CBS 4-Channel Discs

AUDIO

AUGUST 1971 60c

The Authoritative Magazine About High Fidelity

Hellyer on Tape Recorder Maintenance * The Hows, Wheres, and Whys of Testing High Quality Loudspeakers

SPECIAL CASSETTE RECORDER ISSUE

Comparison Tests of Thirteen Models

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The Scott 433 Digital Frequency Synthesizer FM Stereo Tuner gets you about as close to the actual broadcast as today's technology will permit and with greater convenience than ever before. Using such space age electronic circuitry as a phase locked loop, a varactor tuned RF section and a quartz crystal reference standard,

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AUDIO

Successor to RADIO, Est. 1917

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Coming in September

AUDIO's Annual 1972 Directory of Stereo Hi-Fi Component Equipment.

Here, in one issue, is a comprehensive directory of what's available in the latest hi-fi component models:
■ Amplifiers ■ Preamplifiers ■ Tuners ■ Receivers ■ Record Changers ■ Turntables and Arms ■ Phono Cartridges ■ Loudspeaker Systems ■ Open-Reel Tape Recorders ■ Cassette and 8-Track Recorders ■ Headphones.

Testing Loudspeakers—Part II of H. D. Harwood's article

AS WE GO TO PRESS

Saul Marantz has joined Rudy Bozak, and we look forward to exciting developments from these two audio pioneers and wish them every success.

About the cover: Shown are 11 of the 13 cassette recorders reviewed in this issue. What happened to the other two? Well, the Pilot 100 arrived to late for the cover photo—through no fault of the makers—and we had two Harmon-Kardon "look-alikes," one with Dolby, one without. Cover design by John Kwasizur.

Audioclinic

JOSEPH GIOVANELLI

Electronic Organ Volume

Q. I notice that if I adjust the volume of my electronic organ, using the expression pedal, that there is a very slight delay between the time I make the volume change and the time I actually hear it take place. What is the cause of this? I have had this trouble ever since I purchased the organ.—Arthur Darrow, Albany, N.Y.

A. Some firms employ potentiometers linked to the expression pedal as a method of controlling the volume of sound produced by electronic organs. During musical renditions, the expression pedal is used quite often, which means that even the best potentiometers will wear out after a time. Organ manufacturers have overcome this problem in various ways. One approach is to use a photocell connected across the output terminals of the instrument. The more light which falls on the cell, the less resistance the cell has, which, in turn, shorts out some of the signal, thereby reducing its volume. The expression pedal might move the light source or it might actuate a movable mask between the light source and the cell. In some photo cells, there is a delay between the time there is a change of light intensity and the change of resistance of the cell. Under these circumstances you would notice the delay.

Some organs place the cell in series with some element in the circuit. In that case, the more light striking the cell, the louder the instrument becomes.

In either case, perhaps you can locate a photocell which has less delay. Of course, it must have characteristics similar to the one now in use, i.e., resistance vs. light level.

Perhaps your organ controls a voltage which, in turn, changes the bias on an audio amplifier. If a delay occurs in such a circuit, check for overly long time constants. A bypass capacitor's value might have to be decreased.

Many ingenious methods have been devised to bring about volume control in electronic organs. All that was possible here, therefore, was to give you a broad outline of some of the approaches as they apply to time lags. If your circuit is different from these, study it with a view to locating the source of a lag.

Chassis Leakage to Ground

Q. My Scott Lk60 B produces a very strong spark when connected to ground. How can I measure this leakage? I suspect a faulty capacitor somewhere because the amplifier makes loud "discharge" noises periodically.—Joseph P. Laronda, Cheshire, Conn.

A. The spark you get when grounding your amplifier may be a normal condition. If you know, however, that this state of affairs did not exist when you first used the amplifier, you should suspect that the line bypass capacitor has become leaky. This capacitor usually connects one side of the line to ground. In some circuit, both sides of the line are bypassed. Disconnect these capacitors and see if the condition still occurs. It should not if all input sources are disconnected from the amplifier.

Before definitely suspecting the amplifier, however, disconnect the various input sources as I have already said. Then make your ground checks. If the sparking is not present, perhaps you will find that the real culprit is one of your other pieces of equipment.

Whether the amplifier, tape recorder, or tuner is to blame, and if line bypasses are not at fault, you probably have a bad power transformer, with leakage between the primary winding and the core. The cure is a new power transformer.

The so-called discharges you hear emanating from your system may not have anything to do with this problem. They may be line transients which find their way into the amplifier's input. It also may be that there is some other defect in the amplifier or other program sources which is producing the "discharge." Of course, an intermittent line bypass capacitor could give rise to the transients.

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

Tape Guide

HERMAN BURSTEIN

Oscillator Coil Adjustment

Q. All of the instructions for maintenance and adjustment of my tape recorder are very complete. The steps are detailed and easy to follow, using an audio oscillator and audio VTVM, except for the following: "Adjust the core of the oscillator coil to a frequency of 78-80 KHz." Can you tell me what equipment is needed to make this adjustment? How does one know when the slug of the coil is correctly adjusted?—Lee Stair, Coral Gables, Fla.

A. To check the oscillator frequency, you would need an oscilloscope and a signal generator capable of generating the oscillator frequency. Connect the generator to the 'scope until you get, say, 3 cycles showing on the 'scope, with sync set at minimum. Connect the output of the oscillator (taken, say, at the record or erase head) to the 'scope, and adjust the oscillator coil until again 3 cycles are displayed on the 'scope. Alternatively, you can connect the generator to the horizontal input of the 'scope and the oscillator to the vertical input, and adjust the oscillator coil until you get a straight line on the 'scope.

Conversion to Stereo

Q. I have a mono Ferrograph tape recorder about 13 years old which was very little used. Is it feasible to convert it to stereo? I asked at one shop, and they were cool to the idea, but I had the impression that they preferred several small jobs to one big one for their own economic reasons.—Lawrence Lynton, Bronx, N.Y.

A. I don't think you can attach much blame to a service shop for not undertaking a task really outside its scope and quite possibly involving a substantial number of headaches before all works well. The task in question is really that of an experimenter, not of a service shop.

Yes, it is probably possible to convert your Ferrograph to stereo, although I cannot give you specifics. What is necessary is to substitute stereo heads for the present mono ones, and to add two amplifiers for the second channel: a record amplifier and a playback amplifier. You can follow the circuitry of the original amplifiers. I don't know if there is room inside the mechanism for these additional amplifiers; if not, they would have to be "outboard" ones. On the other hand, if you use new transistor circuits, rather than tube circuits, the problem of finding room for the additional amplifiers will be substantially reduced. After the new heads and amplifiers are installed, it will be necessary to make proper adjustments with respect to bias current, audio drive current, VU meter (for electronic eye) calibration, azimuth, vertical positioning of the heads. Also, there may be a question whether the original oscillator can supply enough current for two record channels and two erase channels. For information on replacement heads and transistor circuits, I suggest that you write to The Nortronics Co., 8101 Tenth Avenue N., Minneapolis, Minnesota 55427.

Equalization, Etc.

Q. I would like to make some queries regarding my Revere Model T-70163 tape recorder: (1) The output of my machine is bassy. I use a Shure Unidyne III 545 microphone, which according to the manufacturer is remarkable for faithfully reproducing the human voice, yet even the voices of women sound "big" with the tone control set a maximum treble. Nothing seems to be wrong with the recording circuit, because when the recorder is used as a PA system, the output is also bassy. What could be wrong?

(2) I have been trying to record with my machine at 7½ ips with the aid of a capstan sleeve, although my machine is really made for 3¾ ips. The resulting recordings sound very sharp. Since the output at 3¾ ips is bassy and at 7½ ips too sharp, I wish to obtain a compromise tone at 3¾ ips which will be sharper than the 3¾ ips tone and less sharp than the 7½ ips output. What components should be adjusted or changed to achieve this?

(3) In calculating the power output in watts of my recorder, should the voltage be measured at the terminals of the voice coil of the speaker or at the leads at the end of a phone plug connected to the extension speaker jack with the built-in speaker disabled?

(4) The "normal" neon lamp indicator of my recorder no longer lights up fully even when the "distort" neon lamp indicator is fully lighted. I tried interchanging the lamps, but obtained the same result. What could be the trouble?

(5) I intend to connect a standard VU meter to my recorder but I am unable to use the output from the extension speaker jack for the purpose inasmuch as the output at normal recording level is less than 4½ volts. According to the meter's manufacturer, however, it may be used with my recorder by connecting the meter to the plate of one of the amplifier tubes. How is the connection made (or with one lead from the meter connected to the plate, where is the other lead connected)? What tube in my tape recorder would you recommend as a source of power for the VU meter?

(6) Aside from the ability to use a longer cable and the suppression of hum, what other advantages, if any, are offered by the use of matching transformer between a low impedance microphone and a high impedance amplifier? Does the connection improve fidelity?

