EXTRA: TAPE RECORDER BUYING GUIDE

The Authoritative Magazine About High Fidelity

AUDIO

JANUARY 1970
60¢

Splicing Tape & Applications

Construct a Variable-Frequency Source

The 8-Track/Cassette Cold War

The 4-Channel Disc & Quadrasonics on the Air

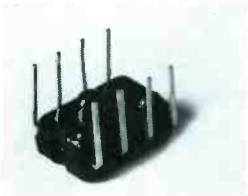
ALSO: Stereo Equipment & Record Reviews

Inside Scott's new 382C AM/FM stereo receiver is a specially-developed digital computer circuit called "Perfectune," that takes the fiddling, guesswork, and wasted time out of tuning . . . gives you perfect sound, instantly, every time.

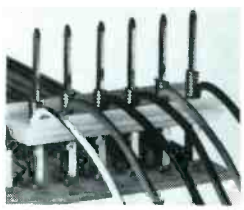
How does it work? The Perfectune integrated circuit scans the other tuner circuits and decides exactly when you have tuned for both lowest distortion *and* best reception. It then flicks on the Perfectune light.

Perfectune gives a far more exact reading than a meter, which may read at its highest point when the signal is masked by interference. The Scott 382C still has a meter . . . but it's a signal strength meter you use only to position your antenna for optimum signal . . . then you let Perfectune take over for perfect sound!

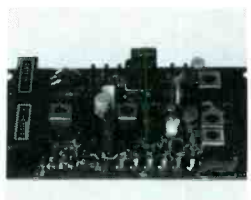
Perfectune is only one of the advanced Scott features that make the 382C your best AM/FM stereo receiver buy. The photos below show some of the other Scott exclusives incorporated in this superb unit.



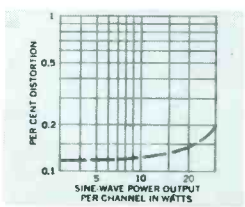
Full complement of 7 Integrated Circuits . . . more than any competitive receiver.



"Wire-Wrap" . . . a permanent connection technique that eliminates solder joints.



New IC multiplex section that gives better stereo performance and reliability.



Full Complementary Output circuitry that gives virtually distortion-free listening at all levels.

Snap-in printed circuit modular construction for reliability and ease of service.

Specifications:

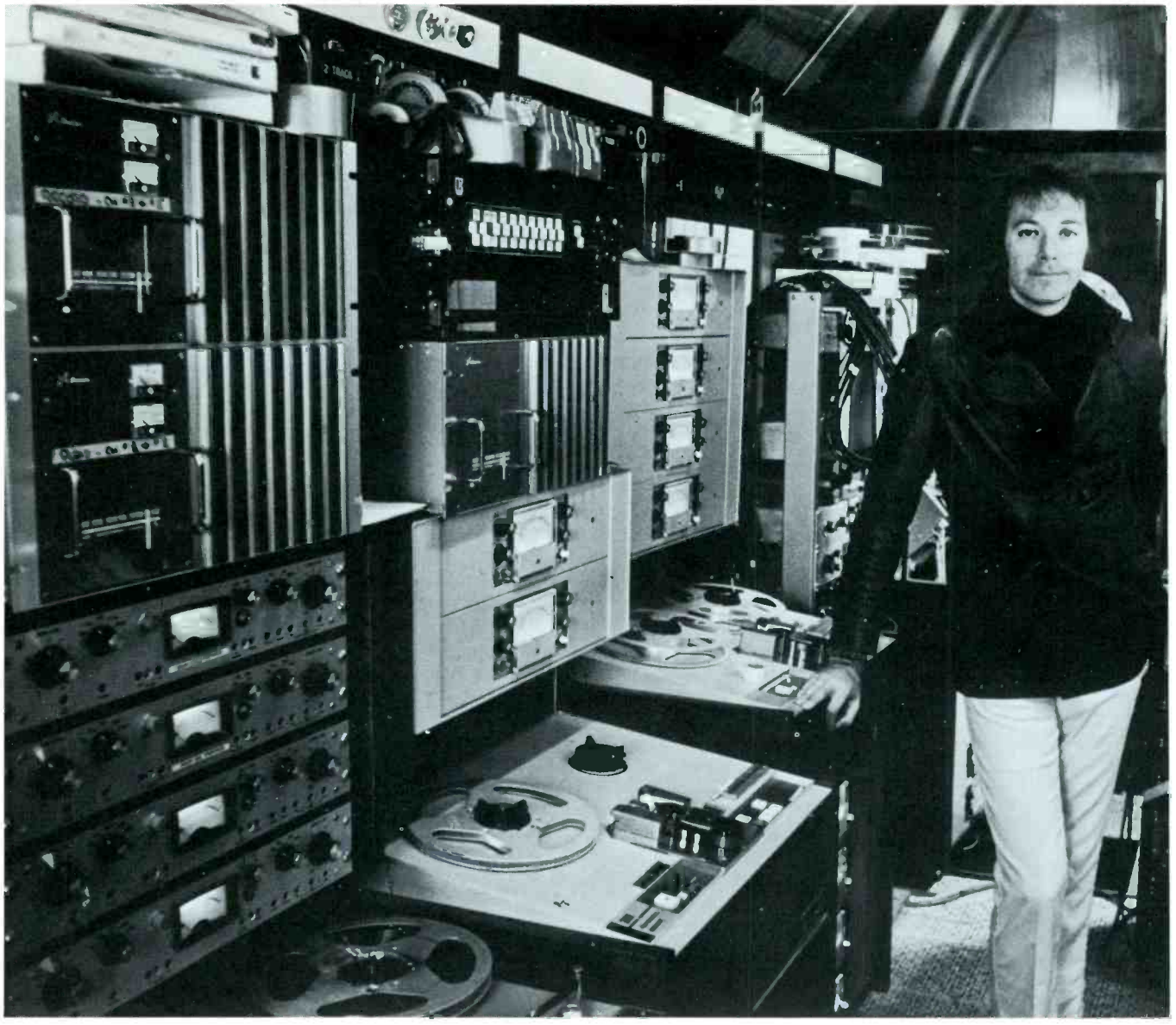
Power (± 1 dB) 110 Watts. IHF power specifications @ 0.8% distortion, both channels driven: Dynamic power @ 4 Ohms, 45 Watts per channel; Continuous power @ 4 Ohms, 33 Watts/channel, @ 8 Ohms 25 Watts/channel. Selectivity, 40 dB; Frequency response, ± 1 dB, 15-30,000 Hz; IHF power bandwidth, 15-25,000 Hz; Cross modulation rejection, 80 dB; Usable sensitivity, 1.9 μV; Stereo separation, 30 dB; Capture ratio, 2.5 dB. Prices and specifications subject to change without notice. Walnut-finish case optional.

Choose either the 382C AM/FM stereo receiver at $299.95 or its FM stereo counterpart, the 342C at $269.95.

H SCOTT®

For detailed specifications, write:
H. H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. 01754
Export: Scott International, Maynard, Mass. 01754

Check No. 100 on Reader Service Card



"Elektra was first in recognizing the value of the Dolby System for multi-track rock recording,"

says Jac Holzman, President of Elektra Records.
"Since early 1967, we have used Dolby units on most of our recordings of The Doors, Judy Collins, Tim Buckley, Tom Paxton, The Incredible String Band, Roxy, and many others. The New Music can have a surprising dynamic range, and we find that the Dolby System not only gives a really low-noise background during quiet passages, but it helps to preserve the clarity and definition of complex musical textures. A related advantage is that the mixdown is faster and less tedious. In working out the final mix, we no longer have to resort to intricate equalization schemes to retain crucial nuances and subtleties of the performance."

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N. Calif.	**Audio-Video Systems Engineering** 1525 Tennessee Street, San Francisco, Calif. 94107 Tel. 415-647-2420
Midwest	**Expert Electronics, Inc.** 7201 S. Western Avenue, Chicago, Illinois 60636 Tel. 312-HE 6-2700
Canada	**J-Mar Electronics, Ltd.** 6 Banigan Drive, Toronto 17, Ontario, Canada Tel. 416-421-9080

January, 1970 Vol. 54, No. 1

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FEATURE ARTICLES

TAPE RECORDER DIRECTORY

EQUIPMENT PROFILES

RECORD/TAPE REVIEWS

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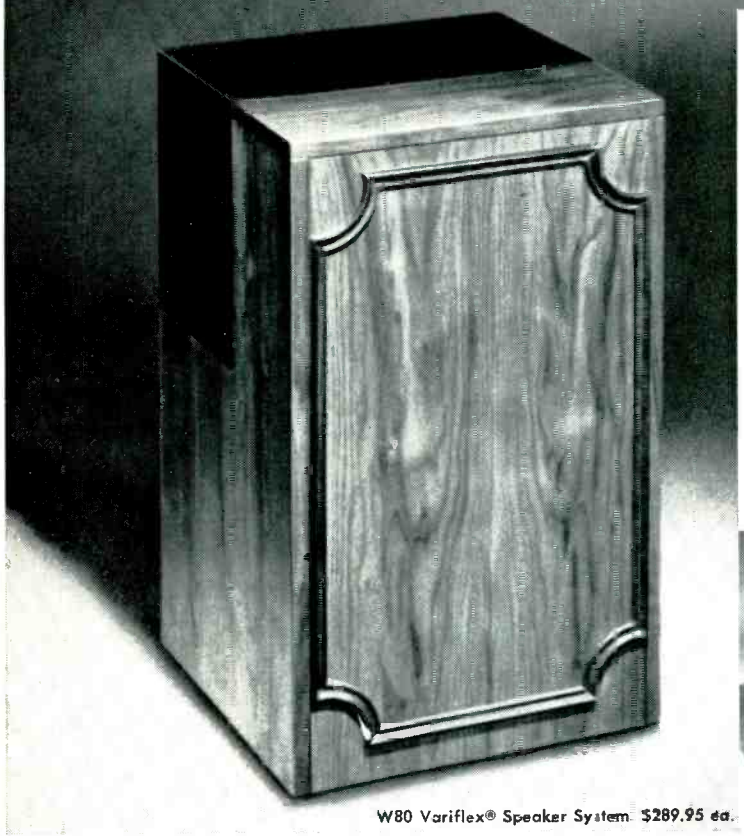
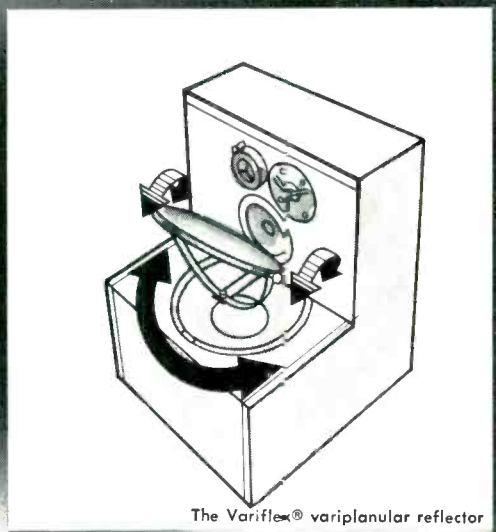
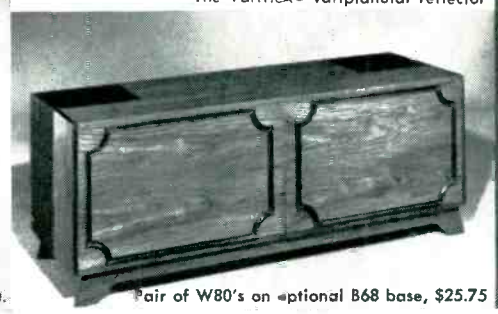
Take any seat in the house.



W80 Variflex® Speaker System. $289.95 ea.



The Variflex® variplanular reflector



Pair of W80's on optional B68 base, $25.75

Introducing—a most significant breakthrough in home stereo reproduction

The WHARFEDALE Model W80 VARIFLEX® Speaker System

This new concept completely eliminates the usual limitations involving speaker placement!

- The VARIFLEX requires no special spacing apart, or from a wall or above a floor.
- It can be used in pairs, anywhere in the room.
- Or, two W80 speakers can be used to form a single 56" console.
- VARIFLEX brings balanced stereo sound *to* the listener.
- Stereo perception is *preserved*, rather than splattered promiscuously by uncontrolled room acoustics or speaker elements.
- No need to disturb existing high fidelity systems. Does not require electronic equalizer.
- Exclusive sand-filled construction to eliminate undesirable enclosure resonances and coloration.
- Modest in size (only 17" x 17¼" x 29"), the W80 is truly fine furniture, attractively styled to enhance rooms of virtually any decor.

What is VARIFLEX?

Ordinary reflective and "omni" speaker systems have one thing in common: Sound dispersal is promiscuous and subject to acoustical phase distortions caused by the shape and furnishings of the room. Splattered sound, whether solely against a wall or through use of a conical reflector in the speaker enclosure, is *uncontrolled* sound. Hence, in the case of some types of systems, "optimum" spacing is recommended from a wall or above the floor. In other instances, sound is projected over a wide area, equally, from both speakers of a stereo pair. But, in this case the *levels* at which sounds of different frequencies arrive from both channels to a given point in the room are unequal and therefore *unbalanced*. In both instances, the distribution pattern of sound is fixed and therefore unable to accommodate the multitude of differences which exist between rooms.

The Wharfedale VARIFLEX employs a *variable* device which bends sound waves in a definite and controllable manner so as to form the particular sound distribution pattern *required* by room conditions and/or the listening and decor needs of the user. This variplanular reflector is capable of directing sound waves both in the vertical or horizontal planes, or any combination of these angles.

For full specifications on the W80 and all the Wharfedale systems, write Wharfedale, div. British Industries Co., Dept. HA1-9, Westbury, N.Y. 11590.

Wharfedale

ACHROMATIC SPEAKER SYSTEMS

Coming in February

A Practical View of dB's, dBm's, and VU's—George H. R. O'Donnell describes some practical methods for coping with the subjects.

Transient Power of a Stereo System — Osamu Goda discusses power output of amplifiers when faced with sudden power demands as caused by abrupt, loud music.

The Best of '69 Recordings—Audio columnists pick their personal favorites among LPs and pre-recorded tapes heard in 1969.

An Integrated-Circuit Frequency Modulation Detector — Eugene Patronis, Jr. presents a new detector, illustrating how it is constructed and how it works.

. . . and more.

EQUIPMENT PROFILES:

Roberts 420XD Stereo Tape Recorder.

Dynaco SCA-80 integrated stereo amplifier (kit).

Rectilinear X three-way speaker system . . . and others.

ABOUT THE COVER:

Four-channel stereo is exemplified by a disc and a stereo FM scope photo, both of which are being touted as four-channel media. AUDIO has articles concerning both in this issue.

Audioclinic

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.

JOSEPH GIOVANELLI

Two Uses for an Oscilloscope

Q. I would like to connect an oscilloscope to the tuner section of my stereo receiver to determine signal strength and multipath conditions.

I would also like to use it for observing channel separation of the section.

What would be the best point of connection? Sol Kohen, Philadelphia, Pa.

A. Multipath indication can be derived by connecting the horizontal plates of an oscilloscope to the "live zero" detector output. The vertical plates are connected to the input of the first limiter. The two signals will deflect the beam both vertically and horizontally. If the signal is a straight line, there is no multipath distortion. If there is a dip, or droop, in the line at any point, you do have some multipath distortion. The greater the dip, the more multipath is indicated. The scheme just described is a method used by H. H. Scott for this purpose.

If you do not have enough signal from the detector and limiter to cause sufficient beam deflection (and this is likely) when connecting the signal to the plates, feed the signals to the d.c. inputs of your oscilloscope amplifier. This amplifier must have good high-frequency response, to at least 100 kHz.

Stereo separation can be shown on a 'scope by connecting the vertical plates to one channel and the horizontal plates to the other. You might need to use the *a.c.* input of your 'scope amplifier to increase sensivity. You must set the 'scope to have the same gain for each channel.

If the trace on the 'scope is a diagonal line, the signal is mono. This brings us to something quite interesting. Once you know the direction of the diagonal line with a correctly phased signal, you can then detect out-of-phase mono simply by noting that the direction of the diagonal has shifted 90 deg.

The more the signal becomes stereo, the more the trace departs from a true diagonal. There will be a number of traces which will proliferate on the "scope face, determined by the difference in phase of the two channels at any instant and at various frequencies of which the program material might be composed.

Speaker Phasing

Q. There was an article in April 1969 issue of AUDIO *on "Don't Let Speaker Phasing Faze You." In it the author mentions that speaker phasing meters are available at some audio dealers. I have not been able to locate a dealer carrying these meters. Can you send me an address of a dealer or dealers who might have these units?* —Don Davis, Waverly, N.Y.

A. A couple of years ago RCA sold a phasing system to radio and TV dealers. However, I never saw it and I cannot vouch for its effectiveness.

I wonder if perhaps some of you reading this might have some information about these devices which they would be willing to pass along to all of us.

In the absence of such a meter, this brief discussion of speaker phasing may be helpful. Phasing is not all that difficult to determine. First of all, there are some listening rooms which have such severe problems with standing waves that correct phasing does not bring about much improvement in sound reproduction over that which is heard when phase is reversed. Also, there are listeners who cannot hear the difference between proper and improper phasing. If no difference is noticeable to the listener, there's probably no reason to be concerned about the problem. Of course, if this listener invites some other audio buffs to hear his system, it would be well to have the speakers phased. Sometimes this inability to determine the difference in sound between what is correctly phased and what is not is actually a matter of understanding what to listen for.

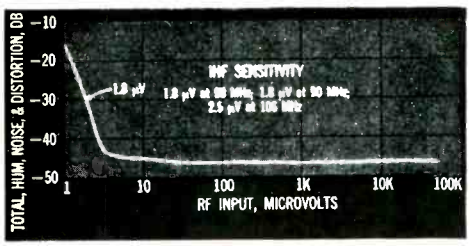
To phase two speakers in a stereo system all that is necessary is to play a mono source, or at least have your amplifier set to a position whereby stereo is converted to mono, with both speakers operating. Balance the sound

How to explain to your wife why you spent an extra $400 for this stereo receiver.

There's no doubt about it. You can get a fine receiver for as little as $200 or $300. We know, we make them. But we also make a $700 receiver. We know what goes into it. Once you know, you might be compelled to buy one and if you do, you might have to convince your wife about spending $700 for a stereo receiver. So here's what you can tell her.

Point out that the 6120 is actually a bargain. It's sensitive (1.8 microvolts, IHF) so it pulls in stations that other receivers can't. As long as you are paying for the entire FM Band, you might as well get all of it. Prove it by letting her tune up and down the generous 8-inch tuning dial listening to station after station pop out. Show her how the two tuning meters help locate the strongest signal and the exact center of each channel for best reception.

She understands traffic jams, so tell her about the heavy traffic on today's broadcast bands. Stations are crowded together with little or no separation between them. Despite this, there's no interference from nearby stations with the 6120 and the one station you want to hear is the only one you'll hear. No other programs or unwanted noises. Adjacent channel selectivity, 100 dB.



No wife likes noise. And noise is particularly annoying when combined with music. With the Sony 6120 noise and interference don't intrude upon the music. The 6120 delivers sound as clear and pure as possibly can be expected outside a concert hall. Purer, in fact, for she won't be putting up with audience noises, such as coughing and throat clearing. If she wants proof, mention a few of these specifications: signal-to-noise ratio, 70dB; rejection 90dB; i.f. and spurious image rejection, 100 dB each; and AM rejection 65 dB.

Now you can get a bit romantic. Turn on some moody background music, quietly. She'll relax. Now turn up the volume. Normally you'll be operating the 6120 at well below one watt. But just so it doesn't have to strain and distort when there's a crescendo passage, it has plenty of power in reserve (rated amplifier power 60 watts per channel into 8 ohms, both channels operating). The 6120 coasts along taking everything in stride from Beethoven to Berlioz, without distortion at any listening level (IM distortion 0.3% at rated output; 0.05% at one watt; harmonic distortion, 0.2% at rated output; 0.05% at one watt).

You're making progress. Now point out that the 6120 can capture the nuances in the music that are the result of harmonics and other subtleties that make music such a delightfull experience. The 6120 can easily handle the audible sounds with none of the strain and distortion that a narrower band would have to fight. It has more range than you'll ever need, from deepest basso profundo to the highest lyric soprano. The proof: Power bandwidth from 12 Hz to 70 Hz.

Time to begin your closing arguments. Point out all the pleasures of the SONY 6120-FM stereo and FM broadcasts, superb reproduction of records, tapes...only control she'll ever get involved with is the quick-action function selector. In the upper position, the tuner is connected; in the lower position, the record player; in the center, a knob selects microphone, tape head, phone 2, aux 1 and 2. You really don't have to go into detail on the 6120's many other conveniences. But, should your wife ask, you might mention the mode control with 7 positions and switches for low and high filters, loudness contour, tape monitor, FM mode (automatic stereo or stereo only) high blend and muting. The aux 2 input on the front panel accepts a stereo phono jack. It's useful for making a quick patch in of a tape recorder on playback, or any other high level signal source. For recording there's a front panel line-out jack. There's a headphone jack, speaker selector, treble and bass controls.

The rear panel has inputs corresponding to the front panel selector plus a duplicate set of aux 2 jacks, tape inputs and outputs,

and an additional tape recorder receptacle for 5-pin (European type) connections. A separate mixed left and right channel jack can be used to drive a mono amplifier, or to pipe music into another room. Maybe your wife won't understand the significance of all these conveniences, but she'll know she's getting something extra for her money.

It's time for your wife to audition the 6120. Try plugging a pair of stereo headphones into the front panel jack and mention how compatible the 6120 is. You can enjoy your 6120 while she can enjoy her favorite TV programs in the same room, without interruption.

Next, allay any doubts she might have. She might feel that while the 6120 sounds beautiful today, how will it sound 3 or 4 years from now? After all, her appliances wear out. Tell her about the "forever filter." The SONY solid-state IF filters (there are 8 of them) that preserve the high standard of performance in the 6120 for almost ever, since they cannot go out of alignment.

Now that you have demonstrated the performance capabilities of the 6120, show her how beautiful it is with oil-finish walnut cabinet, brushed aluminum paneling. Tell her it would take two of the finest components available today to equal the performance of the 6120, and they would cost considerably more. And take up more space, too. Finally, tell her it's Sony, made by those same people who make all of those wonderful things people have come to enjoy in both sight and sound. Now play her favorite musical composition. You've saved a happy marriage and become the proud owner of a new SONY 6120 FM/FM stereo receiver.

SONY Corporation of America, 47-47 Van Dam Street, Long Island City, N.Y. 11101

SONY® STR-6120

between the speakers. If the phasing is correct, the sound will appear to be coming from a virtual source between the two speakers. However, if the phasing is incorrect, the sound will appear to be coming from both speakers, as it indeed is. This sound will be accompanied by a peculiar "pulling" of the ears. The effect is similar to that of reduced pressure on the eardrum. It is a distinctly unpleasant sensation.

Minimum Speaker Driving Power

Q. In the April 1969 AUDIO *there is a long list of speakers. One item covered in this list is "minimum amplifier power required in watts." Just what does this mean?*—H. J. Klumb, Rochester, N.Y.

A. When a loudspeaker manufacturer refers to the "Minimum Amplifier Power in Watts," he believes that this is the minimum power at which the speaker will give satisfactory volume as heard by the listener. Thus, your amplifier must be able to supply at least this minimum power to provide full, room-filling volume.

You may need to walk around the room a bit to find the best listening position from which to observe the correctness of speaker phasing.

To correct an out-of-phase condition, reverse the leads connected to *one* of the speakers.

IC's Installed in Tonearms

Q. If one were to take advantage of the fact that an integrated circuit can be placed in the tonearm, would it be better construction to feed it into the phono input or into an auxiliary input?—Dan Derbick, New York, N.Y.

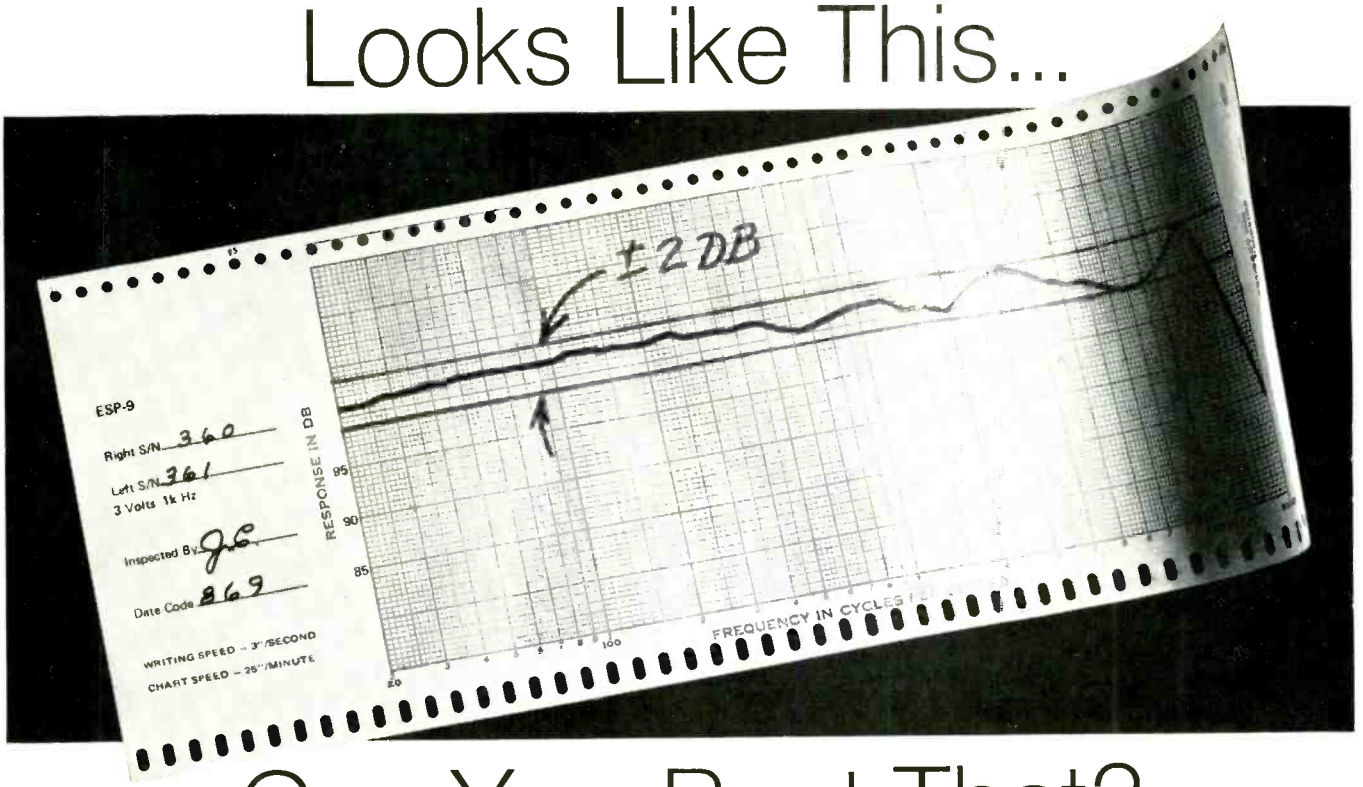
A. Unless there is a good reason to add an integrated circuit to your tonearm you should not do so. If the leads between the phonograph and preamplifier are short and if the cartridge you are using has sufficient output to provide good signal-to-noise ratio, you won't require the use of the IC. Of course, under this latter condition, the IC can boost the voltage sufficiently to supply the necessary output to drive your preamplifier properly from the auxiliary input.

Because the object of such circuits is to provide a small amount of gain rather than equalization, you still will want to put the output of the IC into the phonograph input in order to obtain proper RIAA compensation.

Another purpose for employing an IC in a tonearm is to enable the listener to place his turntable at some distance from the preamplifier. The output impedance of most of these devices is fairly low, and hence, it is possible to use many feet of shielded cable without hum pickup or the loss of high frequencies which would result when this greater length of cable is added directly between the cartridge and the preamplifier. In such circumstance, it is not necessary for the circuit to provide gain, but rather, an impedance stepdown. (I guess I really ought to say that the stage must only supply *current* gain, not voltage gain.)

A single transistor, connected as an emitter follower, should serve just as well as IC in this application.

The Sound Of KOSS Looks Like This...



Can You Beat That?

To guarantee performance to specifications, this individual machine-run response curve comes with every ESP-9 Studio Monitor Headset. You get, for the first time, flat ± 2 db monitoring over the entire audible spectrum because the ESP-9 is a breakthrough electro-acoustical development achieved by exploiting electrostatic principles. Only Koss electrostatics give push-pull balanced acoustical circuitry, cancelling all second harmonic distortion to provide fatigue-free listening through long recording sessions. Now you hear what the program material *really* sounds like, uncolored by monitor room reflections. Exceeding the range and cleanliness of any speaker system, the ESP-9 gives the measure of separation and accurately positions the soloist. 40 db isolation through comfortable, fluid-filled cushions relieves the noisy distraction caused by producers, A and R men, time-killing artists, and other visitors in the control room. The ESP-9 eliminates the masking effect of blowers, breath sounds, clothes rustling and other control room ambients. So now you have a running check on low-level system noise. You monitor the sounds you only *saw* before on the VU meter, like the "whoosh" of a stage door closing, ventilator rumbles and music stand rattles — because speakers simply don't have the super-wide-range you need to hear them.

The ESP-9 has a signal handling capacity of 10 volts at 30 Hz with good wave form versus 6 volts for the integrated ESP-6 introduced last year. This is made possible by increasing the size of the coupling transformers by a factor of 4 and mounting them in the E-9 Energizer external to the cup.

The E-9 Energizer offers the option of self-energizing for the bias supply, or energizing through the ac line; choice is made with a selector switch on the front panel. When energized through the ac line, very precise level measurements can be made. Thus the unit is ideal for audiometry, and for evaluating the spectral character of very low level noise in tape mastering machines and recording consoles.

SPECIFICATIONS

Frequency Response Range, Typical: 15-15,000 Hz ± 2 db (10 octaves) 10-19,000 Hz ± 5 db. An individual, machine-run calibration curve accompanies each headset. Sensitivity: 90 db SPL at 1kHz ± 1 db referred to 0.0002 dynes/cm² with 1 volt at the input. Total Harmonic Distortion: Less than ⅓ of 1% at 110 db SPL. Isolation From External Noise: 40 db average through fluid-filled cushions provided as an integral part of the headset. Power Handling Capability: Maximum continuous program material should not exceed 10 volts (12 watts) as read by an ac VTVM; provides for transient peaks 14 db beyond the continuous level of 10 volts. Source Impedance: Designed to work from 4-16 ohm amplifier outputs. External Power Requirements: None, except when used for precise low level signal measurement, when external ac line can be selected by a front panel switch on the E-9 Energizer.

See your dealer today or write for free technical paper, "An Adventure in Headphone Design" and ESP Catalog 108.

KOSS MODEL ESP-9 ELECTROSTATIC STEREOPHONES WITH E-9 ENERGIZER

$150.00

KOSS

KOSS ELECTRONICS INC.
2227 North 31st Street
Milwaukee, Wisconsin 53208

KOSS ELECTRONICS S. r. l.
Via Valtorta 21/20127 Milan, Italia

Check No. 7 on Reader Service Card

What's New In Audio

Magnetic Tape & Equipment

Robins Industries Corp. has introduced a compact cassette tape splicer, Model TS215, for on-the-spot editing or repair without opening the cassette itself. The splicing block is machined from metal bar stock, and includes guides for conventional 45° and 90° cuts. $10.00.

Check No. 119 on Reader Service Card

The Weltron Company, Durham, N.C., has introduced an adaptor, the Model C/8 "Coordinator," that enables the output from a tape cassette machine to be played through an 8-track stereo cartridge unit. This would allow one to take advantage of a larger speaker(s) and more powerful amplifier, $9.95.

Check No. 120 on Reader Service Card

A new tape splicer has been introduced by the Irish Magnetic Tape Co. The splicer, made of metal and plastic, cuts tape diagonally and trims waste at the side of each splice to prevent adhesive from touching critical parts of a recorder. Among its features are an adjustable blade, see-through window on handle, replaceable cutter cartridge and pod, blade-centering adjustment, and a felt bottom to avoid marring surfaces. $8.15.

Check No. 121 on Reader Service Card

Literature on technical properties of BASF's new LH low-noise high-output magnetic tape and professional tape is available. The LH tape is available in a variety of reel sizes and tape thicknesses, and is packaged in the company's plastic storage container.

Check No. 122 on Reader Service Card

The Nortronics Co. announces the availability of four heads for 4-channel stereo recording systems: Models P-BQL and P-BQQ, record/playback heads for ¼" tape, W4J, which is for use with cassette machines, and STR-4 for 4-channel mastering on ½" tape. All the heads utilize four in-line channels on a single head.

Check No. 123 on Reader Service Card

A stereo record/playback cassette tape deck that is designed for future conversion to play and record 4-channel stereo (that is, four independent tracks simultaneously) has been announced by Lumistor Products, Inc., Port Washington, N.Y. The unit features interlocking controls, three-digit counter, dual VU meters, and separate input level controls. Dimensions are 12½" x 7½" x 4½". Price of the deck is $99.95; walnut base, $10; matched pair of microphones, $10; 4-channel converter pack, $49.95 (tentative).

Check No. 124 on Reader Service Card

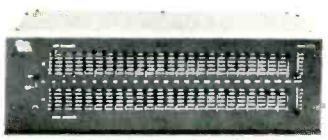
Deluxe Miracord

Benjamin Electronic Sound announced its new Elac/Miracord automatic turntable Model 770H, priced at $199.50 less base. The unit features a built-in illuminated stroboscopic speed indicator, with digital readouts of exact speed, variable speed control, and an ionic elapsed-time stylus wear indicator that records the cumulative number of hours that the stylus has been used. All of the regular features of Miracord turntables have been incorporated into the 770H, including a Papst hysteresis motor, pushbutton operation, stylus overhang adjusting screw, silicon-damped cueing, anti-skating adjustment, and dynamically balanced die-cast platter.

Check No. 125 on Reader Service Card

Equalizers

Altec Lansing has introduced its "Acousta-Voicette" stereo equalizer, Model 729A, a lower-priced equalizer adopted from its Acousta-Voicing process used in commercial sound installations. According to the manufacturer, the new unit will enable a user to "tune" a stereo sound system so that the listener can hear the recorded material as it was recorded in the studio's



environment rather than the exaggerated ones produced by a listening room's acoustic properties. The equalizer has 24 filters spaced at ⅓-octave-band centers from 63 Hz to 12,500 Hz per channel. There are 48 critical band filters total, plus a gain control on each channel for balance.

Check No. 126 on Reader Service Card

Frazier, Inc. has a commercial equalizer, Model E-12, to compensate for acoustical peaks due to loudspeaker or room acoustical response, and to provide special sound effects. Designed

for combos and other small groups, the equalizer contains 12 band-reject filter sections, each ⅔-octave wide, and controlled from the front panel. Overall coverage is continuous from 50 Hz to 12,500 Hz. $500.00.

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Sansui Integrated Amplifier

Sansui Electronics has a new integrated stereo amplifier, the Model AU555, that features total power output of 60 watts (IHF); 25 watts continuous power (rms)/channel at 4 ohms. Power bandwidth is 20 to 30 kHz with less than 0.5% harmonic distortion. The AU555 has a two-position damping-factor-selector switch to match characteristics of speaker systems, and a full complement of controls, including low- and high-frequency filters, tape-monitor switch, muting switch for instant volume suppression, and a four-position speaker-selector switch. In addition, there are two phono inputs (47k and 100k ohms), tape-head inputs, microphone input, and three auxiliary inputs. There are also stereo-headphone output and tape-recording output jacks. $159.95.

Check No. 128 on Reader Service Card

$1500 Tubed Power Amplifier

Peploe of Minneapolis, Minn. has introduced a vacuum-tube-construction power amplifier, the Dual 100, at $1500.00. Utilizing separate chassis for power supply and amplifier, continuous power (rms) is rated as at least 75 watts per channel with both channels operating. Harmonic distortion is under 0.15% at 1 kHz at rated power. Hum and noise is rated at least 80 dB below rated output. Both sections total 135 lbs. A $750 preamplifier is also available from the company to complement the amplifier. The company recently acquired the JansZen Speaker Div. of Neshaminy Electronic Corp.

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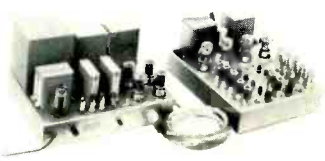

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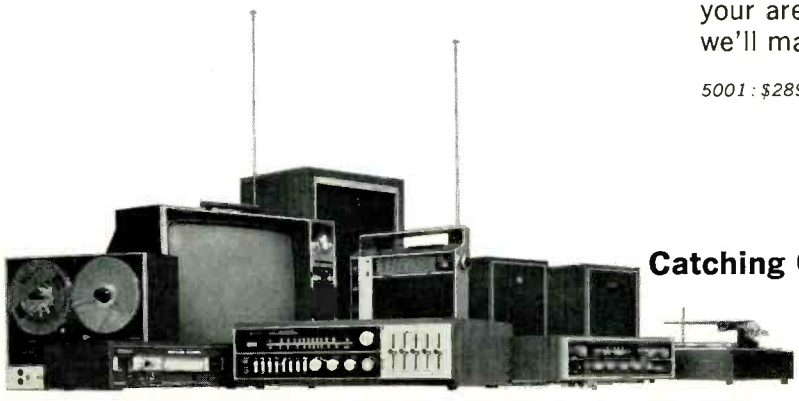

Catching On Fast

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BEHIND THE SCENES

BERT WHYTE

4-CHANNEL DISC & BROADCAST

To oldtimers in the business, the hi-fi scene today is very reminiscent of the early days of stereo. Except, of course, the emphasis is on simultaneous four-channel stereo, rather than the classical two-channel variety. Four-channel stereo is undergoing the same painful metamorphosis that afflicted its two-channel ancestor. There is much confusion—not enough information, too much mis-information, a lack of four-channel recording and so on.

