mode selector switch which turns it on and off, enables the meter to read its battery voltage and selects between fast and slow meter response. The FAST position enables the meter needle to follow dynamics pretty much like a VU meter while the slow position damps the pointer's motion, averaging out most fluctuations and making for easier reading.

The instrument's case is made of high impact plastic and is light and comfortable to hold. The 1" dynamic microphone is built into the nosecone, while the entire electronics assembly is built onto a small, demountable sub-chassis.

To use the meter, one sets the selector to FAST or SLOW mode, sets the SPL range and points the microphone at the sound source. The indicating meter is set in at the unit's rear, to be seen in conjunction with the range switch. Either hand or both hands may be used for operation. The battery used is an inexpensive 9 V transistor radio type, easily replaced from underneath, without disassembling the unit. A recessed calibration screw is provided at the side, as is an RCA type phono jack which can be used to connect the unit's output to an oscilloscope or recorder. In fact, the sound level meter can be used as a regular microphone by connecting its output to the high level input of a sound system's preamp mixer or tape recorder. Unfortunately, it is missing a threaded stand mount for this application, so it must be either hand held or rested on some shock absorbent material like foam rubber. Also, it doesn't have a pop filter, so don't use it for close-up singing.

One good application of this instrument is to measure the loudness of the sound produced by the speakers in your room. In comparing speakers, amplifiers, or phono cartridges which all have different efficiencies, it is essential to keep the loudness constant and this unit will indicate that level to you. It ought to be used by all dealers when they switch between components during demonstrations. If you take one of these meters to a concert and measure the sound pressure level put out by a live orchestra, then come back to your home and play a similar recording at the same level, you're in for a surprise and might learn something.

By taking the meter to a local discotheque, you might really find out whether the sound levels there are dangerous to hearing. You won't be able to quantitatively evaluate the nature of noise because of the instrument's limited range and accuracy. If you do that chore, first save lots of money and then get yourself one of the Scott, General Radio, B & K or Hewlett Packard units made for that purpose.

In testing the Realistic meter, we used pink noise and music as sources and compared readings with a calibrated General Radio type 1565A sound level meter. The Realistic fell well within its specified accuracy and stayed within 2 dB of the G.R.'s C scale throughout its range.

In use it was more difficult to read than the G.R. and its ballistics were not as positive as the taut band meter movement of the more expensive unit. Considering the 1-to-15 cost ratio between them and the intended application, it worked just fine.

Frequency response of the microphone and electronics was pretty flat out to 10 kHz, then began rolling off. That's okay because most acoustic energy in music as well as in noise is below 10 kHz. Besides all sound level meters using 1 in. microphones roll off at 10 kHz. Distortion of the meter's output signal was 2% and judged high for instrumentation or even microphone use but acceptable for use as a relative indicator of level in recording. It's about time someone made this gadget. Go out and get one right away! *A.R.*

Check No. 51 on Reader Service Card

ADDENDA

Tuners and Receivers Directory

H. H. Scott, Inc. informs us that we were inadvertently supplied with incorrect prices for two receivers. The 342-C should have been priced at $269.95; the 382-C, $299.95.

Sony Corp. notes that the current price for the ST-6055 receiver is $299.50, while the ST-5000F tuner has been reduced in price from $499.50 to $399.50.

Country Comes to the City

Don Altobell

NOT SINCE the din of rock 'n roll first jarred the senses back in the mid-fifties has any style of music captivated so many people as country music has now.

And today, country music is appreciated by persons in all walks of life throughout all of the United States and the world. There are, for example, currently three network TV shows featuring country artists; approximately 600 local radio stations devoting all or a major part of their programming to country; and the number of live country shows around the nation is steadily growing. (In Philadelphia, for example, attendance at the four-or-five times a year *Country Shindig* featuring a half dozen or so country artists, has more than tripled in the past five years since its inception.)

But it is in the sale of phonograph records and tapes by country singers that the growing popularity of C & W, as it is known, is most evident. One well informed source in the music business estimates that a billion-and-a-half dollars worth of country records were sold in 1970.

Of course, there have always been records by country singers. The first that really sold was Vernon Dahlart's "Prisoner's Song" (now known as "If I Had the Wings of an Angel") way back in the early twenties. (Dahlart made more than $1 million in royalties.) This and other successful *"hillbilly"* recordings prompted the Victor Talking Machine Co. to send a representative down to the mountain country of Bristol, Tenn. to scout local talent.

The rep placed an ad in the local paper offering auditions with the promise of a Victor recording contract. One of the respondents was a young fellow named Jimmie Rodgers. Rodgers won an audition and was brought up to Camden, N.J. to record his unique *blue yodel* style. This was so totally different from the Charleston and other Roaring Twenties music that it caught on and Rodgers found himself nationally known.

In the few years before he died in 1933, Rodgers etched his style and himself so deeply into country music that he has become the model for all country singers. Speaking of him, Johnny Cash said, "Almost every country singer has taken something from Jimmie Rodgers."

It was records and radio that first brought country out of the South where it started back in the late 1800's. Radio was a major force as people, fascinated by powerful sets, stayed awake late into the early morning trying to get distant stations.

Two they picked up were Atlanta's WSB, the first to feature country back in 1922, and Nashville's WSM. One of WSM's programs started in 1925 and is still broadcast today nearly a half century later. The *Grand Ole Opry* has four shows weekly, and one is broadcast and heard in part of each of the 50 states. To fans, the Opry is somewhat of an institution, and many of them travel as far as 500 miles to attend; to performers, it is the epitome, like Yankee Stadium for baseball players, the Met for opera singers.

The Opry is an example of why radio has been called the lifeblood of country music. Radio is where fans first hear the records they may later buy and where the careers of performers are fed by exposure to others who don't buy.

Station WRCP in Philadelphia is a prime example of a full time country station in a metropolitan city. It shows what country music can do to revitalize a station which otherwise just played "good music," but was a nonentity among other Philly stations. When they went country in 1967, WRCP began to reach that segment of country music fans in Philadelphia who'd previously had to listen to out-of-town stations. As country became generally more popular, this segment grew. Today, WRCP still reaches only a particular portion of the total Philadelphia radio audience, but that portion is steadily growing and the station is clearly in the black.

Of course, during World War II and since, the military has done much to spread the country sound. Fellows from the North who took their basic training in the South were exposed to it; Southerners who worked in Northern defense plants brought it up with them via records and the Opry.