(7) Has there been discovered a way to make tape recordings permanent or unerasable?—Domingo Riego, Jr., Manila, Philippines.

A. (1) The fault appears to be in part due to excessive bass in playback equalization. And in part to the low tape speed, which in some machines, particularly older ones such as yours, have sharp treble drop above 5,000 Hz or so. The difficulty is perhaps exaggerated by a playback head with too wide a gap because of initial design or wear.

(2) The playback equalization for 7½ ips requires what amounts to more treble cut and more bass boost than at 3¾ ips. Therefore using 3¾ ips equalization when operating at 7½ ips will result in sharp sound. I am sorry, but this column cannot help you to redesign your tape recorder. I suggest that you try the component values suggested in your service manual for conversion to 7½ ips.

(3) To calculate power output, disconnect the speaker and substitute a high-wattage resistor having the same ohmic rating as the output impedance of the audio amplifier (e.g. 8 ohms). Measure voltage across this resistor and calculate power by Ohm's Law.

(4) I guess that a capacitor or resistor leading to the normal lamp has changed value.

(5) A true VU meter should be fed from a low-impedance source, such as a cathode follower or anode follower. To answer the rest of your question: Connect the other lead of the meter to ground.

(6) A low-impedance microphone allows a long cable run without significant treble loss.

(7) Not to my knowledge.

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

What's New in Audio

Sony TA-2241 SQ decoder

This decoder is designed to be used with the recently announced Columbia SQ quadraphonic system, which permits four channels to be reproduced from a two-track source. Also announced is the SQ-444 from Columbia Masterwork, which includes decoder-receiver, automatic turntable, and four speakers.

Check No. 4 on Reader Service Card

E-V RE85 lavalier microphone

This dynamic microphone uses double-wall construction with two separate cases, one nested inside the other and insulated with highly compliant rubber. The unit weighs 8 oz., is 2⅝ in. long, and has a diameter of less then one in. This omnidirectional microphone has a specified frequency response of 90 to 10 kHz and is matched for low impedance inputs. Price, $133.

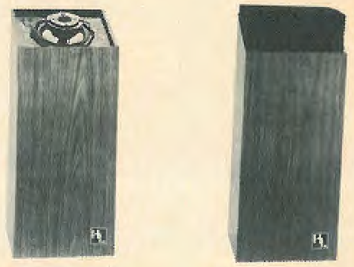
Check No. 6 on Reader Service Card

Ampex RR-200 tape reproducer

This new master reproducer is designed for rapid duplication of cassette, cartridge, and reel-to-reel audio tape recordings. It is intended for use by master recording studios and in educational and industrial applications where large numbers of tape copies are required. Prices begin at $11,000.

Check No. 7 on Reader Service Card

Hegeman speaker system



The Omni speaker system is a two-way coaxially mounted system in a small floor-standing, closed box enclosure. Power required for an average room is 15 watts, while maximum power handling capacity is specified at 25 watts. Impedance is 8 ohms, and the dimensions are 10⅛ × 8¼ × 25 in. Price: $180, pair.

Check No. 8 on Reader Service Card

Lafayette Criterion 4X speaker

The Criterion 4X speaker system features a four-speaker design, with a 12-in. bass speaker, a 5-in. mid-range, a 3-in. for the 5000-to-10,000 Hz range, and a 1½-in. super tweeter for frequencies up to 20,000 Hz. Impedance: 8 ohms. Size: 22 × 14½ × 11⅝ in. Price: $69.95.

Check No. 9 on Reader Service Card

Booklets and Catalogs

E-V/Game, Inc. has released their new 1971 needle catalog, 71N, a 120-page booklet which contains a quick reference pictorial guide, an updated set-to-needle guide, and a section covering accessories including stereo headphones, headphone accessories, cassette microphones, and 45 spindle adaptors.

Check No. 10 on Reader Service Card

BEHIND THE SCENES

BERT WHYTE

As I write this, the opening of the 1971 Consumer Electronics Show at mammoth McCormick Place in Chicago is but a few days away. In spite of the name this is a trade show and is not open to the public. The CES is always an extravaganza, encompassing just about every aspect of electronic home entertainment. This includes audio products of course, and the new equipment you will see at your local hi-fi salon in the fall most likely made its debut at the CES.

Most manufacturers put their best foot forward at the CES. It is a buyers' show, and it is meant to generate sales. The CES is always exciting, but this 1971 show is going to be remembered as one of the most significant in recent years. The reason for this is the heavy concentration on four-channel sound and the Dolby noise reduction system. Because of the sluggish economy, sales in the home entertainment electronics has been "soft," and the manufacturers are embracing these new technologies in the hope that they will stimulate their market. It may well be that sales will improve for some, but there is going to be an intense "sorting out" process among competing four-channel systems, for example, that is bound to leave some people disappointed.

The advocates of four-channel stereo seem to be dividing into several camps. The largest group by far are those favoring some sort of matrix system. As an "industry insider" friend of mine said, "every time you turn a corner at the CES, you'll meet an ingenious Japanese engineer trying to convince you his matrix system is the best." Well, the permutations and mathematics of matrix systems are not infinite, and as noted in last month's column, all of them have many similarities. The Electro-Voice "Stereo Four" system is on the market and in use in quite a number of FM stations, which is of course a big advantage. This evidently is not going to deter the eager moguls of the Japanese hi-fi industry, nor for that matter those of the companies in this country. It has long been known that Columbia Records was working on some type of matrix system. As I go to press, Columbia has announced their intention to market their system with a first year release of 50 recordings. To say this has caused consternation in certain quarters is to put it mildly! The Columbia four-channel disc system is a 4-2-4, encoding/decoding matrix system incorporating some phase manipulation. Strong claims of superior stereo separation and other advantages have been made. Information on the system is scarce, and I have not heard it as yet, thus I can hardly venture an opinion. It is obvious however that another entry in the matrix sweepstakes is going to create problems. I wanted the reaction of Electro-Voice to this development and contacted E-V president Larry LeKashman. Mr. LeKashman felt that the Columbia system added a "new factor of confusion" and pointed out that at an EIA meeting last May, specifically convened to discuss four-channel stereo disc standards, for the Columbia system allegedly was "incompatible." The meeting was held at Columbia studios, with the Columbia engineers in attendance. The incompatibility reportedly is that normal two channel stereo discs won't play in the usual fashion through the Columbia decoder. It is said that some sort of special switching would have to be used in going from four-channel stereo to two-channel and vice versa. Mr. LeKashman noted that recordings made with the Columbia matrix would not playback properly on E-V and Dyna decoders presently on the market. For example, the two rear channels of the Columbia system would be heard through all four channels of the other systems. Mr. LeKashman said that he didn't see any reason why the Columbia system should be any more compatible at this time than it was last May. He stated that more than ever, there was a pressing need for four-channel stereo disc standardization. He also declared that Electro-Voice was prepared to adopt and convert to whatever matrix system is ultimately chosen as the industry standard.

Well now!! No doubt we will be hearing Columbia's side of the story before long. Columbia has one great advantage, and that is that it controls the availability and output of its own software. Lack of program material has been one of the major stumbling blocks of four-channel stereo. With Columbia, they have the resources and depth of catalog to issue 500 recordings just as well as 50, if the situation warranted such a release.

At the CES there will be plenty of hardware for the backers of four-channel open reel stereo. Not even the most avid supporters of matrix systems, dispute the fact that in the four-channel scheme of things, the open reel discrete sound is still the best. However, it is sad to relate that the open reel software situation is not good. Oh, there has been some marginal improvement . . . a few new titles from Enoch Light, a couple of new items from Vanguard. But by and large the format which started the whole four-channel bandwagon rolling is not faring well. All I can say to devotees of this format is "hang in there." Help will be forthcoming because of the way certain things are shaping up . . . but you will have to be patient for a while. Take comfort in the thought that by utilization of the Eargle process there are potentially thousands of four-channel stereo recordings sitting in the vaults of the record companies.

There is one other format for discrete four-channel stereo and that is of course, the four-channel/eight track cartridge espoused by RCA. Of late, this has been gaining momentum. For example, Fisher Radio and RCA recently held a joint press conference announcing Fishers' entry into the four-channel cartridge hardware market. Presumably made in Japan, Fisher is offering the Model CP-100 2/4 channel cartridge player (in essence a cartridge deck for use with your own amplifiers etc.) at $169.95, and the Model TX-420 Converter, which is the same player with two 15-watt rms amplifiers for the rear channels at $299.95. This equipment will be at the CES, as will the Motorola/RCA cartridge players. Another newcomer to the eight track and four-channel stereo cartridge market is Ampex. Recently introduced at their Colorado Springs sales meeting and to be shown at the CES is the Model 8400 which combines a 2/4 channel stereo cartridge player with an AM/FM stereo receiver. No doubt we will see other four-channel stereo cartridge units from various Japanese manufacturers at the CES. The big thing this format has going for it is the availability of software. RCA has already released over 70 titles, and a number of other record companies are issuing products in this format. The catalog is predominantly pop, as can be expected with a market ratio of 95% pop to 5% classical. As you might expect, the pop material, although discrete, is of the "total surround" variety. At present there are no four-channel cartridge tapes recorded with ambient information. While the signal-to-noise ratio of a cartridge is somewhat better than a cassette due to tape speed, it is still a pretty hissy proposition. As I have pointed out before, tape hiss per se is bad enough . . . when you hear it from both front and rear, it is nigh impossible to live with. The four-channel cartridge needs to be Dolbyized just as much as the cassette. Until they are, there is little point in trying to record ambient information on the rear channels. I would also think it prudent not to issue any ersatz classical cartridges with weird channel configurations, as it can only alienate those who purchase them.