In the rush to climb on the four-channel bandwagon, many "quickie" demonstrations have been given. Unfortunately, they have been generally unsatisfactory, perhaps alienating some auditors toward this new medium. The situation is actually worse than the one we had in the pioneer days of two-channel stereo. At that time stereo was confined to tape. Today we have four-channel tape, plus the "two station/two receiver" broadcast concept, four-channel multiplex on a single stereo FM station (waiting in the wings), and a possible four-channel disc.

The audiophile who decides to enter the new world of four channel stereo will have to tread very cautiously. Needless to say, there will probably be numerous changes and modifications in the four-channel recordings, until a more or less "standard" technique evolves. Two-channel stereo also went through its gimmicky "ping-pong" phase of grossly exaggerated directionality. For example, there are four-channel exaggerations of perspective to show that you are, indeed, listening to four channels. Perhaps this is necessary in the beginning, but while two-channel stereo sort of "grew out" of its gimmick period, we may have a somewhat different situation with four-channel stereo. There are some psycho-acoustical considerations in the recording of four-channel stereo which must be resolved.

In last month's column I mentioned the existence of a four-channel disc, which *Time* Magazine reported was the brainchild of one Peter Scheiber and his associate, Tom Mowrey. Since then I have had the pleasure of meeting these gentlemen and listening to a demonstration of their recording.

These young men have formed the Audio Data Co. with the express purpose of commercializing their product. They call their technique an "Analog Multiplex Encoder/Decoder System," which is a very broad term and therefore not very informative. Mr. Scheiber did not reveal the details of their process at this point. Since they had not concluded a deal with any record company at the time of the demonstration, their reluctance to discuss the workings of their system is understandable. All they would say was that during the cutting of the disc their encoding device supplies front- and rear-left information to one channel and front- and rear-right information to the other channel. They claim complete compatibility for the system, since they say that the disc can be cut with standard stereo cutters such as the Westrex 3D, and played back with any standard stereo cartridge. According to Mr. Scheiber, if you play the disc without their recorder you get normal two-channel stereo. With the decoder you can pick off the two rear signals and feed them to your rear amplifiers and speakers. I asked Mr. Scheiber if a classical recording was played back without the decoder, would the front speakers then have an enhanced or exaggerated amount of reverberation content. He replied that this would not be a problem. Regardless of techniques, the $64 question is: Did I hear four-channel stereo from a disc? Does it really work? The answer must be a qualified "Yes."

To begin with, the demonstration was presented under rather poor circumstances. The equipment and the speakers were set up in an unlovely, acoustically poor television shooting stage. The speakers set-up was somewhat different than I had seen in previous four-channel demonstrations. The front speakers were arrayed in normal stereo fashion, but the rear speakers, instead of being directly behind the listener, were at 90 degrees to each side. Thus, they radiated directly into the ears of the listener. This arrangement seemed to work all right, but this kind of configuration would seeem to be limited to certain types of speakers. Disc playback equipment was of the standard variety, as was the pair of well-known, high-quality amplifiers. The encoder/decoder device evidently was built to high-quality professional standards. Unfortunately, there was not provision made for a four-channel tape machine. As a result, a switching set-up could not be made for AB comparisons between disc and tape.

For the first part of the demonstration, they played their four-channel stereo disc and switched on each channel individually during the playback. There was no question that front and rear speakers were responding in normal fashion. Then Mr. Scheiber played a selection in which an organ fanfare was heard successively from all four speakers. The degree of isolation between the four channels was almost total. When the organ was resounding from left-rear, for example, there was no audible response from the other three channels even though the channels were active and "on." Having established this point, Mr. Scheiber played an excerpt from "Swan Lake." Sure enough, the by-now familiar four-channel sound was heard, though with too much rear sound. However, when all four channels were playing simultaneously the separation seemed to be considerably lessened. Furthermore, there was a "vagueness" about the sound which suggested that there were some phase problems. Minimal separation is not too serious in four-channel sound—the ears are very accommodating in this respect. In fact, I suspect part of Mr. Scheiber's system is based on some clever psycho-acoustical trickery. As mentioned, there was no AB facilities. It was apparent, however that the disc stereo, at least at this stage of development, wasn't the equal of a four-channel tape. Some

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other selections were played, including some of the gimmicky pop music in which all four channels are of equal intensity. The pop music worked very well, but the classical pieces still had that curious diffuse quality. Nonetheless, it can be said that we were indeed hearing four-channel sound from a disc and the the rather poor results might have been influenced by the poor physical and acoustical situation.

Part of the problem was that Mr. Scheiber didn't have enough of the kind of music which would make for more detailed and analytical listening. Admittedly, four-channel material is scarce at this point. Mr. Schreiber observed that if this system is adopted by one of the record companies, the decoding device could be sold to the consumer for a very modest price. I am going to watch this development very closely and hope that Mr. Scheiber and Mr. Mowrey can set up a more effective demonstration in the very near future.

Meanwhile, Jerry Minter of Components Corp. is hard at work on *his* four-channel multiplex disc. In a recent conversation he reported good progress and said that he had talked to several photo cartridge manufacturers who indicated they anticipated no difficulty in making cartridges that would have response beyond 40 kHz. Mr. Minter said he is committed to making a full-range, four-channel disc with response to 15 kHz.

4-Channel Broadcasts

The stereo broadcasts utilizing two stations and two stereo receivers have now been launched in New York and have met with decidely mixed reactions. Comments have ranged from "great" to "lousy," with more than a smattering of indifference. The poor and lukewarm opinions were evidently cause by a mixture of bad receiving set-ups and some transmission problems, apparently in the area of noise. I have not personally heard any of these broadcasts, but the reports I have received have been from expert and reliable people. I would guess that the limiting factor in these broadcasts is that the Columbia University station, which carries the reverberent information, is not very powerful, thus, people any distance from the transmitter have trouble receiving it; even people in the city have problems with the addition of multipath trouble.

As one who was involved with the early AM/FM "binaural broadcasts" I can sympathize with the nice people who went to the trouble of arranging these broadcasts, but they will have to face up to the same thing I did: at best this sort of experiment is cumbersome and an interim thing, serving mainly as a stimulus for the four-channel concept. The logical way to go for broadcast quadrisonic sound is multiplex. Last month I told you about the Halstead system (with its frequency limitations) and the full-range system envisioned by Murray Crosby. One of the FCC commissioners was asked about experimental licenses to broadcast four-channel multiplex. He stated that it would take time and he would have to see some spectrum analyses. He was promptly furnished with same, by one of the interested parties (see page 79), but evidently this had little immediate effect and we will just have to wait for the mills of the FCC bureaucracy to grind away at its accustomed pace.

As to four-channel playback equipment, there has been some modest progress. In addition to the tape units of Crown, Teac and Telex, Astrocom/Marlux is reportedly readying a playback unit, and I heard a demonstration of a neat-looking new Wollensak/3M recorder at the recent AES convention in New York, which combines conventional 4-track record and play facilities with four-channel playback capability. This would appear to be a logical pairing. The unit produced excellent sound in both modes and is expected to cost less than $500. Some well-known Japanese tape recorder manufacturers are said to be rushing four-channel machines to market. You'll probably see a rash of them at the Consumer Electronic Show in June at New York. H. H. Scott has a single-chassis four-channel amplifier, and AR is expected to follow suit with a similar unit. At this point it would be pertinent to say that speaker manufacturers are licking their chops in anticipation of the growth of the four-channel market.

The readers of AUDIO have always been in the forefront of new developments and have often undertaken construction projects of equipment which pre-dates the introduction of commercial units of similar type. For those of you who may be thinking of converting a recorder to the four-channel format, here is some information which may help (or then again, it might cause you to think twice about your project).

Obviously, the first consideration is the availability of four-channel tape heads. Michigan Magnetics has four-channel heads, but I am lacking details on them. Nortronics is able to supply four-channel record and playback heads at a cost of over $100 (gasp) each. Even in lots of 24, the cost is over $66 each! Unfortunately there are no four-channel selective erase heads available. There are several alternatives here. You can bulk erase your tape; you can use a full-track erase head; or if the deck you are converting has room for four heads, you can use two quarter-track erase heads in a staggered arrangement. Incidentally, you can use two record/playback quarter-track heads in a staggered configuration to give you four-channel capability, *but only for four-channel material you record yourself.* It obviously won't work with any four-channel in-line pre-recorded tapes. As to the extra preamps, the Telex Company can furnish both record and playback pre-amps, or if you are really ambitious you can look up the record/playback circuit diagram of your recorder in Sam's Photofacts and "roll your own."

Since four-channel recording presently is pretty much confined to live music, and the chances for recording same quite limited, the simplest thing to do is to convert for playback only. This will require just the one head and the playback preamps. Expense is a relative thing here. The heads and preamps aren't cheap, but if you throw in your labor for free, the cost is still way below the commercial equivalent. One last word of caution: check the head manufacturer for data on the impedance, inductance, bias voltage, and so on, of the heads he supplies to make certain they are compatible with the particular tape preamps you intend to use.

Most of the four-channel demonstrations have used the Vanguard tape along with some Columbia material. Vanguard has announced the com-

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The Stereo 80 and our PAT-4 preamplifier create an outstanding combination which delivers crystal clear sound, free of noise and distortion, and with excellent flexibility as the control center for the most complete hi fi installation.

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The SCA-80 gives quality plus compact flexibility. The Stereo 80 plus the PAT-4 gives quality, increased flexibility for installation, and greater range of control function. The Stereo 120 plus the PAT-4 gives all this plus extra power plus the benefits of a stabilized highly filtered power supply which makes performance independent of power line variations. In all these choices, quality and value are outstanding—and in the SCA-80, the synergistic benefit enhances the value of the unit.

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Behind the Scenes

(Continued from page 12)

mercial availability of its tapes, as I noted last month. Columbia has obviously been experimenting with four-channel tape for some time, and while they seem to be hedging about commercial production, there is every reason to feel they will issue such tapes.

Columbia was kind enough to supply me with some classical and pop four-channel tapes which I have had the pleasure of playing on my big Crown four-channel recorder at home. The Columbia microphoning techniques for four channel do not appear too markedly different from that employed by Vanguard. The halls were different, of course, and thus the reverberent content is dissimilar. On music which is scored in normal fashion, (i.e. not for any rear dissemination) the Columbia recording is not quite as "close-up" as some of the Vanguard material. With front and rear speakers adjusted for equal intensity, the specially scored music is quite exciting. Columbia did some Gabrieli works with choral and orchestral forces front and rear, and the effect is just stunning. They specially commissioned a four-channel piece of electronic music by Subotnick that, in it's way-out fashion, is quite interesting and highlights some of the potential of the four-channel medium for contemporary composers. Then there are excerpts from "Swan Lake" and "Symphonie Fantastique," with Bernstein conducting, which are recorded in the "straight" four-channel sound. Here you adjust the rear speakers until you do *not* hear instruments behind you. Then the reverb is just about right, albeit a subtle thing.

Switching the rear speakers on and off is convincing proof of what the four-channel technique can do to enhance the realism of the sound in the same environment. The equal-intensity pop music was both amusing and somewhat dis-orienting. Evidently most of the pop stuff is mix-downs from 8- and 16-track stereo to four-channel stereo recorders. Thus you get a cut where you have strings, woodwinds, and brass in the front speakers, and a rhythm track to your right rear; with Tony Bennett on both rear speakers! Overall, Columbia seems to be on target. Æ

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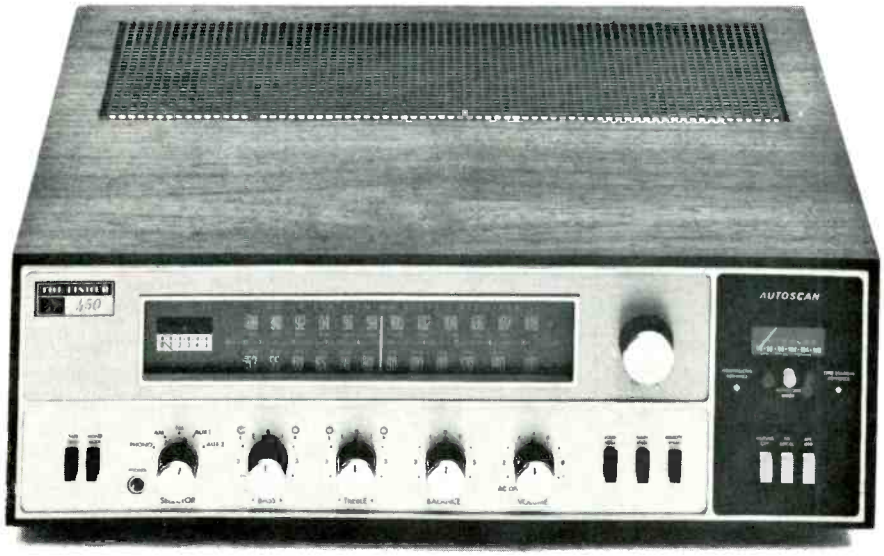

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"AutoScan is probably more accurate in tuning to center of desired channel than can be accomplished manually."

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Tape Guide

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HERMAN BURSTEIN

Q. I have been attempting to run a frequency response curve on my tape recorder. It is my purpose to determine the response of the entire recorder—including the record amplifiers, tape recording heads, playback heads, and the tape itself. I have tried several different methods to accomplish this; all of them involve inserting a sine wave at the input of one channel, recording it, and monitoring the playback amplifier output of the same channel. Depending on the procedure used, varying results were obtained in the frequency range below 12 kHz. With all methods, however, an extremely sharp dropoff was noted above 12 kHz. With this background information in mind, I ask the following questions What is the proper procedure for determining the frequency response of a component tape deck which will take into account the capabilities of the entire tape recorder system?—Walter B. Pearson, Panama City, Fla.

A. You make no mention of the recording level at which you conducted your tests. In checking the record-playback response of a tape machine, it is essential that this be done well below "normal operating level," for otherwise you run into tape saturation, particularly at high frequencies. In typical natural audio material there is usually substantially less audio power at high frequencies than at lower ones. Therefore tape saturation is unlikely to occur even though your record-level indicator shows that maximum permissible level has been reached. I suggest that you conduct your tests at a level at least 15 dB below maximum permissible recording level, as shown by your record-level indicator.

Further, you do not mention the tape speed at which you conducted your tests. At 7.5 ips, you have the right to expect of a quality machine that it will provide response flat within 2 or 3 dB out to at least 15,000 Hz. At 3.75 ips, however, you do not have the right to expect much beyond 12,000 Hz unless you are willing to make appreciable sacrifices in terms of distortion and signal-to-noise ratio.

Q. Can you tell me where I can find information on the procedure for optimizing my tape deck for low-noise tape. I would also like to know if plans for a bulk eraser have been printed somewhere.—David O. Hafemeister, Philadelphia, Pa.

A. Procedures for optimizing bias, record equalization, and record drive current should be obtained from the manufacturer of your tape machine, or from his authorized sales or service agency. In general terms, low-noise tape compared with conventional tape requires slightly greater bias, slightly higher recording level, and slightly less treble boost.

How to construct a bulk eraser from a power transformer was discussed on page 86 of my book, *How To Get the Most Out Of Your Tape Recorder* (John F. Rider Publisher, Inc., 116 W. 14th St., New York, N.Y.) I quote: "Disassemble the transformer, remove the E-shaped and I-shaped plates from the transformer core, re-insert only the E-plates so they all face in the same direction, and reassemble the transformer except for the casing. Attach lamp cord and a plug for the house socket to the leads of the primary winding. Be sure that you know which are the primary leads—usually they are black. Snip all other windings and tape them so they will not make contact with each other. Wind the bulk eraser with friction or rubber tape to protect the core and windings."

Q. I have a question regarding impedance matching of my transistor tape deck when connected to my tube preamplifier. Here are the rated input and output impedances of each to help you decide whether or not they are matched:

Tape deck preamp INPUT is 220k
Tape deck preamp OUTPUT is 10k
Tube preamp tape INPUT is 250k
Tube preamp tape OUTPUT is 1k terminating at 100k

Actually, I experience no audible troubles with my hookup of these two components, except that when recording a disc to tape I notice a slight decrease in bass response. Electrically, and perhaps audibly, what differences would impedance mis-matching produce? I have been told that as long as the INPUT *of any component is higher than the source* OUTPUT *there is no need for concern. Is this correct?*—Monte L. Henrie, Casper, Wyoming.

A. The general rule is that as long as the input impedance is at least 10 times the source impedance, the former has no significant effect on the latter with respect to frequency response, distortion, and signal level. Such is the case for your equipment.

As for the slight decrease in bass response when making a tape recording, this is probably due to the equalization circuit of your tape machine, most likely in playback. Seldom is equalization perfect. If one listens hard enough, he can almost always find some minute difference between the original and the copy. It is also true that the bass loss in your tape machine may be deliberate; some manufacturers go somewhat lightly on bass response in playback because by doing so they also reduce hum and thereby improve the signal-to-noise ratio.

Q. A question I have wondered about is what effect the width of a magnetic recording has on the quality of the sound. I know that the frequency response is limited by the speed of the tape, but I don't think I have ever seen anything on width. I can remember when sound was recorded on the full width of ¼" tape, and now the stereo tapes have four tracks in that space. There are tape cartridges with eight tracks, and I don't think the tape in them is any wider than ¼". Thank you for any information you can give me.—Charles L. Anderson, Sacramento, Calif.

A. A wide track (say the full width of the tape has the following characteristics relative to a narrow track (say 1/6th the width of the tape, allowing for three blank islands between four recorded tracks): (1) Higher signal-to-noise ratio because more information can be recorded on a wider track. (2) Greater freedom from dropouts because the wider track permits more room for tape imperfections to cancel out. (3) Less volume variation owing to changes in contact between the head and the tape. (4) Greater treble

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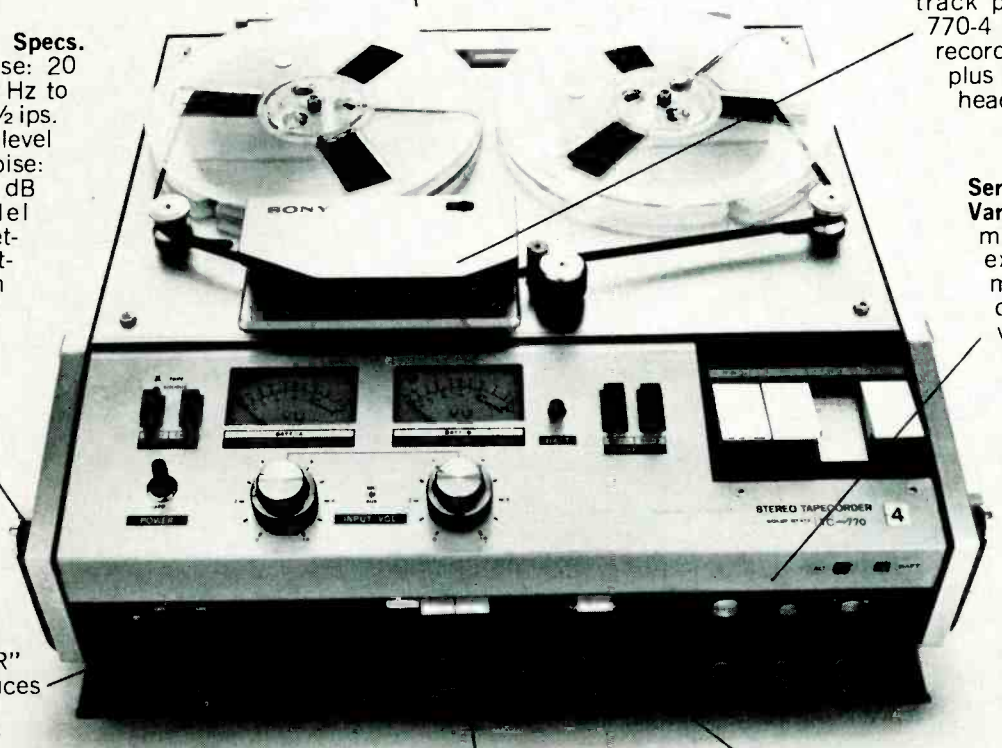
Better-than-Studio Specs. Frequency response: 20 Hz to 22 KHz, 40 Hz to 18 KHz ±2 dB @ 7½ ips. S-N ratio at peak level to unweighted noise: (Model 770-2) 58 dB or better; (Model 770-4) 56 dB or better. Wow and flutter: less than 0.09% @ 7½, less than 0.12% @ 3¾, less than 0.2% @ 1⅞.



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Three Speeds. 7½, 3¾, 1⅞ ips. Other features include two professionally-calibrated VU meters, built-in line-and-mike mixing, push-button operation, scrape flutter filter, low-impedance Cannon plug mike inputs, tape/source monitoring.

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loss in case of azimuth misalignment; for a given degree of azimuth misalignment, the narrower the track the less is the treble loss.

Q. I am planning to make a trip to Hawaii or Mexico and want to use a portable tape recorder to record the trip. Do you have to have a more sensitive mike than that comes with this tape machine?—Vern E. Long, Cleveland, Ohio.

A. Generally the microphone that comes with a tape recorder has sufficient sensitivity, although it may not have the width and smoothness of frequency-response characteristic of a high-grade microphone.

Q. I am very interested in tape recording and in tape duplication. Are there any laws concerning duplication for personal use and for small resale?—(Name Witheld)

A. There certainly are laws concerning copying of discs or tapes for resale. Even the practice of copying for personal use is open to legal question, although difficult to restrain in most instances as a practical matter. Also, AUDIO published an article in its May 1964 issue, *Tape Recorders and the Copyright Law*, that would help you.

Q. I would be much obliged if you would answer some questions about tapes that have been bothering me: (1) For certain purposes where high fidelity is not essential, second-line recording tapes should be suitable. However I have been told that such tapes might damage the tape heads. I would think that if the second-line tapes are rejected standard tapes, then the abrasive properties would be about the same. Am I correct? (2) Some catalog houses sell their own brands of tape. Can I assume that except for their lowest priced lines (comparable in price to second-line tapes) the house brands are equivalent to standard or professional tape as claimed? (3) I have been told that acetate tape will stick together under certain conditions. Whether or not this happens depends on the binder it would seem; therefore Mylar tape with the same binder would also stick. Is this right?—King Lee, Buffalo, N.Y.

A. (1) There is no guarantee that second-line tapes, as you call them, necessarily have the same physical characteristics, such as abrasive quality, as first-line tapes. For one thing, the second-line tape may be made to a price, so that less care is taken in keeping abrasion low. For another, the tape may have been rejected for first-line use because of its abrasive characteristics (as well as for other reasons, perhaps).

(2) I cannot comment on house brands of tape, partly because of lack of sufficient experience with the myriad of types available.

(3) I do not know whether Mylar has greater or less tendency to stick than does acetate. I have had no difficulty of this sort with either kind of tape, provided it has been of first quality.

Q. It has occurred to me that I could reduce noise of my tape system by turning up the treble while recording and turning it down during playback. Would you comment on this idea? Would the frequency response be reasonably smooth when operating in this manner?—King Lee, Buffalo, N.Y.

A. Yes, you could reduce noise by boosting treble in recording and reducing it in playback. In fact, one of the leading manufacturers of tape recorders uses or has used this idea for special purposes (such as tape duplication), with boost concentrated in the region of about 3000 Hz. However, if you employ ordinary treble boost, becoming ever greater as frequency rises (out to 15,000 or 20,000 Hz), you are likely to run into the problem of excessive distortion owing to increased treble emphasis. Keep in mind that the typical tape recorder already supplies a good deal of treble boost in recording, and if you add to this, the problem of distortion becomes quite serious.

Letters

Lowering Tape Hiss/Noise

• I read with much interest the "Tape Guide" feature in the September issue concerning R. B. Martin's question on tape-noise problems. In addition to the suggestions Herman Burstein gave to reduce effects of noise is to utilize a bulk eraser prior to recording, even on a reel of new tape, and to use less treble boost on the amplifier. To spot the effects of utilizing a bulk tape eraser one only has to run a reel of new tape through a tape deck and turn up the volume control until tape hiss/noise can be heard, then bulk erase it and run the reel again and see how much further the volume control can be advanced to get the same level of tape noise.

MARTIN L. DULING
A.P.O. New York, N.Y.

John Philip Sousa Recordings

• The reviewer of "John Philip Sousa conducts his own Marches" (Everest 3260) surmises that the originals used were acoustical recordings of the early 1920's. This may have discouraged some readers from buying the album; others may have listened for what isn't there, failing to hear what is there. I have compared the stereo reissue with Sousa Band 78's in my own collection, and the actual sources would appear to be as follows: "Washington Post" and "El Capitan," Victor 20191; "Stars and Stripes Forever," "Fairest of the Fair," 20132; "Hands across the Sea," 22940.

These five were recorded electrically between 1927 and 1931, and thus should sound rather better than "The Thunderer" and "Jack Tar" (16151) and the three non-Sousa compositions, recorded acoustically some 20 years earlier. In no case does the original label show Sousa as conducting in person, though he is identified as guest conductor of a Philadelphia band in an electrical recording of his "March of the Mitten Men" (since recorded only by the Deutschmeister Band, as "Power and Glory") and "The Thunderer."

Let's hope for more reissues of Sousa and/or his band, though not at the expense of new recordings by the few remaining great bands.

FRANK R. MCGUIRE
Ottawa, Canada

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EDITOR'S REVIEW

■ The audio part of the magnetic recording industry is estimated to have worldwide sales of $841 million in 1969. (As a reference point, total hi-fi components industry sales approximate $300 million.) Pretty good for an industry that didn't really get its commercial start until 1948 when Ampex offered its Model 200 magnetic recorder. The consumer section of the industry is well represented by the Tape Recorder Buying Guide presented in this issue.

The cassette tape format is growing like Topsy. A problem plaguing the industry, however, is the poor quality of some low-priced cassettes. Without standardization at this writing (the EIA is hard at work on this), and with little likelihood of being able to enforce standards anyway, the end user might well experience some difficulties when he uses cheap blank cassettes.

Pre-recorded stereo cassettes got a boost recently when Ampex Stereo Tapes announced full-length operas on the cassette format. These include London's "La Traviata." "La Boheme," "Tosca," and others. Among the artists performing are Renata Tebaldi, Birgit Nilsson, and Joan Sutherland. As an example of length and cost, "La Traviata" is about two hours long, is contained on two stereo cassettes, and is priced at $14.95.

The cassette format is blossoming forth for video tape recorders. Sony is showing a low-cost video tape system in Japan that uses cassettes. The playback unit is expected to be priced around $350, and the target date for introduction of the video player is reported to be late 1970. A $100 adapter is said to add monochrome and color recording capability to the unit, which, says a spokesman, can be used with any standard TV set without modification. Panasonic, too, is said to have a magazine-loading VTR system which is scheduled for 1972 marketing in this country. Victor of Japan and Hitachi, Ltd. are both reported to be readying video cartridges.

Collectors of historical recordings on 78-rpm records will be interested in some new equipment that is said to improve sound of the "oldies but goodies." Called the "Sonic Attenuator," Model A, a single-channel unit, features five controls: Bypass, for before/after comparison; Low pass-1, for high cutoff settings; Low pass-2, for high cutoff settings; Midrange, for boost and attenuation; Bass, for boost and attenuation. Model B, a two-channel operation unit, has the same controls. Prices are $78.00 and $150.00, respectively. For more information, write to A. Schifrin, 214-05 Richland Ave., Flushing, N.Y. 11364.

* * *

Superscope, Inc. announced the release of three 33⅓-rpm LP albums on the Superscope label of the "Keyboard Immortal" Series. Marking the company's entry into the classical record field, the albums include music heard only over the Sony/Superscope-sponsored radio programs, which were reproduced from music rolls which were originated on a piano that recorded music originally performed by artists as long ago as 70 years. The initial releases feature performances by Rachmaninoff, Debussy and Hofmann.

* * *

High Fidelity Shows will take place in Philadelphia (February 13, 14, and 15) at the Benjamin Franklin Hotel and at Atlanta (March 20, 21, and 22) at the Sheraton-Biltmore Hotel, according to its producer, Teresa Rogers.

* * *

A new, interesting car antenna was introduced at a recent radio exhibit show in Germany. Manufactured by Kolbe, it is a printed-circuit AM/FM bandpass antenna circuit that has separate transistorized amplifiers. The whole works is housed in an automobile side mirror. The pickup element itself is the rim of the mirror, which is spring-mounted so that it can be adjusted easily. *A.P.S.*

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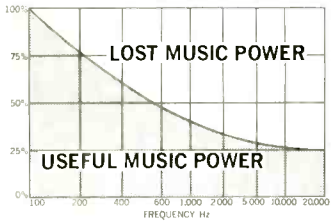
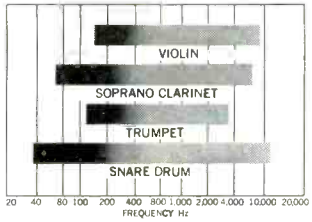
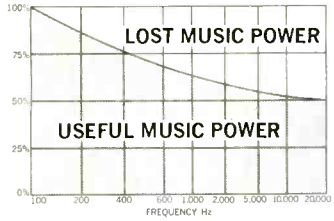


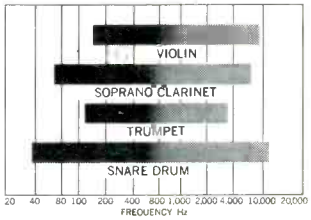
CARTRIDGE "C"
at 25% Music Power



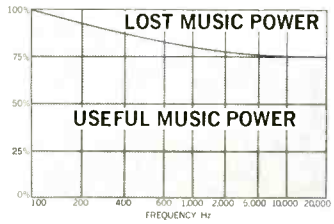
. . . a serious loss of definition occurs: because cartridge "C" has completely lost 75% of the Music Power at the higher frequencies.



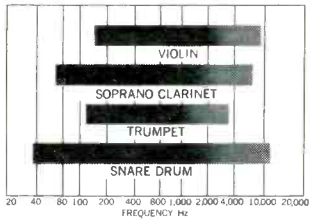
CARTRIDGE "B"
at 50% Music Power



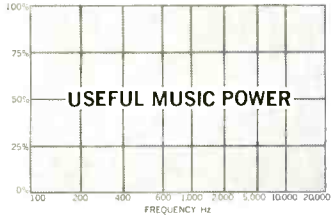
. . . in this case you lose definition of tone and instruments: because cartridge "B" loses as much as 50% at higher frequencies.



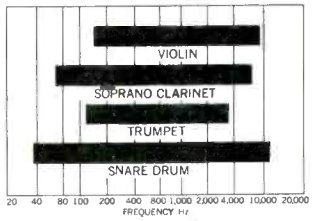
CARTRIDGE "A"
at 75% Music Power



. . . the instruments seem a little faded in the upper frequencies: because cartridge "A" attenuates higher frequencies as much as 25%.



XV-15
at 100% Music Power



. . . the instruments, all of them, are distinct and clear throughout the entire fundamental frequency range.

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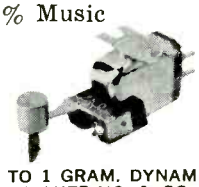

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Quadrasonics On-The-Air

LEONARD FELDMAN

The state-of-the-art of "simultaneous 4-channel stereo" from a single stereo FM station

THE COMING OF 4-CHANNEL SOUND in the home has been discussed more than once in recent issues of AUDIO. Suddenly, a long-dormant interest in multi-channel sonic reproduction seems to be coming from all segments of the audio and high-fidelity industry.

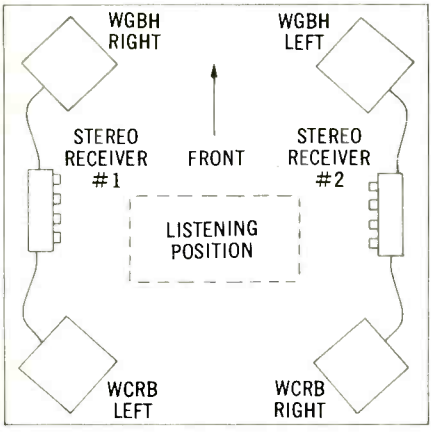


Fig. 1—Suggested speaker arrangement for the Boston Symphony 4-channel broadcasts.

The first practical program source to supply material for 4-channel listening was, of course, pre-recorded tape. Computer technology has, for many years, been utilizing 8, 12, 24, and even more channels of information on a single reel of tape. It is therefore rather surprising that more than three decades of time have elapsed since we were treated to the marvelous aural experience of Walt Disney's *Fantasia*. Those of us who are old enough to remember our first reaction to that version of "total surround stereo" have perhaps wondered over the years why such an all-encompassing sonic experience has been denied us. Apparently our patience is about to be rewarded.

If and when the history of 4-channel sound is ever written in the future, several individuals and firms will be mentioned as having been responsible for this new interest in 4-channel sound. There will be those, too, who will skeptically maintain that this new approach to home music listening is nothing more than a sales gimmick thought up by greedy manufacturers intent upon selling "another pair of everything." These skeptics simply haven't heard total surround stereo. To hear it is to realize what has already become a cliche in this brand-new technique: "the difference between 4-channel and conventional stereo sound is perhaps greater than between 2-channel stereo as we know it and monophonic reproduction."

Vanguard Recording Company and Acoustic Research, Inc., must be credited with stimulating the initial new interest in this field. In cooperation with FM radio stations WGBH and WCRB in the Boston area, these two firms have been sponsoring a series of live symphonic concerts utilizing the regular subscription series of the famed Boston Symphony Orchestra.

Figure 1 illustrates the layout of the four loudspeakers and the two FM stereo receivers required in a home listening situation. Two things are apparent when you examine this figure. A great deal of equipment is needed and the distribution of 4-channel information is very odd. When we first saw this diagram we questioned the wisdom of putting the front-left and rear-left on one FM station while the other station carried front-right and rear-right information. What sort of a lopsided program would the listener equipped with only *one* stereo receiver hear?

Recently we had an opportunity to discuss this problem with Mr. Richard Kaye, one of the directors of participating station WCRB. Once he explained the microphone placement used in the concert hall and diagramed in Fig. 2, we realized the nature of the problem. Had WCRB elected to broadcast front-left and front-right and relegated the rear-left and rear-right to cooperating station

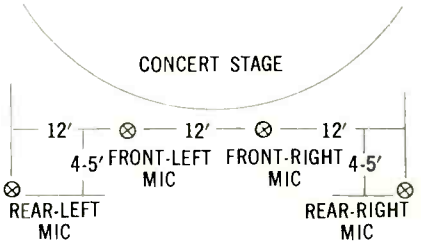


Fig. 2—Placement of microphones.

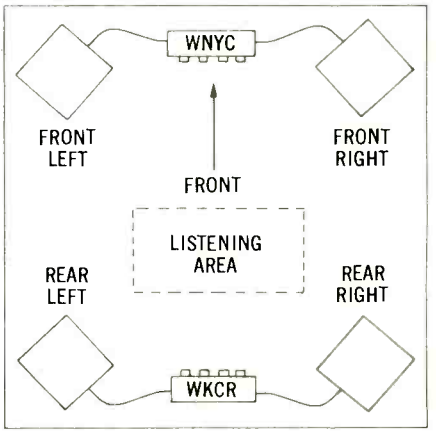


Fig. 3—In New York experiments, the "primary" stereo channels are carried by WNYC-FM, while WKCR carries the rear-right and rear-left channels.

WGBH, can you imagine the phone calls that WGBH would have received from its irate listeners? The microphone placement shown in Fig. 2 was an attempt to offer all things to all listeners. While the left two microphones were designated as left-front and left-rear, the left-rear microphone was, in fact, considerably further to

the left than the left-front and only four or five feet behind it. The same arrangement applied to the two right microphones. In this way, it was hoped that a listener equipped with a single stereo receiver would still experience a fair amount of separation, while the hearty souls able to set up dual stereophonic systems would experience some of the ambient qualities of the symphony hall—the avowed purpose of the 4-channel experiment in this instance. Listeners have been most enthusiastic, but we wonder if this enthusiasm is prompted by the novelty of the 4-channel listening experience rather than by its state of perfection.

Beginning October 26, 1969, New York City audiophiles were able to duplicate the experience of the Boston listeners. Harry Maynard, host of the popular "Men of Hi-Fi" program broadcast weekly over WNYC, has crusaded for 4-channel stereo. With the assistance of members of the New York Audio Society who helped to publicize the broadcast and the cooperation of radio stations WNYC-FM and WKCR, (WNYC-FM is the municipally run broadcasting facility and WKCR is operated by Columbia University), 4-channel stereo broadcasting is a regular event in the New York City area. Unlike the Boston experiment, however, the channel arrangement is as shown in Fig. 3.

Admittedly, WKCR must be making ing a supreme sacrifice in agreeing to carry just the rear-right and rear-left channels. As of this writing we don't know what the reaction will be from listeners attempting to tune in to WKCR on Sunday night at 10 p.m. utilizing either a single monophonic FM receiver or even a conventional 2-channel stereophonic receiver. Those of us involved in the New York experiment felt, however, that this microphone arrangement will provide greater impact for 4-channel listeners than would be possible with the Boston arrangement. It is apparent, I think, that both arrangements have serious limitations. We are reminded of similar compromises that took place in the mid-1950s when early attempts at stereophonic broadcasting were confined to AM/FM combinations. True, the problems inherent in those early experiments were even greater, since the quality of the AM channel was so inferior with respect to noise and frequency response. Although the current experiments at least involve all-FM transmission, there do exist somewhat more subtle problems, such as: phase relationships between the cooperating stations, distances from each transmitter to a given receiver, compounded multipath effects, etc.

As was true in the 1950s, a better way will have to be found. William S. Halstead, a noted pioneer in the field of multiplex FM (and one of the many system proponents for stereo FM in the late 1950s), and myself, have proposed at least one solution to the problem. Before describing our proposal, I would like to make it clear that this is by no means the *only* method possible. When 2-channel stereo FM was being considered by the FCC, some 17 systems were proposed before the presently adopted system was approved. We have no doubt that others will come forward now as well. In any event, the system we are proposing does work, permits a single FM station to broadcast four distinct channels of information simultaneously and (subject to certain qualifications which will be discussed in a moment) is compatible with the requirements of effective 4-channel musical reproduction as we presently understand them.