Still another reason why country music is now better accepted in big cities is the change in the music itself. People don't call it *"hillbilly"* so much now because even while retaining its pure country flavor, most of it has been refined so that people everywhere can appreciate and enjoy it.

Probably the major contributor to this urbanization of country music has been Eddy Arnold. They still call him the Tennessee Ploughboy, but for more than 25 years now, Eddy has worn a tuxedo and violins accompany his guitar. Arnold has always been *class;* a smooth singer, a polished performer. To date, he has sold more records than any other country singer, with 75 in the Top 10 of their particular day.

Country "purists" say Arnold has sold out and isn't "real country" anymore. But even with all his polish, Eddy's Tennesseean upbringing is still more than evident in the feeling he brings to the music he sings.

The big noise in the music of the late fifties was just that: *noise.* And while rock 'n roll was stampeding over the good and the musical in music, it both hurt and was helped by country.

Rock *hurt* country in the minds of many who grew up in the midst of the baby boom; rock and country were both simply pop music before being split into separate camps. The tunes produced under the loose association were known as *rockabilly* and gave many people a wrong introduction to country and left a bad taste. At the same time, country helped perpetuate the monster by lending it the man who was its standard bearer. Many people don't realize that Elvis Presley was first and is now again a country singer. (Of course in the meantime, Elvis has made several millions of dollars and probably couldn't care less!)

Other country singers who were first introduced to large numbers of persons via rock vehicles include Jerry Lee Lewis, the Everly Brothers, and Conway Twitty. Because of their rock popularity in the fifties, they're now remembered as performers of primitive rock and not the fine country singers they are. Shame.

In the sixties, at the same time rock evolved, after a dreadful cacophonous eight years, into a mature and more musical state, better country gained a more general acceptance as well. This was in part, I believe, a substitute for straight pop. Because with fewer good pop songs being written, pop singers began recording good country. Singers like Dean Martin, Al Martino, and even Frank Sinatra did country with good success. At the same time, some country singers and songs were also more widely accepted.

Today, of course, there are Johnny Cash and Glenn Campbell. Both have weekly network TV shows; both are great favorites across the nation. Of the two, Cash is more highly respected by country listeners because of his background and the railroad and workingman songs he sings. Campbell, younger and a bit more polished in his own boyish, wholesome way, has more young fans. But country he is, and an accomplished guitarist, too.

Besides these "giants," there are hundreds more country singers. And many, if not *most,* of them write their own songs. All with that same deep-in-your-gut honesty that makes you hold your head high with pride, wrench your fist at injustice, brush a tear from your eye, or smile at genuine humor.

And this honesty is perhaps the essence of country music's popularity with the young people who listen to it. Their quest for truth leads them to country, and some of the progressive rock stars are recording a kind of *country rock,* that could develop into still another form of music. (The Grateful Dead, The Band, The Byrds, and James Taylor are working in this direction, and Bob Dylan has recorded with Johnny Cash.)

Country lyrics are basic in their narrative; they are everyman's story: love gained, love lost; God; mother; country. They are without sham, pretense or exaggeration. Another reason why people can closely identify with the songs is that the singers, with some vocal shortcomings, sing more like the guy or gal next door than like Steve Lawrence or Eydie Gorme. (Even with their tremendous feeling, Steve and Eydie *sing so well,* that they are clearly professional singers.)

And as you otherwise non-country folks look for music to identify with and get really close to, try country. It *grows on you!* If you listen with an open mind (and open ears!), I think you'll enjoy it.

Start with Eddy Arnold then move on to Johnny Cash and Charlie Pride. You're on your way! AE

Introductory Country Music Discography

Eddy Arnold	Portrait of my Woman	RCA Vic. LSP-3709
Chet Atkins & Hank Snow	By Special Request	RCA Vic. LSP-4254
Bobby Bare	Where Have All the Seasons Gone	Mercury SR-61316
Johnny Cash	The Johnny Cash Show	Col. KC-30100
Merle Haggard	Tribute of the Best Damn Fiddle Player	Capitol ST-638
David Huston	Wonders of the Wine	Epic E-30108
Loretta Lynn	Coal Miner's Daughter	Decca DL-75253
Elvis Presley	Elvis Country	RCA Vic. LSP-4460
Charlie Pride	From Me to You	RCA Vic. LSP-4468
Jim Reeves	Yours Sincerely	RCA Vic. LSP-3709
Marty Robbins	El Paso	Har. KH-30316
Statler Brothers	Bed of Roses	Mercury SR-61317
Porter Wagoner & Dolly Parton	Two of a Kind	RCA Vic. LSP-4490
Tammy Wynette	Greatest Hits	Epic BN-26486

Classical Record Reviews

EDWARD TATNALL CANBY

The Philadelphia Goes to Town

Mendelssohn: Elijah. Marsh, Verrett, Lewis, Krause; Singing City Choirs, Columbus Boy Choir, Philadelphia Orch., Ormandy. **RCA LSC 6190** (3 discs) stereo ($17.94).

Mahler: Symphony No. 2 ("Resurrection"). Mandac, Finnila; Singing City Choirs, Philadelphia Orch., Ormandy. **RCA LSC 7066** (2 discs), stereo, ($11.96).

Since its return to RCA, the Philadelphia-Ormandy forces have been showing a definite yen for monumentality. The results are generally useful. For such big pieces, an orchestra that plays with the Philadelphia's finesse and polish is particularly desirable, and so is the full rounding-out of personnel on the largest scale, which these works require, and don't always get. Ormandy's "augmented" forces, moreover, are given a definitely American sound by the use of U.S. choral forces. The Singing City singers (led by one of those indomitable lady conductors whose energy seems always more buoyant than any conceivable male competitor) perform with irrepressible verve if not always with subtlety. Ormandy, ever the suave musical politician, recruits them from the local scene to spell the Temple University Choirs, also local.

For the American church choir and the church musical audience, "Elijah" is one of the traditional be-all-and-end-alls, right up in the "Messiah" bracket. For those who listen to oratorio as part of the wider musical scene, "Elijah" is pretty hard to take today with its (for us) watery harmonies, weak grandiloquence and oversized dimensions. It is the essence of "Victorianism" and, as such, back when Queen V. herself was a young queen (1847), it rates surely as a fine work—according to the demands of the time, when Bigness was still new and Romanticism freshly flowered. Today, most of us (including us non-musical dopes) are too sophisticated for all that. And we don't much like the diluted Bach sound which so entranced Mendelssohn's listeners. (He was the man who "rediscovered" the big Bach choral works).