Other four-channel stereo items we expect to see at the CES are the JVC discrete disc, and the Astrocom four-channel "in-line" cassette. With the latter unit, the head configuration permits automatic reverse play of two-channel prerecorded stereo cassettes. Also in the reverse play category in cassette decks is the new Ampex Micro 155, which features an incredibly complex six-element (two erase, record and play) head. The same system is featured in the Ampex Micro 335, which is an automatic reversing, 12-cassette changer.

You won't be able to turn around at the CES without encountering Dolby equipment. There will be a plethora of cassette units with built-in Dolby B Type circuitry. From Revox and Ferrograph there will be open reel recorders with built-in Dolby B Type. From quite a number of Japanese (and possibly several American) companies there will be receivers with built-in Dolby B Type noise reduction. There will be a number of new "black box" Dolby units, including a playback only unit that will sell for $49.95. It is also entirely possible that by the time of the CES, we may be able to hear Dolbyized FM broadcasts from the always venturesome WFMT in Chicago.

However, the big news from Dolby this month is that the main essentials of the Dolby B Type noise reduction circuit—FET, transistors, resistors, etc. —have been reduced to a monolithic integrated circuit chip! Add power supply and capacitors and you are in business. Dolby Labs and Signetics Corp. of Sunnyvale, Calif. are collaborating on the development of the IC, and it is expected to appear in consumer audio products early in 1972. Signetics will enjoy a short period of exclusivity with the IC and then it will be available to the entire IC industry. With what amounts to an industry standard version of the Dolby B Type circuit, costs will be very significantly lower than present discrete versions of the circuit. The great advantage in addition to lower costs is that reduced to a tiny IC chip, Dolby B Type noise reduction can be built into virtually any type of tape machine or tuner/receivers, no matter how small they might be. With the Dolby B Type circuit so reduced in size and cost, you can expect a great proliferation of prerecorded tapes in all formats, including our much-desired open reel. It doesn't take much of a pundit to predict that by this time next year tape hiss in all formats will be well on the way to being only an unpleasant memory! Æ

Editor's Review

THE CONSUMER Electronics Group of the EIA has now issued a supplemental statement to the Federal Trade Commission concerning the proposed trade regulation rule on amplifier power output. Many of the recommendations are beyond criticism; for instance, it is pointed out that all factors that could influence power measurements should be clearly defined. These include power line voltage, operating temperatures, load resistance, positions of covers and bottom plates, specifications of output meters, and so on. But I imagine few audio engineers will agree with the following:

"As indicated by one witness (at the previous Hearings) during the two days of testimony there was almost no reference to the psycho-acoustical aspects of what the human ear can hear. Nevertheless, several witnesses suggested there is substantial improvement in sound quality if the total harmonic distortion is greatly less than 5 percent. They provided no scientific support for this contention. Before the Commission adopts a rule based on a total harmonic distortion below 5 percent, we believe they should evaluate all studies and scientific data which is (sic) available on the subject. We believe it would be a mistake for the Commission to base such a value judgment solely on the hearsay evidence which has been placed in the record. It is our belief that all available scientific information will indicate that for most consumers *there is little or no perceptible difference in the sound quality between an amplifier rated at 5 percent and one rated at a lesser distortion.*"

Cassette Tests: Lucky 13

Thirteen cassette recorders are compared in our test reports which appear on page 26. In case you are wondering whether these are the only models worth considering, the answer is a definite "No." Some manufacturers were in the midst of production difficulties and did not want a review at the present time; others were busy with new models which were not ready. A more complete list of available recorders will be published in our Annual Directory next month. Meanwhile, the tests on the Lucky Thirteen show just how far cassette recorders have advanced during the past year and also what the Dolby system can really offer.

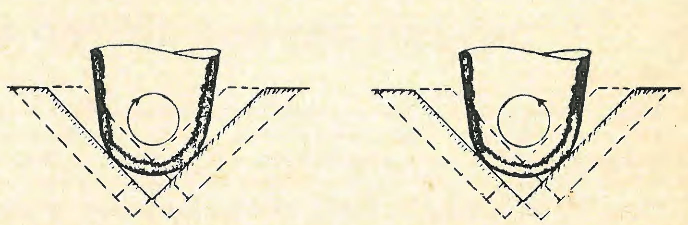
SQ and Q/8

CBS has finally announced the release of their quadraphonic discs which are designated "SQ." An agreement has been reached with Sony for the production of playing equipment and decoders as well as marketing in Japan. It is stated that 50 records will be available by the end of the year, and the tentative price is expected to be one dollar more than conventional records. In essence, the SQ system gets the two additional channels on the disc by using two circular modulations, as shown in Fig. 1. As the record rotates, a clockwise helix is produced for the right back channel and a counter-clockwise helix for the right rear. Figure 2 shows the grooves of a SQ record under a powerful microscope displaying the four modes of modulation. We hope to publish more technical details in the near future, but meanwhile some aspects of the disc are discussed by E. T. Canby on page 44. As stated in our last issue, Fisher is cooperating with RCA in launching the Q/8 format, previously known as "Quad-8." The name was changed due to legal action by the Acoustical Manufacturing Co., Ltd. of England, who have used the name "Quad" for many years. At a recent Fisher-RCA demonstration, it was announced that 67 Q/8 tapes are now available.

Humor in Advertising

"The Mike Matthews Freedom Amp—Free yourself from bureaucratically dominated sources of electricity . . . blast out in the solace of the woods." Striking a blow against the Establishment is all very well and will certainly help impoverished battery makers such as Union Carbide—but how about Noise Pollution in those woods fellas?

G.W.T.



Left Back Modulation   Right Back Modulation

Fig. 1—The two circular modulations of the SQ system.

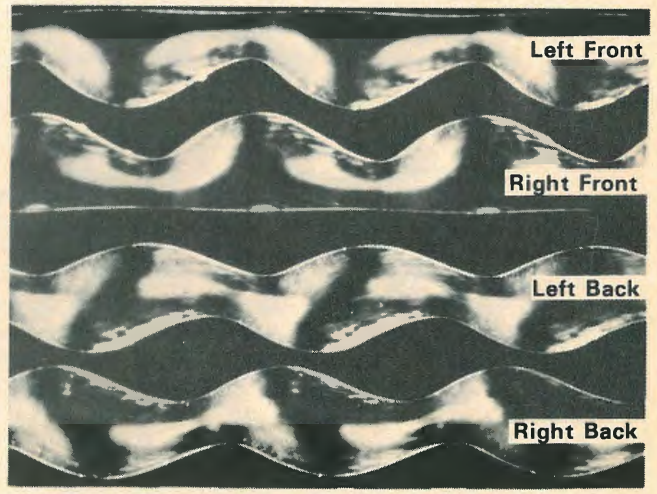


Fig. 2—Magnified view of an SQ record.

The Hows, Wheres, & Whys of Testing High Quality Loudspeakers

Part one H. D. Harwood*

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THE OBJECTIVE TESTING of loudspeakers in a free-field environment has often been attacked on the grounds that they are not listened to under these conditions and that in any case there are subtle effects which are not amenable to measurement.

Whilst these arguments contain a certain amount of truth, there is no reason why we should go to the other extreme and ignore the extremely valuable information which can be gathered from such measurements. At the BBC, loudspeakers are, in the end, judged subjectively on their ability to reproduce program material accurately, not just as a pleasant sound, and are judged by comparing the reproduced quality with that in the studio itself. When, however, questions of the basic design or modifications are involved, it is found that these can usually be determined simply by objective measurements in a free-field room. This paper describes the hows, wheres, and whys of the tests made during the development of BBC monitoring loudspeakers. The order in which the items are given is not to be taken as an indication of their importance.

Frequency Response

The steady state axial frequency response characteristic test is carried out by measuring the axial sound output as a continuous function of frequency, at a specified distance from the loudspeaker, in free-field surroundings when a constant a.c. voltage is applied to the loudspeaker terminals. It is the measurement which is most often made and contains a great deal of information.