Figure 4 shows presently approved spectrum distribution of a single FM channel engaged in stereo and SCA (background music, etc.) transmission. Main-channel material occupies the range from 50 to 15,000 Hz. The stereo pilot subcarrier can be seen at 19,000 Hz, modulating the main carrier approximately 10 per cent of the total. Stereophonic (L−R) information is contained in the range from 23,000 to 53,000 Hz. Finally, the SCA subchannel is located at a nominal frequency of 67,000 Hz and since it is an FM subcarrier, is seen to occupy the total range from 59 kHz to 75 kHz. The presence of the private-subscriber SCA subchannel necessitates a reduction in deviation of the main and stereo subchannels to a

Fig. 4—Presently authorized modulation and frequency distribution for stereo FM plus SCA broadcasting. (Only one half of spectrum is shown—other half is mirror image to left of the "0" or carrier-frequency line.)

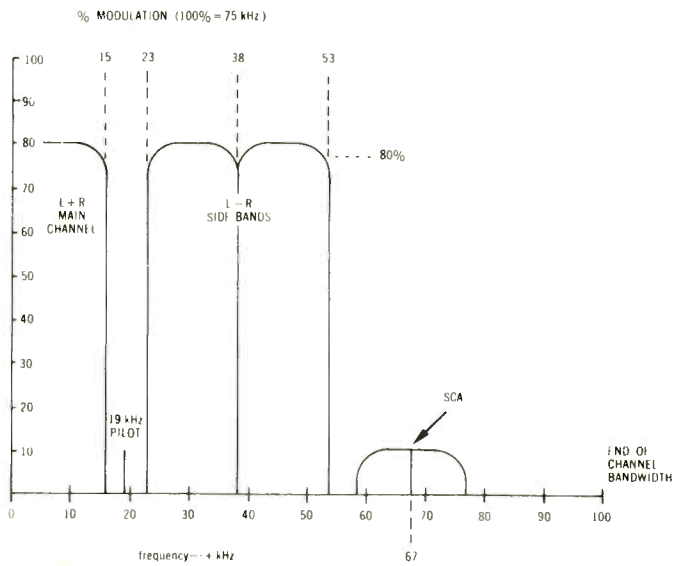
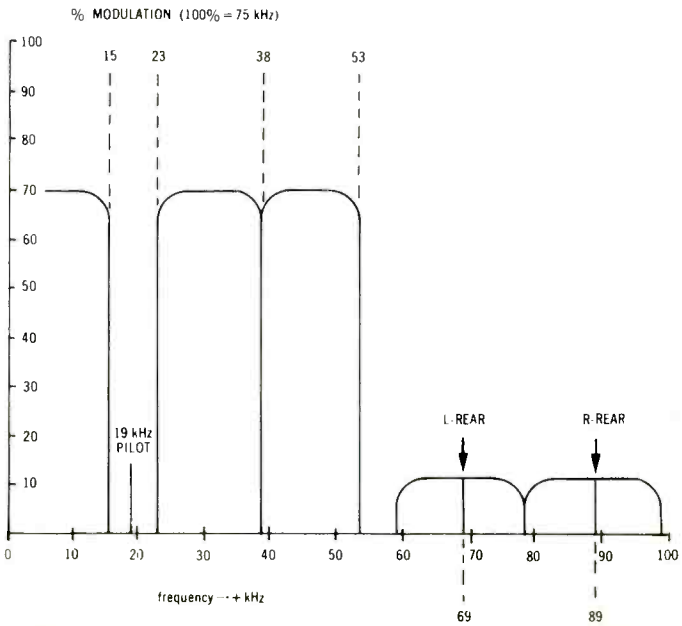


Fig. 5—Proposal for 4-channel FM multiplex broadcasting system, again showing only one half of the entire spectrum.



maximum of 80 per cent. Thus, total deviation consists of 80 per cent main and stereo subchannel, 10 per cent pilot carrier and 10 per cent SCA.

Figure 5 illustrates the new spectral distribution proposed by Mr. Halstead and myself. All we have done is to add a second FM subcarrier at a frequency of 89 kHz (or thereabouts), shift the previously used SCA subcarrier to approximately 69 kHz, and back off the main and stereo subchannels an additional 10 per cent so as not to exceed 100 per cent modulation for the total composite signal. In terms of s/n it is interesting to note that our two "rear" subchannels (for we intend to use them for rear-left and rear-right information) are expected to be as good or possibly better than the presently used stereo subcarrier sidebands. This is so because the presently used L−R sidebands are AM in nature whereas our proposed subchannels will be modulated in an FM mode.

What about frequency response for our two additional channels? Our early experiments indicate that it will be possible to broadcast frequencies as high as 10,000 Hz. We realize that the purists will scream and call this "lo-fi." To evaluate the adequacy (or inadequacy) of these parameters accurately, we must examine just what it is we're trying to accomplish with the addition of the third and fourth channels. If we are trying to duplicate more realistically the reverberant effects experienced in the live concert hall, there is sufficient evidence on hand to justify this modest frequency limitation imposed upon the extra channels, since their function is that

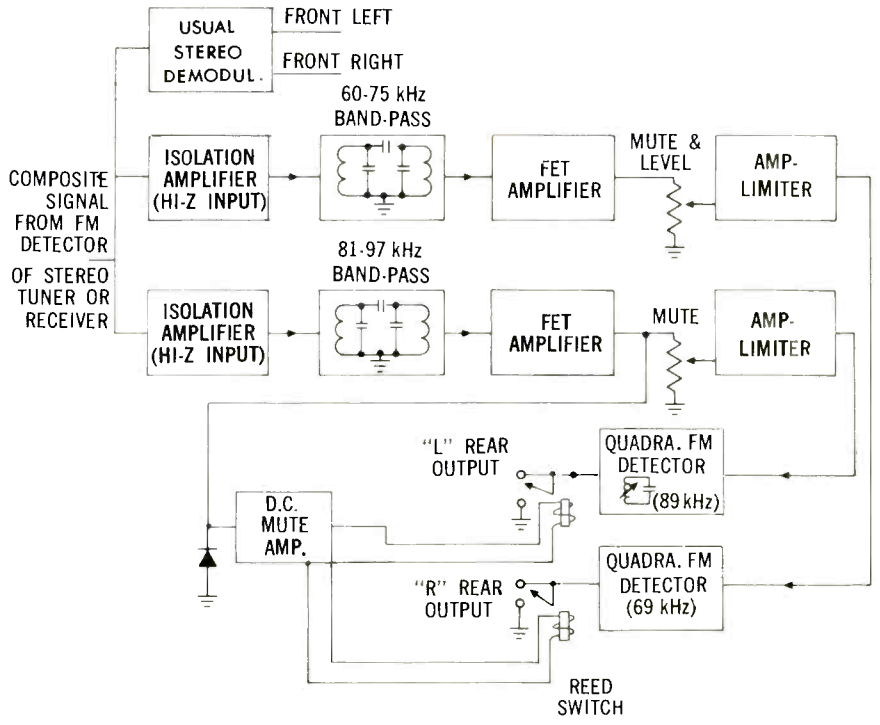


Fig. 6—Block diagram of 4-channel stereo FM adapter used to recover the 3rd and 4th channels.

of reinforcement and not that of providing primary musical information. If, on the other hand, the many popular musical forms on the scene plan to use the four channels for new creative effects (such as putting each member of a four-piece combo in his own corner), then it might be argued that all four channels must be equal in fidelity.

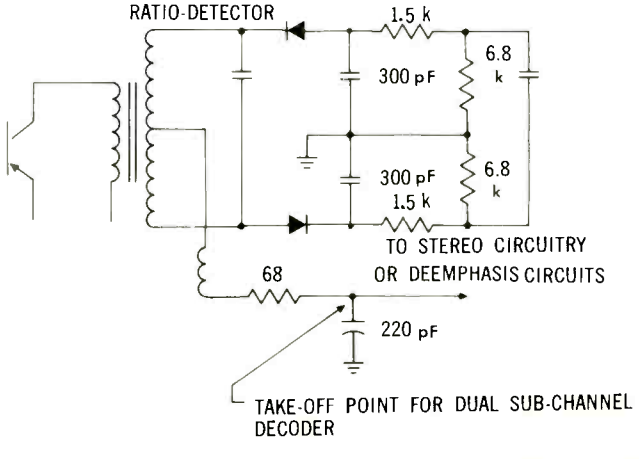
It is our contention that unless the recording session is "gimmicked" to the extent of recording these four instrumentalists in totally separate studios (a trick resorted to very often in the early days of stereo), primary spatial information is sensed from fundamental tones rather than from harmonics or overtones. If this is so, then limitation in frequency response of the third and fourth channels will not perceptibly degrade the listenability of the end product.

Currently, radio station WNYC-FM has requested permission from the FCC to transmit this system on an experimental basis. If, and when, the FCC grants permission, these questions and a great many technical-feasibility questions will be answered in short order. Since such requests

(Continued on page 78)

Fig. 7—The author about to measure performance of the first decoder designed to work with the Halstead 4-channel stereo FM broadcasting system.

Fig. 8—Typical ratio-detector circuit, showing connection point for "3rd-&-4th-channel" decoder.



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SPLICING TAPES

ANDREW H. PERSOON*

THE ART OF SPLICING evolved very shortly after the first piece of recording tape broke. While seemingly unimportant, quite a bit goes into achieving the "ideal splice" —enough to assure cleaner recordings and better-functioning equipment when properly done.

A proper splice is one that will remain intact for an indefinate period of time. It must be mechanically strong, have a minimum of "adhesive escape" around the edges of the splice, and must in itself produce no audible disturbances.

While all these considerations are quite familiar to recordists, there are considerations from a manufacturing standpoint as well as some fundamental procedures which lead to correct splicing.

Tape Construction

Any pressure-sensitive tape takes two components into consideration in its design: Backing and adhesive coating. While there are many types of adhesive tape on the market, only one set of combinations is truly suitable for the splicing of magnetic recording tape.

The backing for a splicing tape has to be tough and durable while being as thin as possible. Paper is not suitable, so plastic is used instead. Both acetate and polyester backings are currently being produced for splicing tapes.

The adhesive presents other design problems. Three basic adhesive qualities must be considered: (1) Shear adhesion, (2) peel back or ASTM adhesion, and (3) wet grab.

Shear adhesion is the resistance of an adhesive to being parted from its adhered surface by a full force in what is called the shear direcion. (Fig. 1).

Peel-back (ASTM adhesion), is a measure of the adhesive's resistance to being peeled away from the surface to which it is adhered. (Fig. 2).

"Wet grab" is an elusive quality. It is more popularly referred to as "thumb appeal" or "quick stick." It is the quality of an adhesive to feel sticky. Oddly enough, it is not an important quality as far as the actual strength of the bond is concerned, but it is a quality readily noticeable by the user. Completely untrue is the statement that the stickier the tape feels, the better the splice.

*Technical Director,
Magnetic Products Div.,
3M Company.

A tape with high "wet grab" might improve peel back adhesion, but this apparent advantage may result in damage to the equipment and recording tape.

First of all, a sticky adhesive creates a bond on recording tape that produces excess "ooze" which may actually bond one layer of tape to another within the tape reel. The more pressure exerted on the splice, the more probable "ooze." The result might be the complete removal of oxide on the layer of tape above the splice on the reel, or worse, complete blocking of the reel.

Secondly, an increase in "wet grab" decreases shear strength. If this is reduced, the tightly butted ends of the recording tape—essential for an inaudible splice—could "creep," and may leave adhesive on the recorder's heads and tape guides—in addition to the problems already mentioned.

A properly designed splicing tape, then, does not feel "sticky" by intentional design—yet will produce a strong bond.

Splice Geometry

There are several variations in splice geometry, the right one depending on the conditions of use. Necessarily these considerations include the size of the spliced area and the angle at which tape ends meet each other.

The length of a splice depends on the amount of curvature it will have to sustain in its path from reel to reel, (Fig. 3). As a recording tape passes around the curved surface of a

Fig. 1—Shear adhesion (creep).

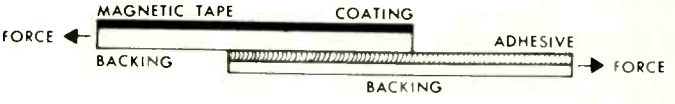
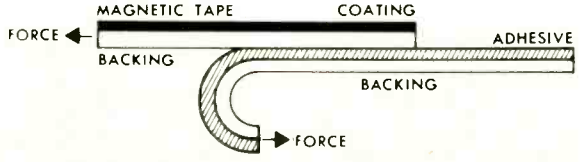


Fig. 2—ASTM adhesion (peel-back)



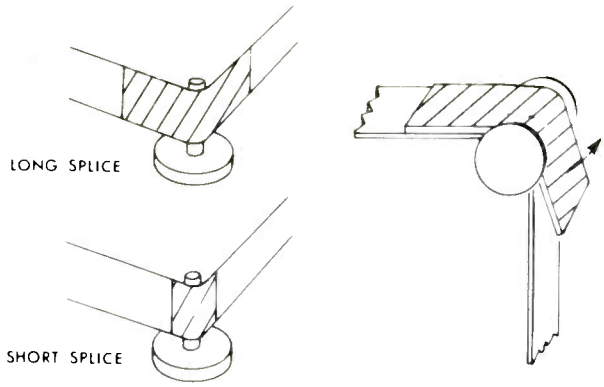


Fig. 3—Splice length and bend radius.

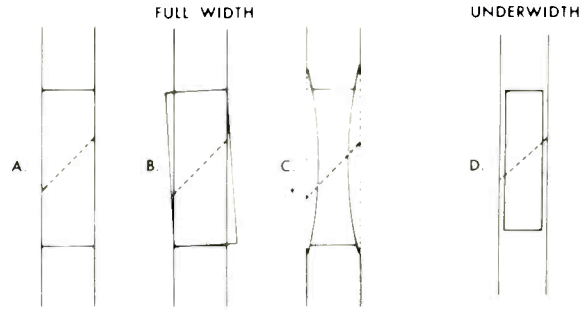


Fig. 4—Splicing widths: (A), full-width, properly done; (B), full-width, carelessly trimmed; (C), full-width, with an arc cut in the sides; and (D), under-width splice.

guide, as is shown at (A), there is a tendency for the leading edge of the splicing tape to continue in its original direction, as at (B). In effect, it is attempting to peel itself away from the recording tape, and is an example of one design parameter: Peelback (ASTM) adhesion. Here, the length of the splice has no effect on the tendency to peel, but is important for another reason.

A short splice, as at (C) Fig. 3 may tend to loosen if subjected to a tight bend because the area of peel may extend far enough into the tape's bond to free one end of the recording tape.

A longer splice solves this problem extending beyond the splice junction. Even if the splicing tape tends to peel at a guide, the junction remains undisturbed. Once the tape is wound again on a reel, pressure from succeeding wraps of recording tape secure the splice firmly by pressure.

Generally, this rule of thumb evolves: The smaller the radius of the bend expected, the longer the splice.

As we have mentioned, the tendency to "creep" is dependent on the shear strength of the splicing tape adhesive. The force that opposes this shear strength is, of course, the amount of tension the tape encounters on the transport and while wound on a reel during storage, (shear strength is constant for a given splicing tape). If subjected to a constant tension—for example a properly adjusted transport—the variable affecting "creep" is the area of the bond. The larger this area, the better the "creep" resistence.

Carrying this thought further, a splicing tape with a poor adhesive shear strength could be used if the area of the splice were increased. Limited by the width of recording tapes—¼-inch—the area could only be increased by additional length. A spliced bond of two or three feet would increase shear strength, but realistically would be impossible to execute mechanically. Since program material exhibits a drop in level of 2 to 4 dB in the area of the bond; the shorter the splice, the less disturbance during playback, a fact supporting the need for a splicing tape with high adhesive shear strength.

Splicing Tape Width

Should the splicing tape be the same or narrower in width than the recording tape? Several considerations affect this decision.

When using a full-width splicing tape, care must be taken not to overlap the edges of the recording tape being spliced. Adhesive may adhere to adjacent tape layers causing problems similar to those encountered with ooze. While splicing jigs are available which cut an arc into each side of the splice —to eliminate overhang—the possibility of adhesive "ooze" remains.

A narrow-width splicing tape offers a number of advantages with no apparent disadvantages: (1), Overlap is eliminated completely; (2), A simple splicing jig may be used, eliminating undercutting; and (3), Overall bond area is not materially affected.

(Figure 5 shows four examples of full- and under-width splices)

Splice Angles

Ideally, a recording tape to be spliced will be cleanly cut at an angle of 45 to 60°—measured with respect to the tape edge. As the angle increases above 60° toward the perpendicular, the amount of electrical disturbance is increased because the recorder head sees the discontinuity as an abrupt change—producing an annoying pop or click.

A shallower angle produces less disturbance, but as the angle is decreased below 45°, the pointed corners of the recording tape become extremely vulnerable to being peeled back or actually debonding.

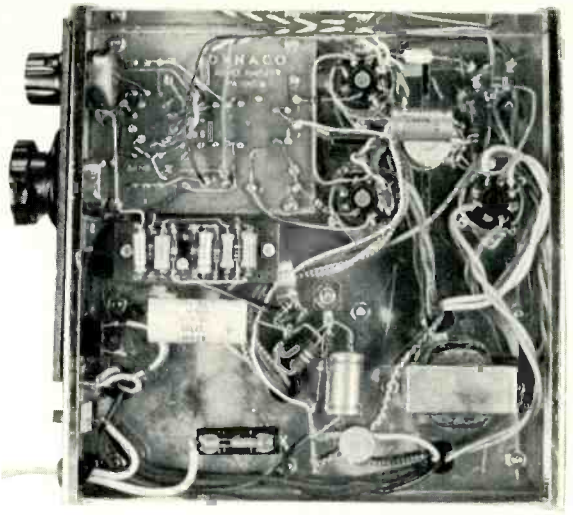
Commercial jigs are available which produce the ideal 45° splice angle as well as affording a means for an even, clean tape cut.

Tape Handling

Cleanliness is probably the most important consideration in making a good splice. Hands especially should be free from oil or dirt as a single oily fingerprint can reduce output several dB. Also, contamination of the backing or adhesive can reduce the strength of the board—possibly inducing bond failure. The cut itself must be executed cleanly using a sharp *demagnetized* razor blade. When handling the pressure-sensitive splicing tape, care should be taken not to touch the adhesive more than necessary. After carefully aligning and splicing the tape, all air pockets should be removed with the fingernail to promote a secure bond. Æ

BUILD THIS VARIABLE FREQUENCY POWER SOURCE

C. G. McPROUD



The completed Dynaco Mark III amplifier after conversion to a 60-watt variable-frequency generator. The offset carrying handle straddles the center of gravity.

THERE ARE MANY TIMES when the hobbyist, recordist, or engineer wants a source of variable frequency.

He may want to change the pitch of a record or tape played on a machine which does not incorporate a vernier frequency control; he may be interested in experimenting with electronic music; or if he is an engineer, he may want to find out how a variation in supply frequency affects the performance of his equipment.

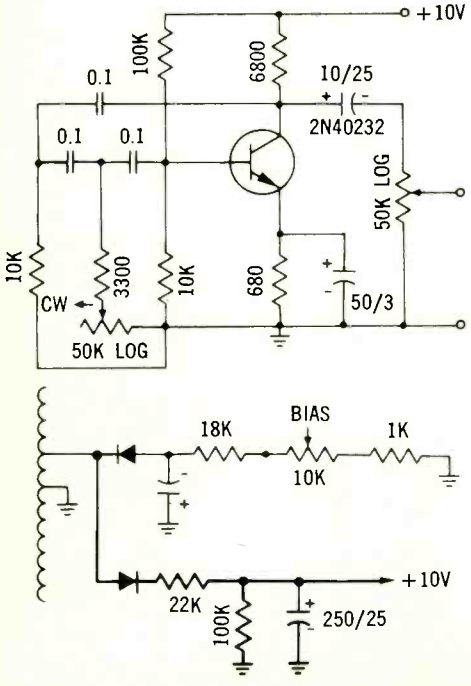
Falling in the latter category, the writer found that a variable-frequency source was necessary in testing equipment. One could, of course, start from scratch and build a professional instrument, or possibly he could buy such a device ready made at a cost of a few hundred dollars. A quick study of the requirements shows that the desired 117 volts could be obtained from a conventional amplifier with a 500-ohm output. To have sufficient power to drive a turntable or most any tape recorder would require an output of, say, 60 watts. The output voltage across a 500-ohm secondary—the desired 117—would mean that the output power would have to be a *minimum* of 27.38 watts from the formula $E^2/R=P$.

The desired output impedance could be obtained by connecting a 500:8 line transformer backward across the output of a conventional amplifier, but that would mean that some form of generator would still have to be connected to the input. The logical solution would be to take a 60-watt *tube-type* amplifier with a 500-ohm output and build into a simple variable-frequency generator.

There are many 500-ohm amplifiers available, but in general they are PA types and relatively expensive. The most reasonable solution was to obtain a Dynaco Mark III amplifier with a 500-ohm output transformer and build the generator into it.

The next problem was that of the

Fig. 1—Schematic of the oscillator section (upper) and the power-supply changes (lower) for the variable-frequency generator.



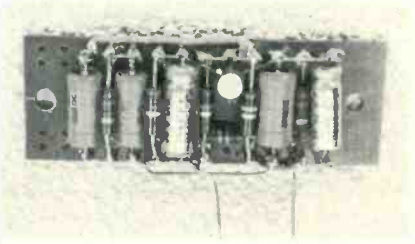


Fig. 2—The completed oscillator circuit assembled on a resistor-mounting strip.

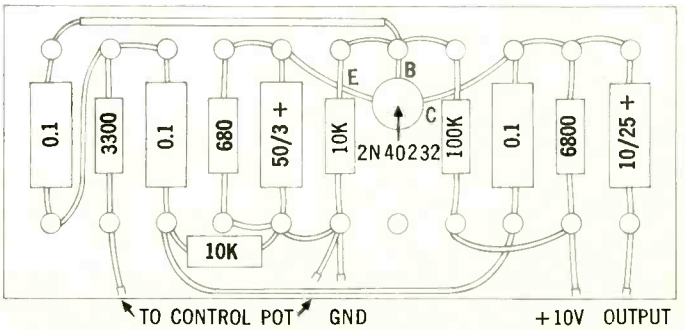


Fig. 3—Pictorial of the resistor-mounting strip assembled as a variable-frequency oscillator.

We suspect that the new Dual 1219 will get a warm reception from the independent testing labs. For the same reasons that they welcomed earlier Duals.

With so many similar audio products, equipment reviewers appreciate innovations. And Dual has traditionally obliged them.

The 1219 continues this tradition in many ways.

One of the 1219's features that sets it apart from all other automatics is the Mode Selector that shifts the entire tonearm base down for the single-play mode and moves it up for the multiple-play mode. The tonearm is thus able to track at the ideal 15° stylus angle whether playing one record or the middle record of a stack. (Instead of tilting down on single records.)

Another "first" is the 1219's tonearm suspension which is a true four-point ring-in-ring gyroscopic gimbal. The tonearm pivots vertically from an inner concentric ring which, in turn, pivots horizontally from a fixed outer ring. The tonearm is centered within these rings and pivots on four identical needle bearings.

The 1219's anti-skating system is also noticeably different. It provides a separately calibrated scale for each stylus type, conical or elliptical. (Elliptical styli create more skating force than do conical styli.)

Another touch of Dual precision is the tonearm counterbalance. As it is rotated, there's a click for every hundredth-gram. (Makes balancing easier and faster, especially when interchanging cartridges of different weights.)

Several other 1219 features might be mentioned. Effective tonearm length is 8-3/4", longest of all automatic arms. The 12-inch 7-pound platter is dynamically balanced. The cue control is damped in both directions, so the arm moves with equal delicacy, and without bounce whether you're raising or lowering it. And the motor combines high starting torque with the absolute constancy of synchronous speed.

Although we can anticipate all the above features and refinements being welcomed by the testing labs, we don't presume to predict how they might be evaluated in terms of performance. Which, after all, is what really counts.

But reviews of earlier Duals have included terms like "superior, uncompromised performance" and "one of the finest record playing mechanisms I have used."

Reviews like these aren't easy to top, but if any automatic turntable can do it, we believe the 1219 can. Even though its price of $175.00 may cause the reviewers to set their standards correspondingly high.

Until the reviews are published, we can only suggest that you write for our descriptive literature, or see the 1219 yourself at your dealer. Then write your own review.

United Audio Products, Inc., 120 So. Columbus Ave., Mount Vernon, New York 10553. Dual

The Dual 1219 should give the testing labs something new to talk about.

Only Marantz Has a Built-in

What's a Marantz?

Any audio engineer or stereo hobbyist will tell you Marantz builds the world's finest high-fidelity components. And has for fifteen years.

This message, therefore, is not to engineers but to professional musicians, serious music-lovers, and beginning stereo hobbyists. We'd like to introduce you to Marantz.

Never Heard Of Marantz?

Until this year, the least-expensive Marantz stereo component you could buy cost $300.00. And our FM tuner alone cost $750.00! To own a Marantz, you either had to be moderately wealthy or willing to put beans on the table for awhile. But it was worth it. And a lot of experts thought so, too, because the word soon got around, and the products sold themselves.

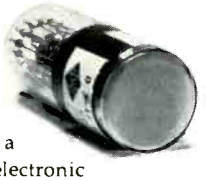
What The Competition Said

The chief design engineer of a major competitor once said that no one even tries to compete with many of Marantz' sophisticated features; it would be just too expensive. Marantz designs its circuits the same way the aerospace industry designs missiles and jet planes – for utmost performance and reliability.

Built-In Oscilloscope

The unique features of a Marantz component are there for only one purpose: to make possible the highest level of listening enjoyment.

That's why we put an oscilloscope in our best components.



An oscilloscope is kind of a TV tube. But instead of the "Wednesday Night Movie," it shows you a green wavy line. An electronic picture of the incoming FM radio signal, telling you exactly how to rotate your antenna for minimum multipath distortion (ghost signals) and maximum signal strength (clarity) even from the weakest stations.

The "scope" also shows correct stereo phasing: that is, whether the broadcasting transmitter or your equipment is out of phase. And it lets you set up optimum stereo performance and reception to create a solid "wall" of sound.

Features, Not Gimmicks

You've probably never heard of Butterworth filters because no one else

uses them besides Marantz. And the U.S. Military. Other manufacturers feel they can get by without them. And they can. Because their standards don't have to measure up to Marantz'. Butterworth filters let you hear music more clearly, with less distortion, and, unlike conventional I.F. coils or filters, they never need realignment. They help pull in distant FM stations and separate those right next to each other on the dial.

Although Butterworths cost more, Marantz designed not one but four of them into our Model 18 receiver.

Marantz also offers a different tuning experience because you rotate the actual tuning flywheel. This results in the smoothest, most precise tuning possible. And this Marantz-exclusive design requires considerably fewer moving parts than conventional systems used by other manufacturers. The benefits: reduced friction, wear, and service problems. We call this patented feature "Gyro- Touch tuning."

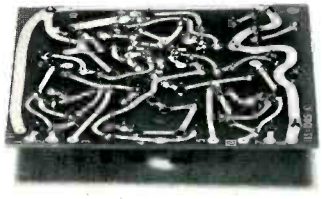
Built To Last

Marantz stereo components aren't built in the ordinary way. For example, instead of just soldering connections together with a soldering iron, Marantz uses a highly sophisticated waveflow soldering machine – the type demanded by the Military. The result: perfect, failproof

Oscilloscope!

connections every time.

Even our printed circuit boards are a special type—glass epoxy—built to rigid



military specifications, ensuring ruggedness and dependability.

Marantz Power Ratings Are True

When someone tells you he has a "100-watt amplifier," ask him how the power was rated. Chances are his 100 watts will shrink to about 75 or 50 or perhaps even as few as 25. The reason is that most manufacturers of stereo amplifiers measure power by an inflated "peak power," or "IHF music/dynamic power."

Marantz states its power as "RMS continuous power" because Marantz believes this is the only method of measurement that is a true, absolute, scientific indication of how much power your amplifier can put out continuously over the entire audible frequency range.

But if Marantz *were* to use the unscientific conventional method, our Model Sixteen 80-RMS-80 power amplifier could be rated as high as 320 watts per channel!

Moreover, you can depend on Marantz to perform. For example, the Marantz Model 16 can be run all day at its full power rating without distortion (except for neighbors pounding on your wall). That's power. And that's Marantz.

Marantz Speaks Louder Than Words

In a way, it's a shame we have to get even semitechnical to explain in words what is best described in the medium of sound. For, after all, Marantz is for the listener. No matter what your choice in music, you want to hear it as closely as possible to the way it was performed.

In spite of what the ads say, you can't really "bring the concert hall into your home." For one thing, your listening room is too small. Its acoustics are different. And a true concert-hall sound level (in decibels) at home would deafen you.

What Marantz does, however, is create components that most closely recreate the sounds exactly as they were played by the musical performers. Components that consistently represent "where it's at" in stereo design. And no one gives you as much—in any price range—as Marantz.

Every Marantz Is Built The Same Way

Every Marantz component, regardless of price, is built with the same painstaking craftsmanship and quality materials. That's why Marantz guarantees every instrument for three full years, parts and labor.

Now In All Price Ranges

Today, there is a demand for Marantz quality in other than very-high price ranges. A demand made by music-lovers who want the very best, no matter what their budgets. True, you can still invest more than $2,000.00 in Marantz components, but now we have units starting as low as $199. Though these lower-priced models do not have every unique Marantz feature, the quality of *all* models is the same. Marantz quality.

And quality is what Marantz is all about.

Hear For Yourself

So now that you *know* what makes a Marantz a Marantz, *hear* for yourself. Your local dealer will be pleased to give you a demonstration. Then let your ears make up your mind.

marantz®

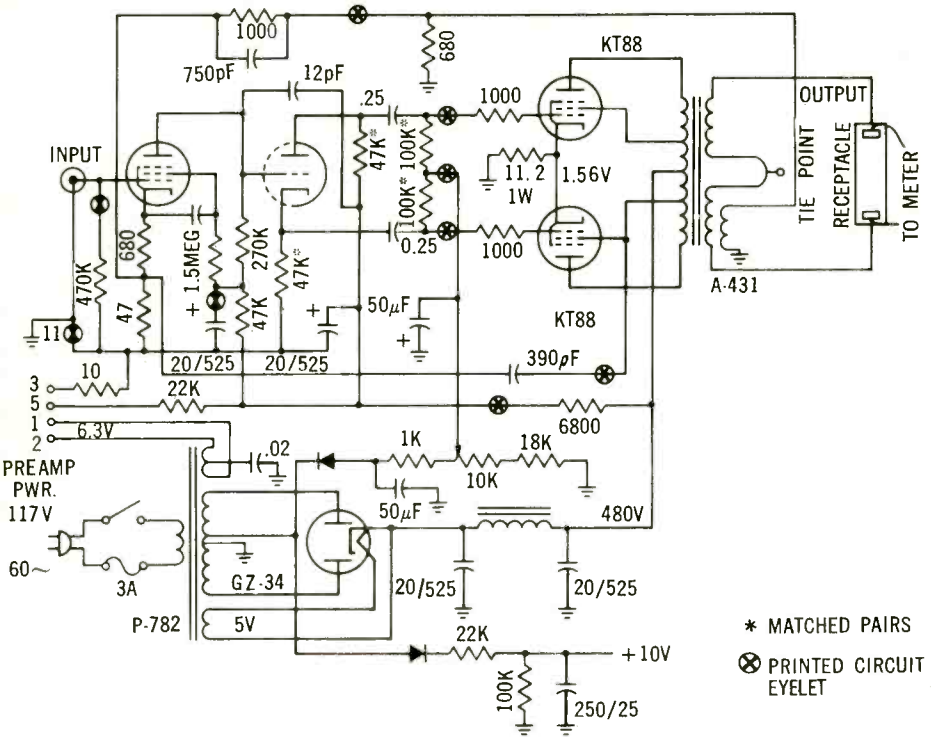


Fig. 4—Complete schematic of the original Mark III-500 amplifier, showing changes made to provide the 10-volt supply for the oscillator.

type of generator to be used. The simplest choice seemed to be the phase-shift circuit, which can be made adjustable by substituting a variable resistor for one of the fixed resistors. In general, the phase-shift oscillator employs three identical capacitors and three identical resistors to provide a single fixed frequency.

The Dynaco Mark III doesn't have adequate space for a vacuum-tube stage, so the oscillator would have to be transistorized. Since the amplifier employs a fixed-bias arrangement, there is a 60-volt tap on the secondary of the power transformer, together with a rectifier and filter network. We could have used a PNP transistor, but one wasn't at hand, while several NPN's were. Therefore, in the circuit of Fig. 1, the 40232 transistor was used. The maximum collector voltage for this transistor is 18 volts, and a tryout showed that the output was adequate and fairly constant over the desired range with a supply of 10 volts.

The addition of another silicon rectifier, two resistors, and a filter capacitor provided the required 10 volts from the tap on the transformer secondary.

Returning to the oscillator circuit, it was found that the circuit of Fig. 1 would give a range from 42 to 84 Hz with one turn of a 50k pot. The log-taper pot—commonly called "audio taper," gives a reversed dial indication, but it spreads out the range in a desired manner. A 50-k reverse-taper pot would have changed this, but it was not considered sufficiently important to warrant the extra effort involved in getting such a pot. A second similar 50-k pot was used to control the output so the voltage could be varied to suit the required drain.

Fig. 5—Underside of the completed generator.

Construction

The oscillator circuit was assembled on a resistor-mounting board as shown in Figs. 2 and 3. These boards are available in several forms, and one of suitable size was procured. It was too long for the circuit, so it was shortened by simply cutting off the overage. Space was left for two holes for mounting, using #6 x ¾ sheet-metal screws through holes drilled in the chassis in the location shown in Fig. 4, and using ½-in. bushings to hold the strip away from the chassis.

The octal socket on the front apron of the amplifier was removed, as were the output terminal strip and the input phono jack. In place of the latter was put the 50-k output pot, using a 3 x 5 Bakelite panel on the outside of the apron. The frequency-control pot was mounted on the Bakelite panel in the approximate position of the former octal socket, and an receptacle was mounted in the position of the output terminal strip. The Bakelite panel provides space for the decal lettering, as well as to cover up the holes in the chassis.

As a final gesture toward a finished appearance, a hole was cut in the cover to accommodate a 150-volt a.c. meter so the output could be adjusted as required and without exceeding the input voltage for the equipment under test. Actually, 60 watts of power would provide an output of 173 volts, which underlines the need for an output voltmeter.

The supply for the oscillator is built directly on the Dynaco chassis. A 1-amp, 400 PIV silicon diode is connected to the selenium bias rectifier at the point where the lead from the transformer is connected. Its other end is connected to a tie point mounted on the same screw that holds the present one, and the 22k (1-watt) and 100-k (½ watt) resistors are mounted on the new tie point. At their junction, connect the + end of the 250-μF, 25-V filter capacitor, and connect the − end to a soldering lug mounted under one of the transformer-holding screws. The leads from the input phono jack are unsoldered from the existing circuit

If everyone were an expert, there'd be only three speakers left on the market.

We mean this very seriously.

If everyone had a good ear without any high-frequency loss...

If everyone listened to *live* music regularly...

If everyone understood the idiosyncrasies of commercial records and tapes...

If everyone could see through shallow technical arguments...

In sum, if everyone had the qualifications of an expert judge of loudspeakers—then only three of the current models on the market would survive.

The **Rectilinear III,** the **Rectilinear Mini-III** and the **Rectilinear X.**

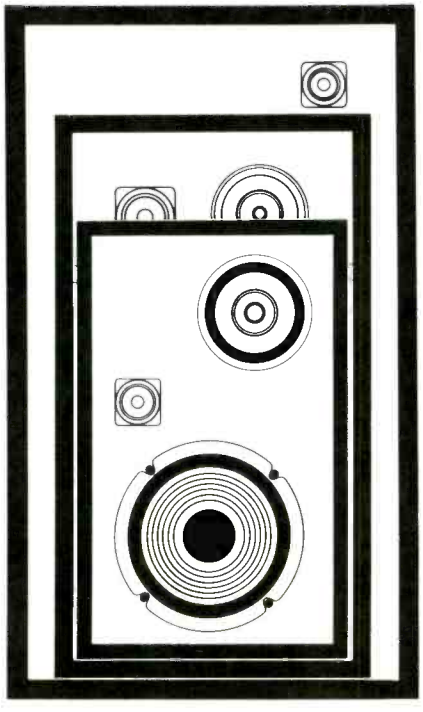
We base this brash assumption on our study of people possessing the above qualifications.

They seem to reject, to a man, all speakers created for a particular "taste." The big-bass taste. The zippy-highs taste. The Row-A-spectacular taste. Or even the more refined taste for subtly rich bass with slightly subdued upper midrange but sharply etched highs.

They want no personality at all in their speakers. Just *accuracy*. What goes in must come out, no more and no less. If the input is less than perfect, they use tone controls and filters, rather than loudspeaker manufacturers, to improve it.

And they're unimpressed by novelty for novelty's sake. They've got to *hear* that engineering breakthrough, not just read about it.

These people are invariably reduced to a choice of no more than six or seven models, out of literally hundreds. Three or four of this ridiculously small group of neutral-sounding, transparent speakers are full-range electrostatics. Which means that they're huge, awkward to place, murderously expensive and far from indestructible. Which, in turn, leaves only three, as we said:



The **Rectilinear III,** a classic after less than three years, acclaimed by every reviewer under the sun as the floor-standing monitor speaker without equal; four-way with six drivers, $279.00.

The **Rectilinear Mini-III,** the only small compact with class; three-way with three drivers, $89.50.