For these reasons, the Ormandy "Elijah" should hit the jackpot. It isn't sophisticated, it isn't highbrow; it is no more than it ought to be, which is accurate, well played and sung, and unfailingly enthusiastic, to no matter what length. Those who go for "Elijah" should find it just what they're looking for, a model performance to inspire a hundred others and make them a bit better.

As for Mahler, sophistication is very much needed though of a special musical sort, for Mahler's still-youthful concept of the gigantic spectacle has its own problems in believability. The way out of Mahler is always musical—he is a greater composer than philosopher—and here the Ormandy-augmented forces are uneven. Mahler requires dedication, almost fanatical, as from a Bruno Walter or an Otto Klemperer. Ormandy is not the man for that sort of intensity. The first huge movement, thus, seems to me to flounder for sheer lack of voltage and the second, where the Viennese-style waltz rhythms begin, is too much of a divertimento (though a lovely slow waltz) and lacks that passionate undertone of tragedy which is surely implied in the score. Too bland. But when the voices begin, the indefatigable Singing City people and the excellent solo voices, soprano Evelyn Mandac and contralto Birgit Finnila, the vast musical machine begins to find its proper strength. By the end, I was moved and gratified.

Performances: B+, B Sound: B+

César Franck: Organ Works/Volume Two. Jeanne Demessieux, Organ at the Madeleine, Paris. **London Treasury STS 15104,** stereo, $2.98.

Lady organists abound and most of them are, shall we say, tough babies—you have to be to manage all that machinery, with both hands and the feet. This French organist, who died at a lamentably early age (a mere 47), was really great, a profound interpreter and, as evidenced by this series, particularly understanding of her great countryman Franck's music, out of the 19th century—at the top of the Romantic school and a zillion miles from the Baroque and all such frippery. Here, she plays Franck on one of those purebred French Romantic organs that abound in Paris, mainly put together by the great Cavaillé-Coll, who built Franck's organs. And the lady has got old Papa Franck down for a fare-thee-well.

He isn't easy for us moderns, and for modern organists—his music is so moody, so devotional, so at-length (I did *not* say long-winded!) with such enormous climaxes of roaring noise, such endless whisperings of near-total silence, that it takes a big, imaginative, even a one-track mind, to cope with the style and produce the performance. This one does it to perfection. Never heard it so good.

In an unobtrusive way this is a splendid test record for your rig. It's not the loud climaxes that do the testing but the very quiet segments in which extremely low pedal tones play against mild counterpoint in the upperworks. The kind that shake the cathedral—and generate incredible IM. If you can play *this* stuff, you're OK, your system has no problems. Just try the beginning of Side 1, for one example among many.

Performance: A Sound: B

Introducing 8 Cellisti. Works by Casals, Ehrlich, Linn, Vivaldi; Jerome Kessler, conductor. Orion ORS 7037 stereo ($5.98).

If you are a cellist, the implication is, you live, eat, dream, play cello from one day to the next. And you *record* cello.

That, apparently, is what these eight excellent cellists do. The music they play is without any question of great interest to other *cellisti.* Not being a cellist myself, I must ask the inevitable question, what's in it for me? (Not to mention for you.) The answer in this case is, I think, quite a bit. Especially if you like cello music. But maybe not enough to warrant acquisition of the platter.

Just the mere fact of cellists playing nothing but celli is not enough to hold a recording together. If a cello is a work of art, and if these pieces of music are the same, then a recording in a sense is also an art work and must have its own unity and diversity for the consumer.

I enjoyed the two items by veteran Pablo Casals, one of them a sardana—he wrote many of these—a fixed-up art version of the Catalan national dance music, sort of a suite of semi-pictorial tunes all in a row, done up in the style of about a century ago. This one has a wierd dissonant episode, as though two orchestras were playing two different pieces or somebody's radio music were interfering. Just program stuff, depicting a human pyramid (it says). The other Casals is a melodious fugue, somewhere between Brahms and Henry Purcell, taken from a Casals Christmas oratorio. Nice. But in between these is a modern work, with a wispy 12-tone start and finish around an academic dry-jazz middle (Robert Linn) which doesn't mix well at all. More modern; a rather well-written set of six serial pieces by Jesse Ehrlich. They're old-fashioned by the latest standards but modern even so. They fill up much of side two and set off the Robert Linn nicely, though it puts Casals out of joint.

To conclude, there is the inevitable arrangement, the Vivaldi Concerto Op. 3, No. 11 of *L'Estro armonico,* originally for violin and string orchestra. The eight celli play it with verve (and about five times the speed old Casals might have tackled it) but if you ask me, the original is much more interesting, given a halfway decent performance. (I miss the continuo with harpsichord, the solo fiddle, the string orchestra, and I miss the proper contrast between solo and the orchestral *tutti.)*

Now, to conclude, if I were in a roomful of performing cellists, I'd

certainly enjoy this particular arrangement, just for the fun of it, on the spot. But instead, I am in a roomful of records, and the catalog in front of me lists roughly 196 Vivaldi offerings of concerti, including three versions of the complete *L'Estro armonico* and umpteen of this particular work. What's more, I don't like the jolting shift from contemporary music by Jesse Ehrlich to Vivaldi-Varga (Varga did the arranging).

That's my view of this particular recorded art work, for what my view is worth. If you are a cellist, of course, there's no argument at all; go out and get it.

Performances: B Sound: B

Bartók: Piano Concerto # 2; Four Pieces for Orchestra (1912). Alexis Weissenberg; Philadelphia Orchestra, Ormandy. **RCA LSC 3159,** stereo, ($5.98).

A recording debut for the little-known "Four Pieces" of Bartók, and an interesting event for all who know a bit of this dynamic Hungarian.

Bartok's style underwent a radical changeover after a kind of crisis (cf. Rachmaninoff) in which the composer simply stopped work altogether for a considerable time beginning in 1912—he did not touch the orchestra again until 1923. The earlier music is intensely Romantic-Impressionist, as in the early String Quartet music, "Bluebeard's Castle," "The Miraculous Mandarin." Today, the later and much more dissonant-dynamic Bartók is easier for most ears and more typical of the composer's strength, notably in the fiercely joyous music for chamber ensembles with percussion and in the piano concerti and the well known Concerto for Orchestra.