There have been suggestions that since a listening room clearly departs widely from free-field conditions that the loudspeaker output should be measured in a live room. It is assumed that because a listener usually sits sufficiently far from the loudspeaker to be largely in the reverberant sound field that this is the factor which should be measured. In fact, the ear does not take account of the reverberation as a first order quantity but only as a second order, otherwise a person speaking in one room would sound quite different when in another room having differing characteristics, and we know from experience that this is not the case. In practical conditions the ear fastens on the direct sound and although the reverberation cannot be neglected, relegates it to a secondary place. Measurements taken under specified free-field conditions therefore contain much more relevant and easily interpreted information than those taken under live conditions which apply to that room only.

Another suggestion [1] that has been made is that an intermediate condition should be used and measurements should be made with the loudspeaker radiating into an infinite plane, i.e. into 180 degrees instead of 360 degrees. Compared with free-field measurements this would give a bass lift to the response up to a frequency which would depend on the size of the cabinet. This bass lift would therefore be a variable quantity not easily allowed for; furthermore it is admitted in the same article [1] that we do not in practice hear such a bass lift and the free-field measurement seems to agree best with what is heard in a practical situation.

The test conditions for the steady state axial frequency response characteristic need therefore to be specified quite closely.

In the first place true free-field conditions are assumed for most cases, that is unless a loudspeaker is designed to be mounted in a corner or so that the sound is deliberately reflected from a wall or ceiling. True free-field conditions can only be obtained in the open air at least 30 feet from any obstacle or in a large enough free-field room. In the latter case, the author has shown elsewhere [2] that it is necessary for the tips of the wedges on opposite sides of a free-field room to be at least one wavelength apart at the lowest frequency of interest for free-field conditions to apply, even with perfect absorption at the wedges. The trouble is that excess absorption takes place, as in an acoustically lined duct, when the spacing is appreciably closer than this; with too small a room this will have the effect of giving an apparent bass cut. In the larger free-field room at the BBC's Research Department a special type of polyurethane wedge is used and the dimensions are such that free-field conditions exist to below 40 Hz within ± 1 dB out to 10 feet from the loudspeaker under test [3].

In addition to providing free-field conditions it is essential for the measurement of the axial frequency response to be made at an adequate distance from the loudspeaker, particularly for multiple unit designs. A minimum distance of five feet is adopted for this sort of work, for it can easily be calculated that at closer distances the relative contributions of l.f., m.f. or h.f. units is changed significantly and a wrong appreciation will be obtained of what the listener will hear, in practice, at a distance of 6½ feet or over.

The next question is that of the bandwidth to strive for. We can adopt the rather näive approach that as the ear can hear frequencies over a range of 16 Hz to 20 kHz, or to over 30 kHz for children, we should aim for this range with all its attendant difficulties. At the BBC, however, we have adopted the rather more mature engineering approach of trying to determine the narrowest bandwidth which can be used without the listener noticing any degradation in quality. In a series of experiments [4], known under the delightful name of Operation Clothear, the upper cut-off frequency of program material was altered and the number of persons who could detect the change on an ABA test was found. The program material was carefully selected to be the most sensitive for this sort of test and observers whose ears had been checked were used. Even under these very critical conditions, surprisingly few observers were able to detect a cut-off frequency of 12 kHz. As a result it has been decided that monitoring loudspeakers should have a response extending to at least this frequency and that if this can be achieved on the axis, greater weight should be attached to obtaining, (a) a good spatial distribution, (b) a smooth curve and, above all, (c) a high degree of repeatability, than to extending the frequency of cut-off.

At the bass end the decision is more difficult and as an engineering compromise between size, cost, and response, the latter is maintained to about 45 Hz and allowed to fall below this figure.

It should be made clear that whilst the axial frequency response characteristic is a necessary measurement, it is by no means sufficient to obtain a smooth or even flat response curve. Very little work has been done to determine either the smallest irregularity which is audible, how wide-range trends in response affect the reproduction, or even, given a perfectly smooth axial frequency response curve, whether it should be flat to give the most faithful reproduction. Although it is often assumed to be true, it is doubtful whether a flat axial response curve gives the most realistic performance, but in this connection it is necessary to state our own assumptions. At the BBC we assume that the microphone and the amplifiers should have a uniform response; for tests on new types of loudspeakers the microphones used are equalized to be uniform ± ½ dB over the frequency range of 40 Hz to 15 kHz, or beyond if it is possible to do so without degrading the signal-to-noise ratio too much. It then follows that for the most realistic performance the axial frequency response characteristic of the loudspeaker must be allowed to take any form dictated by the ear, and it is found in practice that a slight slope over the frequency range from 200 Hz to 5 kHz is desirable, the response at the latter frequency being about 3 dB lower than the former. It should not be surprising that a uniform curve is not ideal, for the sound field in the listening room is very different from that in the studio and if, psychologically, a trend in the axial frequency response characteristic gives a better illusion of realism, this is regarded as entirely justified. There is also the factor that the aural effect of small degrees of coloration can be reduced by "cooking the curve." This procedure must be used with care, however, as it is not rigorous and it can easily be overdone.

It should be noted that the ear is not uniformly sensitive to broad-band changes throughout the frequency range. Thus a change in level in the 500 Hz to 2 kHz band of 1 dB is audible and one of 2 dB is quite marked. On the other hand, at the extremes of the range a change of 2 dB is barely audible at all.

Some figures from our experience are worth recording here. From the point of view of local irregularities we have an octave-band variable equalizer which in the "flat" condition shows a ripple on the frequency response curve of ± 1½ dB. That equalizer can be switched in or out and it can be stated definitely that this degree of ripple in a flat average response is absolutely inaudible. On the other hand we have had a case where a microphone had a smooth downward slope of 3 dB over the range of 100 Hz to 3 kHz. This was detected and equalized by ear by the program operators to within ± 1½ dB without reference to any kind of objective measurement! The obvious moral is that small local irregularities are permissible and that there is little point in aiming at too smooth a curve, but that broad trends are detectable to quite a fine degree.

Off-Axis Response Characteristics

The off-axis response is measured in a similar manner to the axial characteristic and is important for two reasons. Firstly, we do not always listen to a loudspeaker whilst seated on its axis, and secondly, it is largely the off-axis curves which determine the reverberent sound.

Taking the first point, it is important with monitoring loudspeakers, and to a lesser extent with the domestic types, that there should be a wide angle over which a listener can hear accurate reproduction, preferably indistinguishable from that on the axis. With multi-unit loudspeakers, apart from the coaxial types, this implies that care must be taken in mounting the units to get the best distribution in the desired plane. Thus for normal monitoring and domestic listening a two-unit loudspeaker would have the units mounted one above the other so that the system is symmetrical in the more important horizontal plane. In some cases in broadcasting, e.g. in a mobile control room, the opposite may be the case and it may be in the vertical plane that uniform characteristics are required. A further limitation with multi-unit loudspeakers is that there is a miminum distance at which they should be listened to if equal contributions from the units are expected.

The sort of trouble that is experienced off axis with a two-unit loudspeaker is illustrated in Fig. 1. The two units might, for example, be a 12 in. woofer and a two in. tweeter. If the overall response is made flat on the axis, that at 60 degrees might well follow the second curve, for at the upper end of its band the woofer could be quite directional whilst the tweeter, where it takes over, should be omnidirectional. This variation can be reduced by partially covering the woofer with plates leaving only a narrow slit to radiate the sound. The process must not be carried too far however, as the inertance of the slit resonates with the compliance of the air inside the cone giving a peak in the response followed by a sharply falling response. The degree of improvement effected by the slit never reaches the full theoretical amount; this is discussed in greater length in Ref. 5.

Greater uniformity in response with angle can of course be achieved, at a cost, by employing three units each covering a narrower frequency range. By judicious use of these methods the off-axis curves can be smooth and follow that on the axis within ±3 dB for angles up to 60 degrees over most of the frequency range.

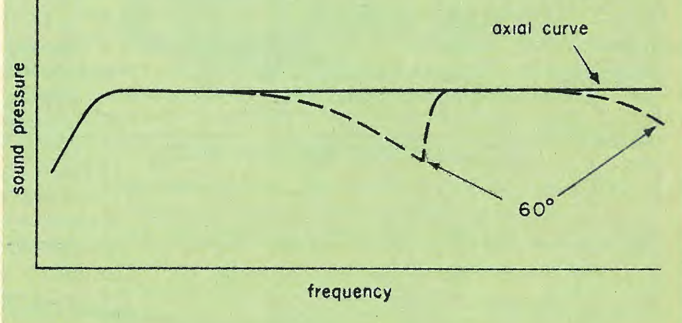

Fig. 1—Two-unit loudspeaker. Nominal frequency response characteristics on axis and at 60 degrees in the plane at right angles to that containing the two units.

The response in a plane containing the units is also irregular as at some angle in the crossover frequency range the two units are half a wavelength apart and a cancellation occurs at smaller angles than in the orthogonal plane, as shown in Fig. 2. Fortunately the crevice is narrow and the frequency varies at a discrete frequency; it does however mean that appreciable off-axis angles in this plane are to be avoided if possible. This means that contrary to many advertisements, multi-unit loudspeakers have definitely a "right way up" for serious listening.