The **Rectilinear X,** "the world's fastest bookshelf speaker," with unprecedentedly low time delay distortion; three-way with three drivers (including our new high-excursion 10-inch woofer), $199.00.

Of course, in the real world out there, everyone is *not* an expert, so there'll be many speakers left on the market.

But there seem to be enough experts around to keep one company very happy.

(For more information, see your audio dealer or write to Rectilinear Research Corp., 30 Main St., Brooklyn, N. Y. 11201. Canada: H. Roy Gray Co. Ltd., 14 Laidlaw Blvd., Markham, Ont. Overseas: Royal Sound Co., 409 North Main St., Freeport, N. Y. 11520.)

Rectilinear

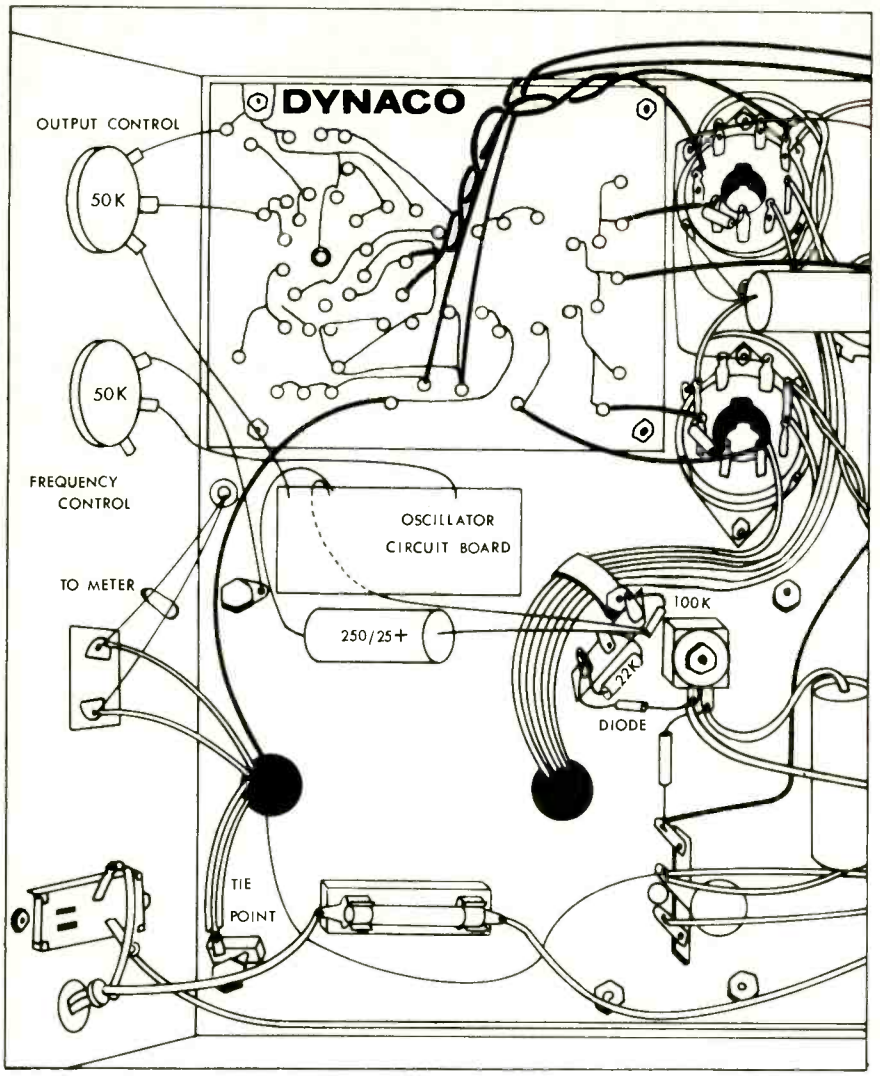


Fig. 6—Pictorial of the underside of the converted Dynaco Mark III.

board and replaced by a pair of leads from the output potentiometer. A ⅜-in. hole in the top of the chassis near the output receptacle if fitted with a rubber grommet, and leads to the voltmeter are passed through it. Since the whole assembly weighs around 29 lbs., a carrying handle was thought necessary. Its position is shown in the photo of the finished device. It may seem strange that it should be so off center in appearance. It is, however, straddling the center of gravity, so the unit carries level with the handle in the position shown.

The labeling on the Bakelite panel was done with decals. The positioning of the frequency-designating figures was determined by comparing the output on a 'scope against that from a conventional audio oscillator. It could be done by Lissajous figures against the line frequency, if no oscillator is available.

The generator has a fairly constant output with a given load, so it is possible to set the output voltage once and then vary the frequency over the entire range without changing the output control. For those requirements of variable voltage, the frequency may be set and the output varied from zero to over 150 volts with the usual turntable or tape recorder.

Changing the 0.1-μF capacitors in the oscillator circuit should move the covered frequency range from the 40- to 80-Hz range to anywhere desired. For a range of 60 to 120 Hz, a capacitor value of .068 should be about right, although some trimming might be necessary. The 3300-ohm resistor limits the high-frequency end of the range, and the total range is determined by the value of the frequency-control pot. A value of 50k ohms is about the maximum that will permit the oscillator to function. If the 3300-ohm resistor is decreased appreciably, it effectively shorts out the phase-shifting network and oscillation will stop. The values shown in the schematic were chosen for the desired range and reliable operation.

While any power amplifier will function in the same fashion as this one if the output transformer is changed to provide the 500-ohm output, it would likely require some experimentation to achieve the desired result. The Dynaco Mark III is priced in kit form at $89.95, and the remainder of the parts should not exceed another $15.00 at most. So for around $105.00 can have a variable-frequency generator for whatever need you may have for one. If you already have a Mark II or Mark III that is retired from hi-fi service, you can replace the output transformer with a 430-500 for only $44.95 and start using the amplifier again. In any case, you are sure to find the variable-frequency generator a useful tool in the shop, and a great help if you dabble in electronic music. **AE**

Parts List

1 10-μF, 25-V electrolytic, Sprague TE-1204
1 250-μF, 25-V electrolytic, Sprague TVA-1208
1 50-μF, 3-V electrolytic, Sprague TE-1302
3 0.1-μF, 10% capacitor, Sprague 192P-10492
1 680-ohm, ½-watt, 10% resistor
1 3300-ohm, ½-watt, 10% resistor
1 6800-ohm, ½-watt, 10% resistor
2 10k, ½-watt, 10% resistor
2 100k, ½-watt, 10% resistor
1 22k, 1-watt, 10% resistor
2 50k audio taper pots, IRC 13-123
1 40232 transistor
1 3 x 5" Bakelite panel, ⅛" thick
1 a.c. panel-mount receptacle
1 2" knob
1 1½" knob
1 150-V a.c. voltmeter
1 resistor mounting strip
1 two-lug terminal strip (tie point)
Decals
Handle
Miscellaneous hardware, wire, solder, etc.

Versatility that's surpassed only by performance

A new criterion of excellence in sound has arrived. The Pioneer SX-1500TD AM/FM multiplex stereo receiver was meticulously designed for the audio perfectionist. Its advanced design circuitry, incorporating an FET front end and IC's IF strip, offers an array of features for the ultimate in stereo performance. Music power is at a zenith of 180 watts, rated in compliance with the standards of the Institute of High Fidelity. Extremely versatile, it provides six sets of inputs. The pre and main amplifiers may be used independently. An exclusive highlight is the unique facility for Dynamic Microphone Mixing which provides simultaneous recording with broadcast music . . . voice over music announcements . . . 5-position speaker selection for announcements over speakers in several locations. You can connect up to three different speaker systems. Complementing its magnificent sound reproduction is the subdued elegance of the hand rubbed, oiled walnut cabinet faced with brushed silver and jet. Hear the true sound of quality at your Pioneer dealer. Only $399.95, including microphone.

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PIONEER ELECTRONICS U.S.A. CORPORATION, 140 Smith Street, Farmingdale, N. Y. 11735 • (516) 694-7720

West Coast: 1335 W. 134th Street, Gardena, Calif. 90249 — (213) 323-2374 & 321-1076 • *In Canada:* S. H. Parker Co., Prov. of Ontario

AUDIO TAPE RECORDER DIRECTORY

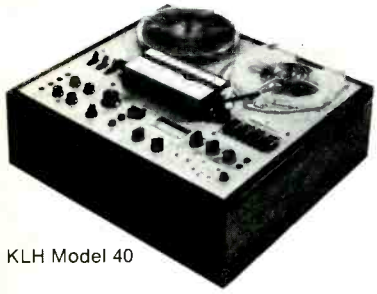
(Specifications listed are those of the manufacturer)

Ampex 755A

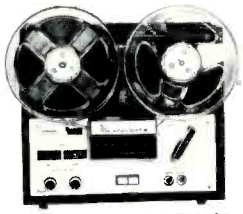
Indicate speed by letter code:

	A	B	C	D	E	F	G	H
½					x	x	x	
7½	x	x	x		x	x	x	
3¾	x	x	x		x		x	x
1⅞	x		x	x			x	x
15/16			x					

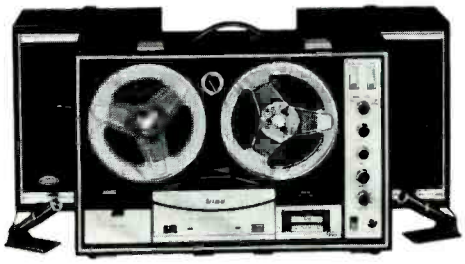
* at the highest speed of the machine



KLH Model 40



Lafayette Model RK820



Allied TR-1080

Crown International 800 series

REEL TO REEL

MANUFACTURER (Circled numbers indicate adv. page)	Model	Speeds (see letter code)	Power Amp(s) Built In?	Max. Reel Size, in.	No. of Heads	No. of Tracks	No. of Motors	Drive Motor Type	Drive to Capstan	Frequency Response * Hz to kHz, ± dB	Wow and Flutter, %*	Signal-to-Noise Ratio, dB*	Fast Wind, 1200 Ft., Sec.	Mic Input Z, Ohms	Rec'ng Level Indicator Type	Dimensions, W x D x H, in.	Weight, Lbs.	Price	SPECIAL FEATURES
AIWA	TP-719	A	Yes	7	2	2	2	d.c.	Belt	100-10K ±5	0.25	43	165	10K	Mtr.	16½ x 13 x 3⅝	16½	149.95	3-way power source (a.c., batt., car) auto/manual rec. level contr.; attache-case.
	TP-1001	A	Yes	7	2	4	1	Hys.	Idler	30-18K	0.15	45	140	10K	2 Mtrs.	14⅝ x 13⅜ x 10¼	33	179.95	Auto shut off; spkr. on/off sw.
ALLIED	TD-1039	A	No	7	2	4	1	Cap. Start	Belt	30-20K ± 3	0.1	48	210	10K	2 Mtrs.	15½ x 13½ x 6¾	20	135.00	Linear lever contrs.; retractable pinch roller; 4-digit counter; s-o-s; auto shut-off.
	TR-1080	A	Yes	7	4	4	1	Cap. Start	Belt	40-19K ± 3	0.15	47	160	10K	2 Mtrs.	19⅛ x 12¾ x 12¼	38	299.95	Auto rev; records in both dir.; solenoid operation; detachable spkr. encls.
AMPEX	755A	A	No	7	3	4	1	Hys.	Belt	20-20K ± 3	.08	48	120	150K	2 Mtrs.	15¾ x 13 x 6½	27	249.95	S-w-s; s-o-s; echo, pause contr.
	757	A	Yes	7	3	4	1	Hys.	Belt	20-20K ± 3	.08	48	120	150K	2 Mtrs	23½ x 14 x 8½	42	349.95	As above, plus power amps.
	1455A	A	No	7	4	4	1	Hys.	Belt	20-20K ± 3	.08	48	120	150K	2 Mtrs.	15¾ x 13 x 6½	27	349.95	s-w-s; s-o-s; echo, pause contr.; auto. reverse, auto. threading.
	1467	A	Yes	7	4	4	1	Hys.	Belt	20-20K ± 3	.08	48	120	150K	2 Mtrs.	23½ x 8½ x 14	40	449.95	As above, plus power amps.
ASTROCOM MARLUX (41)	407	B	No	7	4	4	3	Hys.	Belt	30-20K ± 3	.07	50	60	10K	Dual Meter	21 x 14½ x 10½	40	349.95	Auto rev., p.b. oper.; s-w-s; s-o-s.
CONCERTONE	790	G	Yes	7	3	4	1	d.c.	Idler	20-22K	0.17	55	140	10K	2 Mtrs.	11⅞ x 6 x 14½	18	260.00	
CONCORD (43)	509D	A	No	7	2	4	1	Ind.	Idler	30-15K	0.17	55		10K	2 Mtrs.	13¾ x 11 x 4⅞	17¼	140.00	Cue and edit control.
	MK II	A	No	7	3	4	1	Hys.	Belt	20-23K ± 3	.09	52	116	15K	2 Mtrs.	18½ x 13 x 6	25¾	230.00	Var. echo contr.; tape/source monitor, 4 preamps.
	MK III	A	No	7	3	4	1	Hys.	Belt	20-27K ± 3	.09	55	116	15K	2 Mtrs.	18½ x 13 x 6	25¾	260.00	As above.
	MK IV	A	No	7	4	4	1	Hys.	Belt	20-23K ± 4	.08	55		15K	2 Mtrs.	18½ x 13 x 6	25¾	330.00	Auto reverse playback; silent sensing; dual capstan.
CRAIG CORP.	2401 (910)	B	Yes	7	2	4	1	Hys.	Idler	50-15K ± 3	0.18	40	150	10K	Mtr.	16⅛ x 12¾ x 7¼	26	169.95	b.f. control of tape functions; meter switchable between chans.
	2408	A	Yes	7	2	4	1	Hys.	Idler	50-15K ± 3	0.2	40	120	10K	2 Mtrs.	16¼ x 13½ x 10½	28½	199.95	Auto shut-off; spkr. encls. close over 7" reels.
CROWN INTERNATIONAL (45)	SX 724	B	No	10½	3	4	3	Hys.	Belt	30-25K ± 2	.09	60	45	350K	2 Mtrs.	19 x 9 x 15¾	45	995.00	Dual mic or line mixing; 2-tk play opt.; 5" mtrs.
	CX 724	A	No	10½	3	4	3	Hys.	Belt	30-30K ± 2	.09	60	45	350K Opt.	2 Mtrs.	19 x 9 x 17½	50	1,295.00	Dual mixing; tone contrs. during rec. & play; tape echo; plug-in modules; RIAA & phone amps. opt.
	SX 824	B	No	10½	3	4	3	Hys.	Belt	30-25K ± 2	.09	60	45	350K	2 Mtrs.	19 x 9 x 15¾	48	1,495.00	As above; remote contr. opt.
	CX 822	E	No	10½	3	2	3	Hys.	Belt	30-30K ± 2	.06	60	45	250 Bal.	2 Mtrs.	19 x 9 x 17½	53	2,120.00	As above, but with Pro-800 transport.
FERROGRAPH (71)	704A-S	A or E	No	8⅛	3	2 or 4	3	Ind.	Idler	30-17K ± 2	.08	60	60	10K	2 Mtrs.	14⅞ x 16 x 8 13/16	37½	549.00	Chassis model: 724A-W in wal. case, $599.00; portable: 724A-P in port. case $649.00.
HITACHI	TRQ 727	A	No	7						30-18K				10K	2 Mtrs.	13⅝ x 14 x 8¼		149.95	"Levelmatic" auto vol. contr.; pushbutton operation; 3-digit counter.
JVC (9)	1561	H	Yes	5	2	2	1	d.c		100-8K	±0.4	38	120 (600')		Meter	12 x 11⅝ x 4⅛	7.3	79.95	Batt and a.c operation; a.c. bias; auto. rec. level cont; tone contr.
	1694	H	No	7	2	4				30-20K	±0.15	52	150			15¼ x 12⅝ x 8⅛	20	169.95	s-o-s; s-w-s; slide-type vol. contrs; 4-digit counter; a.c. bias; phone and line outputs
KLH	41	A	No	7	3	4	1	Ind.	Belt	50-20K ±3	±0.1	>68	130	100K	2 Mtrs.	14 5/16 x 11½ x 7⅝	17½	229.95	Dolby Noise Reduction System.
	40	B	No	7	3	4	3	Ind.	Belt	45-20K ±2.5	±0.1	>68	65	200K	2 Mtrs.	16 x 14⅜ x 7½	60	650.00	As above.
LAFAYETTE (77)	RK-825	A	Yes	7	2	4	1	Ind.	Idler	40-15K ±3	0.23	46			2 Mtrs.	12¼ x 11⅝ x 6⅝	22	129.95	S-w-s; s-o-s; single tape function contr; Safety interlock pause contr; 3-digit counter.
	RK-920	A	No	7	4	4	2	Ind.	Belt	30-22K ±3	0.2	50			2 Mtrs.	17 x 15½ x 8¼	50	199.95	As above; auto-reverse, auto shut-off.

Breaks the sound barrier.

This is the A-6010U, top of the TEAC tape deck line. And these are just a couple of its supersonic breakthroughs: Unique phase sensing auto reverse operates electronically at any chosen point on the tape. Or it can take a sensing foil if desired. But don't look for this system on anybody else's machine. Separate heads for record and playback allow off-the-tape monitoring while recording; most other machines in this price range can monitor the sound source only.

What's the barrier to your complete sound enjoyment? Chances are, TEAC has broken that, too.

A-6010U • Exclusive symmetrical control system • Dual-speed hysteresis synchronous motor for capstan drive • 2 exclusive eddy-current outer rotor motors for reel drive • Pause control • Unique tape tension control • 4 heads, 4 solid-state amps, all-silicon transistors • Independent LINE and MIC input controls

TEAC®

TEAC Corporation of America
2000 Colorado Avenue
Santa Monica, California 90404

Check No. 39 on Reader Service Card

REEL TO REEL (Continued)

Indicate speed by letter code:

	A	B	C	D	E	F	G	H
15					X	X	X	
7½	X	X	X		X	X	X	
3¾	X	X	X		X		X	X
1⅞	X		X	X			X	X
15/16			X					

* at the highest speed of the machine

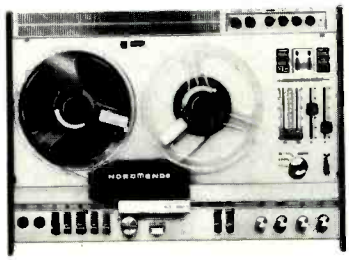
Roberts 800X

Revox A77

Sony/Superscope 770-4

Pioneer T-600

Tandberg Model 11



Nordmende 8001/T

MANUFACTURER (Circled numbers indicate adv. page)	Model	Speeds (see letter code)	Power Amp(s) Built In?	Max. Reel Size, In.	No. of Heads	No. of Tracks	No. of Motors	Drive Motor Type	Drive to Capstan	Frequency Response * Hz to kHz, ± dB	Wow and Flutter, %*	Signal-to-Noise Ratio, dB*	Fast Wind, 1200 Ft. Sec.	Mic Input Z, Ohms	Rec'ng Level Indicator Type	Dimensions, W x D x H, In.	Weight, Lbs.	Price	SPECIAL FEATURES
NORMENDE	8001T	A	Yes	7	3	4	3	Hys.		40-18K ±3	.09	54	48	500	Dual Meter	19½ x 14 x 6	36	429.95	Built-in 4-channel mixer.
PANASONIC	RS-765	A	No	7	2	4	1	4-p	Idler	30-18K	0.1	50	240	20K	2 Mtrs.	13⅜ x 11 x 5	17½	125.00	Head phone jack.
	RS-768	A	No	7	3	4	1	Hys.	Idler	20-27K	.09	52-57 w/HS	150	20K	2 Mtrs.	18½ x 13¼ x 8	24	219.95	3-head sys.; source/tape mon.; noise suppressor.
	RS-796	A	No	7	4	4	1	4-p	Belt	30-20K	0.1	52	180	20K	2 Mtrs.	20 x 14 x 8½	33	249.95	Auto reverse; dual capstan drive; 4-head sys.
	RS-790	A	Yes	7	4	4	1	4-p	Belt	30-20K	0.1	52	180	20K	2 Mtrs.	17 x 16½ x 9	38	329.95	As above.
PIONEER (37)	T-600	B	No	7	4	4	1	Hys.	Belt	30-20K	0.12	50	110	50K	2 Mtrs.	17¼ x 17⅛ x 8	33	299.95	Rec/play auto reverse; swing-out pinch roller; auto brake; dust cover
REVOX	A77	B	Opt.	10½	4	2 or 4	3	Servo	Dir.	30-20K ±2	.08	58	60	Lo,Hi	2 Mtrs.	16 x 8 x 14	34	529.00	Electronic-governed capstan motor; all-metal low-wear heads; avail. w. wood case or in portable case w. spkrs; 15/7½ ips model, $629.00.
ROBERTS	771X	A	Yes	7	3	4	1	Hys.	Belt	30-22K ±3	0.15	50	60	5K	2 Mtrs.	14 x 20 x 10	42	329.95	S-o-s, mute/monitor switch, PA operation.
	800X	A	Yes	7	3	4	3	Hys.	Belt	30-22K ±3	0.18	50	60	5K	2 Mtrs.	18¾ x 13¾ x 9½	48	539.95	Auto-reverse, s-o-s; s-w-s.
	5050XD	A	No	10½	4	4	3	Hys.	Belt	30-25K ±3	0.12	50	60	5K	2 Mtrs.	17 x 15 x 9½	49	599.95	24-Hr. programming, mag. brake; auto-reverse; deck model.
	420XD	A	No	7	4	4	3	Hys.	Belt	30-22K	0.12	50	60	5K	2 Mtrs.	16 x 17½ x 10	62	699.95	As above, plus auto rec. vol. contr.
SONY/ SUPERSCOPE	155	A	No	7	1	4	1	Ind.	Idler	30-18K	.09	50	150	–	–	15⅜ x 12½ x 6 11/16	16⅜	99.50	Play only; 3-speed; vertical or horizontal operation.
(17)	222A	H	Yes	5	2	2	1	Servo	Belt		0.15	48		Low	Meter	11⅝ x 11⅞ x 4⅝	8⅞	99.50	AC/DC servo-contr. motor; auto or manual rec. level contr.; built-in recharging cct.; p.a. capability; mono.
(47)	255	A	No	7	2	4	1	Ind.	Idler	30-18K	.09	52	150	Low	2 Mtrs.	15⅜ x 13¾ x 7⅛	19¾	179.95	S-w-s; ultra h.f. bias; scrape flutter filter; auto shut-off.
(79)	355	A	No	7	3	4	1	Ind.	Idler	30-22K	.09	52	150	Low	2 Mtrs.	15 5/16 x 14 x 7 1/16	22	229.50	Tape/source mon.; ultra h.f. bias, noise suppressor, scrape flutter filter, s-o-s, auto shut-off.
	650	B	No	7	3	4	3	Hys.	Belt	20-22K	.06	54	90	Low	2 Mtrs.	15⅞ x 6 3/16 x 16 13/16	40	399.50	Feather-touch solenoid operation opt. 2-track, plug-in head assy., opt. rem. contr., eq. selector.
	666D	B	No	7	4	4	3	Hys.	Belt	20-22K	.09	53	60	Low	2 Mtrs.	17 3/16 x 16⅝ x 8 1/16	48¾	575.00	Auto-rev; ultra f.f. bias; SNR noise reduction; solenoid oper.; auto tape lifters.
	780	A	No	7	3	4	3	Servo	Belt	20-25K	.04	56	90	Low	2 Mtrs.	18⅛ x 22 11/16 x 10 7/16	57 5/16	695.00	Auto-reverse; 6-head function; dual capstan drive; ferrite heads; auto program scanner; rem. contr.
	770	A	No	7	4	2 or 4	1	Servo	Belt	20-22K	.09	58	120	250	2 Mtrs.	16½ x 15 5/16 x 3 13/16	24¾	750.00	Noise reduction; built-in limiter; mic. + line mixing; var. speed contr.; scrape flutter filter; 4th head for 4-or 2-tk p.b.
TANDBERG	1600X Series	A	No	7	2 + Bias	4 or 2	1	Ind.	Idler	40-20K ±2	<0.1	58	100	Low	2 Mtrs.	15⅜ x 11 13/16 x 6 11/16	19½	249.00	
	11 Series	A	Mon. Only	7, 5 w/ Cover	3 + tach.	1 or 2	1	9-V d.c.	Idler	40-16K ±2	<0.1	55	105	Low	Meter	13 x 10 x 4	9.5 w/o batt.	449.50	Also available in pilotone version w/ty synchronizer for lip sync, $699 + $350 for sync unit; mono.
	1200X	A	Yes	7	2 + Bias	4 or 2	1	Hys.	Idler	40-18K ±2	<0.1	58	120	Low	2 Mtrs.	15⅜ x 11 13/16 x 6⅞	23	485.00	
	6000X	A	No	7	3 + Bias	4	1	Hys.	Idler	40-20K ±2	.07	56	105	200	2 pk. rdg.	15½ x 12⅜ x 6½	21		
TAPESONIC	70-TRSQ	E	No	10½	3	4 or 2	3	Hys.	Direct	35-26K ±2	.08	56	35	10K-50K	2 Mtrs	19 x 14 x 5½	51	615.00	Portable carrying case $34.50. Two low-Z Mic inputs with Cannon XLR connectors, $35.00.

We've been telling you what a great tape recorder the ASTROCOM/MARLUX 407 is—

Now we'll turn the floor over to

AUDIO

Magazine—

AUDIO EQUIPMENT PROFILE

"Every once in a while we come across a product which so clearly stands out in its class that we must evaluate it relative to much more expensive equipment, otherwise only superlatives would be found on this page. The fact is that Astrocom/Marlux has produced a terrific tape deck. . . ."

High praise indeed from the notoriously tough uncompromising equipment reviewers of Audio! Our dealers will be pleased to give you a copy of the complete Audio review and demonstrate today's outstanding buy in tape recorders —the Astrocom/Marlux 407.

ASTROCOM | MARLUX

Oneonta, New York 13820

Wollensak 6250

Teac A-6010

Indicate speed by letter code:

	A	B	C	D	E	F	G	H
15					x	x	x	
7½	x	x	x		x	x	x	
3¾	x	x	x		x		x	x
1⅞	x		x	x			x	x
15/16			x					

* at the highest speed of the machine

REEL TO REEL (Continued)

MANUFACTURER (Circled numbers indicate adv. page)	Model	Speeds (see letter code)	Power Amp's Built In?	Max. Reel Size, in.	No. of Heads	No. of Tracks	No. of Motors	Drive Motor Type	Drive to Capstan	Frequency Response * Hz. to KHz. ± dB	Wow and Flutter, %, *	Signal-to-Noise Ratio, dB*	Fast Wind, 1200 Ft., Sec.	Mic Input Z, Ohms	Recrg. Level Indicator Type	Dimensions, W x D x H, in.	Weight, Lbs.	Price	SPECIAL FEATURES
TEAC (39)	A-1200	B	No	7	3	4	3	Hys. 2-spd.	Belt	50-15K ±3	0.12	50	100	10K	Dual Meter	15½ x 17 x 9¾	41	299.50	S-o-s; echo; opt. remote pause contr.
	A-1500	B	No	7	4	4	3	Hys. 2-spd.	Belt	50-15K ±3	0.12	50	100	10K	Dual Meter	15½ x 17 x 9¾	41	399.50	As above, plus auto reverse.
	A-4010	B	No	7	4	4	3	Hys. 2-spd.	Belt	50-15K ±3	0.12	50	100	10K	2 Mtrs.	17¼ x 17½ x 9¾	48	469.50	Touch-button controls; auto reverse; tape tension control; opt. remote control.
	A-6010	B	No	7	4	4	3	Hys. 2-spd	Belt	45-15K ±2	.08	55	90	10K	2 Mtrs.	15¼ x 8¼ x 7	52	664.50	As above, plus phase sensing auto reverse; plug-in head ass'y.; elect. and transport separable.
	A-7030	F	No	10½	4	2 & 4	3	Hys. 2-spd.	Belt	30-20K ±2	.06	58	120	10K	2 Mtrs.	17⅛ x 20¼ x 8	62	749.50	Touch buttons; plug-in head ass'y; nab hub adapters; extra 4-tk. p.b. head; cue control.
	A-4010 SRA	F	No	7	4	4	3	Hys. 2-spd.	Belt	40-20K ±3	.08	50	100	10K	4 Mtrs.	2 Sects.	60	799.50	4-track, 4-channel in-line heads; recs. and plays 4-tracks simultaneously.
	A-7010	B	No	10½	4	4	3	Hys. 2-spd.	Belt	45-15K ±2	.08	55	120	10K	2 Mtrs.	17⅛ x 20¼ x 8	62	849.50	Similar to A-7030, but 4-track with auto phase-sensing reverse.
TELEX	433	A	No	7	3	4	3	Ind.	Belt	40-18K ±3	0.2	54	70	50K	2 Mtrs.	15⅜ x 14⅜ x 8¾	30	374.95	Sgl. contr. for operation; illum. indicators;
	230 QQ	B	No	7	1	4	3	Hys.	Belt	40-16K ±2	0.2	52	60			19 x 10½ x 8	30	670.00	4-channel in-line, with 4-channel playback preamps. p.b. only
	230 QQRM	B	No	7	4	4	3	Hys.	Belt	40-16K ±2*	0.2	52*	60			19 x 10½ x 8	22	626.00	4-and 2-channel in-line transport (no ampls.) * with recommended ampls.
WOLLENSAK	6120	A	Yes	7	3	4	2	Ind. d.c.	Idler	30-20K ±2	0.15	50	60	500	2 Mtrs.	16 x 13 x 5	20	179.95	Pre-amp stereo deck, tape monitor facility; s-o-s; s-w-s.
	6250	A	Yes	7	3	4	2	Ind. d.c.	Idler	30-20K ±2	0.12	54	60	500	2 Mtrs.	20 x 13 x 7	25	359.95	As above.
	6154	A	Yes	7	3	4	2	Ind. d.c.	Idler	30-20K ±2	0.12	54	60	500	2 Mtrs.	20 x 13 x 7	25	500.00	As above, plus "Quad/Stereo" preamps for 4-chan. p.b.; records and plays 2-chan. stereo.

CASSETTE

MANUFACTURER (Circled numbers indicate adv. page)	Model	Type: Portable, P; Home, H; Car Mount, C	Power Amp. Built-in	Rated Power Output, W	Mode: Stereo, S; Mono, M	Frequency Response, Hz, ± dB	Wow and Flutter	Signal-to-Noise Ratio, dB	Supply Voltage	Speakers — Built-in or External	Dimensions, W x D x H, in.	Weight, lbs.	Price	SPECIAL FEATURES
AIWA	TP728	P	Yes	0.5	M	200-5K ±4	0.55	40	6 Batt.	Built-in	10⅜ x 6 x 3⅛	4½	69.95	AVC; p.b. operation; extra input and output jacks; fast fwd/re-wind, auto cassette pop-up.
	TPR-101	P	Yes	1.0	M	200-6.3K ±4	0.45	40	6 Batt	Built-in	11¾ x 3½ x 9	6	89.95	As above, plus 3-band AM/FM/Marine radio.
ALLIED	1100	P	Yes	1.25	M	200-11K	0.3	35	7.5 Batt. 117 a.c.	Built-in	5 x 12 x 2½	5	39.95	Keyboard p.b. contrs., Snap-on AC adapter; record-level/battery meter.
	1150	P	Yes	0.75	M	100-6K	0.25	35	9 Batt 117 a.c.	Built-in	6 x 9½ x 2½	3½	69.95	As above, plus switchable auto level contr.; pause button.
AMPEX	Micro-14	P	Yes		M				6 Batt.	Built-in	5⅛ x 9 x 2¾	7⅞	74.95	a.c./d.c. oper.. auto. charge cct., switchable auto. rec. level contr., batt. cond. meter.
	Micro-32	P	Yes		M				7½ Batt.	Built-in	12 x 7 x 3	9¾	129.95	As above,plus AM/FM radio; built-in antennas.
	Micro-90	H	No		S				117 a.c.	Ext.	15¼ x 9¼ x 4⅜	11	129.95	Auto. changer; stereo and mono p.b.
	Micro-52	H	No		S	40-12K	0.25	45	117 a.c.	Built-in	16¼ x 10¼ x 5¾	15	149.95	Hys. motor; record-level motor, stereo record and p.b.
	Micro-86	H	Yes		S	50-10K			117 a.c.	Ext.	14¾ x 8¾ x 3¾	9¼	189.95	As above, plus 2 spkrs, 2 mics.
	Micro-87	H	Yes	25/chan.	S	40-12K	0.25	45	117 a.c.	Ext.	16¼ x 10¼ x 5¾	34	219.95	Stereo contr. center/amplifier; switchable auto. rec. level cont., 2 mtrs; hys. motor, 2-spkrs., 2 mics.

Voltage supply in your city can vary as much as 10%. And even a 2% variation causes a significant tape speed change in tape decks with induction motors and a difference in reproduced sound that is intolerable.

The Concord Mark II stereo tape deck completely ignores fluctuations in line voltage. It is driven by a hysteresis synchronous motor which locks onto the 60 cycle power line frequency and maintains constant speed (within 0.5%) regardless of voltage variation from 75 to 130 volts. So if you're about to buy a tape deck that doesn't have a hysteresis synchronous drive motor, you're liable to negate any other fine feature it might have.

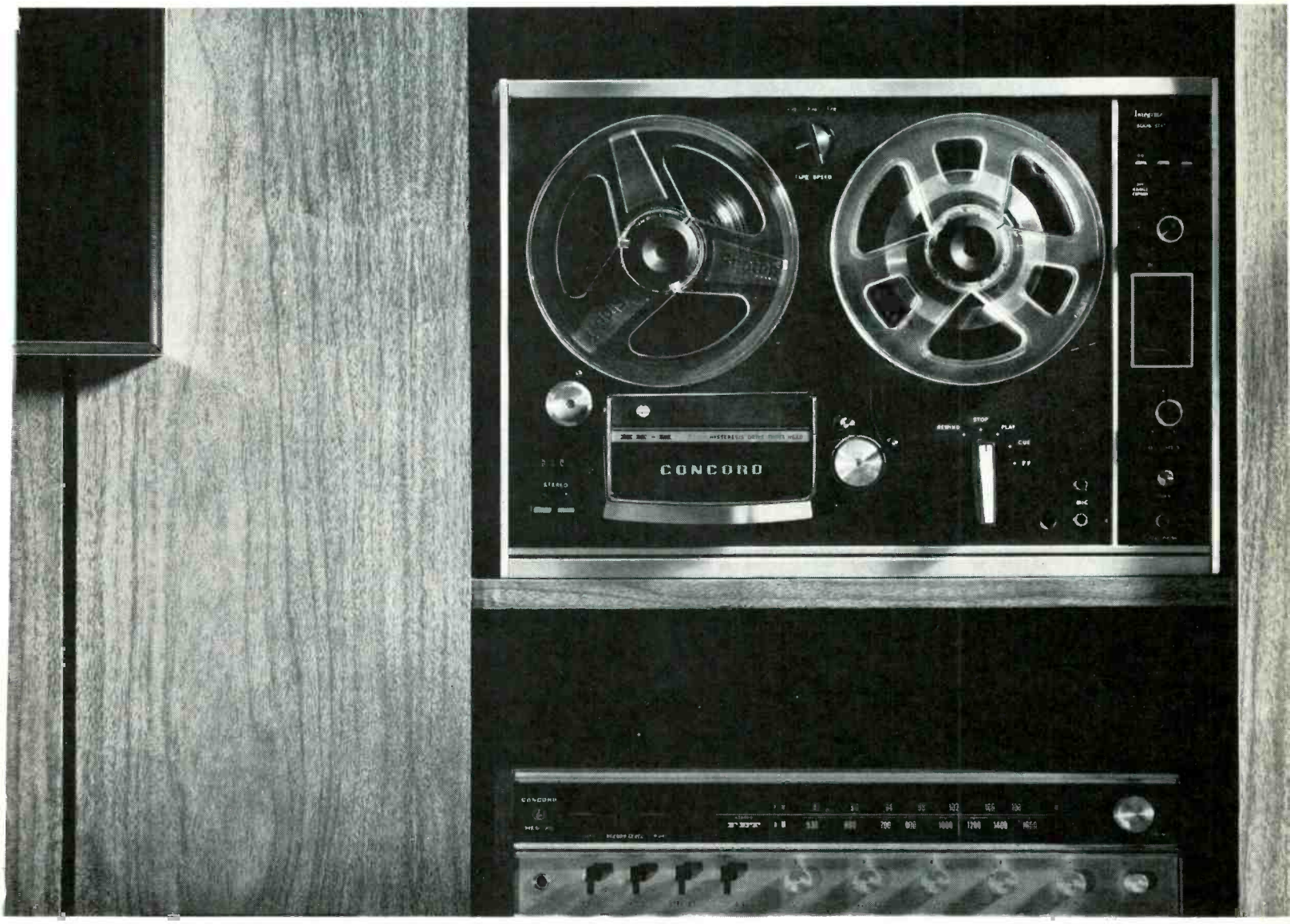
Don't get the idea the hysteresis motor is all the Concord Mark II has to offer. It also has just about every other professional feature. Three high-quality heads: ferrite erase head; wide gap Hi-Mu laminated recording head for optimum recorded signal and signal-to-noise ratio, narrow gap Hi-Mu laminated playback head for optimum reproduced frequency response. No compromise combination heads. The three heads and four preamplifiers also make possible tape monitoring while recording.

The tape transport mechanism assures a fast startup—you don't miss a note. Supply and takeup tape tension arms eliminate startup burble. A special flutter filter eliminates flutter due to tape scrape or cogging action. A cue control provides instantaneous stop and start operation. Other important conveniences: the flip-up head cover permits you to see the head gap position markings for professional editing; 3 speeds; automatic sound-on-sound with adjustable level controls; variable echo control for reverb recording; calibrated VU meters with individual record indicator lights; stereo headphone jack; electronically controlled dynamic muting for automatic suppression of tape hiss without affecting high frequency response. All this, for under $230.