The "Four Pieces," nominally the last of the older-style works, was not even performed for a long 10 years, during which the new-type works had already had an explosive impact. Recorded here for the first time, the score turns out to be gratifyingly forward-looking, already clearly suggesting the later Bartók. Superb orchestral color, plenty of typically jagged rhythms, easily digested themes of folk-like quality, make this music a pleasure to discover.

There's no judging Ormandy's performance since this recording is unique; but the Piano Concerto No. 2 has been played often enough and I find this version not very satisfactory. Somehow it slurs over and misses many of the niceties of the work, most notably the Bach-like "Baroque" quality of the outer movements, featuring superb brass writing. But the record is worth acquiring for the second side alone, the "Four Pieces."

Performances: B-, B Sound: B

György Ligeti: Adventures; New Adventures: Atmosphères; Volumina. Asst. soloists, Chamber Ens. of Darmstadt, Southwest German Radio Orch., Baden-Baden, Karl-Erik Welin, organ. **Heliodor Presents Wergo 2549 003,** stereo, $4.98.

Heave above! H - - - below! Lord A'Mighty! If you'd like to know what real avant-garde is like, just try this.

You know, I've always figured that a true revolutionary, like Edgard Varèse or John Cage, must have enormous imagination—because he has to think up new ideas and most people just don't know how, even if they want to. They just come out with the same old thoughts or language or what-have-you, the way you say to a friend "Whatcha doin'?" because you can't think of anything better to say. (The answer is, of course, "Nuttin!" If he *had* been doing anything, the question wouldn't have been asked.) So here, my friends, is the ultimate. So far.

Just take (for "Adventures") three singers and seven conventional instruments, soprano, alto, baritone and chamber ensemble. Then write something **NEW** for the combination. How new? What? I'm tempted not to say—you should get this disc for yourself and try it on a party of friends, preferably talking and full of cocktails or highballs. The "music" will just join in, as naturally as you can imagine, until the soprano begins to strangle and the bass to gargle and whoop and the alto to let out blood-curdling screams, etc. It builds, it really builds.

Then there's "Atmosphères" for Large Orchestra Without Percussion. Everybody plays at once in the most gut-rendingly squalling dissonance you have *ever* heard. Takes real skill, and I mean it. And the organ—a piece to see what could be done with its clumsy mechanical nature (as if nobody had tried before . . .). Well, the player uses hands and feet all right, but more the flat of the arm than the hand, and the feet must be sidewise. Great gasps and squalls of horrendous sound—amazing.

The man is good. He's good if only because of the sheer originality of his approach. And the record is a party-stopper any time. Do NOT miss it. Get it IMMEDIATELY.

Performances: *Magnifique!* Sound: A-

Canby's Capsules...

TITLE	CONTENT	SOUND
Romantic		
Brahms: Piano Concerti Nos. 1 and 2. Artur Rubinstein; Boston Symph., Leinsdorf; RCA Symph., Krips. **RCA VCA 7071,** (2 discs), ($13.96).	You can have Horowitz—all the young Romantic pianists! Rubinstein is unique. An utterly right Brahms, dramatic, but economical and beautifully shaped with perfect technique. There's nobody left like him; it'll soon be a lost art.	Two dif. orchestras, conductors, locations. What *is* the "RCA" with Krips? It does the best, in Concerto #2. The BSO under Liensdorf has bigger, fuller sound but isn't as fully cooperative with the piano. Top piano sound in both—the same piano.
Tchaikovsky: Piano Concerto No. 1. Ivan Davis; Royal Philharmonic, Henry Lewis. **London Phase 4 SPX 21056,** stereo, ($5.98).	Davis is solidly youthful, muscular, powerful but not too exciting—maybe this piece is too much old-stuff competition music? Henry Lewis, black conductor, does excellent job with orchestra.	Vast piano, technically impeccable, outbalances the orch. and so intended. Nice as piano sound but not good for the music as a whole. Orch. is Phase-4-close, but kept down.
Music of Liadov. U.S.S.R. Symph. Orch., Svetlanov. **Melodiya/Angel SR 40159,** stereo, ($5.98).	Includes "The Enchanted Lake" and "Snuff Box," ultra-familiar, plus lengthy program of seldom heard tone poems, etc. It all adds up to a lot of rather dated late Romanticism, thin music, colorfully orchestrated.	The big, fat Russian recorded sound does its best for this colorful but not very meaty orchestral music. The higher your fi, the better you'll like it.
Koussevitsky: Concerto for Double Bass (1902). Gary Karr; Oslo Philharm., Antonini. **Bloch: Sinfonia Breve.** Minneapolis Symph., Dorati. **CRI SD 248,** stereo, ($5.98).	Koussevitsky's one claim to fame (aside from 41 years conducting)—a late Romantic humdinger, outrageous steal from Grieg with trimmings! Sort of nice. The Bloch was commissioned by Koussevitsky Foundation, hence presence here. *Not* a good reason.	The Oslo sound is respectably hi fi and mellow; nice balance between nasal double bass and the orch. The Bloch, a long post-Romantic screamer, is ex-Mercury job, poor acoustics, deadish, recorded close. Horrible mixture with the concerto—play 'em on different days.
Grieg: Peer Gynt Suite. London Symph., Stanley Black. **London Phase 4 SPC 21046,** stereo, ($5.98).	Never can tell! Ostensibly a semi-pops, a Montivani-Camerata-Mancini sort of disc, this turns out to be very well and delicately played, with real love and care. It communicates. Nice.	"Thousand and one strings" sound, in a vast skating rink space, the close-up Phase 4 separation nicely mellowed. It's good for the music—which, after all, is ancestor of Montivani, et. al. and a trace corny in its own right. So why not?
Imperial Band Concert. Nineteenth Century Waltzes & Marches. U.S.S.R. Defense Ministry Band, Nazarov, Sergeyev. **Melodiya/Angel SR 40161,** stereo, ($5.98).	This is a nice idea—old-fashioned Russian band music—more like Strauss than Sousa, very mild mostly.	Bad planning—all waltzes on one side, marches on the other—gets monotonous. They could have mixed them up. Big arena sound both sides. Waltzes come off best.
The Guitar and I. My Early Years in Grenada and Cordoba. Plus Exercises for Developing Technique and 12 Studies by Coste, Sor and Giuliani. Segovia. **Decca DL 710179,** stereo, ($5.98).	Phew! After umpteen doz. solo records, 'way back into the 78 rpm days, Segovia does a blockbuster—at least for worshippers of Segovia. The Story of His Life, in broken but very understandable English. Gently Romantic, a Spanish Horatio Alger tale, in the olden tradition—up from nothing by sheer hard work, etc.; but nice. The exercises show the old man hasn't lost any finger dexterity. Far from it!	
Let Me Touch You. The Bob Crewe Generation. **CGC 1000,** stereo, ($5.98).	This well played but routine set of smooth pop arrangements has a special aspect—it is cut for the Electro-Voice Stereo-4 Decoding system. Also some others on this label. Increasingly there are discs via other quadraphonic code-decode systems on various small labels. All are compatible, 4-2-1.	
Electronic Music from Razor Blades to Moog. Produced & composed by J. D. Robb. **Asch AHS 3438,** stereo, ($5.98).	Last I heard of Asche Records was about 1947, on 78s. (Asche, Disc, Union, et. al. became Folkways for LP.) An energetic individualist, ancient of days (at least for Moog!), did these. The first is a piece of an opera by him, backwards. I played it on an old AR table—backwards. Rest purely electronic. Mostly a bit old fashioned, these items, in lowish fi and minus sharp color, percussive bleeps, etc. of newer synth. and computer music.	