The influence of the off-axis response on the reverberation is of course very large. If the loudspeaker is regarded as the center of a sphere which is divided into concentric bands occupying equal angles at the center, then the area covered by ± 5 degrees say will only occupy a small fraction of the area covered by 85 degrees ± 5 degrees, and the contribution to the total energy radiated into the room will be correspondingly small. The reverberation will thus be largely determined by the off-axis curves and it is at once apparent that any large discrepancy between direct and reverberant sound will be detected.

Polar Response

For this measurement the loudspeaker is mounted in the free-field room, and the measuring microphone rotated about it by a boom controlled by selsyn motors from outside the room and which also control the rotation of the polar recording paper. As with the axial frequency response characteristic, it is essential to provide true free-field conditions and the microphone must be at a distance from the loudspeaker great enough to give representative results, say five to six feet. Measurements are taken either at discrete frequencies or, more usually, employ bands of noise when general trends are required.

The polar response is of course another way of regarding the off-axis curves discussed above. It is not used extensively however because it is not the polar response as such which is listened to but the frequency response characteristic at a specific angle. The polar response measurements are therefore largely used to supplement the response at angles when a specific feature is to be examined at one particular frequency or band of frequencies during the design of the loudspeakers.

It is also useful in estimating the service area which will be well covered by one loudspeaker or in calculating the directivity or total power radiated by the loudspeaker.

Directivity and Power Response

The directivity of a loudspeaker is a measure of the degree to which a loudspeaker fails to be omnidirectional and is defined as the total acoustic power radiated at a frequency, or band of frequencies, compared with the power which would be radiated by an omnidirectional source having the same axial output. When measured in bands over the whole frequency range, it gives an indication of the way the reverberant sound will differ from the direct sound heard on the axis for a nominally flat axial frequency response characteristic and the two are therefore best dealt with together.

Since the parameter we want determines the reverberation level, this at once gives a clue as to one method of measurement. The loudspeaker is stimulated with bands of noise and the reverberant field measured as a function of frequency. By knowing the absorption characteristics of the room, the total radiated power can then be calculated from the formula:

$$SPL = PWL + 10 \log_{10} \left(\frac{Q}{4\pi r^2} + \frac{4}{R} \right) + 0.5 \text{ dB}$$

Where SPL is the sound pressure level re 2×10^{-5} N ÷ m^2 PWL is the power level, Q is the directivity factor, r is the distance in feet from the loudspeaker to the microphone and R is $S\alpha \div 1 - \alpha$ where α is the average sound absorption coefficient for the room and S is the area of the bounding surfaces of the room in square feet. In practice a reverberation room is used as this gives a more uniform field and has known absorption characteristics. However, similar limitations as to size apply to this room as to the free-field room and unless the room is large enough, true integration will not take place at the bass and in addition there is always some danger of the vent resonance in a vented cabinet being affected. It is however the most widely used method and properly instrumented, taking measurements at a number of points in the reverberant field, can give fairly accurate results.

The directivity can also be obtained in a free-field room by recording the polar radiation pattern at a large number of angles around the loudspeaker and calculating thence the directivity. As these measurements must be carried out at a number of frequencies, the labor involved is quite large and this method is rarely used.

The method employed at the BBC is similar but more convenient and quicker, the details being described in Ref. 6. In practice it consists of integrating the total power output "ρ" of a microphone as it is rotated around the loudspeaker in

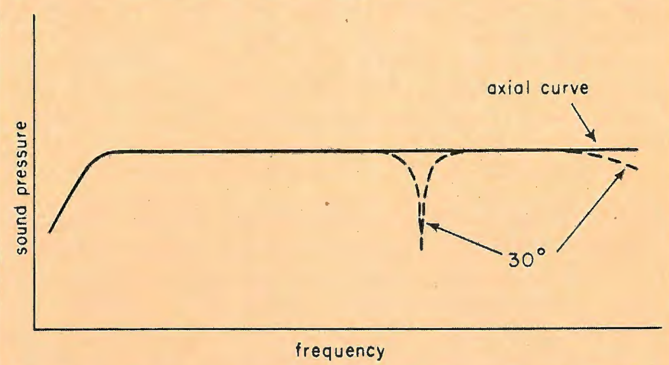

Fig. 2—Two-unit loudspeaker. Nominal frequency response on axis and at 30 degrees in the plane containing the two units.

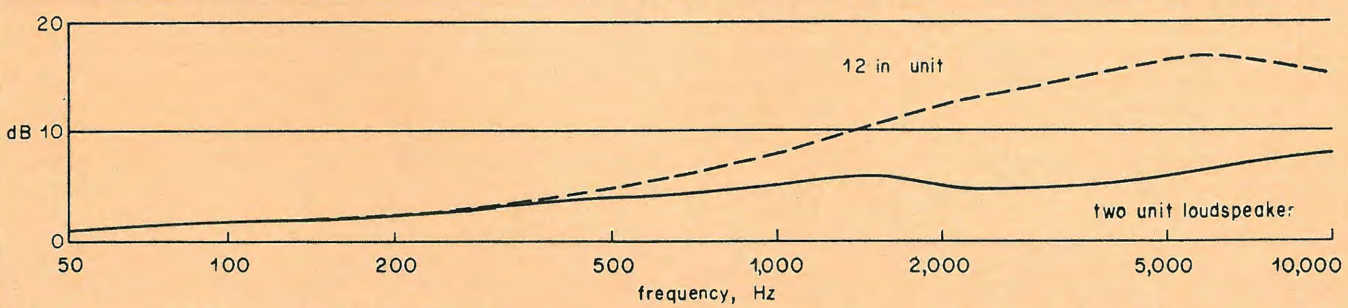

Fig. 3—Directivity of a single 12 in. unit and of a two-unit monitoring loudspeaker having a 7 in. slot in front of the 12 in. bass unit.

the free-field room in sectors, rather like the segments of an orange, for which the integral to be determined is

$$\int_0^{\pi} \pi\rho^2 \; \sin\theta \times d\theta$$

The microphone is fed to a sine law potentiometer and to an integrator so that the directivity can be measured for any frequency. Since the free-field room is usable down to 40 Hz, the directivity can be measured over the whole spectrum without difficulty.

An illustration of the sort of result obtained is given in Fig. 3, both for a simple 12 in. radiator and for a two-unit monitoring loudspeaker.

It will be noted that the curve of the directivity of the latter, although much more uniform than that for a single 12 in. unit is still not flat. In the nature of things a 3 dB slope is to be expected as the bass unit is fundamentally omnidirectional whilst the tweeter can at best only radiate into a hemi-

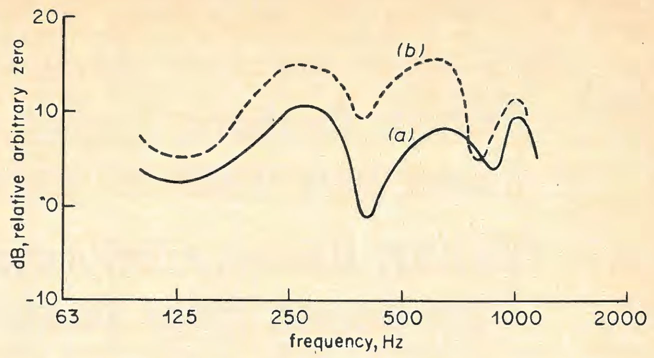

Fig. 4—Curve a, measured frequency response characteristic of loudspeaker in a corner using warble tone. Curve b, frequency response characteristic of loudspeaker in a corner calculated from three images in walls and ceilings. (Curves arbitrarily displaced.)

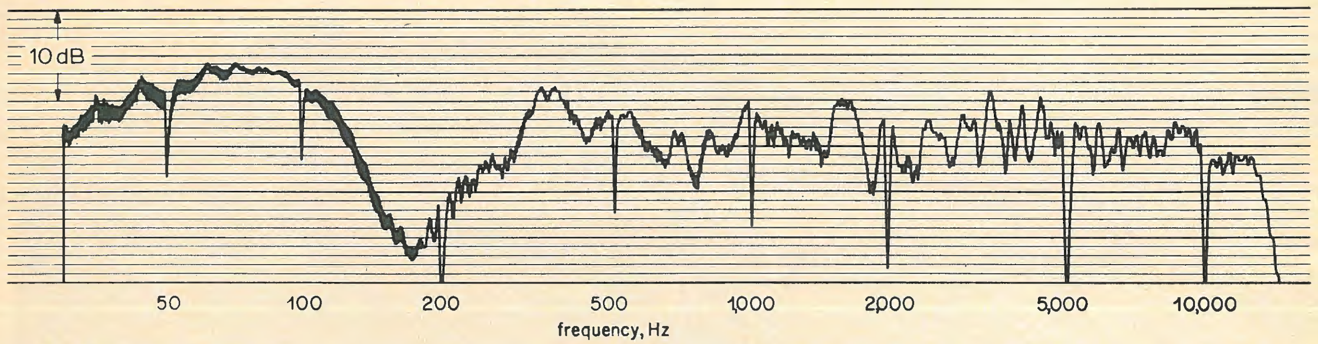

Fig. 5—Measured frequency response characteristic of a loudspeaker when touching the three surfaces in a corner.

sphere. It is clear therefore that even if found to be desirable, a loudspeaker having a flat total power response cannot be achieved using a conventional cabinet. It is of interest to note here that a monitoring loudspeaker with a close approach to an omnidirectional middle and high frequency unit was designed by one broadcasting authority [7] but later designs from the same authority have retreated considerably from this concept. Our tests on this loudspeaker with speech and solo instruments certainly indicated that the directivity was too small for this type of program material and the later changes by the designers indicate an acceptance of this verdict. For example, with speech, too great a degree of diffusion will give the impression of a voice spread over a large area. On the other hand, at the BBC with more conventional types of monitoring loudspeaker, any increase in angle of radiation so far has been welcomed. There is therefore some sort of optimum which, however, has never been satisfactorily determined, and measurements such as the total power response for differing types of loudspeakers will help to settle this feature in the future.