The hysteresis drive Concord Mark III has all of the features of the Mark II plus pressure-sintered ferrite heads for extended frequency response and virtually no head wear. It sells for under $260.

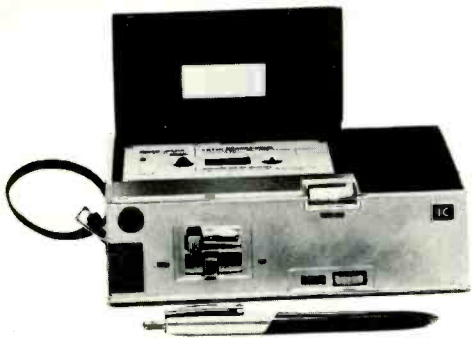
The hysteresis drive Mark IV, the top-of-the-line Concord deck offers all of the performance and conveniences of the Mark II and III including wide gap record, narrow gap playback heads, tape source monitoring, sound-on-sound, echo recording. Plus, a dual capstan tape transport mechanism with electronic automatic reverse, no metal foil or signal required on the tape. Superior recording performance plus the convenience of automatic reverse and continuous play. A superb instrument with the finest performance money can buy, and it's under $330. Audition the new Concord Mark series, the tape decks with the hysteresis synchronous drive motor. For "all the facts" brochure, write: Concord Electronics Corp., 1935 Armacost Ave., Los Angeles, Calif. 90025. (Subsidiary, Ehrenreich Photo-Optical Industries, Inc.) EPI

For copy of Concord Mark III Instruction book, mail 25¢ in coin



NEITHER AIR CONDITIONERS, TV SETS, WASHERS NOR ANY OTHER ELECTRICAL APPLIANCE CAN KEEP THE HYSTERESIS-DRIVE CONCORD MARK II FROM ITS PRECISELY APPOINTED SPEED.

CASSETTE (Continued)



Concertone 240

Concord F-400

Crown CTR-8750

Craig 2608

Harman-Kardon CAD-4

MANUFACTURER (Circled numbers indicate adv. page)	Model	Type: Portable, P; Home, H; Car Mount, C	Power Amp: Built-in	Rated Power Output, W	Mode: Stereo, S; Mono, M	Frequency Response, Hz, ± dB	Wow and Flutter	Signal-to-Noise Ratio, dB	Supply Voltage	Speakers — Built-in or External	Dimensions, W x D x H, in.	Weight, lbs.	Price	SPECIAL FEATURES
CONCERTONE	240	P	Yes	0.3	M	100-8K	≤0.3	35	9 Batt.	Built-in	7 x 4 x 2	2¼		Fast fwd. and rewind ≤ 100 sec. (C-60); a.c. bias; ext. spkr. jack; level indicator.
CONCORD (43)	F-98	P	Yes	4	M	50-10K	≤0.25	45	117 a.c. Batt.	Built-in	12 x 9 x 4½	8	≤90.00	
	F-101	P	Yes	1	M	50-10K	≤0.25	45	Batt.	Built-in	4½ x 6⅞ x 2	2¾	≤125.00	
	F-103	P	Yes	4	M	50-10K	≤0.25	45	117 a.c. Batt.	Built-in	12 x 9¼ x 3¾	5½	≤130.00	
	F-400	P	Yes	8	S	50-10K	≤0.25	45	117 a.c. Batt.	Built-in	12 x 9¼ x 3¾	11	≤180.00	
CRAIG	2610	P	Yes	1.2	M	100-7000	0.35	40	6V Batt./ 117 a.c.	Built-in	9¾ x 10¼ x 3¼	6.5	47.95	Auto level contr. recording batt. or AC with auto switching.
	2608	P	Yes	3	S	80-8000	0.35	40	9V Batt./ 117 a.c.	Ext.	12¼ x 6⅛ x 8⅛	13.5	129.95	Adv. auto level contr. recording; detachable spkr. enclosure.
CROWN RADIO	CTR-9001	P	Yes	1.0	M	100-8.5K	0.5	30	6 Batt.	Built-in	4¾ x 8 13/16 x 2½	3.3	44.95	
	CTR-8750	P	Yes	1.0	M	100-10K	0.5	30	6 or 117	Built-in	7⅝ x 7 11/16 x 2½	4.4	49.95	
	CRC-7550F	P	Yes	1.5	M	100-10K	0.4	35	6, 12, 117	Built-in	10 7/16 x 8 13/16 x 2 15/16	5.1	119.95	AM/FM/SW radio built-in.
	SHC-44B	H	Yes	3 chan.	S	100-10K			9 or 117	Ext.	13 3/16 x 8⅞ x 3 9/16	7.7	189.95	Accommodates FM-400 tuner plug-in 6 "D" cells or a.c. line.
	CDM-10	P/H	Yes	1.5	M	100-10K	0.5	35	12 or 117	Built-in	11 x 5⅛ x 11	9	225.00	Dictating/transcribing unit with rec/play auto-pause foot control.
FISHER (15)	RC-70	H	No	–	S	30-12K ±3	0.25	43	117 a.c.	–	5¼ x 11 3/16 x 3 1/16	5	149.95	Includes 2 mics; auto. motor shut-off p.b. controls, 2 meters, mono/stereo sw., counter. Walnut base 12W optional.
HARMAN-KARDON	CAD-4	H	No	–	S	30-12.5K ±3	0.15	49	117 a.c.	–	12½ x 9 x 3¼	10	159.95	2 mic. inputs; dual meter; auto shut-off; o-load ind. light; reg. motor speed control; push-pull bias oscillator.
JVC (9)	1620	P	Yes	1.0	M	100-8K	≤0.4		6V Batt.	Built-in	6½ x 2¼ x 9⅞	3.7	59.95	Built-in AM radio; "hide-away" mic., opt. a.c. adapter, molded plastic cabinet.
	1624	H	No	–	S	30-15K	≤0.35	≤40	117 a.c.	None	8¾ x 10¾ x 3½	9.9	159.95	a.c. bias, recs. and plays 4-tr stereo and 2-track mono; pause contr.; tape counter.
LAFAYETTE (77)	RK 90	P	Yes		M				6V Batt.	Built-in	7 x 2⅛ x 9½	5	44.95	Built-in AM radio; batt./record meter, a.c. bias; record safety interlock.
	RK 99	P	Yes		M				6 Batt.	Built-in	5¼ x 12⅝ x 10½	5	49.95	Remote contr. mike; a.c. bias; batt./record meter, a.c. operation with opt. adapter (3.95).
	RK 760	H	No		S	45-12K	0.3	35	117 a.c.	No	12⅜ x 5 x 8¼	8	89.95	2 mic. inputs, 3-digit counter, record light; dual meter.
	RK 510	H	Yes	5 chan.	S	35-12.5K ±2	<0.2	44	117 a.c.	No	14⅜ x 8½ x 4½	12	149.95	Incls. 2 mics; 2 mic and 4 aux input jacks; pre-amp and 8-ohm spkr. outputs; 3-digit counter. With 2 spkr. sys., $179.95.

FOR THOSE WHO DEMAND

The Very Best

Some people can accept reduced quality in their audio components. For others — the recording engineer, the professional musician, the music connoisseur — there is only *one* quality — *the very best.* These are the uncompromising — the people who choose CROWN.

They know that behind each Crown product stands the teamwork of some of the nation's finest audio engineers and proudest American craftsmen. These are the designers whose innovations have led the tape industry with exclusive electro-magnetic braking, the first solid-state components, original computer logic tape control, the new industry standard power amplifier — DC300, and now an ultra-flexible, high-performance control center. These are the craftsmen who carefully hand-fabricate and test each unit, entering measurements on individual proof-of-performance records. This is the product line that is worthy the pride of both its makers and its owner.

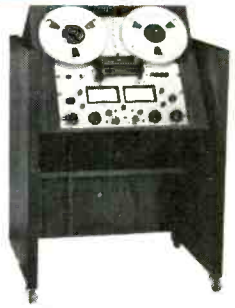
To discover what you're missing — compare CROWN's Total Performance sound today. Write Crown, Box 1000, Elkhart, Indiana, 46514.

Crown®

MADE ONLY IN AMERICA

CX844 For the audio perfectionist or professional, the ultimate in live recording. 4 channels in-line, 3 speeds, computer logic tape control never breaks tapes, remote control optional, sound-on-sound, sound-with-sound, echo effects

All models shown feature total silicon solid-state design, non-mechanical brakes, precision micro-gap heads, 5" VU meters, 4 mic or line inputs, 3/16" panel with massive central casting, third head monitor with AB switch, rugged construction, 100 hours in-plant testing.



CX722 Superlative professional quality with outstanding flexibility for on-location recording. 2 channels, 3 speeds, pushbutton electric control, remote start/stop optional, sound-on-sound, sound-with-sound, echo effects, shown in studio console.

SX724 Professional performance at a minimum price, essential for the finest component systems. 1/4-track stereo 2 speeds, push-button electric control, remote start/stop optional, sound-on-sound, shown in scuff-proof carrying case.

SX824 For the serious audiophile, the ultimate home recorder. 2 channels, 2 speeds, computer logic control never breaks tapes, remote control optional, sound-on-sound, shown in genuine walnut hardwood cabinet.

DC300 Laboratory standard basic amplifier. 300 watts per channel RMS, complete output protection, extreme purity, shown in walnut cabinet

D40 The ideal monitor amplifier. 40 watts per channel RMS, compact, low distortion, shown in walnut cabinet.

CASSETTE (Continued)

Sony/Superscope 20 Auto Player

Wollensak 4310

MANUFACTURER (Circled numbers indicate adv. page)	Model	Type: Portable, P; Home, H; Car Mount, C	Power Amp. Built-in	Rated Power Output, W	Mode: Stereo, S; Mono, M	Frequency Response, Hz, ± ? dB	Wow and Flutter, %	Signal-to-Noise Ratio, dB	Supply Voltage	Speakers – Built-in or External	Dimensions, W x D x H, in.	Weight, lbs.	Price	SPECIAL FEATURES
NORELCO	RR-25	P	Yes		M	80-10K	0.18	40	9 Batt.	Built-in	11½ x 8½ x 3¼	5¼	69.95	Includes AM radio; a.c. adaptable
	2400A	H	Yes	8 chan.	S	60-10K ±3	0.15	45	117 a.c.	Ext.	14 x 8½ x 3	6¾	149.95	Reg. motor speed contr.; p.b. operation complete deck functions.
	2400	H	Yes	8 chan.	S	60-10K ±3	0.15	45	117 a.c.	Ext.	14 x 8½ x 3	21¾	199.95	As above, but includes 2 speakers.
PANASONIC	RS-252	H	No	–	S	30-12K			117 a.c.	Deck Only	10 7/16 x 10 x 3¾	7⅜	109.95	Deck; p.b. oper.; counter; pause contr.; 2 mtrs.; noise suppresser; phone jack.
	RQ-210	P	Yes	0.6	M	50-10K			6 Batt.	Built-in	3¾ x 1⅞ x 6⅜	2¼	125.00	Pocket-cassette recorder and p.b.; auto rec. level contr.; pop-up cassette.
	RS-256	H	Yes	10 chan.	S	30-12K			117 a.c.	Ext. 2-6½	19¼ x 11½ x 5½	20	229.95	AM/FM/FM stereo radio; 2 spkrs.; slide contrs.; blackout dial; 2 mtrs.
SONY/ SUPERSCOPE (17) (47) (79)	TC-70	P	Yes	1.2	M	50-10K	0.28	42	6 Batt. 117 a.c.	Built-in	8 13/16 x 8¼ x 2 5/16	5⅛	69.50	Built-in recharging cct.; end-of-tape alarm mic and aux. inputs; tone and vol. contrs.; batt./record meter.
	TC-110	P	Yes	1.0	M	50-10K	0.28	42	6 Batt. 117 a.c.	Built-in	5¼ x 9⅜ x 2⅜	4⅞	99.50	As above, plus built-in elec. cond. mic.
	TC-50	P	Yes	0.25	M	80-8K			4.5 Batt.	Built-in	3 9/16 x 1 7/16 x 5 7/16	1¾	125.00	Pocket sized; built-in mic. and spkr.; remote mic. input; batt.-cond. indicator; auto rec. level contr., p.b. vol. contr., phone jack.
	TC-20	C	Yes	6 chan.	S	50-10K	0.28	45	12V d.c.	Ext.	7 3/16 x 2⅞ x 8¼	8	129.50	Car system: auto eject; p.b. controls; includes mtg. hdwe; slot loading set of 2 speakers, $9.95.
	TC-120	P	Yes	1.5	M	50-10K	0.25	46	6 Batt. 117 a.c.	Built-in	10¼ x 6 x 2½	5	129.50	Built-in electret cond. mic.; batt. cond. indicator, end of tape alarm; opt. Nicad batt. pack $14.95.
	TC-125	H	No	–	S	50-10K	0.2	45	117 a.c.	None	13 x 3⅜ x 7⅜	7½	129.50	Auto rec. level control; noise suppressor, mic. and line inputs; phone jack.
	TC-124	P	Yes	0.5 chan	S	50-10K	0.28	45	6 Batt. 117 a.c.	Built-in and ext.	6 11/16 x 9¾ x 2 11/16	5	199.50	Auto rec. level control; rec. level/batt. indicator tone, vol., and bal. contrs.; remote start/stop sw. with 2 ext. spkrs, $175.00
WOLLENSAK	4300	P	Yes		M	50-10K	0.35	45	7.5 Batt.	Built-in	12 x 10 x 3	7¾	99.95	Auto rec. level control, manual over-ride.
	4310	P	Yes	1	M	50-10K	0.35	45	7.5 Batt.	Built-in	12 x 10 x 3	7¾	129.95	As above, plus built-in AM/FM radio.
	4700	H	No		S	60-12K ±3	0.25	45	117 a.c.	Ext.	14 x 9 x 4	13	179.95	Pre-amp deck; biperipheral flywheel, full-sized a.c. motor.
	4800	H	Yes	8 chan.	S	60-12K ±3	0.25	46	117 a.c.	Ext.	14 x 9 x 4	22*	229.95	As above plus 2 compression loaded speakers.

8-TRACK CARTRIDGE

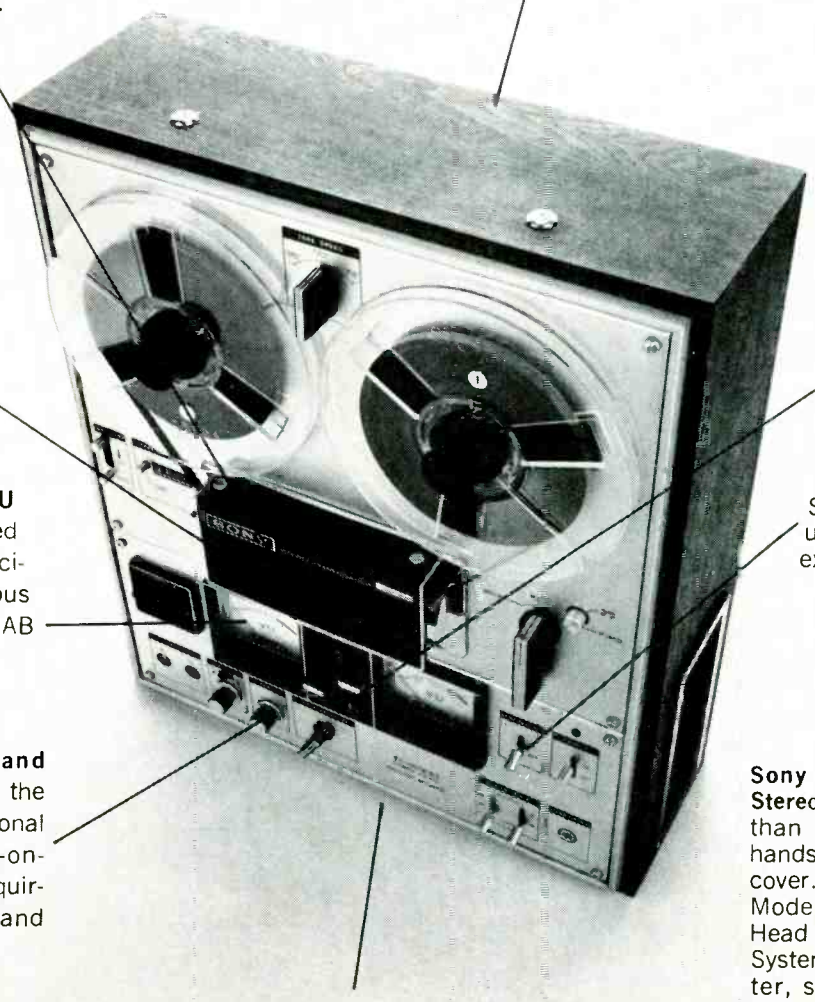
MANUFACTURER (Circled numbers indicate adv. page)	Model	Type: Portable, P; Home, H; Car Mount, C	Power Amp. Built-in	Rated Power Output, W	Mode: Stereo, S; Mono, M	Frequency Response, Hz ± ? dB	Wow and Flutter, %	Signal-to-noise, dB	Supply Voltage	Speakers – Built-in or External	Dimensions, W x D x H, in.	Weight, lbs.	Price	SPECIAL FEATURES
PANASONIC		H	No		S	50-12K			117 AC	Deck Only	9½ x 9½ x 4	6⅝	59.95	Lighted chan. ind.; p.b. chan. sel.
SONY/ SUPERSCOPE	TC-8	H	Yes	–	S	45-13K		52	117 AC	None	12 x 8½ x 4½	11½	129.50	Auto. rec. level contr.; auto. shutoff; prog. indicator; phone jack; rec. interlock.
TELEX	811	H	No	–	S	40-15K	0.3	50	117 AC	None	15 x 11 x 4½	80	99.95	Player deck; feeds hi-fi sys.
	811A	H	Yes	5 Chan	S	40-15K	0.3	50	117 AC	None	15 x 11 x 4½	22	129.95	Player, w/vol., bal., tone contrs. & power amp.; walnut case.
	811W	H	Yes	5 Chan	S	40-15K	0.3	50	117 AC	2 Ext	15 x 11 x 4½	30	159.95	As above, plus 2 wal. fin. spkrs.
	811P	H	Yes	5 Chan	S	40-15K	0.3	50	117 AC	2 Ext	15 x 11 x 8¼*	30	159.95	As above;* with detachable speakers.
	811R	H	No	–	S	40-15K	0.3	50	117 AC	None	15 x 11 x 4½	25	189.95	Records/plays; auto stop at end of program or end of cartg.

Music lovers, take control!

Specs You Can Brag About. Frequency response: 20-22,000 Hz @ 7½ ips, 20-17,000 Hz @ 3¾, 20-10,000 Hz @ 1⅞. Wow and flutter: 0.09%. Signal-to-noise ratio: 52 db.

Three Heads. Allows monitoring of either input source or the actual recording made on the tape.

Non-Magnetizing Record Head. Head magnetization build-up, the most common cause of tape hiss, is eliminated by an exclusive Sony circuit which prevents any transient bias surge to the record head.



Professional Slide Controls. Two fingertip controls are positioned vertically side by side for immediate precision adjustment of recording volume. Easier to read, easier to establish interchannel volume relationship than with conventional knobs.

Noise-Suppressor Switch. Special filter eliminates undesirable hiss that may exist on pre-recorded tapes.

Full-Size Professional VU Meters. These internally lighted instruments provide the precision metering for really serious recording. Calibrated to NAB standards.

Built-in Sound-on-Sound and Echo. Switching networks on the front panel facilitate professional echo and multiple sound-on-sound recordings without requiring external patch cords and mixer.

More Sony Excellence. Ultra-high-frequency bias. (Sony achieves lowest recording distortion through use of ultra-high bias frequency—160 KHz!) Scrape flutter filter eliminates tape modulation distortion. Automatic shut-off. Pause control with lock. Vibration-free motor. Four-digit tape counter. Automatic tape lifters for fast-forward and rewind reduce head wear. Retractomatic pinch roller for easy tape threading. Variety of inputs and outputs. Vertical or horizontal operation.

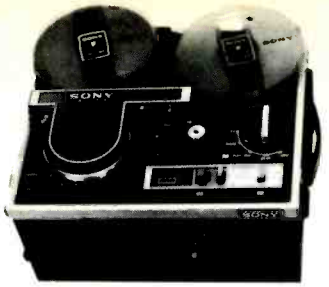
Sony Model 630-D Solid-State Stereo Tape Deck. Buy it for less than $299.50, complete with handsome walnut base and dust cover. **Also available:** The Sony Model 630 Solid-State Three-Head Professional Stereo Tape System, with stereo control center, stereo power amplifiers, microphones, and lid-integrated full-range stereo extension speakers, for less than $449.50. For a free copy of our latest catalog, please write Mr. Phillips, Sony/Superscope, 8142 Vineland Avenue, Sun Valley, California 91352.

SONY SUPERSCOPE The Supremacy in Stereo

You never heard it so good.

Check No. 63 on Reader Service Card

VIDEO TAPE RECORDER DIRECTORY



Sony CV-2600

Ampex VR-5000

Sony EV- 320

Roberts 1050

VIDEO TAPE RECORDERS

MANUFACTURER (Circled numbers indicate adv. page)	Model	Tape Width, in.	Tape Speed, ips.	Video Head-to-Tape Speed, ips.	Video Bandwidth, Hz to MHz	Lines Resolution	Audio Frequency Response, Hz to kHz, ± dB	Weight, lbs.	Price	SPECIAL FEATURES
AMPEX	VP-4900	1	9.6	1000	30-3M	300	90-9K ±4	61	1,150.00	Playback-only unit. Mod. 4900 C – color p.b. only, $1,995.00
	VR-5100	1	9.6	1000	30-3M	300	90-9K ±4	62	1,750.00	
	VR-7400	1	9.6	1000	30-3M	300	50-10K ±4	90 +	3,500.00	Time-lapse recorder for surveillance.
	VR-7500	1	9.6	1000	30-4.2M or 30-3.5M	350	50-12K ±4	100	4,500.00	High or low band color recording optional. High resolution or x-ray model VR-7500X, $5,000.00.
	VR-7800	1	9.6	1000	20-4.2M	350	50-12K ±4	140	10,000.00	Opt. items: color proc. amp.; drop-out compensation; educ. bdcst. std.
CONCORD (43)	VTR-900	½	12	484	30-2.5M	250	50-12K	52	995.00	Simple oper.; p.b. contrs.; plays through std. TV set; portable.
	VTR-600	½	12	484		250			1,150.00	Built-in head cleaning; portable.
	VTR-700	½	12	484		250			1,495.00	Rem. contr. oper.; auto rewind; auto shut-off.
	VTR-2000	1	8.57			350			3,750.00	Prof. rec. and p.b. capabilities; 67 min. recdg. on 2900-ft. reel; stop action, slow motion, fwd. or rev.; audio dubbing.
	VTR-2100	1	8.57			350			4,000.00	As above but with dual audio channels.
	VTR-400	½	12			260	80-10K	15		Light weight portable; incls. two 12-V rechargeable batteries.
PANASONIC	NV 8100 AD	½	12	484	50-2M	≥ 260	80-10K	63	1,400.00*	*Approx. prices.
	NV 8080	½	12	484	50-2M	≥ 260	80-10K		1,400.00*	Port. batt. oper. model; uses 4½" reels.
	NV 505	1	12	484	10-4.5M	≥ 450	40-20K ±2	120	5,000.00*	
ROBERTS	1000	¼	11¼	300	30-2.6M	250	80-10K	66	1,095.00	Also serves as 4-track audio recdr. at 7½ and 3¾ ips. Any TV recvr. adaptable as monitor.
	1050	¼	11¼		30-2.6M	250	80-10K	20	1,800.00	Batt. oper. portable; 5-in. reels; recs and plays on monitor. Incls. camera, monitor, recharger.
SONY (5)	CV-2600	½	7½			220	80-10K +1, –6	31	675.00	Lghtwght.; sgl. lever contrs. all tape mvmnt.; a.g.c. in vid. & aud.; new servo sys. for inst. tape stab.; interchg. tapes w/all Sony CV ser.; 1-hr recd.
	CV-2200	½	7½			220	80-10K +1, –6	49	850.00	Dupticate tape with 2 units and VDC-1 adapter; 1 hr. recdg. time.
	TCV-2110	½	7½			220	80-10K +1, –6	70	1,050.00	Audio and video a.g.c.; auto shutoff; suitable for audio dubbing.
	DVK VCK 2400 "Videorover"	½	7½			220	100-8K +1, –6	16	1,250.00	Batt. oper.; audio and video a.g.c.; built-in screen viewfinder, 20 min. rec. time on 5-in. reel; incls. camera.
	EV-310	1	7.8	590		300 (mono) 240 (color)	50-12K	77	3,700.00	NTSC color rec/p.b. capability w/CLB-1B color adap.; solenoid oper.; rem. contr. oper.; guar. tape interchangeability w/EV-series.
	EV-320	1	7.8	590		300 (mono) 240 (color)	50-12K +1, –6	8.6	4,900.00	Capstan servo, electronic editing; no ext. sync. gen. req. for p.b.; color-adaptable; slow– and stop-action in color & monochrome.

Amsterdam's new "Total Comfort"

EXECU-LOUNGER and KING-SIZE OTTOMAN

gives you a man's kind of comfort!

Every man deserves his own special chair where he can rest, relax and relieve tensions from the hectic pace of a busy day. Enjoy it in your office . . . or at home after a hard day's work! The Execu-Lounger and matching Ottoman gives you all the deep-down masculine comfort and restful relaxation of a backyard hammock.

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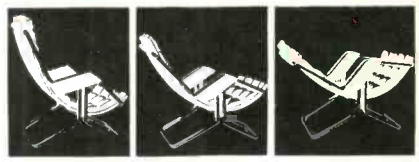
100% top grade Naugahyde. Tough, yet leather-soft and supple, to withstand the roughest punishment. Resists stains. Washes with mild soap and water; polishes with a dry cloth.



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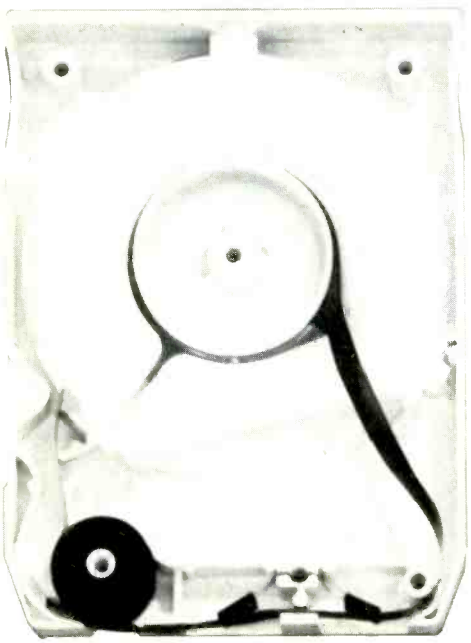
The 8-Track/Cassette Cold War Gets Warmer

Don Humphreys*

For several years now the eight-track-cartridge supporters and the cassette supporters have been playing down the existence of a conflict over which system will become the victor and which will be the vanquished in the consumer marketplace. Some observers feel that there will be no decisive winner, that each system will find its own niche, and that the two systems will co-exist as in the case of the 45-rpm disc versus the 33⅓-rpm disc. They further feel that this peaceful state of co-existence will also find room to tolerate the open reel-to-reel market, the four-track-cartridge system, and even the Play-tape system. Other observers feel that one of the two (either eight-track or cassette) will bury all the other systems.

* Michigan Magnetics, Vermontville, Mich.

Fig. 1—Cutaway view of 8-track endless-loop cartridge.



As a neutral observer, we have noticed how each industry has been striving to add the features of the opponent's system to its own system. For instance: when the original battle lines were formed, eight-track featured: (1) Playback only; (2) Continuous play; (3) Rapid one-direction selection of four programs; (4) A formidable library of pre-recorded music from the top-of-the-line duplicator (record) giants. In contrast, cassettes featured: (1) Record/playback capabilities. (2) Fast forward and reverse search capabilities. (3) A more compact tape package.

The cassette people subsequently introduced: (1) Playback-only models to appease the recording/artists/copyright faction; (2) Continuous-loop winds in cassette cartridges; (3) Excellent libraries of pre-recorded tape releases to satisfy the dealers' requests for a continuing after market.

The eight-track people, not to be outdone, countered with: (1) Record/play models, (2) Smaller packages that matched the cassette in two dimensions (now they would only be thicker to accommodate the ¼" tape instead of the 0.150 tape).

The "Match Features" contest intensified as both systems displayed radios packaged into their cartridges that effectively converted the tape players into FM and AM receivers and the Audio Component people began showing the systems packaged with tuners, record changers, and portable transistor radios. One enterprising manufacturer even showed an eight-track cartridge that would accept and play a cassette.

Somewhere in the middle of all this, a "Starr-System" modification of the basic cassette system was introduced; and stack loaders and slot loaders were introduced by Phillips and several others. Shortly thereafter a company named Quatron entered the fray by introducing a carousel-type, eight-track unit that approximates the new stack-loader features of the opponent.

If you now compare the two systems, you can see that each industry has almost matched the other, feature for feature. Nevertheless, there still remained two salient differences: (1) Eight-track could not reverse or search (although several manufacturers are

Fig. 2—Cutaway view of enclosed reel-to-reel cassette.

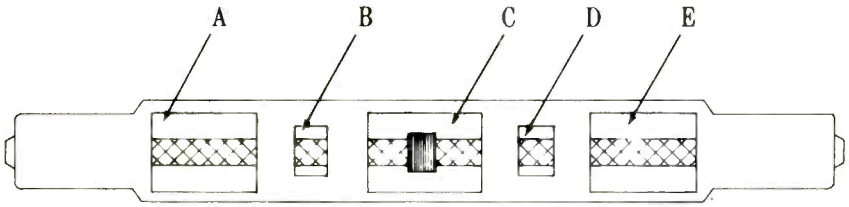


Fig. 3—Standard cassette openings are illustrated here. See text for references.

now promising this feature soon). (2) The continuous-loop cassette was not considered a bona fide solution to the continuous-play requirement.

For better than a year now, many cassette manufacturers have been promising automatic reversing machines to solve the continuous-play dilemma. In fact, at the last CES show in New York (June), Craig showed a playback-only version of an automatic-reverse unit; and Roberts showed a prototype of a unit that reached into the cassette, pulled out a loop of tape, and accomplished the bi-directional feat.

The record feature of the eight-track worked well, but potential users were frustrated in their recording attempts by the inability to reverse or pause conveniently during the recording process to eliminate commercials or to record over a selection no longer wanted on this program.

Eight-track remained the best continuous-playback medium, and cassette remained the best recording system.

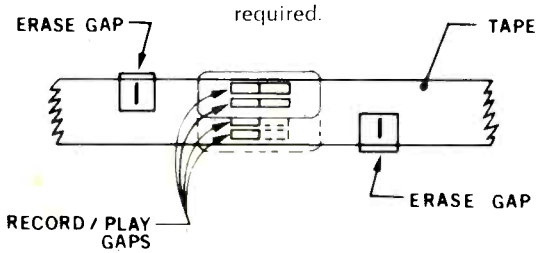
A patent recently issued to Michigan Magnetics, and other patent applications in process, have now added the next chapter in the unfolding drama. The Michigan Magnetics "K-Set System" utilizes a shifting cassette head (similar to eight-track) that provides a solution to achieving a *bi-directional cassette* with full record and playback features.

The problem was a tricky one. As can be seen in Fig. 3, the standard cassette has only five openings. Openings A and E are taken up (in an automatic reversing deck) by pinch rollers, since one roller is needed for forward tape motion and another needed for reverse. For best time-base stability, the capstan and pinch roller should be downstream of the tape head to ensure adequate tape wrap and a pulling movement of tape instead of a pushing movement.

Openings B and D have no pressure pads behind the tape, so using a head in these holes was considered impractical.

This leaves only opening C to accommodate three heads! Worse yet, the pressure pad in most cassettes is only ⅛" long. To use a four-channel combination head would require *six* gaps on a pad measuring ⅛" by 3/16". To date no one has been able to mass produce such a design. Note that a four-channel head would be needed to provide stereo pairs in both directions. This means up to six coils in a tiny head, with each coil acting on the others in a transformer fashion so that a signal in one would induce crosstalk in the others. A further complication arises when four channels replace two. In this instance, all coils must have less turns to make room for each other; and less turns mean less output. As the output of a head decreases, the signal-to-noise ratio of the system must suffer. If you are not yet impressed with the complicated nature of the beast, let me now add that a record/play head without an erase head upstream is almost useless. For effective recording technique, a system would have to have the six gaps positioned as shown in Fig. 4.

Fig. 4—For effective recording in a reversing cassette system, six gap positions are required.



The Michigan Magnetics "K-Set System" proposes to solve the problem by using the proven eight-track shifting technique. Erase heads are inserted in openings B and D to erase the tape immediately before recording in either the forward- or reverse-drive direction. As indicated earlier, this would not be an ideal place to erase because there are no pressure pads behind the tape for good tape-to-head contact. Still true, but the difference is that this system uses a newly developed *ferrite* erase head that will take high-frequency (70 kHz) erase currents of sufficient amplitude to "bloom" well beyond the gap and erase previously saturated tape to a remarkably low level of −60 dB. The outboard erase heads have built-in precision tape guides that replace the fork type common on many heads.

Now we get into the heart of the system. Michigan Magnetics has announced that the shifting head (that will operate in opening C of Fig. 3 will have the same electrical specifications as its standard "K-Set" stereo head. This means no sacrifices in the 1-kHz sensitivity, or in the 1 to 10 kHz frequency-response ratio, or in the crosstalk specs. Perhaps even more important, it means a program-1-to-program-2 crosstalk level that is almost non-existent. One of the problems that confronted engineers considering the four-channel-head approach was the fact that every time the tape changed direction, the critical audiophile user would have to jump up and readjust his balance control since a new pair of head channels would be used. The Michigan Magnetics "K-Set System" obviously eliminates this problem, since only one pair of channels is used; and, once the balance is adjusted for one direction of tape travel, channel balance is the same in the opposite direction.

It will be interesting to see how the industry will accept the drop-in feature of the system. AE

Part 3 (conclusion)

Layman's Guide to LOUDSPEAKER SPECIFICATIONS

VICTOR BROCINER

The existing U.S. standards of measurement are quite old, and do not apply to complete speaker systems. Several technical committees in the United States and Europe are at work revising the standards. The most recently issued standard, Publication 200 (1966) is marked "International Electrotechnical Commission Recommendation"; however, it also deals only with "single direct-radiator electro-dynamic loudspeakers of the moving-coil type." Some of the tests outlined are applicable to speaker systems. To quote, "For lack of internationally agreed knowledge and experience, certain important measurements have been deferred for future study . . . " The omissions include:

Harmonic Distortion
Intermodulation
Transient Distortion
Efficiency
Distortion-limited power handling capacity
Objective tests in more typical surroundings
Subjective tests

It is not surprising, then, that speaker manufacturers tend to be rather vague in their specifications. This is more true of advertising than of sales literature. A random selection of speaker advertisements yielded the descriptions and claims that are listed below.

Manufacturer A:
New advanced form of acoustic coupling
Size and weight
True-pitch bass down to 12 cps
Extended hi fi frequency dispersion

Manufacturer B:
Woofer: size; high compliance, with soft rubber annulus
Low-resonance wide dispersion mid-range tweeter with fiberglass pad to smooth frequency variations, and controlled perforations in the cone to eliminate low frequency peaks.
Variable high-frequency control
Impedance
Crossover frequency
Response 35 to 20,000 Hz ±3 dB
Extra bracing in cabinets
Dimensions

Manufacturer C:
Speaker sizes
Number of speakers
Mylar-domed tweeter
High-compliance woofer
Dimensions

Manufacturer D:
High efficiency system
Response 30-20,000 Hz
Woofer size
Horn-loaded tweeter
Dimensions

Manufacturer E:
New surround material on woofer permits large excursions with linearity
Smooth frequency response from below 30 Hz to beyond 20,000 Hz
Dimensions

Manufacturer F:
Heavy large (size specified) woofer in front-loaded exponential horn
High-frequency driver with cast aluminum horn works from lower mid-range (specified) through wide angle
Precision, two-section crossover network
Dimensions

Manufacturer G:
Controlled impedance to complement solid-state amplifiers
Reproduce original sound with no added coloration
Air suspension enclosures

Manufacturer H:
3-way bookshelf system
Woofer and mid-range sizes specified
Cone tweeters plus horn tweeter covers 25-25,000 Hz
Watts peak power input specified
Dimensions

Manufacturer I:
Very compact bookshelf speaker
Elliptical woofer
Matching tweeter
LC network
Dimensions

Manufacturer J:
High-compliant high-linearity woofer (size specified) with optimum damping
Big power handling capacity, particularly at extremes of audio spectrum.
Very smooth response
3-position treble switch to match room acoustics

Manufacturer K:
Frequency response: ±4 dB from 50 to 18,500 Hz
Dimensions (small)

Manufacturer L:
Omnidirectional design eliminates hot spots, pinpointed directionality, gritty ear-shattering highs by diffusing the sound over the entire room. 360° of sound. The music extends beyond the room.

Manufacturer M:
Direct/reflecting speaker
Proper balance of directed and reflected sound, as . . . in the concert hall
Multiple same-size, full-range speakers, internally coupled to eliminate audible resonances
Active equalization for smooth power output throughout the spectrum
Flat power output to the room

Aside from the cabinet dimensions, which are definite, the only other conclusion that can be drawn from advertising is that hi fi speaker systems, regardless of size, price, and design, all cover most if not all of the range of human hearing. Detailed sales literature contains more information, but this requires even more interpretation, in which it is hoped this article will help the reader.