(Continued from page 32)

total harmonic distortion for applications where this is important. An oscilloscope is useful here. The essential requirement is to have the peak clipping voltage of the nonlinear network (measured with R13 and R14 disconnected) equal to 64% of the peak triangle voltage (measured ahead of the 1K attenuator resistor). If it is not, the triangle itself must be adjusted in amplitude at R6. With this set, acceptable waves will be generated with a total harmonic distortion (THD) of about 1%. Further improvement in the THD can be achieved by trimming R13 and R14 for minimum THD as read on a distortion meter; in this way a distortion of 0.7 to 0.8% can be reached. Although this is inadequate for amplifier THD measurements, the waveform is sufficiently sinusoidal for intermodulation and frequency response measurements, particularly when the extreme amplitude stability of the waveform is taken into account.

The remaining circuit details are given in Fig. 2. Separate level controls and outputs are shown for the square wave and the triangle wave inherently produced by the oscillator. These are useful for transient testing and risetime measurements, and for checking the linearity of wideband amplifiers. The simultaneous output feature is desirable for such tasks as oscilloscope triggering and frequency counting while making low level sinewave amplifier measurements. The required ± 15 volt d.c. power is obtained from a conventional unregulated transformer rectifier supply.

Many modifications and adaptations of this design are possible. For example, the oscillator's frequency range may be compressed to 1 kHz or extended to 50 kHz by the simple expedient of substituting a different integrating capacitor. Another possible use for this circuit (which is, in essence, a highly linear voltage-to-frequency converter) is to permit digital voltage measurements to be made with an ordinary frequency counter. The unknown 0 to +10 volt d.c. signal is applied to A1's input, and the resulting oscillator frequency is digitally counted. Larger input signals can be accommodated with an attenuator. In conclusion, the present design is an inexpensive and versatile instrument which can simplify many kinds of audio measurements. Æ

Reference

1. Norman Crowhurst, "The Function Generator," AUDIO, Vol. 54, No. 11, Nov., 1970, p. 22.

Weingarten Looks At...

franklin mathis et al.

MESSAGES, a show biz wit once said, should be delivered only by Western Union. But video's shining light in the field of children's programming, "Sesame Street," proves that the joke is not only unfunny but untrue.

THE YEAR OF ROOSEVELT FRANKLIN (C 30387), a Columbia recording that spotlights many of the characters from the show, directs its messages to tots—but a lot of adults should listen too, if only to be reminded of things that should not have been forgotten or ignored.

For instance, the idea of not giving up against difficult odds is pushed via "Keep on Trying," a tune that showcases Franklin's sister Mary Frances, who tells their brother Baby Ray why it's important not to be a quitter.

The album, with 12 cuts, stars the voices of Matt Robinson and Rosalind Cash. Robinson penned all the lyrics, and helped Joe Raposa compose the music.

Each of the tunes is cute, informative and entertaining—all at once. The music, furthermore, is so catchy it's virtually impossible for a listener, child or adult, not to tap his toes. The emphasis is on contemporary style, peppered heavily with soul.

"Halfies," however, is a pleasant exception, with the character of A.B. Cito, a friend of the Franklins, telling of the joys of sharing, backed by Latin rhythms that excite the eardrums.

More messages are contained in "Just Because," which explains why an individual shouldn't hurt other persons but rather try to get to know those who are different; "The Skin I'm In," on which Baby Ray tells of pride in being black and indicates that skin color shouldn't be a negative value; "A Bear Eats Bear Food," which contends that every living thing is different and thus has different needs, and "Me and You," on which puppet Roosevelt and Mary Frances tell of helping one another, making life easier because of their action, and stress cooperation instead of competition.

And "Old King Midas" is a brief musical version of the folk tale, the message, of course, being one against greed.

As with most of the "Sesame Street" offshoots, this disc teaches fundamentals as well as ethics. For instance, "Roosevelt Franklin Counts," the first tune and the one that introduces the characters, instructs the toddlers in counting from one to 10, the music rocking all the while. "Days of the Week," another rocker, teaches the days, while "Moblity Mosely's Months," still another upbeat tune, lists the months. "Roosevelt Franklin's Alphabet," also a swingin' song, features Roosevelt and his mother exchanging data from A to Z. And the last song, "The Safety Boy Blues," explains traffic rules and the dangers found in the streets.

* * *

Jimi Hendrix is dead, killed by drugs. His music, however, lives long after—and, in fact, is better known now than during his lifetime, probably because of the curiosity of those in the mainstream.

The renewed interest has resulted in a re-release, on the T-Neck/Buddah label, **IN THE BEGINNING. . .** (TNS 3007), on which Hendrix takes second billing to The Isley Brothers.

There are eight cuts, two of which are broken into two sections each, all of which were penned by the Bros. Isley.

Hendrix's guitar roots are clearly evident, and so is his verve. And there's soul galore on these tracks originally recorded in the mid-60's.

* * *

Nicholas Lampe has an excellent folkish voice, and he puts it to good use on **IT HAPPENED LONG AGO** (SD9038), a Cotillion recording showcasing 10 of his own songs.

Lampe, who plays guitar, performs in the folk-rock idiom basically, but his tunes range from ballads to electric rock.

The disc is a find for those who seek upcoming stars, for those who enjoy good music (intertwined with interesting lyrics), for those who want a piece of the future today.