Corner Mounting

It is sometimes most convenient to mount a loudspeaker of the conventional cabinet type in a corner. This may be to try to narrow the angle of be covered or simply to hang the loudspeaker out of the way of the general impedimenta in the room. At the BBC this has been carried out particularly in television control rooms where the monitoring loudspeaker has been hung over the television monitors which are placed in a corner.

However, as the quality of speakers has improved there has been increasing dissatisfaction with the quality of reproduction from a corner placement and complaints of coloration have been made which do not apply when the same loudspeaker stands free of the corner. Measurements of the output of a speaker, fed with warble tone to remove standing waves in the room, have been carried out *in situ* with the results shown in Fig. 4, curve a. On the assumption that the irregular response was due to interference between the various images formed in the adjacent walls and ceiling, curve b shows the expected response. It will be seen that the two curves are very similar and it is not surprising that coloration was noticed at a frequency just below 300 Hz. The effects of a corner position can be mitigated by asymmetrical mounting and also by the use of absorbing materials in the corner, but these are palliatives and the use of corners for normal speakers is to be avoided whenever possible. The effect on the frequency response characteristic of placing the loudspeaker right in the corner is shown in Fig. 5 as an awful warning! For further details of these tests see Ref. 8.

(To be continued)

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TAPE RECORDER MAINTENANCE PART 8: Regulators

H. W. Hellyer

AT THE END of my last contribution (Jan., 1971) I gave a hint of things to come, while referring to methods of motor control. This applied primarily to portable cassette tape recorders, and one small circuit was given, that used by Philips in their EL3302A and similar models. Researching the subject for this continuation, and also for a lecture project I had to do at the request of my old friend Donald Aldous, (see London Letter, Page 10, AUDIO, Sept., 1970) I became convinced that the subject was worthy of a much deeper treatment than was possible as one article in this series. Our Editor (whom St. Cecilia preserve) is in apparent agreement, so I propose to go back to the beginnings and discuss the principles of regulation before leading on to some of the practices.

Reasons for this digression? They are twofold. In the first place, at the aforesaid lecture, when I took along a whole bunch of portable machines to describe and discuss with the lively South Devon Tape Recording Club, of which Aldous is the very active president, I was inundated with questions about the more sophisticated methods of servo control and voltage regulation that some of these tape recorders employ. In the second place, it was evident from some of the questions there and in my correspondence with readers of a number of audio magazines in this country (Great Britain) that understanding of the circuitry is incomplete. Power supplies are too often taken for granted. Either it goes or it doesn't.

Trouble is when it doesn't go, finding the reason is not always easy. It helps to have a knowledge of what a circuit should do before we can ferret out the causes for the stoppage.

Regulation—what do we mean? I would define this as "keeping the supply voltage constant even though the current drawn by the load varies." You may wish to apply a more elegant definition, or tie me down scientifically, but basically, this is what regulator circuits of tape recorders are designed to do. The bite comes with that last word "varies." The ordinary tape recorder has three functions: RECORD, PLAY, and FAST WIND. The first two may require much the same current, but usually the fast winding process demands more power, and the strain on the supply is more evident. Some machines need varying amounts of current for forward and reverse, even for differences between the amount of tape spooled. Simple regulation is not going to help them much when demands vary widely.

Alternative methods have motors which regulate themselves, and the supply line to the main machine can be separately and simply regulated. There are some interesting circuits in this group and we shall take a look at them later. Others employ what is now known as "servo control," where a sensing circuit picks up a mechanically generated pulse as the motor rotates, compares this with an electronically generated reference, and from the error reading feeds back to the motor a controlling change in supply voltage. Again, we have some intriguing variations.

The simplest form of regulation is the large capacitor across the battery supply. The function of this fellow is simply to bypass audio signals. It is a device to be found quite often in cheap radios as well as the more sophisticated gear we are talking about, and it does precisely the same job. In more technical terms, it reduces the apparent source impedance.

The source impedance of an ordinary layer-type battery could be a couple of ohms, and this will get bigger as the battery ages. At 100 Hz, a 1,000 μF capacitor will have an impedance only slightly greater than 1.5 ohms. This is in shunt with the battery impedance to alternating currents, so less voltage drop across the battery results. But if current variations are going to be greater, or, as with the portable tape recorders we are discussing, currents are direct, as used to drive the motor, then the regulating capacitor is only an added refinement.

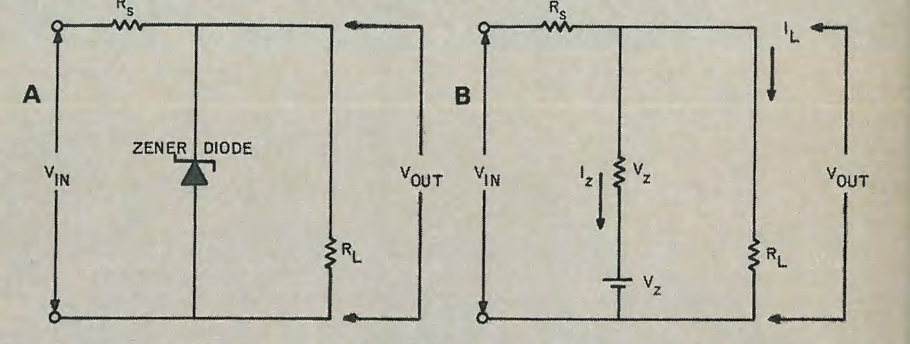


Fig. 1—Zener diode regulation, showing A the actual and B the effective circuit of the zener-controlled power supply.

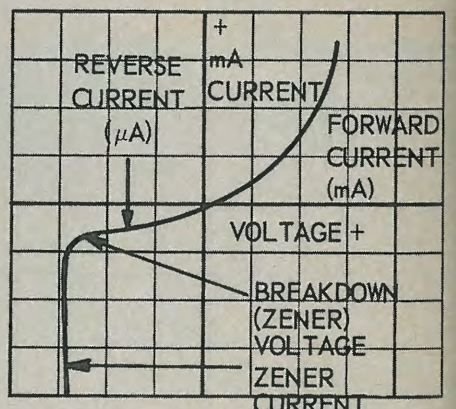


Fig. 2—Characteristic curve of a typical zener diode. Values are not marked on the axes of the graph, as these are different for various grades and specific values would be misleading. Note that reverse current is in microamps.

Next simplest method of applying regulation will be found in devices where the original supply is from the a.c. electricity line. The idea is to "bleed" the power pack with a resistor across it drawing a fairly high current. Then, the current demands of the equipment, though still varying, present a proportionately less demand than when the bleeder and the power supply voltage remains more constant. But this is a brute force method. Neither of the foregoing methods needs more than our passing consideration and certainly should not require an explanatory diagram.

The zener diode across the supply line may seem little more than an elaboration on the bleeder idea. And, in fact, if we use it straightforwardly, as in Fig. 1a, it will have the same drawback—the power pack has to supply maximum current all the time. When our aim is conservancy—who wants to carry a mulepack of batteries?—we cannot use this. But if the machine is operating from an a.c. supply, and we are not too bothered about our bills, it could be used this way to act as a voltage clamp. It is more useful as a linear regulator, and we shall see it used in several of the circuits that follow, so let's take a look at the zener diode and see what it does and why.

If you forward bias a semiconductor diode, it behaves as a short-circuit—well, almost—and current flows. Reverse the applied voltage and only a tiny leakage current remains. This leakage current can be independent of the applied reverse voltage over quite a wide range, but as this voltage increases there comes a point when, zing! the current jumps from a few microamps to many milliamps—enough, indeed, to murder the diode.