As to performance and measurements, a proposal made to amplify the scope of the IEEE standard now being evolved is: "The characteristics to be considered are those that are customarily measured and that are deemed significant in terms of loudspeaker performance." The types of speakers included in the standard are classified according to transducing principles and radiating systems. In the first category, speakers used in hi fi stereo comprise dynamic and electrostatic units. Radiating systems are of two classes: direct radiators and horns.

Frequency Response—The frequen-

cy range covered by a speaker system is usually the first thing one thinks about. This is most generally expressed in words. Quite often, what is specified is "Usable Frequency Range" or "Response from X Hz to 20 kHz." This is so vague as to be meaningless. What is "useful"? How much "response"? There is "X to Y Hz *within* 10 dB". Figure 1A shows the different things this can mean. "Plus or minus 5 dB" is definite, but it reveals nothing of the shape of the curve, whether there are peaks or valleys or shelves or slopes. See Figure 1B.

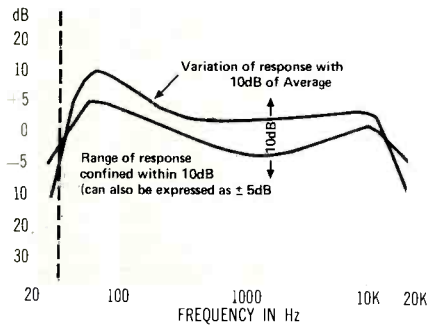


Fig. 1A—Frequency response within 10 dB, X to Y Hz.

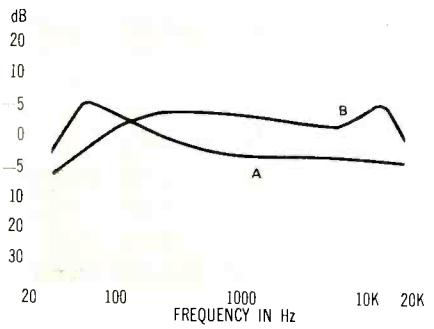


Fig. 1B—Both speakers have a response of ±5 dB, but (A) will sound dull and boomy compared with (B).

Curves of output vs. frequency are usually *on-axis* response curves, taken in an anechoic chamber (reflectionless room). Is this complete information? The off-axis responses are also important. Not only do we usually listen off-axis in stereo, but also the off-axis response largely determines the nature of the sound reflected from the room boundaries, which comprises the major portion of the sound energy reaching our ears.

We can measure the *total sound-power output* of the speaker. This is most conveniently done in a reverberation chamber, which gathers up the sound put out at all angles by the speaker, the way an optical integrating sphere measures the total light output of a light source. For a speakquencies, this is a pretty good criterion of what we hear. Unfortunately, few, if any, speakers approach this ideal. With speakers that become directional as the frequency increases, the on-axis response can be made to increase with frequency so that the total sound-power output remains constant, but the listening quality would be unbearable. Some speakers are designed with a slight rise as a compromise measure. The sound quality seems to be determined by the on-axis response, the first reflections, and the reverberant (multiply-reflected) sound. In the bass range, the listening room and the location of the speaker in the room have a large effect on the response, raising the bass output above that obtained in an anechoic chamber. This is sometimes measured by using a multiple-microphone system in a "typical" living room.

These factors explain why manufacturers are reluctant to publish a "frequency response curve." As you can see, there is really no such thing as *the* frequency response of a speaker. This is particularly true of some of the recently developed types that utilize wall reflections. A series of curves that are smooth, and show wide-range response off-axis as well as on axis, indicate that the speaker is probably pretty good. A curve in a reverberant room is simpler to interpret. The power response should fall off somewhat at the high end unless the speaker is perfectly omnidirectional.

Distortion—If the instantaneous relationship of sound output to electrical input is not linear, the output waveform of a speaker differs from the input. Non-linearity has two effects. When the input is a sine wave, harmonics are generated. These multiples of the original frequency can be measured individually with a wave analyzer and so specified, or their sum can be measured by means of a distortion meter as *Total Harmonic Distortion* (THD). Some authorities maintain that since the higher harmonics are more objectionable to the ear, they should be given more weight when the harmonic components are combined, but this is inconvenient and not usually done. Except at low frequencies, distortion in speakers is quite difficult to measure in a meaningful manner, because of irregularities in the frequency response and variations of spatial distribution with frequency. Low-frequency measurements do provide a reliable guide to the ability of a speaker to reproduce bass tones.

When the input consists of two or more sine waves, non-linearity produces not only the harmonics of the original waves, but their sum and difference frequencies as well, plus all kinds of combinations of sums and differences of harmonics and fundamentals. This is *Intermodulation Distortion*. Most of the intermodulation distortion products are not harmonically related to the original waves and consequently sound far more objectionable than harmonic-distortion products alone. They make music sound harsh, muddy, and poorly defined. When sustained, heavy bass tones occur simultaneously with treble tones, the latter are modulated by the low frequencies, producing a characteristic vibrato effect.

Another IM distortion measurement is that of the CCIF (Comite Consultatif International Telephonique) [Don't ask why "F" stands for "Telephonique"] which uses two frequencies quite close together. This has the advantage that one can traverse the whole frequency range and plot distortion vs. frequency. This type of distortion is demonstrated when a chorus starts and is accompanied by a low-frequency "grunt" by the speaker.

There are other schemes using more than two frequencies and also bands of noise, to simulate program material more closely. They are not in general use.

Two rather special kinds of distortion are *sub-harmonic generation* and *Doppler Distortion*. The first involves the creation of additional frequencies *below* that of the fundamental.

Doppler Distortion is related to the Doppler effect, commonly illustrated by the variation in pitch of a train whistle as the train comes toward us and then moves away from us. Suppose a loud bass note is producing very vigorous cone motion while a high note is also being reproduced. The large back-and-forth motion of the cone at low frequency will cause a wavering pitch or frequency modula-

tion of the high note. There are differences of opinion as to the importance of this effect. It is used as an argument against very small full-range speakers that have large excursions, and in favor of large horn-loaded speakers.

Efficiency—the ratio of the useful power output to the power input, expressed in per cent. It expresses the amount of sound (acoustic output) you get for a given electrical power input. However appealing the term, it has nothing to do with the sound quality of a speaker. A few speakers have *extremely* low efficiency and require amplifiers in the high-power-rating category. Because of irregularities in frequency response that occur in even the best speakers, efficiency should be stated over a frequency *range* rather than at one frequency. This avoids specifying efficiency at a peak or dip in response.

Horn speakers are very efficient but they are most often used for the mid-range and treble only, when they have to be "padded down"—used with reduced inputs—to avoid drowning out the woofer, so their efficiency is not used, whatever other virtues they may have. Direct-radiator speakers that reproduce the extreme bass range in fairly compact cabinets inherently have low efficiencies. The level of low-frequency response of a direct-radiator with respect to its mid-frequency response is determined by the system Q, as explained in a previous section. The frequency at which response drops by a given amount is a function of the low-frequency resonance of the woofer in its cabinet. This, in turn, is set by the compliance and moving mass. There is a limit to the attainable compliance, so the only way to lower resonance further is to increase the mass of the moving system. This lowers the efficiency. Increasing the flux density to raise the efficiency decreases the Q, which makes the bass response roll off. Electrical compensation is feasible, and is used in at least one commercially available speaker.

Horn loading can increase efficiency greatly but results in increased bulk and high cost.

Efficiency is of greater theoretical than practical interest. At a given frequency it is not very easy to calculate or measure how much power is being fed to the speaker. A more useful rating is the amplifier power needed to produce a given Sound Pressure Level at some fixed distance from the speaker, or in an average living room. See "Sensitivity."

Impedance—Determines how much current flows when a given a. c. voltage is applied. Impedance can consist of any combination of resistance, capacitance, (of a "condenser") and inductance (of a coil). The voice coil has resistance and inductance, but if we measure the current flow for a given applied voltage we find that less current flows than these two elements would dictate. This implies that there must be another impedance in series with the circuit. It is called "motional impedance."

The motion of the voice coil in the magnetic field generates an a. c. voltage that opposes the signal voltage, reducing the flow of current. Since this is a current-determining element, it can be represented by impedance. At resonance it can be quite large because of the large excursion of the voice coil, and can be represented by a resistance.

The combination of many resistances, inductances, and capacitances causes speaker impedance to vary widely over the frequency range. With a single speaker, there is a broad region, usually around 400 Hz, over which the impedance is low and nearly constant. Speakers are rated at this value. Multi-speaker systems which include additional capacitors, inductors, and resistors in the dividing network usually also have such a minimum but may have additional minima at higher frequencies.

Variations in impedance result in changes of current flow, so the power input to the speaker also varies over its range. The speaker designer must see to it that frequency response remains uniform by tailoring the efficiency to compensate for this effect.

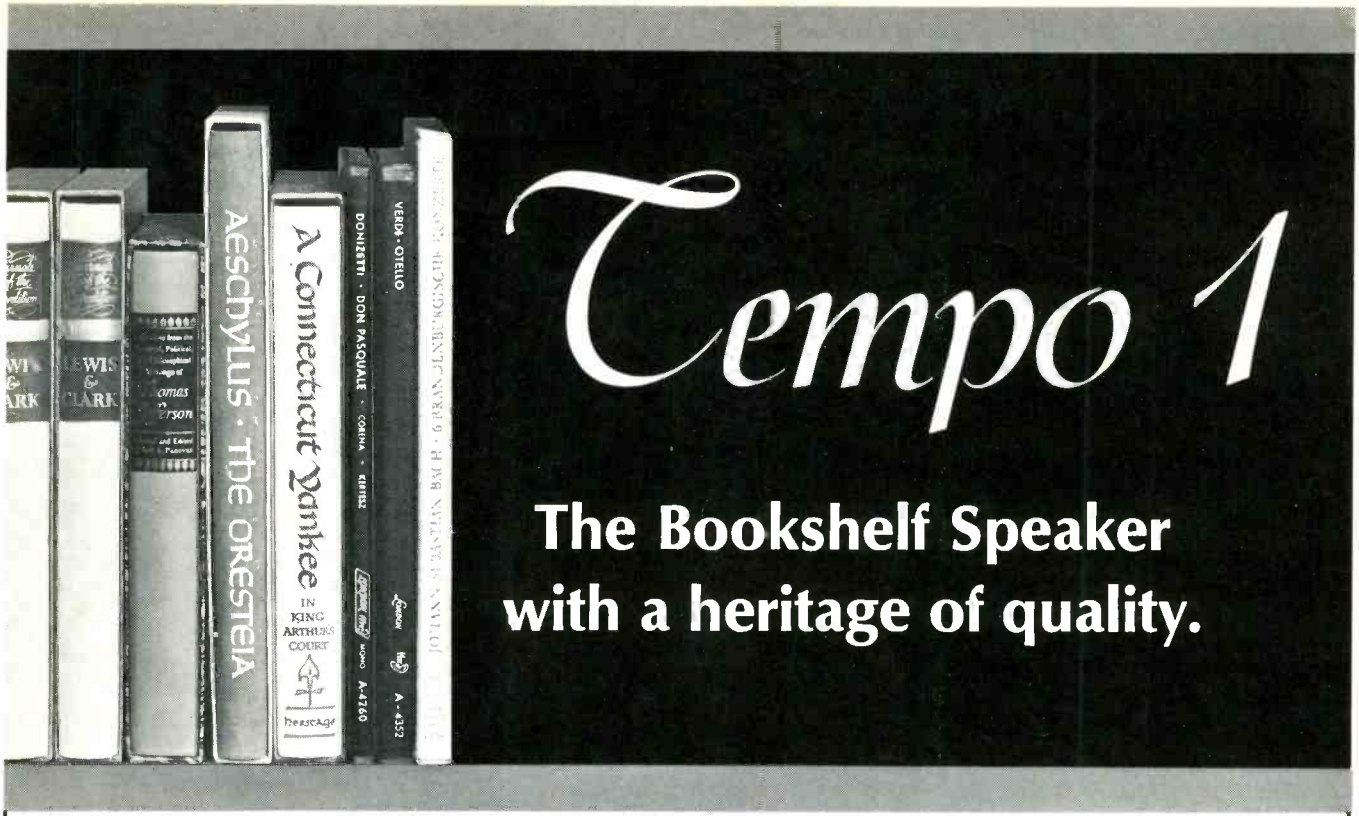
Impedance is of importance because the maximum power available from a solid-state amplifier increases as the load impedance decreases. Below a certain impedance value, the amplifier output current becomes excessive and fuses may blow or damage can result. Even where special protective devices prevent this, the distortion goes up. The distortion increase can take place at low power levels as well. So it is a good idea to keep speaker impedances within bounds. One speaker manufacturer—probably because he was originally an amplifier manufacturer—pays special attention to maintaining speaker impedance as uniform as possible over the frequency range. These systems are called *Controlled Impedance* speakers.

Phasing—Phase is the time relationship between two sine waves of the same frequency. *In-phase* waves are in synchronism. If one is delayed with respect to the other, the signals are *out of phase*. The amount by which they differ in phase can be expressed as a fraction of a wavelength or in degrees, where 360 deg. equals one wave-length. It can also be measured in radians; one radian equals 180 deg./π. One can specify the difference in fractions of a second, but in this case the figure is called *delay* instead of *phase* difference.

If out-of-phase speakers are close to each other, they interact unfavorably. One cone moves inward when the other moves out. At low frequencies the air moves back and forth between the speakers rather than out into the surroundings. At higher frequencies the speakers operate more independently because the sound from each tends to form a beam on the speaker axis. The result is that bass response is decreased. To facilitate correct phasing, speakers usually have one terminal coded. According to the EIA standard, one terminal shall be coded by means of a + mark or a color dot, preferably green.

In multi-speaker systems, there are frequency ranges where the outputs of a woofer and a tweeter (for example) overlap. If they are out of phase their outputs cancel and a dip occurs in the combined frequency response. Observing the polarities marked on the woofer and tweeter does not guarantee correct phasing because the dividing network introduces additional electrical phase shifts, and relative time delays are caused by the different path lengths between the two speakers and the listener. Smoothness of the frequency-response curve is the criterion.

Phasing is also important between the two speakers of a stereo system. If identical signals are fed to two separated speaker systems, a listener located equidistant from the two speakers hears the sound coming from



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a point exactly centered between them. If the speakers are out of phase, there is no definable apparent source of sound, and the correct spatial effects of stereo program material are lost.

Phase (Delay) Distortion—Program material consists almost entirely of waveforms that are not sine waves. Any waveform can be analyzed into a series of sine waves of different frequencies: the fundamental and its harmonics, which are multiples of the fundamental frequencies. The harmonic structure of a wave plays a large part in determining the nature of its sound to the ear, which uses it to identify the different musical instruments.

Now, if a complex wave is formed by the addition of a fundamental and a number of harmonics, its reproduced waveform is altered if any of the components are displaced in phase, or delayed. Under some circumstances the ear can detect this change in waveform, which is caused by *phase or delay distortion.*

Polar (Directional) Response—(angular distribution, dispersion). At low frequencies the sound waves produced by one side of a speaker diaphragm spread out uniformly in all directions. The sound becomes more and more concentrated into a beam with increasing frequency. Polar response is seldom specified for hi-fi speakers, but it is important. Verbal descriptions tend to be even less definite than those of frequency response. "Wide-angle" and "60-degree dispersion" are examples. Since the sound level decreases fairly gradually as one moves off the axis of a speaker, the amounts of decrease should be specified for a series of angles and at several frequencies.

Complete information can be represented graphically. A series of frequency-response curves, on-axis and at various angles off-axis (Fig. 2A), are difficult to interpret, because the off-axis responses tend to be rather irregular and may even overlap each other. Greater clarity results from a series of response plots at different angles for a number of representative frequencies. Fig. 2B.

Power Rating—The concept currently in use, while rather inexact, is the power rating of the most powerful amplifier that can be used with a speaker without damaging it when reproducing average program material at top power. Ratings for electronic guitars and the like are different and must be specified.

A continuous signal of the same power produces far more heating of the voice coil, which gets no chance to cool off as it does in the softer passages and pauses of program material. At low frequencies, the large motions of the voice coil help the air to cool it. Here the principal danger is from mechanical damage due to the coil striking something, tearing of suspension material, breakage due to fatigue of the flexible voice-coil leads, and the like. Consequently, the rating does *not* apply to continuous-wave power. Note that this kind of power rating is quite unlike that of an amplifier—it is not based on distortion.

The power rating is sometimes mistakenly interpreted as the power required to drive the speaker to a reasonable level (see Sensitivity).

Presence—Some speakers seem to give sound a projected or "forward" quality, noticeable particularly on voice. It is caused by a region of somewhat elevated response around 3000 Hz, where the ear has its maximum

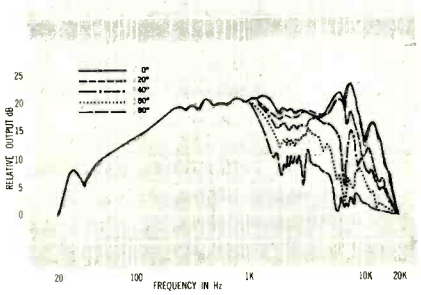


Fig. 2A—Response curve of a speaker on axis and at a number of angles.

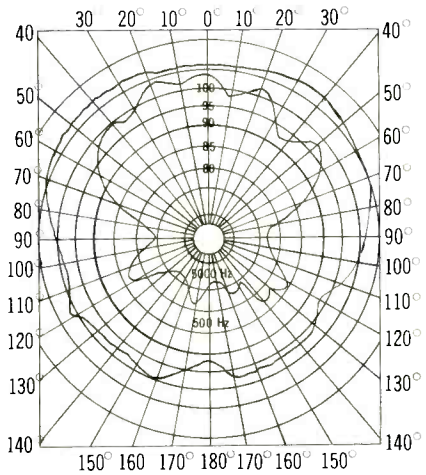


Fig. 2B—Polar response taken at 500 Hz and 5000 Hz.

sensitivity. It tends to bring a voice out so that it is not "inside the box," but it also makes music overly brilliant and "hard" in sound.

Sensitivity—This term is coming into greater use to indicate how much sound is produced by a speaker for a given power input.

The sound pressure level may be given at a point a stated distance on-axis for a given power input. A typical figure for an efficient speaker is 90 dB SPL* at 4 feet on-axis, for 1 watt. The frequency should be specified. It is preferable to make the measurement over a band of frequencies such as 800-1200 Hz. Otherwise one may be tempted to specify sensitivity at a peak in the response curve, which could easily be 5 dB or so. Incidentally, for purposes of comparison, the peak intensity level of a 75-piece orchestra might be 116 dB, and the long-term average at 30 feet distance 96 dB. Normal speech 3 feet from a talker is 65-74 dB.

The EIA (Electronic Industries Association) Pressure Efficiency Rating, used mostly in public address and similar work, has been applied to hi-fi speakers. It is the SPL obtained at 30 feet on-axis for 1 milliwatt input. The EIA figure can be converted to SPL at 4 feet for 1 watt by adding 47.5 dB to it.

The latest IEC (International Electrotechnical Commission) definition of *characteristic sensitivity* is the ratio of the average sound pressure, over a stated frequency range, and referred to a distance of 1 meter (from the speaker) to the square root of the nominal power (input).

These rating systems provide means for comparing the sensitivity of loudspeakers but they do not permit the user to determine directly how much amplifier power he needs. A far less technically involved rating is used by one of our leading consumer organizations. This is the amount of power required by the speaker to provide somewhat louder than normal reproduction of a variety of recorded program material in an "average" living room of 3000 cubic feet, as judged by a group of listeners. A chart is provided that shows the relative power required to obtain the same sound level in rooms of different size as well as those that are more "live" or "dead" than the

* Sound Pressure Level

BOSE on the reproduction of BASS

If you have heard the BOSE 901 Direct/Reflecting™ speaker system, or if you have read the unprecedented series of rave reviews, you already know that the 901 is the longest step forward in speaker design in perhaps two decades. Since the superiority of the 901 (covered by patent rights issued and pending) derives from an *interrelated group of advances*, each depending on the others for its full potential, we hope you will be interested in a fuller explanation than is possible in a single issue. This discussion is one of a series on the technical basis of the performance of the BOSE 901.

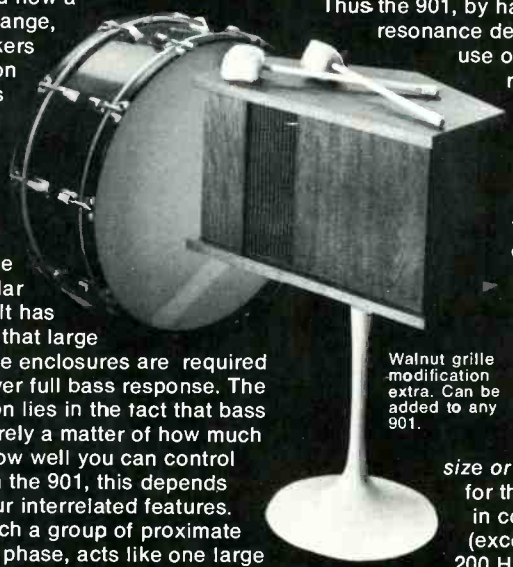
In other issues of this series we have explained how a multiplicity of same-size, full-range, acoustically coupled speakers "eliminate(s) the sound coloration caused by resonances of speaker systems using only a small number of speakers and by irregularities in the radiated energy spectrum of systems employing crossover networks."* But how does the use of 4 inch, full-range speakers allow such spectacular bass performance? It has always been assumed that large woofers in large enclosures are required to deliver full bass response. The answer to this question lies in the fact that bass performance is purely a matter of how much air you can move and how well you can control its movement. In the 901, this depends on four interrelated features.

A) *The 'Array Effect'*, by which a group of proximate small speakers, moving in phase, acts like one large speaker with the area of the group.

B) *The Special Design of the Drivers Used in the 901.* These are special long-excursion, high compliance speakers with large magnets, which can move large amounts of air.

C) *Use of the Well-Controlled Frequency Region Below Fundamental Resonance.* In conventional speaker design the fundamental resonance is pushed as low as possible and the region below this is discarded for music reproduction. Contrary to convention, the fundamental resonance of the 901 is designed *upward* to about 200 Hz. The reasons for this departure are:
1) Below 200 Hz, phase irregularities are much more audible than above 200 Hz.
2) Any speaker exhibits strong phase irregularities in the region of and above its fundamental resonance.
3) Below fundamental resonance, these irregularities are absent. Both amplitude and phase characteristics are very smooth functions of frequency *and are electronically equalizable.*
Thus the 901, by having its fundamental resonance designed at 200 Hz, allows us to make use of this region of smooth response to reproduce bass instruments with unprecedented accuracy of timbre.

D) *Active Equalization.* Since phase and amplitude are very smooth below fundamental resonance, it is possible through active equalization to control the amplifier signal to maintain flat radiated power down to lower frequencies than even the largest conventional speakers can produce. Ask your franchised BOSE dealer for an A-B comparison test with the best conventional speaker systems, *regardless of their size or price.* Listen especially for the deep accurate bass of the 901 in contrast to the artificial bass (excessive response between 80 Hz and 200 Hz) which is often mistaken in conventional speakers for good low frequency response, but whose thumping and droning cause listener fatigue.



Walnut grille modification extra. Can be added to any 901.

***From 'ON THE DESIGN, MEASUREMENT AND EVALUATION OF LOUDSPEAKERS', Dr. A. G. Bose, a paper presented at the 1968 convention of the Audio Engineering Society. Copies of the complete paper are available from the Bose Corp. for fifty cents.**

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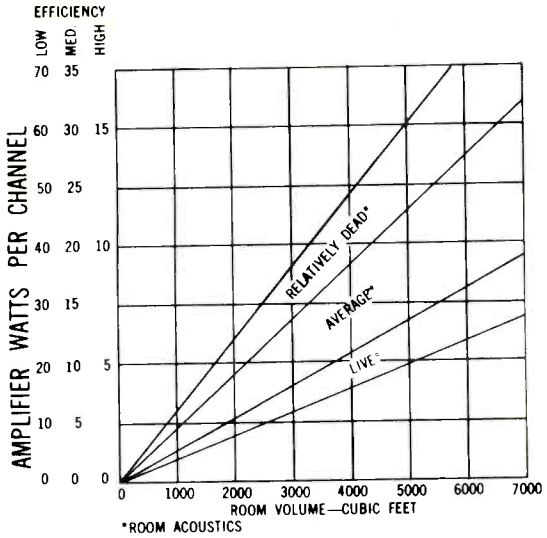

Fig. 3—Power requirements for various room sizes and conditions.

average. See Fig. 3. "Sensitivity" sounds desirable, and it is, other things being equal, but it is not related to the quality of a speaker.

Transient—Although this is not a speaker characteristic or measurement, it requires explanation before the following terms are discussed. A waveform that repeats itself forever is called a continuous or steady-state signal. A waveform that occurs but once (in a while) is termed a transient. Music and speech waveforms are constantly changing and hence are transient in nature.

Transient Distortion—The degree to which a speaker fails to reproduce a transient perfectly. A reproduced transient can differ from the original signal in so many different ways that there is no accepted number that expresses transient distortion; it is more of a qualitative term. It can be represented graphically, however. See below.

Transient Response—The response of a speaker when a transient is applied to it. This is of the greatest importance, since the function of a speaker is to reproduce transients. In general, a speaker with a flat, smooth, frequency response has excellent ability to reproduce transients. However, very small, sharp peaks and valleys in the response curve can cause disproportionate amounts of transient distortion, which is revealed by transient response testing. See "Tone-Burst Test" below.

It is widely believed that transient response correlates closely with listening quality. However, at least one series of experiments has failed to establish such a connection.

Tone-Burst Test—Transient testing on amplifiers uses a square-wave input. With loudspeakers a better method is to use a "carrier frequency" modulated by a square wave. To put it more simply, the signal is an audio frequency signal that is started and stopped periodically, forming a "tone burst."

The speaker output is picked up by a microphone and observed on an oscilloscope screen. The burst builds up gradually to full amplitude instead of instantaneously, and takes time to die out after the signal has been turned off. Good speakers have fast build-up time without overshoot and little hangover. With a really bad speaker, it may be hard to tell when the signal has stopped, the "decay transient" almost completely filling the interval between tone bursts. The frequency range of the speaker under test is traversed by varying the frequency of the sine wave in the tone burst. The bad spots are selected for photography of the oscilloscope trace. Equipment has been built to record the average value of the sound that persists after the burst, providing a curve of this type of transient distortion vs. frequency. The set-up is complicated and difficult to use, and the curve does not show the nature of the hangover. At the present time there is no accepted quantitative measure of tone-burst response.

Conclusions

Experts differ greatly in their opinions regarding the relationship between measurements and listening quality. Indeed, there is not even general agreement as to what listening quality should be. Measurements and specifications are chiefly of benefit to the speaker designer. They are of value in providing a means to ensure that speakers produced according to a given design all perform within predetermined limits with respect to the design standard. There is little question about the desirability of wide-range frequency response, and especially smoothness of the response curve. Good angular distribution at all frequencies is also important. It is not entirely a matter of how a speaker sounds off-axis. The polar response determines the ratio of direct sound to that received after reflection from the boundaries of the listening space. The latter, which is called the reverberant sound, must be sufficiently great to provide an adequate feeling of ambiance—that of being immersed in the sound—as in a concert hall. Low distortion is a contributing factor, but perhaps not quite as much so as most people think. Transient response provides a reasonably good guide to overall quality. But there is no accepted quantitative relationship. It is safer to assume that bad test results connote poor sound quality than that good specifications necessarily indicate fine audible performance.

As to listening quality, it is generally assumed that the objective is the most faithful reproduction of the original sound that can be attained. There are obvious exceptions: users of guitar amplifiers, for example, want artificial sound effects. They have been known to ask for "good, clean distortion." But even for those who want the best possible reproduction, it must be realized that, at best, one can only achieve a good *illusion* of the original sound. Without extremely elaborate systems that call for special recording techniques, the acoustics of the listening room simply prohibit the exact duplication of concert-hall sound. This is one of the reasons why microphone pickup and recording techniques are so varied and complicated. They are intended to create the desired illusion, and they succeed to a truly remarkable extent.

All this means that the final evaluation of speaker system performance is subjective. One must listen to a variety of program material, and decide on the basis of one's own preferences. Æ

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Equipment Profiles

- Pioneer Model SX-990 Stereo FM/AM Receiver
- Acoustic Research Model AR-5 Speaker System
- Pickering Model XV-15/750E Stereo Cartridge
- Audio Dynamics Model 303AX Speaker System
- Elpa Model PE-2018 Automatic Turntable
- Fisher Model HP-100 Stereo Headphone

Fig. 1

Pioneer Model SX-990 Stereo FM/AM Receiver

MANUFACTURER'S SPECIFICATIONS: **(FM Tuner Section)** IHF Usable Sensitivity: 1.7 μV. S/N: 62 dB. Capture Ratio: 2 dB. THD Mono: 0.7%. Stereo FM Separation: 42 dB @ 1 kHz. **(AM Tuner Section)** IHF Usable Sensitivity: 18 μV. **(Amplifier Section)** IHF Power: 100 watts total @ 8 ohms. RMS Power: 35 watts/channel (each channel driven); 28 watts/channel (both channels driven). THD: Under 0.5% at rated power. Frequency Response: 10 to 100,000 Hz ±3 dB. Power Bandwidth: 15 Hz to 40 kHz. S/N: Mag. Phono 80 dB; Aux 100 dB. Tone Control Range: Bass +11 dB, −16.5 db @ 50 Hz; Treble +10 dB, −9.5 db @ 10 kHz. **(General)** Dimensions: 18⅛" W x 14½" D x 5⅞" H. Price: $299.95.

Right near Pioneer's top-of-the-line receiver comes this new entry at just under $300.00. The model SX-990 maintains some of the well-established features of Pioneer's design approach. In addition, there are some clever new features which we have not previously encountered in looking at earlier receiver designs marketed by this firm.

To begin with, let's examine the front-panel layout shown pictorially in Fig. 1. The massive panel, done in anodized aluminum surrounding a stark black dial area, is itself contained within a pair of wood side panels which recede to form an attractive walnut enclosure. (The enclosure incidentally is *not* "optional extra," but comes as part and parcel of the purchased receiver). Starting at the lower left, we encounter a five position speaker switch whose first position is Power-Off. The other four positions permit listening to either or both of two pairs of stereo speaker systems. This control is followed by a conventional stereo headphone jack. Next are the dual concentric calibrated bass and treble controls. Their clutch action permits indivdual adjustment of the bass or treble for each channel. The high and low filters which follow are of the "push-to-actuate, push-to-release" type. Next comes the usual balance control and volume control followed by three more push-push switches for loudness, muting, and tape monitor. The last control at the lower right is a mode switch with positions for stereo, reverse, left-only, right-only and left-plus-right (which is a rather archaic way of saying just plain mono). At the extreme right is a microphone input jack. We felt that the small knobs used for these functions help to create an uncluttered look and are fine for continuously variable controls such as tone, volume, etc., but are a bit too small for the torque required when they are used as switch knobs.

In the AM position a signal-strength meter appears "out of the darkness" at the left of the dial area, illuminated in bright yellow. Dial calibration is illuminated in bright blue, while the dial pointer is lighted in gold. A series of illuminated letters indicate the selected signal source (AM, FM, PHONO 1, PHONO 2/MIC, and AUX). In both the FM MONO and FM AUTO positions a center-of-channel tuning meter appears directly above the signal-strength meter previously noted. As one scans the dial, the presence of stereo FM transmissions is indicated by a bright red series of letters reading FM STEREO. The tuning knob (this time of adequate size and coupled to a moderately effective flywheel) and the selector switch complete the layout of the upper section of the panel.

Examining the rear panel of the

Fig. 2A

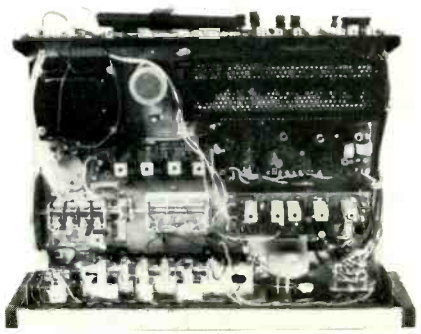

Fig. 2B

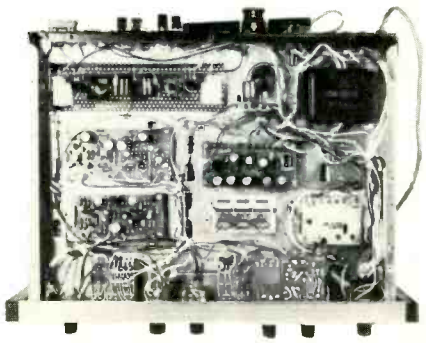

Fig. 2C

Figs. 2A, 2B, 2C—Rear, and exposed top and bottom of chassis.

SX-990 (shown in Fig. 2), we encounter two very important features pioneered by Pioneer. The first of these has been seen on previously-reviewed equipment from this manufacturer. It is the speaker-connecting arrangement, which consists of separately supplied polarized screw terminal blocks to which the speaker leads are attached. Once properly phased-out, these blocks ensure correct phasing whenever speakers are disconnected or the equipment is moved from one room to another and reassembled because the blocks plug into the back of the receiver only one way. The second innovation, and one which is becoming increasingly important in view of all the auxiliary equipment now appearing on the market intended for installation between a preamplifier and the power amplifier, consists of a pair of shorting bars. They come installed between pairs of jacks labeled "pre-amp out" and "main-amp in." By removing them, the user has, in effect, separate preamplifier facilities and separate main amplifier inputs. He can interpose such accessories as reverberation units, any one of the new tonal spectrum contouring units, or what have you.

The rest of the back panel contains the usual number of required input jacks, three convenience AC outlets (two of which are unswitched), FM and AM antenna terminals, a DIN receptacle for certain imported tape recorders, a line fuse, a movable built-in AM ferrite antenna, a center-channel output jack for connection to a center-channel power amplifier if desired and a pair of sturdy ground posts for connection of turntable or tape deck plates.

Figures 2B and 2C disclose the neat, modular-circuit-board construction of the Model SX-990. Ten separate modules, not including the fully-sealed FM front end, make up this unit. The i.f. section includes four integrated circuits, while the front end uses an FET transistor as an r.f. amplifier. In all, there are five ICs, 36 transistors, 17 diodes, and one FET in this massively constructed chassis.

Measurements

Figure 3 discloses that the unit achieves an IHF sensitivity of 1.8 μV at mid-band and betters 1.7 μV at

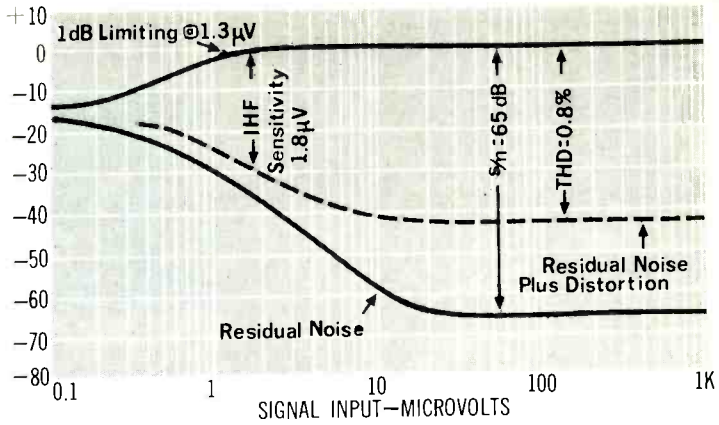

Fig. 3—FM characteristics of Pioneer SX-990 stereo receiver.

88 MHz. One-dB limiting is achieved at mid-band and betters 1.7 μV at measured at 65 dB, while THD for mono measured 0.8% as opposed to the 0.7% claimed. In the stereo mode, THD was just over 1%.

Stereo FM separation is plotted in Fig. 4, measuring 35 dB at 1 kHz, 22 dB at 10 kHz.

The amplifier section conformed to published specifications quite nicely. As with other moderately priced units tested, some of the published and unpublished parameters left something to be desired. Power bandwidth is plotted in Fig. 5, while THD and IM are shown in Fig. 6. The IM distortion is quite low at every power level, though it tends to increase at low power levels (but even here it's only 0.6%). At maximum power levels, however, both THD and IM are seen to conform almost exactly with published claims. Tone-control, filter, and loudness-control characteristics are shown in Fig. 7. While the tone-control curves are somewhat assymetrical, in actual listening use they prove to be quite adequate and effective. The high-frequency filter, with a somewhat steeper (about 10 dB/octave) slope was useful in eliminating surface noise from older records, but the low filter was merely a duplication of the bass control slope and was therefore ineffective. Pioneer chose to revert to both bass and treble compen-

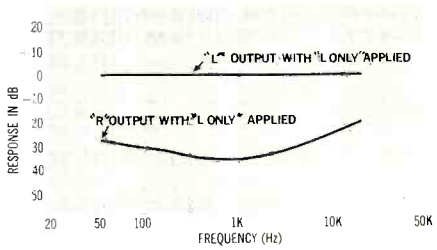

Fig. 4—FM separation characteristics.

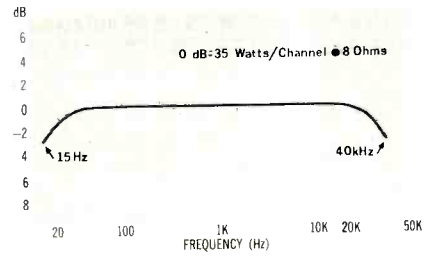

Fig. 5—Power bandwidth (at ½-power points).

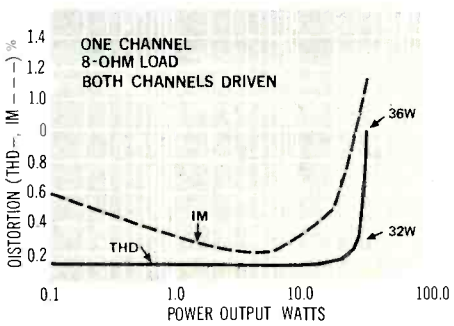

Fig. 6—Harmonic and intermodulation distortion.