* * *

The most ballyhooed song of the year is, unfortunately, blandness personified—the title tune from the movie, **"LOVE STORY."** Although the book and subsequent film have merit, at least on a gut-reaction level (some would call it schmaltz), the song that became a hit as a by-product has little. The lyrics are awkward and insipid, the music banal.

Still, the public cries for it, by performer after performer, another of our mass media zonks.

A new album by Johnny Mathis, for instance, features the ditty as the lead item, and, naturally, utilizes its commercial value by copying the tune's title as the LP's. But even Mathis' unique brand of vocalizing can't instill enough life to make it really worth hearing.

There are, however, 10 other cuts on the Columbia vinyl (C-30499) that can evoke a pleasant response from the audiophile. "Rose Garden," for example, carries a zesty sound that many will prefer to the volume offered by Lynn Anderson (despite the fact that Mathis sounds somewhat nasal).

And "Ten Times Forever More" is a typical old-fashioned Mathis specialty, a ballad that seems as if it were cut in the '50's. Ditto "It's Impossible," the Perry Como smash. But the best number is "We've Only Just Begun," on which the chorus adds a tangible yet fleeting additive that gives the song second-time-around chartbusting qualities.

Don't overlook, however, "What Are You Doing the Rest of Your Life," "Traces" or "My Sweet Lord," winners all for Mathis buffs.

And for those who can't get enough of him, there's also available a two-disc package, **JOHNNY MATHIS SINGS THE MUSIC OF BACHARACH & KAEMPFERT** (G 30350), also a Columbia release. Included in the 21 tracks are "Heavenly" and "Faithfully," both circa 1959, which allow a comparison of the singer then and now.

The first two sides are devoted to tunes penned by Kaempfert, the final two to songs by Bacharach. All have that inimitable Mathis stamp upon them.

Best are "Spanish Eyes," "Danke Schöen," Strangers in the Night," "Walk on By," "The Look of Love," "I Say a Little Prayer," "This Guy's in Love With You" and "Alfie."

* * *

If you'd rather have soul, **GONE,** an MGM vinyl (SE-4741), showcasing the talents of Bill Medley, half of the broken-up Righteous Brothers, is one of the best bets—despite the fact that the disc has been around a while.

There's a great rendition of "Let it Be" on the first side, as well as an excellent version of "Bridge Over Troubled Water." Side Two spotlights the hymn-like "There's a Spirit," the moving "Something," and a production number of sorts, "If This Was the Last Song."

The highlight of the album, though, is the final offering, "Peace, Brother, Peace," a message song that is simple in concept but potent in execution—and filled with love.

Dear Editor . . .

(Continued from page 16)

the velocities of the high frequencies by the same amount. There is a tendency to dismiss high frequency excursions of a wide-band radiator as "negligible" but the excursions and velocity components are in fact very much larger than the free field components. This may do much to psychoacoustically balance the proportions for the listener and largely cancel out the effects of "Doppler." This would be an interesting thing to calculate or measure, but I am too lazy. I suspect the increased high frequency velocity will not truly cancel all the Doppler exaggerations, but it is probably a great aid. In fact, the phenomenon may very well "track" some of the irregularities of the Fig. 1 system.

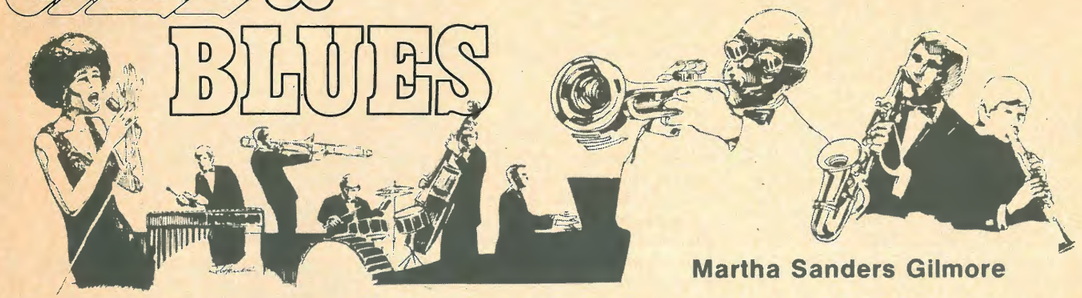
In general, then, perhaps we can suppose that Doppler effects are largely masked (if they are perceptible at all) by more serious speaker defects. I am not 100% convinced that Doppler effects cannot be heard though. Many "sensitive ears" claim to be able to detect a special "horn sound." (Although I wonder how easily these people might detect this sound if they did not know in advance that the system was horn-loaded.) Usually this is attributed to a special kind of "horn distortion" introduced by non-linearities in the expanding area. Even with a very wide-band horn such as Altec's 500 Hz tweeter horn, this distortion only reaches 4% at the highest frequencies. It is pretty difficult to hear the difference between a 15 kHz square wave and a sine wave of similar frequency, so it is hard to take this seriously. Perhaps this "horn sound" (which is a pretty subtle effect) is actually a manifestation of the different proportions of Doppler effect in a horn and in a direct radiator.

It would be an interesting experiment to introduce artifical Doppler modulation into the signal fed to a horn system.

Shame on Mr. Petite of Advent. In his letter he quotes "typical" energy distributions of sound as an argument. "Typical" considerations may be well and good for engineering of telephone systems or even for Muzak systems. Are we to assume that the atypical sounds produced by a pipe organ or the Moog do "not exist in real life?" Now, the fact is, primarily due to deficiencies in human hearing as tabulated by Fletcher-Munson, Robinson and Dadson and others, it takes quite a bit of energy to make very low frequency sound even audible (given background noise) much less to give it any dynamic range. An inspection of the published frequency

(Continued on page 63)

JAZZ & BLUES



Martha Sanders Gilmore

Charlie Byrd: The Stroke of Genius

Musicians: Charlie Byrd, guitar; Hal Posey, trumpet and flügelhorn; Mario Darpino, flute; Joe Byrd, bass; Bill Reichenbach, drums, and Michael Redding, drums and percussion.

Songs: Southern Rider, Something, Everybody's Talkin', Pavanne, Something Pretty; Wave, Nothing but a Fool, What is a Friend, Pretty Butterfly, Sonatina, and Something Like the Blues.

Columbia C 30380, $4.98.