This critical voltage is the breakdown voltage, V_{BR}. When C. Zener discovered it in 1934, it was just a curiosity. The "zener effect" had a few novelty descriptions, but had to wait until 1953 before K. G. McKay and K. B. McAffee published "Electron multiplication in silicon and germanium" in the *Physics Review*. An alternative theory for avalanche breakdown was proposed, and even if I understood it well enough, I would not bore you with the still arguable matter of broken covalent bonds and carrier velocities.

The important thing to cling to is that every diode will exhibit the zener effect, but not every diode will behave as we want our "zener diode" to behave, i.e., under control. Whereas, the zener diode acts as a perfectly normal diode within its "non-zener" area. They are generally designed to handle quite a hefty current for their size and, when not at breakdown, have a small leakage. When choosing zener diodes we have to look for voltage and current characteristics and to remember that the wattage rating is not voltage times current but a value slightly lower. This is because temperature comes into the calculations also. Heat sinks will be found associated with many zener diodes. Quoted specifications are for 25 degrees C. (77 degrees F.) unless otherwise stated. Voltage ranges are from around 3 volts to 150 volts or so and the power ratings cover a very wide range, up to 75 watts and more for special applications. Each diode has a correct zener voltage rating and tolerances may be 5, 10, or 15 percent. So the preferred range of values will be used, and a nominal 9 volt zener is actually 9.1 volts ±5%, or whatever the tolerance of that particular one happens to be. Maximum zener current is equal to the quoted wattage divided by the zener voltage.

One phenomenon of the zener device is a negative temperature coefficient exhibited by those with a low breakdown voltage as against a positive temperature coefficient for those with a higher breakdown voltage. This can be used to good effect by the inclusion of two zeners in a circuit where their characteristics can balance out to give a zero temperature coefficient, at some specific current. A further speciality is the reduction of capacitance of the zener diode as the reverse voltage increases—a factor which comes handy in some television circuits.

A drawback that affects us in audio work is the rather high noise character-

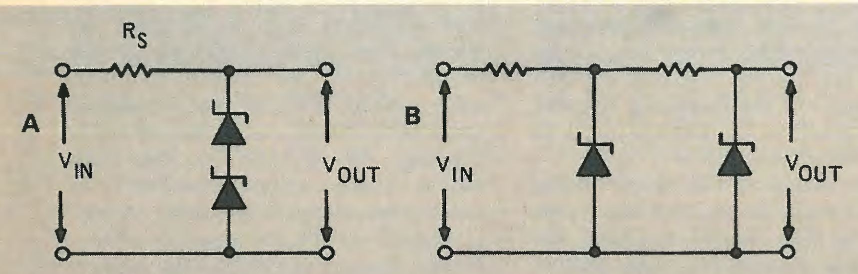


Fig. 3—Where voltage limits are beyond the range of a single zener diode, two or more can be combined, A in series and B in cascade.

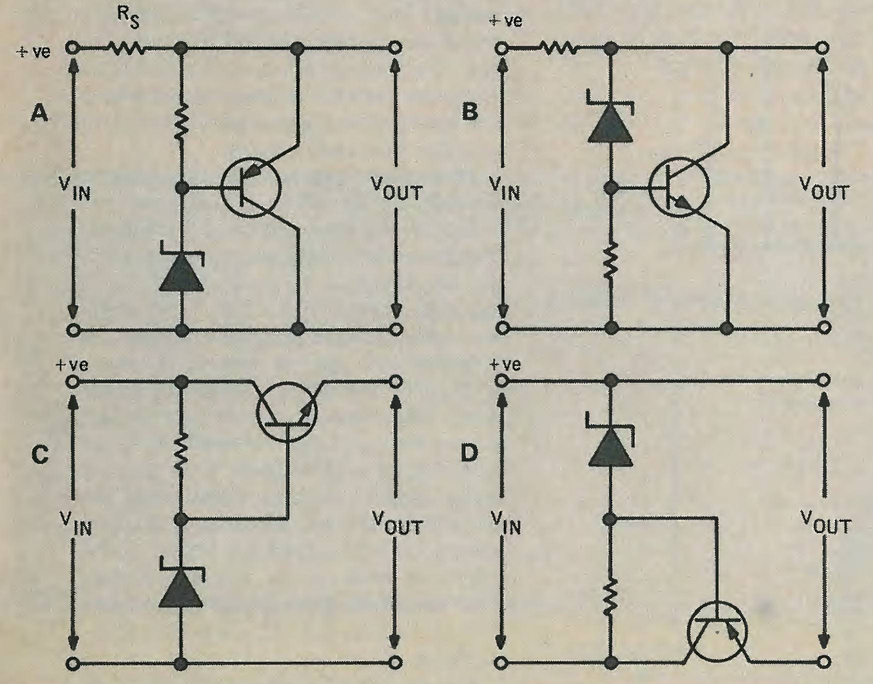


Fig. 4—Control via a bipolar transistor: A PNP in shunt; B, NPN in shunt; C, NPN in series, and D, PNP in series.

istic. This is the reason for that 0.01 μF or so capacitor shunting the diode in many circuits.

So much for what it is. How does it work? Well, a look at Fig. 2. shows the relationship of voltage and current for a particular zener diode, and here we see the characteristic hell-dive when the reverse voltage reaches the break-down or zener point. In Fig. 1b there is a simple example of the circuit where these tendencies can be used. V_{IN} is an unregulated input voltage. For the purpose of calculation we take the minimum V_{IN} and say that $R_s = (V_{IN} - V_{OUT}) \div I_{max}$. V_{OUT} is the breakdown voltage of the zener and I_{max} the highest load current that will be demanded. So long as this load current is not exceeded (see Fig. 2.) V_{OUT} will remain constant. The series resistor in a circuit like this will be chosen to give five to ten per-cent more than the specified load current, as a safety margin. As a further precaution, the relationship of V_{IN} to V_{OUT} will not be less than 1.5 to 1. By having a reasonable size of series resistor through which both load and diode currents will flow, the circuit is kept more stable. The equivalent circuit of this arrangement is shown in Fig. 1b. The dissipation rating of the diode is calculated from $[V_{OUT}(V_{INmax} - V_{OUT})] \div R_s$.

Although the zener can be used primitively, like this, or stacked in series (Fig. 3a) or cascaded, as in Fig. 3b, a more realistic use is as a control device. Where the load current would be too great for a normal zener—or when the cost of a higher rated one forbids—the solution is to use a power transistor as the regulator and a zener diode to set its switching voltage. This can be connected as a shunt or a series regulator, and single-transistor circuits along these lines are shown in Fig. 4.

A shunt regulator (Fig. 4a) has a load current nearly as much as the product of the maximum rating of the zener and the gain of the transistor. If the load decreases and V_{OUT} tends to rise, the base voltage of the transistor rises, relative to the emitter, and the zener in the circuit tends to keep the collector-to-base voltage constant. So the emitter current rises, the voltage across the series resistor goes up and V_{OUT} remains reasonably constant. Only reasonably, for this circuit is still pretty Rube Goldberg, and its main virtue is that it is proof against short circuits. The output resistance is relatively high. But as with the previous circuit, full current is drawn from the power supply all the time, and a further drawback is that special precautions against temperature change have to be taken to prevent this affecting the output voltage. All the foregoing remarks apply as much to the PNP circuit as to the NPN circuit, Fig. 4b.

A more usual device is the series regulator, seen in its PNP and NPN versions in Figs. 4c and 4d. Here, the zener diode clamps the base relative to its appropriate line. Once more, a change in voltage because of demand is corrected by the transistor current varying, but now the current drain is proportional to the load current—or very nearly. So the efficiency of the circuit is greater. The disadvantage is that it is not proof against some Tom Fool short circuiting it, and even a fuse is not an adequate protection. The answer is a more sophisticated version of the same idea. Numerous circuits have been developed and we shall look at a few. These are mainly developments of common-collector high-gain Darlington pairs. The driver transistor provides most of the current gain and the main transistor takes care of the power demands.

An introduction to practical tape recorder circuits is best made via the simple style of configuration used, not in a tape recorder, but in a bench supply unit. This little box of tricks was designed around a Mullard circuit and should give an output adjustable from zero to 15 volts at a load current of a half-amp. This is enough for some pre-amps, small radios and the like, and is chosen only to illustrate my points. The main supply is omitted to save space, and consists of a full-wave rectifier fed from a center-tapped transformer, with quite comprehensive filtering. The 16 volts to the zener diodes is thus negative to the main (zero) line. Part of the zener voltage is tapped off by the control potentiometer R_v and applied to the base of the driver transistor. The OC29 is in cascade so that the pair form a compound emitter follower. The output voltage at the emitter of the second transistor closely follows the base of the first, which is in turn controlled from the variable resistor, across which the zener diodes are connected to give a stable reference voltage.

Protection against short-circuits is limited, up to about 2 amps, by the value of R_s, shown dotted in Fig. 5. This has to be a high-wattage component (or combination of components), and an ohmic value of 7 ohms at 40 watts was used in the original design. As a protection against reverse voltages applied to the output terminals—easily done when testing sub-circuits in the electronic jungle—a reversed diode is fitted across the output. To keep the circuit stable, the series transistor has to be heat-sinked, allowing a thermal resistance of less than 2.5 degrees C/W up to 10 watts at low output voltages. The circuit is quite practical and has proved useful, but no claim for originality is made.