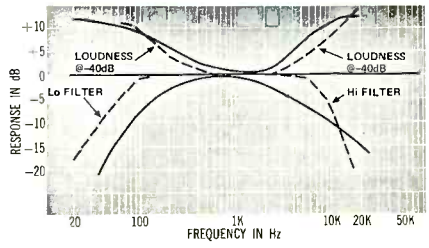

Fig. 7—Tone control, filter, and loudness control characteristics.

sation in its loudness control. While we feel that some treble emphasis in association with a loudness compensation control may be desirable, this unit emphasizes the treble almost as much as the bass at various settings of the loudness control, rendering an unnatural sound to our ears.

Performance

Using a simple dipole FM antenna, we were able to log 39 usable FM stations. Changing to an outdoor 4-element directional antenna improved this number to 46 stations, of which 16 were in acceptable stereo. We found that the signal-strength meter was not too useful since it reaches full scale at an input signal strength of about 50 μV, while half-scale readings take place at approximately 4 μV. The center-of-channel meter, however, was very accurate and corresponded nicely with correct center-of-channel tuning for both weak and strong signals. Muting was extremely effective. Inter-station noise was completely eliminated with the muting switch depressed, yet signals as low as 2.5 μV were able to overcome the muting circuits without the introduction of noticeable distortion.

AM performance was adequate but not outstanding insofar as bandwidth and frequency response were concerned.

As for amplifier power-handling capability, we found it to be sufficient for a pair of low-efficiency, acoustic-suspension-type speaker systems. Amplifier hum and noise were excellent —really inaudible. We tried the microphone input using a high-impedance dynamic mike and found that the gain of this circuit should have been a bit higher. Other input sensitivities were just where we'd like to see them. For example, the magnetic phono sensitivity was 3.3 mV—a good compromise value when no input level adjustment is provided.

The Pioneer SX-990 represents substantial value for its price class, and this is the way it should be evaluated. It would be unfair to stack it against $400 units, of course. Thus, it constitutes a good all-around receiver buy for someone who wishes to enjoy a fair amount of control flexibility but doesn't require every last control feature ever conceived by the high-fidelity component industry.

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Acoustic Research Model AR-5 Loudspeaker System

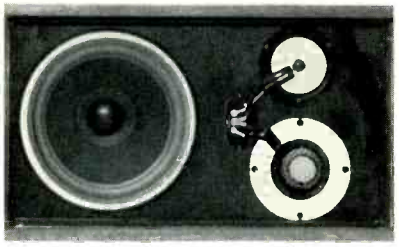

Fig. 1

MANUFACTURER'S SPECIFICATIONS: **Input Impedance:** 8 ohms. **Recommended Power Input** (for average-size room): 20 watts minimum. **Speaker Complement:** 10" acoustic suspension woofer; 1½" mid-range hemispherical dome; ¾" high-frequency hemispherical dome. **Controls:** Independent mid-range and high-frequency-driver level controls. **Dimensions:** 13½" W x 24" H x 11½" D. **Weight:** 39 lbs. **Available Finishes:** Glossy walnut, oiled walnut, cherry, oiled teak, mahogany, birch or unfinished pine. **Price:** From $156.00 (unfinished) to $175.00.

On first listening to Acoustic Research's new AR-5 systems, we were immediately impressed by the similarity between the excellent sound they produced and that of the now-famous AR-3a's, AR's top-of-the-line system selling for about $75.00 more than the AR-5. Further investigation disclosed that the mid-range and high-frequency drivers of these new systems are identical to those used in the more expensive model. Only the woofer, a 10-in. soft-suspension element that embodies a new molded cone, is different. Cone suspension is re-designed, too, and involves the use of a urethane polymer which, the manufacturer claims, helps to reduce low-frequency distortion.

If, as the manufacturer states, the use of the smaller-diameter woofer (10-in.) in this model cuts bass response by ⅛ of an octave (as compared with the larger AR-3a), this very negligible sacrifice is more than offset by an amazing lack of distortion in the bass region. Our 'scope measurements disclosed complete absence of "doubling" to below 40 Hz!

In addition to listening tests, frequency response measurements taken in free air disclose exceedingly smooth response, with no significant "peaks" or valleys greater than 3 dB in amplitude at any point in the audio spectrum. AR does not specify frequency response in its published specifications, contending that useful response is dictated by room acoustics as well as a great many other factors. While we heartily concur with this point of view, we nevertheless would rate the response as being useful from about 35 Hz to 18,000 Hz. Crossover frequencies for this system have been set at 625 Hz and 5000 Hz. The lower of these frequencies, between woofer and mid-range, is a bit higher than the frequency used in the AR-3a.

Since two controls are available (mid-range and high-frequency level), we found it necessary to take several response curves. In the course of these experiments we concluded that the controls actually afford a bit too much control. As an example, it was possible to alter the output at 500 Hz by about 8 dB, while response at 10 kHz, using the "tweeter" level control, was variable over a range of nearly 12 dB. The task of adjusting *two* such controls for optimum response is not easy—there are just too many combinations and permutations of settings. As it turned out in our case, optimally flat response under our listening conditions (fairly "live," medium-sized listening room) was achieved with the mid-range control set about half way up, and the tweeter control set slightly above the half way mark. In all probability, other listening situations would call for settings not too dissimilar from ours and, after all, amplifiers do have tone controls.

Input impedance characteristics of the AR-5 are plotted in Fig. 2, and although the impedance "trend" seems to fall a bit below the nominally stated "8-ohm" figure, at no point does the input impedance fall below the "danger line" (for some solid-state amplifiers) of 4-ohms. Interestingly, the impedance at the very high end was significantly affected by settings of the tweeter level control, the higher curve corresponding to full clockwise setting of that control. This curve also con-

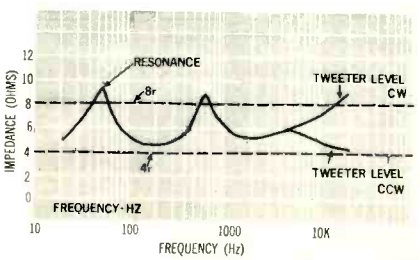

Fig. 2—Impedance characteristics of AR-5.

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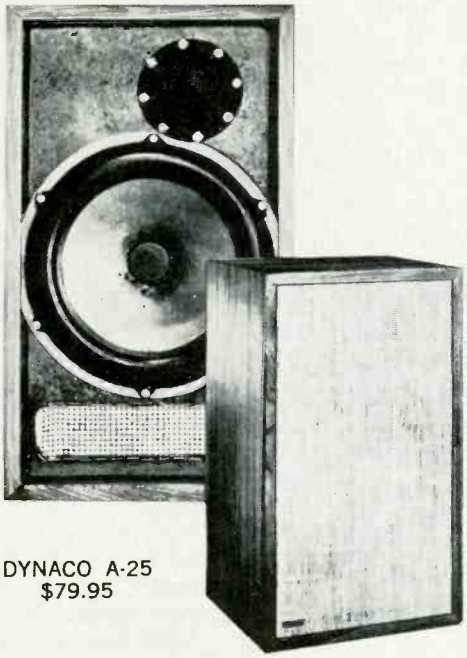

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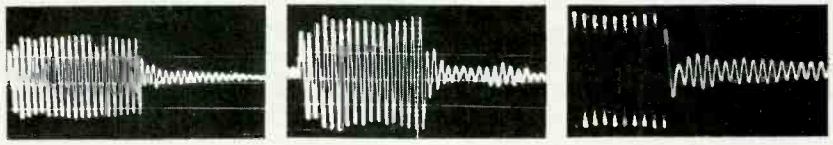
". . . The tone-burst measurements also confirmed our listening tests . . . In the hundreds of tone-burst measurements we have made, we have found a few instances where a speaker was slightly better than this one at specific frequencies, but nothing we have tested had a better overall transient response."

AUDIO, OCTOBER 1969

". . . it was its outstanding transient response which really impressed us. Tone bursts throughout the meaningful frequency range showed up its excellence. In truth, the A-25 produced the finest tone-burst response of any speaker tested in this manner, regardless of price."

"The excellent overall transient response of the Dynaco A-25 speaker system is shown by the tone-burst response photos at (left to right) 600, 2,000 and 10,000 Hz." **(Stereo Review)**



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dynaco INC. **3060 JEFFERSON ST., PHILA., PA. 19121**
IN EUROPE WRITE: DYNACO A/S, HUMLUM, STRUER, DENMARK

firms the fact that woofer resonance is at 55 Hz when measured in its enclosure. Acoustically, the region around woofer resonance had no significant peaks, a fact which further aids to produce an "uncolored" bass sound.

Performance

For all the warnings regarding "adequate power" given by AR and other manufacturers who produce acoustic suspension designs, we found the AR-5 to be remarkably efficient in its class. An amplifier having really low distortion, particularly in the bass region, need have little more than 15 watts of power-handling capacity to drive these systems to reasonable dynamic levels. Of course, more power will afford just that much more reserve and we can safely state that feeding power peaks as high as 40 and even 45 watts rms to the AR-5s resulted in absolutely no bottoming of the woofer cone or any other noticeable distortion. Sonic balance was maintained at all dynamic levels and transient response was as good as anything we have heard. Mid-range dispersion was particularly good and most effective when we played selections in stereo having a bit more deliberate separation than usual.

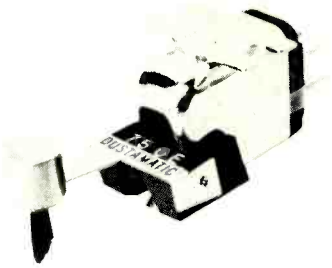
Our microphone tests disclosed only about a 3-dB attenuation of 10,000 Hz at a 60-deg. angle off-axis, which speaks very well for the hemispherical-dome-tweeter and mid-range designs which have been carried over into the AR-5 from previous designs.

Unless you have a lot of music containing frequencies below 35 or 40 Hz that you just have to hear (or "feel"), can satisfy the bookshelf-size needs of many audio buffs who have systems in the medium to moderately high price range. And one need not have a 50 watts rms/channel amplifier, since a very good 15 watts rms/channel or just plain clean 20 watts rms/channel amplifier would do just fine.

Check No. 61 on Reader Service Card

Pickering Model XV-15/750E Stereo Cartridge

Pickering's XV-15/750E is the top-of-the-line phono cartridge of the latest XV-15 series of stereo cartridges. It has an elliptical diamond stylus as well as the traditional "Dustmatic" brush.



MANUFACTURER'S SPECIFICATIONS: **Frequency Response:** 10 to 25,000 Hz. **Output:** 4.4 mV referred to 5.5 cm/sec record velocity. **Channel separation:** 25 dB. Stylus Type: .0002" X .0009" Elliptical. **Tracking Force:** ½ to 1 gram. **Price:** $60.00.

The cartridge is only 5.5 grams in weight, which makes it suitable for use in the lowest-mass tone arms. Its cleverly pivoted, built-in brush acts as a lint- and fuzz-cleaning agent, keeping that nasty dirty stuff away from the stylus during play. Just the right amount of force is automatically applied by the brush's own weight and pivot distance. One extra gram of stylus force set on the tone arm exactly compensates for the brush's force. The brush also acts as an anti-skating device of sorts, so that when used with tone arms with built-in anti-skating devices of their own, one should reduce that compensation by about ½ gram to take into account the action of the brush.

The stylus assembly is of a very low mass, too, which results in excellent tracking at forces of 1 gram. In an SME tone arm, set at 1¼ gram, we could track all our test records without difficulty. The resonant peak, so evident in lesser cartridges, is very much subdued. It's up around 15 kHz in the amount of 2 dB. This accounts the exceptionally smooth sound of the cartridge on good LP records.

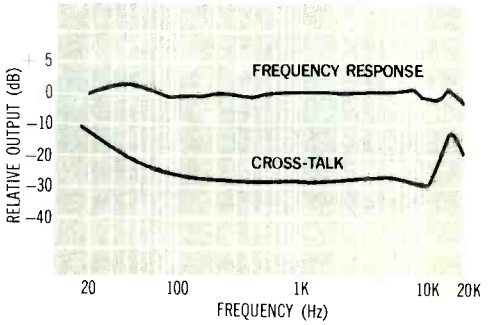


Fig. 2—Averaged frequency response and cross-talk of Pickering XV-15/750E.

Figure 2 shows the response of the Pickering XV-15/750 to the sweep band of the CBS Labs STR100 test record, as automatically plotted on a graphic level recorder. From this curve, we get an average response of 40 to 18,000 Hz ± 3dB, which is excellent. Sensitivity was measured at 4.2 mV for a 3.54 cm/sec rms 45-deg. 1-kHz signal, and was within 1 dB between channels, as shown in the response curve. The average separation between channels in the midband frequency region was 25 dB, which is very good, though less than specified. The difference is probably attributable to a different measurement technique and some crosstalk in our test record. The Pickering XV15/75E is well shielded and not at all susceptible to hum pickup. An excellent signal-to-noise ratio of 65 dB through a wide-band RIAA preamp was obtained during our tests.

We enjoyed playing records with this cartridge because it brought out the best in them—especially the bright, new releases with high recorded velocities, mid-range peaks and all. A handsome, compact-like gold case ensconces the XV15/75E. matching the promise within.

Check No. 62 on Reader Service Card

ADC Model 303AX Loudspeaker System

The 303AX, the latest version of ADC's popular 303A loudspeaker system, is a real winner. The main change is in the newly designed acoustic suspension woofer, which provides a better low end and improved power-handling capability. The result is a a very fine speaker system which is better by a substantial margin over its predecessor, and stands in the forefront of $100-category speakers.

The smartly styled bookshelf-sized 303AX is finished on all sides in oiled walnut, with aluminum trim around the black-and-chrome grille cloth panel. The 10-in. high-compliance woofer crosses over to a 1½-in. Mylar dome tweeter at 1500 Hz. The mid-range and tweeter switches, recesssed into the rear of the cabinet, together with speaker terminals, can be set to one of two positions. Incidentally, "midrange" refers to frequency response, and not to a separate speaker. We found the attenuated position

MANUFACTURER'S SPECIFICATIONS:
Impedance: 8 ohms. **Frequency Response:** 33-20,000 Hz ±3 dB in average room. Tweeter: Mylar dome. Woofer: 10" high compliance. **Dimensions:** 22¾" H x 13" W x 11¾" D. **Price:** $99.95.

sounded best, with a 2- or 3-dB boost of the amplifier's treble control.

In search of a more meaningful speaker response test, we departed here from our previous multi-microphone averaging technique and used a ⅓-octave-band pink noise as the source, plotting the speaker's output as sensed by a condenser microphone three feet away, on axis, in a listening room. We feel that this type of random noise simulates music more closely than sine waves, representing more of what we hear. Futhermore, our results so far point to improved correlation between measurements and listening experience.

When measured in this way, the ADC303AX has a wide, smooth frequency response of ±3 dB between 40 and 10,000 Hz (excepting a 5-db peak at 64 Hz), which are the limits of our microphone calibration at this time. But it was obvious that the 303AX did not stop there. Dispersion is good and no prominent aberrations were detected anywhere in the audible spectrum. Short of going to a three-way system, it would be difficult to improve on this design.

In listening, we noted a particularly good low end and a smooth quality throughout—especially on strings. The speaker sounds pleasant and clear, with no apparent frequency favoring. It sounds bright when it's supposed to. And it can handle lots of power. In matters of efficiency, it is on the reasonable side of inefficient acoustic suspension speakers. We recommend a power amplifier of at least 20 watts rms per channel, though 25-30 would take advantage of the speaker's qualities even better.

The ADC 303AX represents particularly excellent value because it is an especially fine-sounding bookshelf system at the price range where you get the most quality for your money.

Check No. 64 on Reader Service Card

Elpa Model PE-2018 Automatic Turntable

MANUFACTURER'S SPECIFICATIONS:
Speeds: 33⅓, 45, and 78 rpm. **Turntable:** Cast metal (non-magnetic); 10⅔" diameter; weight, 4.4 lbs. **Flutter and Wow:** 0.15%. **Rumble:** −47 dB (converted from DIN 45 507, which is −56 dB re: 10 cm/sec). **Dimensions:** 13⅛" W x 10⅞" D x 4⅞" over and 3⁹⁄₁₆" under motor board. Weight: 12.2 lbs. **Price:** $99.95. (Optional base, $7.00; dust cover, $7.00; 45-rpm spindle, $4.95).

Studying the PE-2018 was almost like studying the earlier (and more expensive) PE-2020, which it resembles in most of its features. (The 2020 was profiled in May, 1968.) The differences can be summed up quite simply: the 2020 has four speeds (including the 16⅔ which has not gained much popularity), is slightly larger (about an inch in each dimension), has a heavier and larger platter (7.1 lbs. and 11½" in diameter), has a 2-dB better (specified) rumble figure, and has slightly less flutter and wow.

But most of the other features remain the same in both models, and these include single-lever control, adjustable vertical tracking angle, automatic set-down position determination. This is effected by a movable pin in the center of a depressed portion of the turntable so that a 7-in. record depresses the pin completely and adjusts the set-down position to the correct diameter for the singles; a 10- or 12-in. record depresses the pin slightly —just enough to disable the automatic shut-off so that the machine will play at all. With no record on the platter, you can operate the start lever and the unit will go through its cycle and return the arm to the rest, thus inhibiting the machine from playing the rubber platter mat, with probable damage to the stylus. The 10-12 selection is done by a plastic lever which rises from a hole in the motor board near the arm pivot assembly—if it rises to its limit, the arm sets down on the 10-in. diameter; if it is stopped by the larger diameter of the 12-in. record, the pickup sets down at the proper position for the large record. This latter feature, along with the 78 speed, is practically academic unless you have a collection of records made over ten years ago—both 10-in. records and 78s are nearly obsolete.

The arm is "dynamically" balanced —that is, you first adjust the counterweight to obtain a static balance, and then you turn the stylus-force knob to the desired value anywhere between 1 and 6 grams. Both the stylus-force and anti-skating knobs are mounted on the base of the arm-mounting assembly. The stylus-force knob has black gradations, while the anti-skating adjustment is graduated with red figures. Both knobs are set at the same number for the usual conical stylus with a radius from 0.5 to 0.7 mils. Thus if you want a stylus force of 1.5 grams, you simply set both knobs at the line between 1 and 2 grams. If your stylus is elliptical, however, you consult a chart in the instruction book and determine the anti-skating knob setting for a desired stylus force. This chart also applies to styli of different diameters than the usual 0.5 to 0.7, since some users still have 1.0-mil "rollers" in their pickups.

Operation of the unit is fairly simple, since it is done by a single control lever. The START position feeds power to the motor and puts the mechanism into its cycle. The arm is lifted, moved over to the correct radius, and lowered gently. If there is no record on the platter, the arm lifts, then returns to the rest. When the cycle is completed,

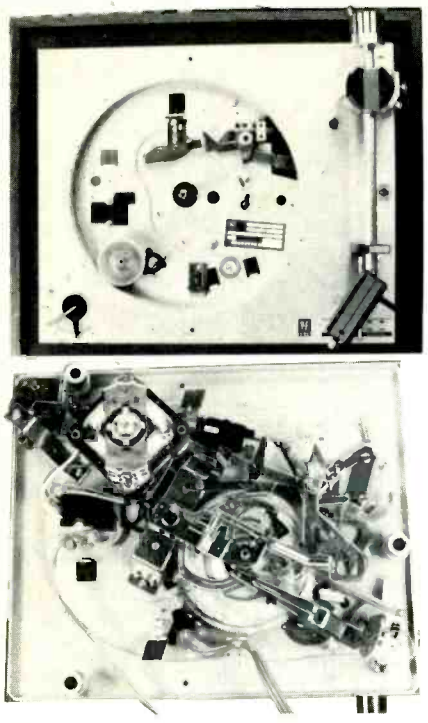


Fig. 2—Views of PE-2018 automatic turntable: Top, with platter removed, and exposed mechanism on the underside of the changer.

the lever returns to the neutral position. To stop the action, the lever is shifted to the STOP position, which starts a cycle that ends with the arm on the rest and the motor shut off.

To the left of the neutral position are two more positions which are marked the word LIFT with the usual pictorial symbols to indicate lifted and lowered stylus positions. The lever starts either of these functions, both of which are actuated by the cycling mechanism, rather than by a direct lift or lower action.

The 2018 uses the same cartridge holder as the 2020, which means that it is adjustable for vertical tracking angle. The knob on the front actuates a cam which raises or lowers the front edge of the cartridge mounting plate. If you are playing single records, you set the knob at 1; if you put a stack of 8 records on the platter, you set the knob at 4—half the number of records (approximately). This gives a 15-deg. tracking angle for the record in the center of the stack, and compromises the others.

Pitch control is also provided as a levered disc which is concentric with the speed control lever, and provides a ±3-per cent variation in speed. We found that a 1000-Hz cut on a test record could be reproduced at anywhere from 965 to 1030 Hz, depending on the setting of the pitch control.

One of the refinements of the PE-2018 is the provision of a pair of hold-down brackets which may be slipped in place under the motor board after the turntable is mounted on its base. The screws which hold these brackets are accessible through holes in the platter, and may be reached by lifting the edges of the fixed rubber mat.

In addition to the usual automatic, manual-automatic, or manual operation of the turntable, it can be made to repeat a single record continuously by inserting the single-play spindle and *not* turning it to the right as you would normally do to secure it in position. The same operation can be done with the multiple-play spindle (after a record is dropped) by turning the spindle to the left, thus unlocking it from its normal position. The spindle must not be turned or removed during a change cycle, however.

Performance

Like the PE-2020, the 2018 is a pleasure to use. The "command" lever operates very easily, and while it takes an appreciable time for the unit to go through a cycle, this delay only occurs at the start of the first record, or when you lift or lower the pickup. Flutter and wow measured .08 per cent in the range from 0.5 to 6.0 Hz, and 0.12 per cent in the range from 6 to 250, as well as from 0.5 to 250 Hz. Rumble measured 39 dB below a stylus velocity of 3.54 cm/sec at 1000 Hz; weighted, this turns out to be −48 dB, which is good for an automatic turntable. All of the rumble appeared to be below 6 Hz, which makes it essentially inaudible. Presented with a variable-frequency source, the speed varied just as one would expect from a synchronous motor, although the motor in the PE-2018 is a 4-pole induction type. With variable voltages, however, the speed was only 5 per cent slow at 75 volts, but it wouldn't go through its change cycle at less than 85 volts.

Although it is theoretically correct to adjust the vertical tracking angle for an exact 15 deg. (and the differences are readily measurable using the CBS Labs STR-160 record and a harmonic distortion meter), we must admit that aurally we could not detect any difference between various settings of the vertical-tracking-angle control. But then we feel the same way about anti-skating—the difference is not greatly noticeable to the ear. But tests prove that anti-skating compensation does reduce record wear.

In any case, the PE-2018, with its handsome grained aluminum dress panel over its solid steel "motor board," is a nice-performing automatic turntable with extra features to improve performance and operating ease. It should be considered for use with any moderately priced stereo setup where playing a stack of LPs is desirable.

Check No. 66 on Reader Service Card

Fisher HP-100 Stereo Headphones

MANUFACTURER'S SPECIFICATIONS:

Frequency Range: 18-22,000 Hz. **Sensitivity:** 2 mW input (at 1 kHz) for average listening levels. **Maximum Power Input:** 0.7 W. **Nominal Impedance:** 50 ohms. **Cable Length:** 8 feet. **Weight:** 11 oz. including cord and plug. **Price:** $34.95.

Most anyone who has occasion to use stereo headphones for any length of time wishes they were lighter, since the weight, combined with the circumaural pads with which most phones are equipped give the impression of being hampered and isolated at the same time. The HP-100 headphones, which weigh only 11 oz. including the cord and plug, give a freer effect than most to the listener, and provide a pleasant listening experience along with comfort.

The advantages of stereo headphones are many, all will agree. The listener is not influenced at all by the acoustics of the room, and everything he hears is just as it comes from the amplifier. If the phones have an adequate frequency range, the user can enjoy the program material without

Check No. 130 on Reader Service Card →

being distracted by outside noises, locally introduced reverberation, and an improved sense of stereo with increased separation.

The phones themselves consist of two 1¾" plastic housings for the transducers, mounted within larger plastic enclosures about 3 x 3¾ in. in size which provide the heating for the fine polyfoam cushions each of which is ¾ in. thick. The inner surface of these velvet-soft cushions is recessed to fit over the transducer housings, and the outer surface is essentially flat. Since the cup-shaped enclosure is only ⅜ in. deep, only the flat face of the cushion touches the ear. The softness of the foam cushions completely eliminates the feeling of having phones on at all, and sound from the outside can still penetrate, although attenuated considerably.

The rear of the transducer housings are provided with slots which provide the correct acoustic loading for the phones and effectively eliminate any boominess which is sometimes heard with circumaural phone pads. The larger plastic enclosures are also perforated with somewhat larger openings which do not affect the acoustic performance, but serve to vent the slots in the transducer housings, as well as reduce the overall weight by a few grams.

The foam cushions provide an acoustic resistance which is said to reduce any possible resonances. The result is that the sound which reaches the ear is quite flat over the range from 19 to 22,000 Hz, according to the manufacturer. We were able to measure some output as high as 20,000, and as low as 20 Hz. From 70 to 11,000 Hz, the maximum deviation from flat response was ±5 dB, which is exceptionally good for phones. The phones showed a measured peak of ±5 dB between 3000 and 5000 Hz, but so do any other phones we have measured with the same facilities. They do not, however, sound as though there is a peak when compared with the same program material reproduced over a familiar speaker system.

The higher-than-usual impedance of 50 ohms makes it possible to use these phones with some tape recorders which have a "high" impedance headphone output, which in the case of solid-state recorders usually means in the vicinity of 500 ohms. The HP-100 phones, however, were designed to work from the usual 4- or 16-ohm output of a stereo amplifier through a 100-ohm resistor, with which most amplifiers are equipped.

The phones are mounted on an adjustable bail which slides up and down in the fitting at the end of the plastic-covered double-steel-wire band, and they will accommodate a wide range of head sizes. The cord emanating from the right phone has a red sleeve over it at the point where it leaves the phone to identify the right unit when the plug is inserted in the usual headphone jack on a receiver or amplifier. The tip is the right channel, ring is left, and the sleeve is common, which is the wiring convention used in the manufacturer's components.

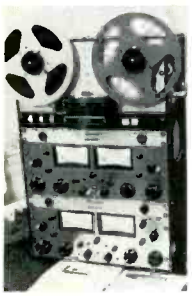
After considerable use of the HP-100, we can certify to their comfort, in addition to their light weight and uniform sound reproduction.

Check No. 67 on Reader Service Card

Compact Studer mixer console shown by Gotham Audio Corporation along with their many other lines.

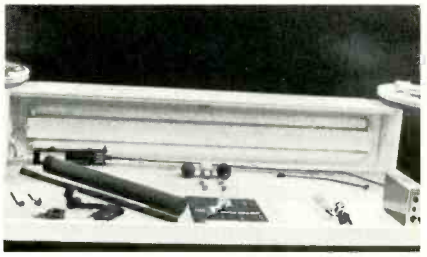
Metrotech combined with parent company, Scully, to show a diversified line of studio tape recorders.

Unique Ampex display showed numerous record jackets from many labels which used Ampex equipment.

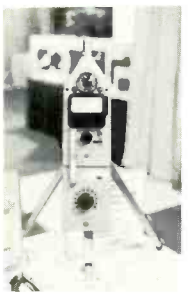


Crown International presents a 4-channel recorder of the established 800 Series, as well as many 2-channel units.

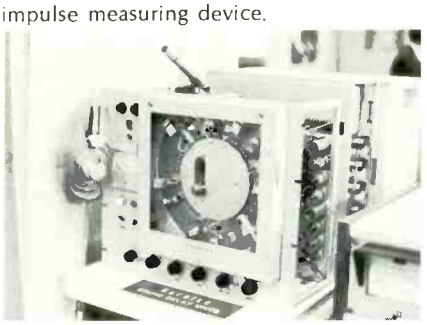
Shure's "Vocal Master" public-address console, ideal for semi-professional use, is shown to professionals for first time.



A few of the various microphones made by AKG and distributed by Norelco are shown in this display.

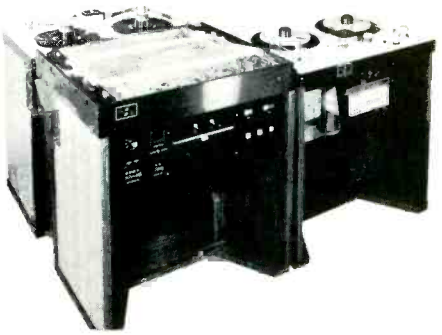


Versatile sound-level meter by B & K Instruments serves as both steady-state and impulse measuring device.

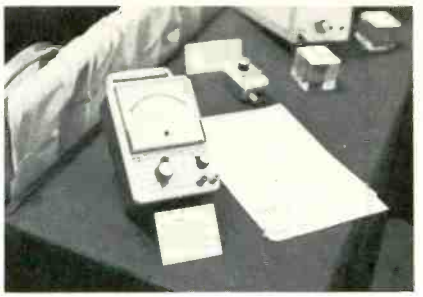


Norelco Sound Delay Unit is capable of a completely adjustable variety of delays with several movable heads.

Electro-Voice showed most of their professional microphones in photos in addition to a large display of their wide line.



Gauss Electrophysics horizontal tape bin with master and slave recorders continues to interest viewers.



Abphot introduces a new a.f. voltmeter with maximum sensitivity of 300 microvolts. Unit is entirely solid-state.

Wiegand Audio Laboratories exhibited one of its many types of consoles, most of which are custom designed.

Dolby Laboratories display had Ray Dolby, much of his professional equipment, and the new Dolby-equipped KLH's.

Michigan Magnetics introduced a head-shifting device for cassette machines to provide reversability with only one head.

Gately Electronics portable mixer in an attache case was shown as part of their exhibit of complete line.

Classical Record Reviews

Edward Tatnall Canby

Post-Christmas Grab Bag

Debussy: La Mer; Dances for Harp and Orchestra. Roussel: Bacchus and Ariadne Suite No. 2. Lamoureux Orchestra, Markevitch.
Heliodor HS 25090 stereo ($2.50)

The record says stereo and so it must be; but there is only the most minute increment of stereo advantage in this curiously dull, deadish recording—too bad. For Markevitch is an intense conductor and the big three-movement La Mer, Debussy's most expansive orchestral work, should really have blossomed out here, if I may mix a metaphor. Of all pieces for orchestra it is the most suited to hi fi picturesqueness. As it is, there is nothing technically bad about the sound in gross terms, but it is ineffective and music lovers will have to sense the Markevitch potency in spite of it.

Debussy's lesser works tend often towards the potboiler category. Oddly, the dances for harp and orchestra of 1904, Danse Sacree and Danse Profane, are small classics of the time but sound today both dated and platitudinous. We've heard too much of the sort of slithery harmony and harpish impressionism that they pioneered—so far back. To be listened to with a grain of historical salt.

Roussel's colorful but somewhat banal music seems always to spring to life in French-oriented recordings of concert programs. (The Boston Symphony under French-slanted Serge Koussevitsky used to play him all the time.) I find it very hard to keep my mind on Roussel, but those who enjoy skillful use of the modern orchestra—Roussel surely is a superpro in that respect—will enjoy his somewhat impressionistic Bacchus music.

Performances: B+ *Sound:* C+

Sitar Music of India. India National Sitar Ensemble. **Everest 3225 sim. stereo** $4.98.

Seems to me I spend a lot of time chiding Everest for left-handed titles. This is another one. The record goes back a bit; it came out as a reissue at the height of the great sitar furor (via the Beatles and Ravi Shankar); but it remains relevant in respect to ethnic recordings of Indian music, of which there are many with titles similar to this.

Instead of the expected set of authentic ragas, however, played in the ancient tradition (if, maybe, cut down a bit in length to fit the recorded medium), we find something altogether different. Yes, the title is technically accurate: we do hear sitars. Two of them. But they play as lead instruments in a Suite for Two Sitars and Folk Orchestra (side 1 and most of side 2) which turns out to be the darndest half-baked mixture of sitar, ill-digested Western pops and "authentic" folk music-of-the-moment you've ever heard. Folk music of the television and movie generation, you understand. For the folk, when left to themselves, even in India, have a way of turning to the nearest sonic status-symbol for their inspiration. Indian folk music, if this is any indication, is fast becoming Hollywoodized.

This extraordinary recital, indeed, reminds me of that zany Chinese people's music that is now infiltrating our part of the world, complete with all sorts of hints from the supposedly warmongering Imperialist West, from Beverly Hills (and Hill Billies?) to the steppes of (Western) Russia with a thousand movie scores thrown in en route. Purity in ethnic music, purity of ethnic culture, is as rare today as it is in life itself!

Taken for what it is, the record is interesting and revealing. But if you ask me, I'd rather hear George Harrison's sitar than these unctuously Westernized models.

Performances: ?? *Sound:* B–

Gilels Szell Cleveland Beethoven's "Emperor". George Szell, conductor. **Angel S-36031 stereo** $5.98.

Angel's American-based recording activities are still somewhat of a novelty to those of us long familiar with that label as an outlet for EMI's highbrow European fare. In an indirect way, this would seem to mark the return of the subordinated Capitol division into high classics. (Pre-EMI Capitol was a major classical label but EMI domoted it to the light classical area.)

This is a splendid job, combining a big-bear sort of Russian massiveness from soloist Gilels with the precision and intensity of the famed Cleveland Orchestra under Szell. Gilels, of course, has all the old fashioned power and sense for large-scale piano drama needed for this mammoth Beethoven, with its enormously long opening movement, its subdued and difficult slow movement, and the on-running explosive finale. On his own, though, Gilels might tend to sprawl. Some fingerwork passages, even here, are not as clear as one might expect. This is where Szell, the driving orchestral perfectionist, picks him right up. The two offset each other beautifully; the combination is big, very big, without trying too hard—as far too many performances do. The music doesn't even go very fast. Doesn't need to. This team can sustain the tension spots effortlessly even at a leisurely pace. Grand; The no-hurry approach brings out the real Beethoven as few modern performance are able to.

There are innumerable minute but significant differences in the Gilels playing of familiar details here that tend to show up what, it soon becomes clear, is now the standard Western concert-type stlying for this often over-

worked piece. Too much to describe in words—but if you know the Emperor you'll hear them. Very interesting.

Performance: A− *Sound:* B+

Rimsky-Korsakoff: Sheherezade. Yevgeny Svetlanov, U.S.S.R. Symphony Orch. **Melodiya/Angel SR-40112 stereo** $5.98.

The listing on this record cover of the conductor, Yevgeny Svetlanov, ahead of the orchestra (as per above) is significant. Angel and, presumably, the Russians, are building Svetlanov up as a virtuoso "personality" conductor. (He and the orchestra have recently been touring the U.S.) The recorded series, of course, already includes major classic of the Russian repertory. All six Tchaikowsky symphonies, for instance, plus such non-Russian-based works as those of Rachmaninoff and Stravinsky, written outside of the U.S.S.R.

Yes, this conductor does interesting things with that old chestnut of the war-horse repertory, Scheherezade. Interesting enough to make one understand, in the listening, why perhaps this work should have made such an immediate impact back in 1888 when its exotic orientalism was fresh, colorful and something quite new. Few Western conductors today, and few Western orchestras, can manage to re-evoke that sound! Time flies, implacably. Now, Sheherezade sounds entirely too much like a sort of Musak on a grand scale—though it is not Rimsky's fault that mood music exists in its present form. (That's our fault.)

I was genuinely interested in this solemn, heavily literal approach to Sheherezade's imposing beginning. This is as it must have sounded when new. Very, very Important and Significant. I followed Yevgeny through most of the first side, too. Good. But, darn it, post mortem judgments on Rimsky still hold. Under all that fancy dress, under the skillful orchestral colorations, still unbeatable in a technical sense, lurks a passel of corn. Particularly in the form of pompous sequences, those repetitions of the same idea moving higher, or lower, that we find so often in Baroque music. They were Vivaldi's trade mark — who'd expect to find the same in colorful Rimsky!

I'm afraid the literal approach, as the spirit of '88, just won't do. It's 1970! I got thoroughly bored by the end of side 2, and sort of wished for, say, the Philadelphia Orchestra and a real snazzy cream-cheese version of the music. That's what it takes to bring Scheherezade to life. Hollywood styling or nothing.

The Russian sound of stereo in this recording is curiously flat, in more than one sense of that word. Could be a two-mike straight pickup, minus accentuation. If so, it isn't well calculated. The orchestra is somehow off-mike, lacking in presence, the Rimsky colors (which are marvelous for accentuation) toned down to a respectable blur. And there is once more that hinto of compression and the slightly soggy *ker-thunk* of percussion that indicate lack of finesse in the transient department.

Performance: B− *Sound:* C+

Bruckner Wolf. (Wolf: Italian Serenade. Bruckner: Quintet in F.) Melos Quartet, Enrique Santiago, 2nd viola. **Candide CE 31014 stereo** $3.98.

Poor Hugo Wolf! Wolf wrote small. Anton Bruckner, that self-effacing peasant emposer (as of the standard description) couldn't write small if he had to, even in the relatively tiny quintet format. Result, here, is that Wolf's only instrumental piece takes up more than the first inch of side 1, while Bruckner's only non-orchestral "chamber" work goes on and on for the rest of side 1 and all of side 2. A curious meeting of a miniaturist and a writer of the gigantesque, and not an altogether happy one, since you are likely to be partial to one or the other composer.

Not the instrumentalists. They do a nice job on both counts. The breezy, Italianate little Serenade, Wolf's pathetic attempt to get out of his own Germanic concentration on superbly concentrated song writing, is inoffensively and accurately played for what it is, without forced gaiety, as in some performances. The Bruckner, for all its endlessness, is done with the most thoroughly musical understanding. For those who love Bruckner this should

prove an almost ideal performance of a work not often heard. (If you're going to listen to Bruckner at length, might as well listen to a Symphony.) For those who don't, almost any five or ten minutes out of the work will turn out to be meltingly lovely. It's just the too much of a muchness . . .