The venerable Charlie Byrd has created a dozen dazzling guitar interpretations with a sophisticated, Southern flavor in this Columbia release, appropriately entitled "Stroke of Genius." Charlie and company, a sextet on this date, go South of the Border and across the seas for arrangements which are legitimately Latin.

Charlie's very own "Southern Rider" leads off at a fast canter, resembling the pace of a vaquero with his wide-brimmed hat, galloping across the range. Byrd superimposes blue notes over his melodic expositions, as a kind of trademark to almost any music he plays. His sound, insinuating Flamenco, is now like that of a Spanish guitar, then unmistakably bluesy.

Providing able assists are Hal Posey on trumpet and flüegelhorn and Mario Darpino on flute, commendable associates who are sadly not afforded the volume they should have to render a compatible balance of musical roles. Nonetheless, in "Rider" Posey has us ringside with the bulls and out again at a horse's gait for a rather overextended ending.

One of the problems with Byrd's music and a conflict for the listener, for it is obvious that the guitarist has total mastery of his instrument, lies in a super-abundance of arranging, resulting in a sort of stop-and-go syndrome which prevents much of his music from getting airborne. In this disc as well, the numbers which are obviously arranged for guitar and rhythm section together with trumpet and flute do not achieve the liberated spirit of improvisation for which jazz lovers listen. Talents such as Posey and Darpino should be allowed room to stretch instead of being hamstrung by brevity. In George Harrison's "Something" and Jobim's "Wave," their entrances are artificial and they are not permitted to develop their thoughts.

In spite of these shortcomings, this is an exhilarating recording by Byrd and more's the pleasure everytime I listen to it.

Fred Neil's "Everybody's Talkin'" from *Midnight Cowboy* opens with cymbals from the wizard's palace and has the group in a whirlwind of mixed tempos ranging from Latin to funk to Dixieland, with Byrd digging deep into the groove. Joe Byrd is outstanding here, as throughout the LP, on a sometimes over-amplified electric bass, but his work is delightful and imaginative, and one finds oneself listening for what he might do next.

The Byrd brothers comprise a winning team! This is perhaps most apparent in their close work in "Nothing But a Fool" by the great Oscar Brown, Jr., and "Something Like the Blues" which is the blues and more, composed by Charlie himself. Joe and Charlie indulge in a rapid fire question and answer period in a musical dialogue.

"Nothing But a Fool" is our choice, uncluttered and abounding in cross rhythms which underlie a poignant melody. It ends too soon but is followed by "Brown Baby," another Brown tune reminiscent of a spiritual, which Byrd plays alone.

Byrd's unaccompanied accomplishments on guitar give impetus to the fact that he studied with Andres Segovia in 1954 in Italy. Byrd is daring to attempt such feats as "Sonatina" by violinist-guitarist Paganini, and "Pavanne," written by Luis Milan in the sixteenth century. Much as a potter, Byrd inscribes his individual stamp on these difficult creations, taking the potentially stately "Pavanne" at a brisk run. We join him in a deep breath at the finish! Acoustic bass might have been a better choice of punctuation here to our way of thinking.

Engineers Tonkel, Laico, and Payne are to be heartily commended for their smooth percussive mixing in "What Is a Friend." Michael Redding on tambourine and triangle is tastefully pervasive without being intrusive, etching an outline with strokes that glisten.

Otherwise, the engineering appears a bit biased with an undisputedly stated preference for high amperage on guitar and bass over that of the trumpet and flute sidemen whose solos carry impact as well.

"Pretty Butterfly" is the most jumping, jazzy tune in this Byrd bag with Darpino flying high on flute and Byrd comping along at the bottom of it all. In this bossa nova, Byrd's guitar fairly twangs as opposed to sounding stately precise as in "Sonatina" and "Pavanne."

In "Something Like the Blues," Byrd puts his fingers on the very pulse of the blues, commencing *a capella* and going on to execute some astonishing runs. Each instrument takes a solo, successively modulating, and then in a real showstopper joins the free for all. The piece builds to a climax with a kind of *ritornello* via guitar which rehashes it all in a dramatic ending.

In the final analysis, where the sound is good in this LP, it is very, very good. But unfortunately, the recording is marred in part by unrelenting background noise and an undemocratic volume modulation. However, Columbia merits praise for thoughtfully mentioning the names of the engineers.

Charlie Byrd strokes his guitar with genius while his arrangements sparkle with originality. This palatable LP would woo the most reluctant beginning listener to jazz and music of the guitar. Neither fish nor fowl, it delightfully defies category and does so brilliantly!

Performance: A- Sound: B+

Dear Editor . . .

(Continued from page 61)

response curves and power output data associated with reviews of the "small" systems shows that very few indeed are truly capable of deep bass (70 Hz down). The subjective musical adequacy of these systems does show the relative unimportance of these frequencies. It seems to be a case of "if you haven't got it, you don't miss it." While atypical (!) music containing deep bass is very much enhanced by systems capable of delivering the bass power, these same selections are quite playable minus this deep bass, evidently. In any case, to get this performance it seems almost necessary to spend a lot of money and put up with a certain inconvenience. The perfectionist should certainly consider the larger systems in this light, though.

John DeHaven
Bangkok, Thailand

van Hessen Replies

Dear Sir:

Well, the posse caught up with me, but I sure gave them a run for their money. The editor kindly sent me a handful of reactions received and with two exceptions they showed a disinclination to think about the Doppler problem; most people preferring to quote authorities instead.

My model failed, of course, where it got rid of the amplifier. Doppler distortion comes in when the amplitude of the loudspeaker diaphragm is larger than that of the microphone membrane. Against the multitude of people holding the loudspeaker responsible, I wanted to point to the amplifier's role which I did by pointing out the absurdity you get into by eliminating it.

If we only amplified the movements of the microphone just enough to move another mike diaphragm with the same amplitude as the first, we would have no Doppler distortion, but we would certainly not have much volume either. What is not generally appreciated therefore, is the fact that we have to dissipate a lot of amplification just to make up for the lack of efficiency of both transducers, and moreover, that we also need amplification to make up for the difference in size between the two diaphragms. It is only the amplification in excess of the foregoing that could give rise to Doppler distortion. And brother, you can save mightily on amplifier power by using horn speakers with their high efficiency. But this is scant consolation for someone who thinks that the real problem in loudspeaker design lies in coloration, not in Doppler distortion. It is for this reason that I feel that my reaction was only slanted differently from some others, but not necessarily more absurd.

Apart from Mr. Marovskis' well-reasoned reaction, I am grateful to Mr. Jay A. Shideler who did some calculations on my model, showing that when the loudspeaker moves 10 times heftier than the mike, the mike accounts for only 10 percent less Doppler distortion (I quote roughly). I still do not think 10 percent decrease is enough to account for the discrepancy between the little Doppler we hear and there may be other factors working in the same direction.

Not many people have pointed out that Doppler distortion is maximal along the axis of the speaker, and minimal 45 to 90 degrees off, depending on the construction. Perhaps it might be possible to isolate Doppler distortion by picking up a loudspeaker's response by two microphones, one in front, one off axis, and subtracting the two outputs. The remainder should (among other products) be rich in Doppler. Beers and Belars published their work in 1943. Twenty-eight years should be ample time to find out whether Doppler distortion is worth bothering about.

In apologizing to the many people I must have caused distress by my absurd reasoning, I wrote my reply to the editor's request. Little did I dream that it would be featured prominently in the April issue! I certainly hope you do not feel I have wasted your time by trying another approach.

Henri van Hessen
Rotterdam, Neth.

Letters were also received from Professor Greiner, Richard Honeycutt, Douglas DeVitt, and many others. Some writers did not believe in Doppler, others came up with astronomical figures, but no one could explain why the ear is apparently insensitive to this kind of distortion. Let Walter Carlos (Switched-on Bach) sum it up. G.W.T.

And a Last Word

Dear Sir:

. . . Alas, the tempest in a teapot has, true to form, proven to be a fine theory, but with no practical concern to even the most stubborn diehard. Like phase (in most cases) such frequency modulations are simply below the sensibilities of our built-in and *un*modifiable aural sense organs, and thankfully so. Can't we all now go on to more significant problems? Theory is fine, but when it ceases to have practical significance, I, for one, will return to my F-sharps and dotted eighth notes.

Walter Carlos, President
Trans-Electronic Music Productions
New York, N.Y.

Classified

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(Continued from page 65)

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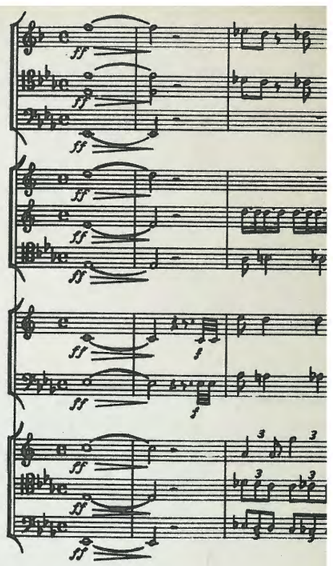

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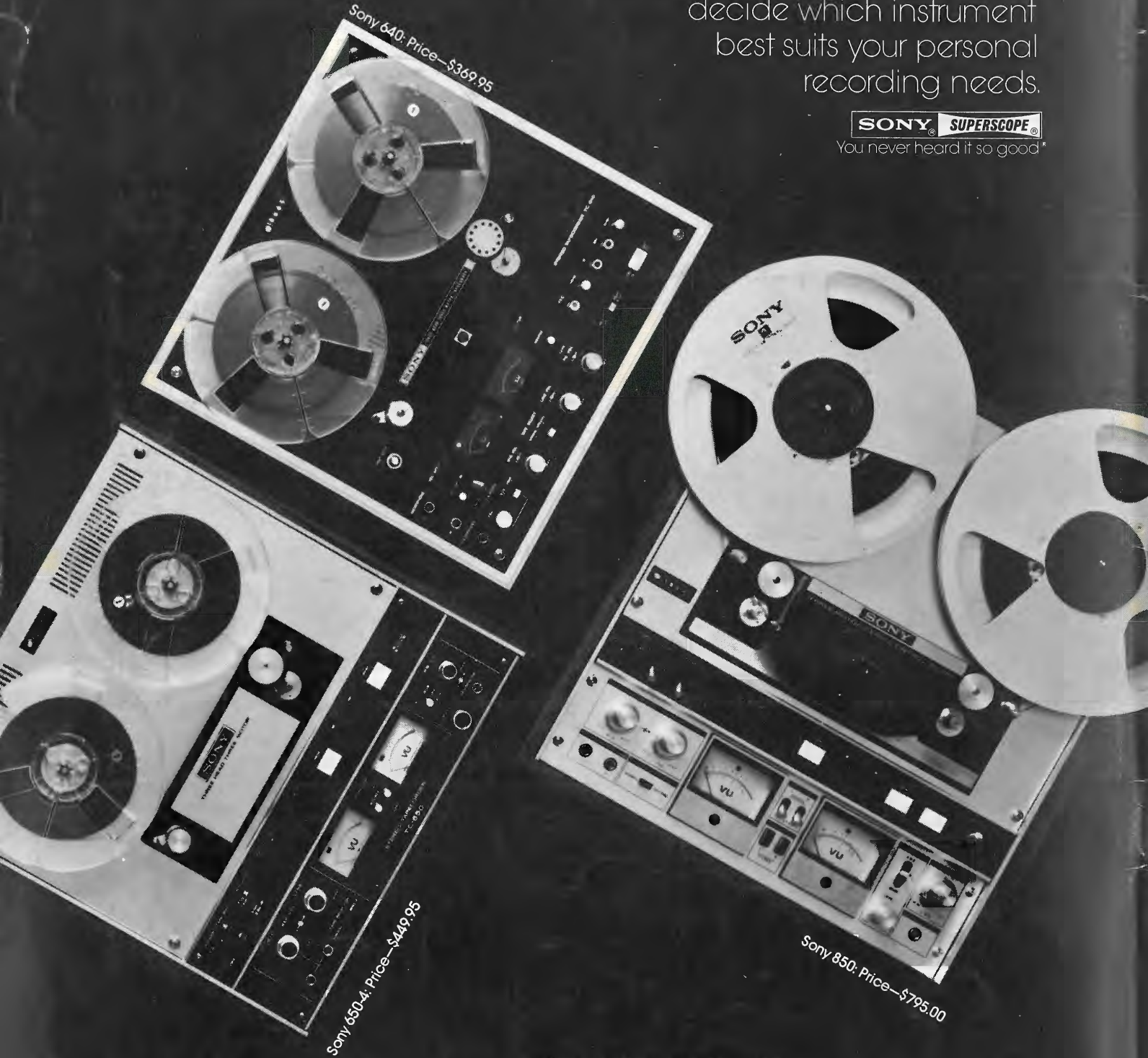

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