Not the sharpest, cleanest, quietest recording I've ever heard, in spite of the advertised Dolby treatment of the tape. Don't ask me why. Dolby can't do everything.

Performances: A− *Sound:* B−

The Moog Strikes Bach . . . to Say Nothing of Chopin, Mozart, Rachmaninoff, Paganini, and Prokofieff. Hans Wurman et al. **RCA LSC 3125 stereo** $5.98.

Mr. Moog is riding higher than ever these days. If I know him, he is affably surprised but nothing loth—for why not a Moog bandwagon? Good musico-engineering work, amply rewarded! wherever you see Mr. Moog himself, these days, his equipment is invariably surrounded by young people in various stages of longhairedness—and these include, of course, numerous practicing members of the august Audio Engineering Society . . .

RCA's striking back, to meet the challenge of "Switched-On Bach," is an amusing record full of sonic entertainment though, for my musical ear, it does not match that fabulous original —which in fact is unmatchable in its combination of entertainment and sheer knowledgeable musicianship. Remarkable (or is it?) the way personality, human individual quality, shows through in the Moog recordings. Walter Carlos in "Switched-On" revealed himself as a sensitive musician and, in particular, a musician who loves, knows, and understands intimately the Baroque style of the Bach music which he processed for Moog. His music was humorous but serious, too, and high-minded.

The personality here is that of Hans Wurman, a man trained to the classical but with definitely a popular touch (he directs church music *and* is music director of a popular hit revue); his ideas of standard classics are on the conventional side and not very profound. This shows up just as clearly via Moog as it might via a conventional

set of arrangements for "live," or acoustic, instruments. Which is not to say Wurman is punk—far from it. But his Moog will never have the universal appeal of the original Bach opus via Walter Carlos. Too clever and, in the last analysis, musically too trite.

The Bach Toccata and Fugue in D forerunner of much that is ultra-familpold Stokowsky roll in his grave if that doughty Bach arranger weren't, as of this writing, still very much alive. Full of hilarious oddities a la Moog, curiously out of focus in that some passages seem studiously to suggest organ sound as of the original yet others are more in the circus carnival mood. Similarly, Mozart's *Eine Kleine Nachtmusik*, combines startlingly humorous sounds with some very solid and consistent "orchestration" in terms of buzzing organ-grinder-style repeated notes. Chopin's "Black Key" Etude buzzes along ingeniously, the "Turkish March," also Mozart (Piano Sonata K. 331), has a Mozart piano sound combined with intriguing "Turkish" effects that might have delighted the composer himself. A Prokofieff Prelude (Op. 12, No. 7) is beautifully realized in harp-like sounds—it was composed for piano or harp. Rachmaninoff's familiar mood-music-like Vocalise, rich in harmony and unctuousness, gets a highly suitable Moogish richness.

But most revealing of all the items is Wurman's own set of Variations on *the* celebrated Paganini theme, composed directly for Moog. Wurman has, it would seem, listened long and well to Rachmaninoff's "Isle of the Dead," that late piano concerto embodying the same theme, set with Rachmaninoff's thickest, most macabre harmonies. Wurman's are similar, very similar. Marvelous Moog; but after thirteen of the Wurman inspirations I got harmonic indigestion.

"Strike Bach" is best in its bright, forward Moog sounds, based largely on percussion and plucked noises and brilliant colors. Wurman is at *his* best, not unexpectedly, in the less weighty classical numbers. He is at his quirkiest in a curious compulsion to bring out all the classical inner voices, the accompaniment figures, while subordinating the main melodic lines of the original.

Performance: ? *Sound:* A

ETHNIC RECORDINGS

"Ethnic" music on records, has finally grown up after more than a half century, as you will discover, if you will try a few of the many Nonesuch Explorer Series recordings, those elegant white packages with the exotic line drawings on the covers. We could devote our entire review space to these, there are that many. But with Beethoven still beckoning, with Berlioz and the Moog and a dozen new Baroque items every other minute, I've merely taken time out for some Explorer sampling. I'm impressed. For here, at last, is that once-rare combination in exotic recording, a stylishly presented entertainment series that also boasts excellent scholarship, first-rate performance and splendid musical presentation via the LP medium, the whole in super-quality uncompromised stereo sound. (Some Explorers are made in the field, others in U.S. studios with traveling virtuosi.) It all seems too good to be true.

Ethnic or exotic music on records has had a long and sorry history from the points of view of musical presentation and technical sound quality. In the early years, to be sure, there was reason. Before WWI Bartok and Kodaly were recording in deepest Hungary, down among the peasantry. Or take an old lady of ninety who long ago wrote to me in her effort to place her field recordings of American Indian music in the Library of Congress. She had made them on a primitive Edison cylinder machine in the very first years of this century! Frances Densmore was an ethnic pioneer. After her death the Library did snap her up, if that is the word for it, and she is now more or less available in published samplings and, *in situ*, at the Library, for the ethnological scholars. Understandably her Indians are barely audible through the noise, and the harvest dances which went on for hours and days in the flesh are necessarily excerpted in bits and snatches, a minute or so long. She could do no better. It was much the same for the early 78 rpm-disc recorders, acoustic and, later, primitive electric. A three-minute top, even though the music they recorded was inevitably of the sort that just goes on and on, depending on cumulative impact. (Might as well take a two-minute sample of the sound of a Shakespeare play—as was, in truth, often done.)

In the thirties the Lomaxes, father John and son Alan, took down Southern U.S. prison songs in this fashion and these, too, are still available in one form or another and repose in all their distorted glory in the Library of Congress. But the Lomaxes, by that time, could really have done better. Ideally, I'd say, around 1000 per cent. Even in the field. Was it money? Or did they just go on using the same convenient old portable recorder, year after year? On that basis one of the folk music scandals of the century in the "Leadbelly Legacy," an incredible collection of bad recordings, many of them made right in New York at a time when modern hi fi was widely available. Only Leadbelly's very last offerings (not his best) were done in passable sound.

By that time, a creeping disease was infecting almost all ethnic recording: let's call it bureaucratic scholarship. As the 78-rpm pop record moulded pop music long after the time limit had been extended, so the super-short samplings of ethnic music lived on, right into the tape age with time theoretically unlimited. So did punk sound quality, via ancient equipment but more often via sheer ineptitude in the use of newer recording machines. A bit of dis'a and dat'a, full of hum, overloaded, off-mike. An African chant rudely cut into, as rudely broken off moments later. A verse and a half of an Irish ditty, crudely faded out in mid-song, which should have run a dozen verses to make any musical sense. A brief blast of dance music, snatched away just as your foot began to tap. Dreadful.

Things got so bad that I just about gave up on all things ethnic—except for folk music entertainment, pure and simple. That, at least, was for listening. People enjoyed it.

Enter the Grand Ethnic Survey. As tape proliferated and recorders got less bulky, the ethnic business began to go into volume production in the field. Miles of tape, vast shipments of big reels, came back home out of every exotic spot you can imagine. What to do with them? Put 'em in archives, of course. But how about publication via discs? Alas, the longer the miles of tape, the shorter became the excerpts! For, after all, you had to "cover" everything. That was the big rub. A monstrously false philosophical syndrome of reasoning grew up, substituting bureaucratic thoroughness of coverage for music sense. The thing ballooned to fantastic proportions.

All-time high in this zany movement came with that monumental Columbia production on LP, the World Library of Folk and Primitive Music, edited by none other than Alan Lomax himself (an excellent musician and scholar). Some fourteen LPs were issued early in 1955 and a few more later, to take you 'round the world in sound. It was a superb idea, except that (a) the sound quality was strictly ethnic, which is to say, often inept; and (b) the samplings were both innumerable and agonizingly short. I have before me, for example, Volume X, devoted to Music of British (as was) East Africa. On this single LP are no less than *thirty-two* separate samplings, sixteen to a side, a pot pourri of unfinished bits and pieces recorded in a half dozen major areas from Uganda to Basutoland and out of twenty or so different tribes. When you consider that the average U.S. pop LP boasts less than half as many short items, all more or less closely related, you may imagine the musical impact of this African whirlwind. Multiply it to sixteen LPs in other sonic surveys, ranging from Ireland to India, Jugoslavia to Japan, France to New

by EDWARD TATNALL CANBY

Guinea, Italy to Venezuela, and you have the Grand Ethnic Survey in all its zany majesty.

Now surely the original recordings for this series, mostly taped, were longer than the excerpts. Most must have been reasonably complete documentations of each single musical event. Impossible to put them all on LP? Of course. *But why the enforced mini-sampling?* Because, you see, that was the whole idea. Coverage.

Columbia after all, might have put out just one African tribe at a time, in just one event, more or less complete or at reasonable musical length, for a really effective musical experience. Did we really *have* to sample the whole musical menu? It is right here that Nonesuch and the other more modern ethnic record people are taking off. Open-ended series. All the time that's needed. Sonic spotlight on only one or two items, not dozens. A pleasure, I assure you, and saleable too, which is more than any Grand Ethnic Survey will ever be.

Nonesuch is clearly out to make each of its Explorer discs a saleable item in all respects, both visual and musical, not to mention in the attached explanatory notes and photographs. The idea even extends to the cover designs and titles—"The Voice of a Hundred Colors," "A Bell Ringing in the Empty Sky." Why not? The titles do legitimately relate to the music. Why not handsome art work, and handsome stereo sound, intelligently applied to the music? It can be done. It should always be done. Here are a few Explorer discs, for your enjoyment, among many more. To the best of my knowledge you will find no compromise in musical quality or scholarship as the price for all this attractive presentation.

"Kingdom of the Sun" (H-72029) comes from the Indians of the high Andes in Peru and displays an engaging mixed-blood music, part traditional Indian-Spanish, part the influence of the outside world both in melodies and harmony and in such instruments as the accordion and violin, plus an "Irish" harp played upside down and carried on the shoulders. Curiously, there is scarcely a trace of Latin-American idiom. Instead, we seem to hear suggestions of Norwegian or even Russian folk styles, out of the far North. Could it be the Andean altitude?

"The Voice of a Hundred Colors" (H-72030) is North (oriental) Indian and "The Ten Graces Played on the Vina" (H-72027) from South India, both offering the now familiar Raga sound in long, satisfying lengths. The longest item runs twenty minutes unbroken. The Northern Sarangi is a wailing, voice-imitating bowed instrument; the Vina sounds as a smaller, tighter version of the Sitar. Tabla and tambura, drone-and-drum background, set the familiar mood for the long build-up of improvisational intensity. "A Bell Ringing in the Empty Sky" could almost be guessed to be Japanese (H-72025). It isn't easy, this one, all for a solo flute that wails and slides and sputters—one of those special Traditions built on an earlier Tradition, and so on back a thousand or so years. The player is only 36.

The most sensational Explorer disc I've heard is "Golden Rain," music from Bali (H-72028). Its first side offers familiar gamelan gong effects in super stereo (and are those metallophonic bell sounds hard to get down without distortion!). Side two is vocal —such sounds as you will never hear again. Monkey Chant. Two hundred men squat closely around a few principal actors in a long drama, punctuating its events with the most astounding vocal mass rhythms I have ever run across. Incredible. Like the hoarse sudden roar of a vast stadium football crowd but lightning-fast in an unbelievably intricate syncopation, more complex than the fastest jazz percussion solo you can imagine. Best of all, this goes on unbroken for almost twenty minutes. That, for my ears, is real ethnic.

Light Listening

Sherwood L. Weingarten

Whither goest pop?

Why, backwards, of course!

Popular music trends of the new decade, at least the early part of it, already are formed. Rock is expanding in every direction, but mostly in reverse, toward the simplistic styles of the 1950s. There's a little Moog tossed in for effect, and supergroups are being created virtually every week (as established groups shatter at shorter and shorter intervals), but the past, rather than being prologue, is present. There's a new emergence of folk music, a throwback to the early 60s and its pure country-pop corn (instead of pseudo-sophisticated urbanity or mystical introspection). Blues are getting whiter (and, thus, more bland) or firing its retro-rockets back to the basic Black of the 20s and 30s. And through it all, Hollywood and Broadway offer bits of nostalgia in place of originality, always seeming to build an extravaganza on a foundation of pap.

Whither goest pop? Just ask the biggest record buyer, the teenybopper, and she'll tell you exactly: Everywhere in general and nowhere in particular. Before we get to the music of the 70s (whatever it becomes), there are some leftovers from 1969 worth mentioning:

Original cast recordings of 69's shows were pale, probably because the musicals themselves lacked anything that might resemble color. A late LP entry, RCA Victor's PROMENADE (LSO-1161), was an exception —though, in truth, no "Hair."

A variety of sounds are presented (in what musical director and vocal arranger Al Carmines, overstating his case, calls "a melange of styles ranging from operatic to jazz, and from chamber music to rock"), all with technical finesse. But the aftertaste is slightly acrid, for the starless show often seems verbose and musically cluttered (there are 32 tunes in the score; only 18 are reproduced in the album).

There's probably not a hit song in the barrel, but the old-fashioned, campy (yet mildly protestant) musical does have a handful of enchanting numbers. "Promenade Theme" is excellent, reminiscent of the old "Third Man Theme" (but substituting a rinky-tink piano and muted horn for the zither); "The Cigarette Song" is a zesty, spoofy item that might be mistaken for a Tom Lehrer composition. "Two Little Angels" is poignant in its melancholy; "Four" is a shadow of Gilbert & Sullivan operetta, and "Listen, I Feel" is a bluesy solo by Sandra Schaeffer. "I Saw a Man" is the best track, certainly most dramatic, with its showstopping performance by Shannon Bolin.

The show, with book and lyrics by Maria Irene Fornes and orchestrations by Eddie Sauter, concerns a pair of escaped prisoners who went their way into the decadence of the 1920s and that era's equivalent of today's jet set. The musical, produced off yet on Broadway (76th Street and Broadway, uptown from the main theatre belt), received raves from New York's critics but appears, on record, to be decidedly uneven.

Lyrics occasionally become too crammed with cleverness (and plot development), fitting the show perhaps but failing to excite the audiophile. One example is a solo by Alice Playten, "Capricious and Fickle," a reputed showstopper but in reality a looooong narrative. If the show's a success, however, it's due to the almost infinite styles. Witness "A Flower" (Margot Andrews' operatic solo), "Isn't That Clear?" (a lesson in antiquity), "Chicken Is He" (with Florence Tarlow acting like a female Tiny Tim and mouthing words that sound as if Noel Coward penned them while his tongue was firmly nestled in his cheek), and "The Passing of Time" (with its Student-Prince-like chorus and brief classical piano interlude). And there's "The Clothes Make the Man," a bouncy, pleasant ditty, and "A Poor Man," a weak-kneed protest song of sorts that is overly long and impact-less at 5:55.

* * *

John Davidson has the kind of voice that's always in style, regardless of what's pouring from the radio, regardless of what gimmicks are "in," regardless of who's No. 1 on the charts. His appeal to middle-of-the-road listeners usually is obvious, and is—at least in part—on his latest, MY CHERIE AMOUR (Columbia, CS 9859).

There's a big problem with the LP, however: It's almost all over-arranged by Peter Knight, with the orchestrations stealing the spotlight from Davidson's voice. And the aim is at the younger audience (the one that actually *buys* records) rather than the one that *made* him, the gray-at-the-temples crowd.

The disc, the second side of which is vastly superior to the first, utilizes Jack Parnel's orchestra and the Mike Sammes Singers—but not to real advantage. "Happy Heart," the lead tune, for example, finds the musicians drowning out the lyrics. "My Way," for which singer-writer Paul Anka penned special lyrics to fit Davidson's youthfulness, effectively looks ahead now instead of to the rear. "I really couldn't see myself singing the original 'Frank Sinatra lyrics'," writes Davidson on the LP jacket, "as I have not yet 'chewed it up and spit it out.' I've just sat down to eat."

But the love theme from "Romeo and Juliet" is an unfortunate composite, with Davidson's booming voice ill-fitting and lyrics that stress a new and brighter world, a world with hope. And the rockish segments that alternate with ballad style make the version compare badly with the all-soft Henry Mancini instrumental rendition of the Tchaikovsky melody.

Adding to the negative picture, "Friend, Lover, Woman, Wife" is basically noise, with a driving beat superimposed on a melange of sound; "You've Made Me So Very Happy" is a gushy Broadway-type loser; and "High Heel Sneakers," the Jose Feliciano smash, lacks the soul of the blind singer-guitarist. To offset this, though, are the title tune (slightly less frantic than the rest of the LP, perhaps because it's arranged by Jimmy Haskell); "Blessed Is the Rain," a ballad that showcases a non-youth-oriented Davidson at his best; "The Windmills of Your Mind," which starts with talk-singing and a string background (almost like a poetry reading) and builds an aura of beauty: "The Letter," a Box Tops hit that is just plain good rock, and "California Bloodlines," folk-country-rock that finds the chorus actually helping. Æ

Recorded Tape Reviews

BERT WHYTE

Berlioz—Romeo and Juliet

Patricia Kern, contralto; Robert Tear, tenor; John Shirley-Quirk, bass; John Aldis Choir

Colin Davis conducting the London Symphony Orchestra

Ampex/Phillips PTF909 **open reel, 3¾ ips** ($9.95)

One thing I find confusing about tape releases is what decision prompts the release of some material at 7½ ips and other material at 3¾. Presumably some evaluation for sonic values is made of the copy of the master sent to Ampex. No doubt certain economic conditions also influence the choice of speed. I have found that musical values evidently have minimal considerations in these decisions. Take this taping of "Romeo and Juliet" as an example. It is a major work . . . it is conducted by Colin Davis, a Berlioz specialist who is being compared favorably with the late Sir Thomas Beecham and Charles Munch . . . and this is the first stereo recording of the work in some years. Nevertheless, it was released at 3¾ ips speed and in my opinion this was unfortunate. I have the disc version of this recording and while there are some poor surfaces to contend with, the overall sound was quite good. It probably would have been even better in a 7½-ips version. Musically the performance is outstanding. Colin Davis essays what would be in some hands a disastrously fast pace, but he gets away with it by exquisite refinement of detail and superb balances between the orchestral and vocal elements. His "Queen Mab" scherzo is sheer poetry, with the London Symphony contributing enormously with their brilliant playing. The soloists are all good without any of them being really outstanding. The acoustic perspective is rather spacious, but orchestral detail holds up quite well. The voices are cleanly articulate with good intelligibility. There was no attempt at gimmicky stage movement, probably in the interests of clarity. What was misisng for me was wider dynamic range and a bass end with more weight and sonority. This is a case here for selective equalization, since using the bass controls on the preamp only succeeds in making the sound muddier. In this respect the disc was no better, but on the overall basis, the disc had better highs and better transient response. I think the 7½-ips speed would have at least equalled or perhaps surpassed the disc in sound values and with such an important work and fine performance it is rather surprising Ampex opted for the slower speed. Well, we can't always win but we can take solace in the fact that at least the tape version gives us better continuity.

The President's Choice

Ampex/Astrostereo CW224 **open reel, ips** ($24.95)

This is one of those three-hour tapes American Airlines uses to lull your restlessness across the airlanes. This is supposed to represent the personal choice of the President of the airline, taken from Vanguard albums. With all due respect, the President seems to be a very neutral character who likes his music fairly quiet and unobtrusive. He has chosen works by Mozart, Torelli, Vivaldi, Schubert, Johaan Strauss, and similar types. There are a few good items, but most of the works have little dynamic contrast and the "sameness" of them will positively anesthetize you over a three-hour period. Generally good sound, and tape well processed.

Quadrasonics

(Continued from page 24)

for experimental transmission are usually granted sooner or later, it would be of interest to detail the nature of an adapter or decoder which might be needed to recover channels 3 and 4. Such an adapter has been built by the author. A block diagram of it is shown in Fig. 6, while its physical dimensions are shown in the photograph of Fig. 7. This adaptor could be connected easily to virtually any FM tuner or receiver presently in use. Older tuners equipped with a so-called multiplex jack (built before the days of FM stereo) would not have to be tampered with at all, since the adaptor would plug right into this multiplex jack. Later vintage equipment could be adapted in minutes by connecting the proposed adaptor to the output of the detector (whether it be of a ratio-detector or discriminator type) of the tuner or receiver in question.

The typical point of connection, in the case of a ratio detector, is shown in Fig 8. Referring to Fig. 6, the entire composite signal derived at the detector output is fed to a pair of high-input-impedance isolation amplifiers. Each amplifier feeds a band-pass filter. The upper filter passes the 69-kHz subchannel, while the lower one passes the 89-kHz subchannel. Futher amplification follows, as well as mute and level controls in each channel. In the case of the 89-kHz channel, the signal is fed to a muting amplifier. The output of the muting amplifier controls a pair of reed relays (or other solid-state switches). In the absence of an 89-kHz signal, both outputs of the decoder are normally shorted so that no output is obtained. In the presence of an 89-kHz signal, the shorts are removed and L-rear and R-rear outputs are obtained.

While this muting function may seem like an unnecessary embellishment (after all, one could turn down the related volume controls on the amplifiers in the absence of 4-channel transmission), it has been incorporated specifically to protect SCA (background music) operators from "piracy." You will recall that SCA operations generally employ a subcarrier of 67 kHz which is very close in frequency to our proposed third channel at 69 kHz. By having the decoder outputs "turned on" only in the presence of the upper (89-kHz) subchannel, inadvertent reception of background music will not occur when the tuner is tuned to a station engaged in that service. Æ

FOR "DOUBTING THOMASES"

The proposal described herein for 4-channel broadcasting from a single FM station may cause some concern over possible excessive spectral distribution in the FM channel. There is a great deal of misconception concerning this matter. Many people suppose that because total permissible deviation is limited to ±75 kHz and because channel bandwidth is nominally 150 kHz, no energy is permitted beyond 75 kHz from center frequency. This is not true!

The FCC permits energy to fall as far as 240 kHz beyond center frequency providing that this energy is attenuated at least 25 dB. Furthermore, subcarriers such as proposed in the main article featured here utilize a deviation ratio no greater than 1, which means that only a single sideband above and below subcarrier center frequency is generated. Thus, if we modulate the 89-kHz subcarrier with a frequency of 8 kHz (audio) and cause the subcarrier to be deviated ±8 kHz, then sidebands will be generated only at 97 kHz and at 81 kHz. It should be remembered, too, that the injection of each of these subcarriers is only 10 per cent of the total injection of 20 dB below the 100-per-cent reference to begin with.

To convince disbelievers of the foregoing, we assembled a formidable amount of test equipment in order to prove these points. Included were a Boonton Model 202-B FM/AM Generator, a Moseley SG-4T Subcarrier Generator, and a Model LA-17 Panoramic Analyzer made by Lavoie Laboratories, Inc. A Crosby SG-292 Stereo Composite Signal Generator served to provide the regular stereo composite signal.

Figure 1 serves to establish the horizontal scale of the Panoramic Analyzer display. In (A) we see an unmodulated r.f. carrier. In (B) the carrier has been detuned by 240 kHz in one direction, whereas in (C) it has been detuned an equal amount in the other direction. Thus, the length of the entire scale, horizontally, is equivalent to 480 kHz.

In the photos of Fig. 2, the vertical amplitude sensitivity has merely been increased by 18 dB. This has been done because this particular Panoramic Analyzer's vertical scale is logarithmic and some of the minute energy bursts which we wish to show would have been invisible had the vertical scale been maintained at its previous sensitivity. Figure 2(A), therefore, is merely a repeat of the unmodulated r.f. carrier presented on this expanded scale. In (B), an unmodulated 69-kHz subcarrier has been added at proper 10 per cent (−20-dB) injection level. In (C), this subcarrier was modulated by 10-kHz audio at a deviation maximum of 10 kHz. Notice that no additional significant sidebands appear. Figure 2(D) shows the introduction of the second subcarrier at 89 kHz, while (E) displays both subcarriers with modulation having been applied to each. Note again that no unexpected additional sidebands appear anywhere.

The next and final group of figures may come as a shock to many readers. Figure 3(A) shows what happens to spectral distribution when a left-only stereo signal is applied. Main carrier modulation audio frequency is 15 kHz.

Yes, there seems to be substantial energy content up to around 150 kHz on either side of center frequency. In (B), we have introduced our pair of subcarriers and even modulated each one with an 8-kHz audio tone, but they are all but lost in the high-amplitude spectral contributions on the still-present left-only signal.

In (C), we applied an L + R signal of 15 kHz + a 10-per cent pilot signal + the two additional subcarriers as before. The L + R signal was allowed to deviate the main carrier ± 50 kHz. Spectral distribution seems almost identical to that of (B).

Next, in (D) we modulated the carrier by independent L and R signals of 10 kHz and 15 kHz, respectively. A 19-kHz pilot carrier is present also, as it was in the previous three figures. We have, however, removed our extra subcarriers and thereby can increase the remaining deviation to a full 100% (75 kHz).

The only conclusion we can draw from this presentation (which actually seems to occupy more spectral distribution than any of the previous ones) is that present stereo broadcasting techniques, when full modulation is applied, actually occupy more bandwidth under certain conditions than our proposed 4-channel system would under *any* conditions. In other words, by backing off 20 per cent in main and stereo subchannel modulation to accommodate the new pair of subcarriers, we are actually more than compensating for their addition. Æ

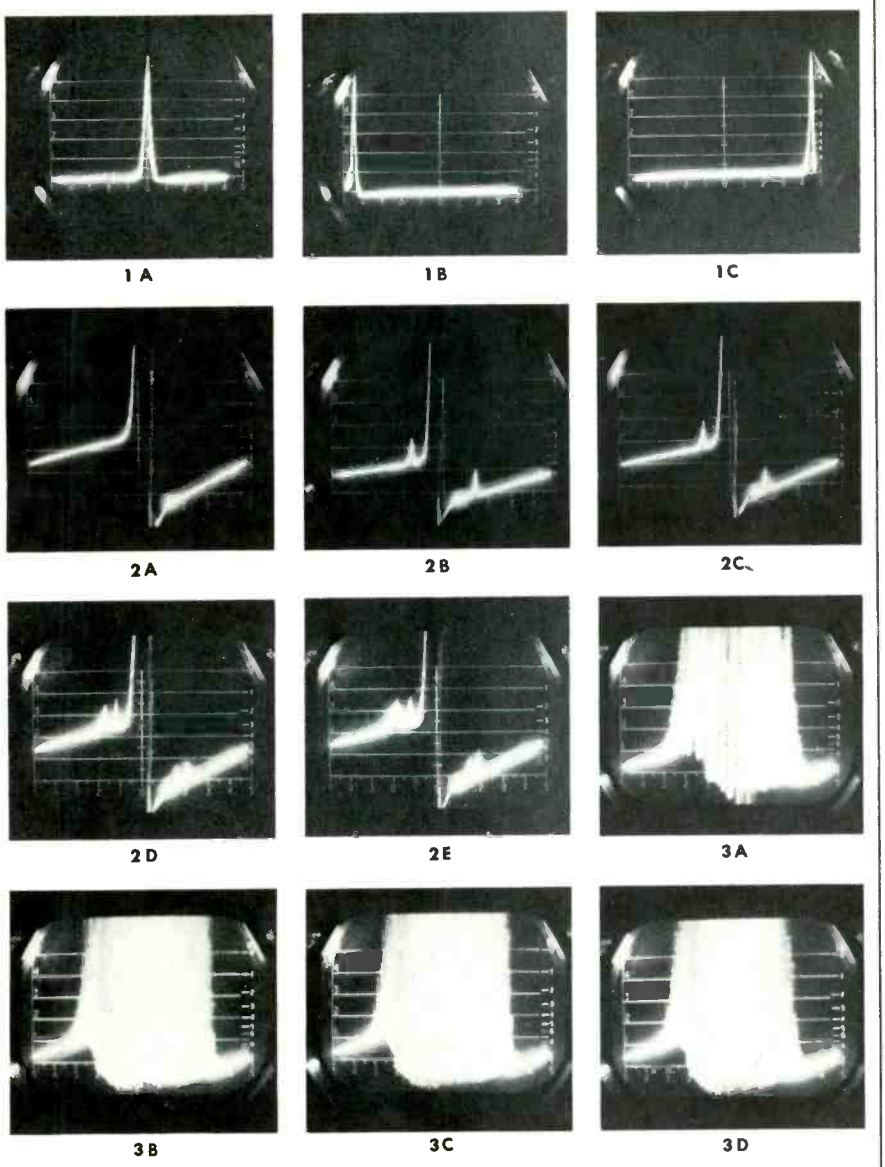


Fig. 1—(A)—Unmodulated carrier; (B)—Unmodulated carrier shifted 240 kHz downward to establish horizontal scale; (C)—Carrier shifted 240 kHz upward to establish other end of horizontal scale.

Fig. 2—(A) Scale amplified so top of dB scale is now + 18 dB so components of smaller amplitude will be disclosed in later photos. (This scale used in all subsequent displays.) (B)—Carrier (unmodulated) with added 67-kHz subcarrier (unmodulated). (C)—Carrier (unmodulated plus 67 kHz subcarrier modulated by 10-kHz audio; deviation maximum of 8 kHz. (D)—Carrier (unmodulated) plus 67-kHz subcarrier (unmodulated) plus 92-kHz subcarrier, each contributing 10% total deviation of main carrier. Main carrier has been monitored continuously to ensure that overall levels have not changed. (E)—Same as (D) except both 67- and 92-kHz subcarriers are now being modulated by 8-kHz tones, with a deviation of 8 kHz.

Fig. 3—(A)—Carrier with an L-only signal applied; deviation is 45 kHz plus 10% contribution of 19-kHz pilot signal. Main carrier modulation frequency is 15 kHz. (B) Same as Fig. 1, except that two subcarriers have been added, each modulated 8 kHz by 8-kHz tones. (C)—Carrier with L-R signals at 15 kHz deviating a total of 50 kHz, plus 10% pilot signal, plus 10% each of two subcarriers, each of which is modulated by 8-kHz tones, as before; deviation is 8 kHz for subcarriers; (D)—Carrier modulated by 10- and 15-kHz L and R signals, full stereo mode, plus 19-kHz pilot. No subcarriers applied. Total deviation of all components is 100% (75 kHz).

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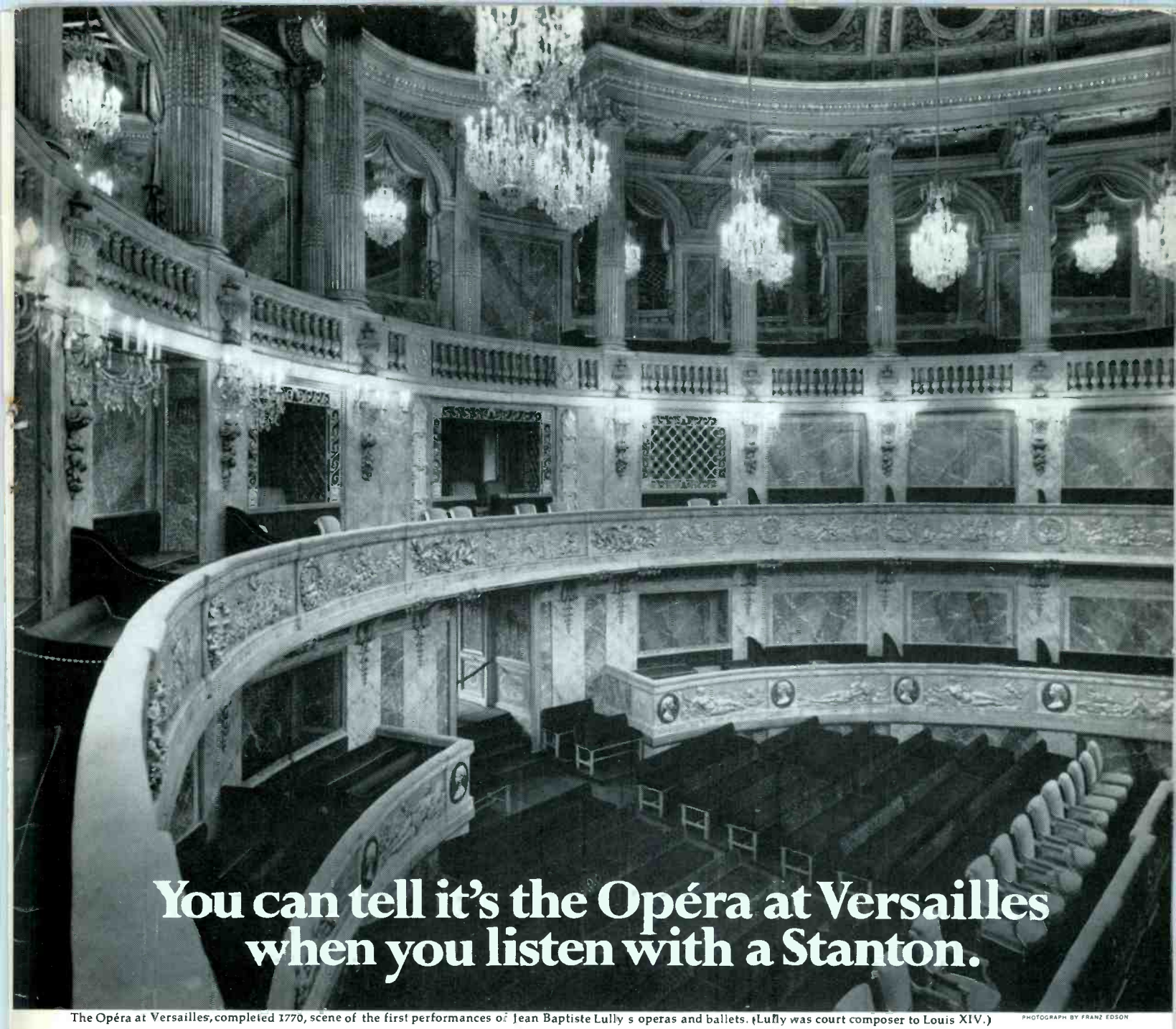

You can tell it's the Opéra at Versailles when you listen with a Stanton.

The Opéra at Versailles, completed 1770, scene of the first performances of Jean Baptiste Lully's operas and ballets. (Lully was court composer to Louis XIV.) PHOTOGRAPH BY FRANZ EDSON

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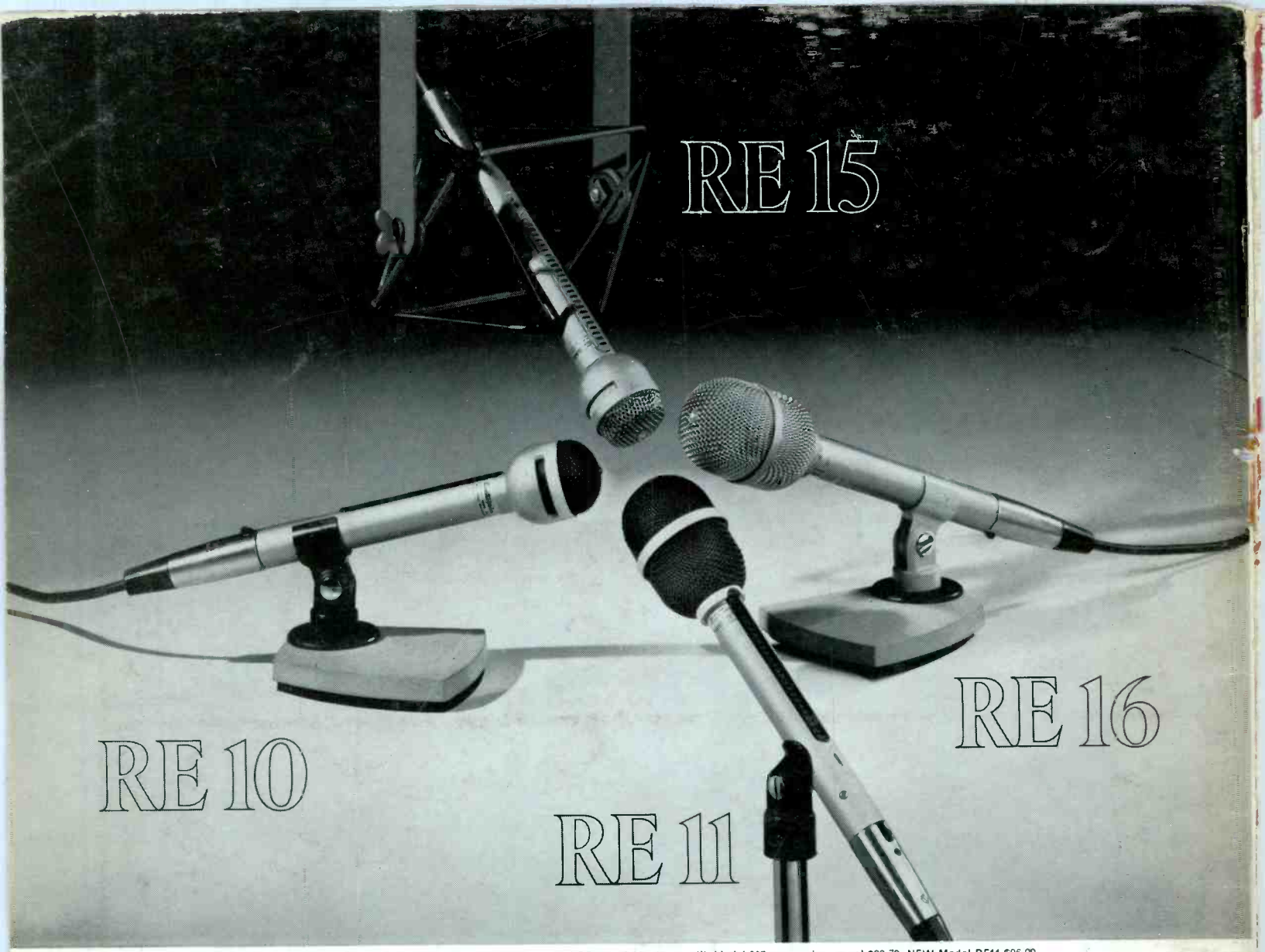

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