It is not always necessary to use zener diodes to set the base voltage of the

(Continued on page 53)

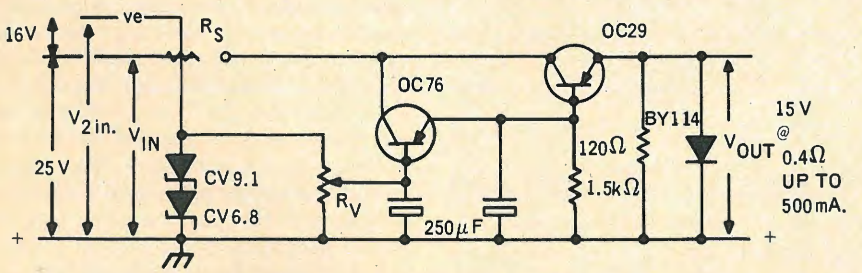


Fig. 5—A simple bench power supply circuit, with rudimentary control, effective over a limited range of values.

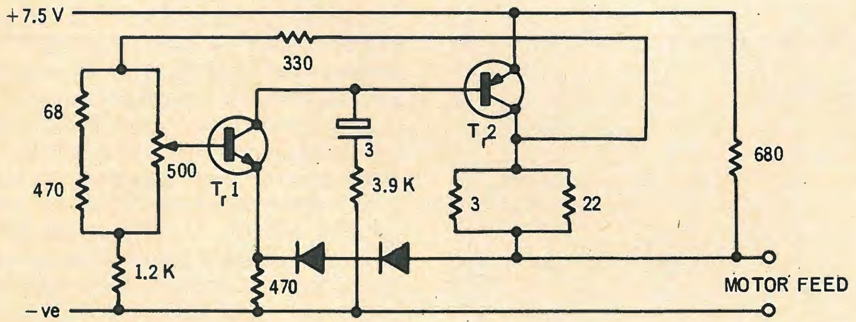


Fig. 6—A variant (by B. R. C. Ltd.) on the supply and motor regulation circuit of the Philips cassette portable shown in the Jan., 1971 issue of AUDIO, p. 28.

Cassette Deck Survey

a buyer's guide to cassette decks

The great surge of interest in cassette machines during the last year has made this one of the more interesting projects of the same period. Both tapes and machines have improved very much in the past twelve months, and the convenience of the cassette system, coupled with excellent performance in the better models, has made it a worthy competitor to the older reel-to-reel machines. The ability to edit still gives the reel-to-reel machine an advantage for the serious recording enthusiast—as well as the professional.

In this roundup, we have taken measurements on 13 machines, played them, subjected them to various types of recording applications, and then described the results. The important figures are combined in a chart which portrays the information most wanted by the prospective purchaser. We then devoted space to individual features of the various machines, those items which could not be tabulated effectively. We have also included performance curves showing frequency response from a "standard" tape, as well as that resulting from feeding a swept signal from 40 to 20,000 Hz at a constant level to the input of each machine, then playing back and recording the output on a graphic recorder. When the machine was equipped for recording on chromium-dioxide tape, "Crolyn," or its equivalent, we have made similar measurements on both ferric oxide and the newer tapes. When the Dolby system was built into the recorder, measurements were made with "Dolby in" and "Dolby out" conditions, and the results are shown on the individual curve plots.

The Measurements

The methods of making the charted measurements are fairly standard. The first two columns were obtained by inspection of the machines—if a "CrO2" switch and/or a "Dolby" switch were present, it is indicated by a yes or no in the respective column. Bias frequency was measured using a UTC "Dot" transformer, DI-T250, with one of the 600-ohm windings connected to the input of a Heathkit IB-101 Frequency Counter. The tiny transformer was put in close proximity to the erase head with the machine in the record mode, and the bias frequency read off the counter—a much simpler and more accurate method than beating the output of the bias oscillator against another oscillator, or showing the Lissajous pattern on a 'scope, which results in a circle when the frequency of the bias oscillator is the same as that of the test source. Signal-to-noise (S/N) measurements were obtained by recording a 1000-Hz tone for a half minute, then continuing with the machine in the record mode with no input signal. Upon playing back, the difference between the two outputs represents the S/N, provided one adds the "+" figure obtained from later measurements of "Level of 3% THD."

The figure for "THD at '0'" was obtained by recording a 1000-Hz tone fed into the line input with the level adjusted to an indicated "0" on the VU meter. The signal was then played back into a distortion analyzer and the figure observed. (The signal was also recorded at levels of +2, +4, +6, and +8 to determine the point at which 3% THD appeared, and this value was listed in a later column.)

For wow and flutter measurements, a 3000-Hz signal was recorded at zero level and played back into a wow-and-flutter meter, with the figure for wow taken from the measurement from 0.5 to 6 Hz, and that for flutter taken from that from 6 to 250 Hz. Input levels were obtained by feeding signals into line and mic inputs with the record-level controls at maximum and measuring the voltage required at each for a "0" indication. Where two figures are given under "Line Input," it is because there were both high and low line inputs on the machine. The values for "Line Output" were obtained by measuring the output when a signal recorded at "0" level was played back, again with the output level controls at maximum if they were present.

Times for fast-forward and rewind were simply measured with a stopwatch for a C-60 cassette, and the listed figure is the average of both directions. All machines are equipped with three-digit counters.

Not charted, but listed under the individual descriptions are the speed deviations under conditions of low and high a.c. voltages and of frequency variations from 40 to 80 Hz.

Tapes

Figure 1 shows the results of a number of different tapes on the same machine—TEAC A-24. It will be noted that the differences are sufficient to influence the curves shown for the different machines. Consequently the same tape was used for all curves run. Because its response could be tailored nearly flat up to 15,000 Hz, the ferric-oxide tape selected was Memorex. From the comparative curves shown, it will be seen that some have a "bump" in the 5000-Hz range which would not lend itself to simple equalization with conventional tone controls. Others show a noticeable droop in the range from 200 to 600 Hz, also difficult to equalize. For those machines with the chromium-oxide facility, Memorex Cr02 was used. We have found it difficult to purchase chromium-oxide or Crolyn tapes, although Advent markets their own brand, Advocate, and one cassette of Advocate tape was supplied with their machine. The Norelco tape used in the comparative curves was from a stock of earlier tapes and should not be considered representative of their latest formulations.

Dolby System Responses

Three of the machines listed were equipped with the Dolby system of noise reduction. While the system has been described in this and other publications, a brief review should not be amiss. The basic principle of the Dolby system is that at low levels the response is shaped like the upper curve in Fig. 2, which is an actual curve from a sweep signal recorded with the Dolby switch on and played back with the Dolby switch off. The recorded level for the input signal was 30 dB below the indicated "0" level on the meter. The bottom curve in Fig. 2 is the result of recording the signal with the Dolby switch off—thus in the normal or "flat" condition—and playing back with the Dolby switch on, which shows the noise-reducing effect of the system. The center curves are the result of combining the bottom curve with the *inverse* of the upper curve to show how the two responses match. Assuredly, we could have subtracted the bottom curve from the top one, but this would have given us a line that is practically straight or the result of actually recording and playing back with the Dolby switch on. In order to make a complete survey of the Dolby system it is necessary to make these curves at a wide range of levels, which we have done in preparing this roundup, but space does not permit showing the results of measurements and curves at levels of 5, 10, 15, 20 and 25 dB below indicated "0" but it can be taken as fact that the effect is essentially the same at all levels. The resulting noise reduction caused by the system is about 6 dB, although this increases at higher frequencies, rising to near 10 dB at 10 kHz. The S/N figures shown with an asterisk on the chart were measured with 1000 Hz as the reference and refer to the S/N with the Dolby system in use.

Chromium-Oxide ("Crolyn") Tape

Six of the machines listed were equipped to use CrO2 tapes, as well as with the more conventional FeO (ferric-oxide) tapes. The CrO2 tapes require about 50 per cent more bias than FeO tapes for the same frequency response. When equipped with a switch to increase the bias for the required amount, CrO2 tape is capable of 6 to 9 dB better response at 10 kHz. The dashed-line curve on the tape-response graph shows the effect of recording on CrO2 tape with the bias determined as normal for FeO tapes, and the curve shows a rise of about 10 dB at 10 kHz. This is probably with some increase in distortion, but we just didn't make any measurements of distortion using CrO2 tapes with lower-than-normal bias. It seems likely that the bias current could be adjusted in most machines to accommodate CrO2 tapes, but then you would have to use that kind of tape exclusively, unless you could engineer a switching system to change bias as you changed tape. From the individual response curves for the various machines, it will be noted that response is extended somewhat when CrO2 tape is used with the proper bias.

If you are using a cassette recorder with noticeably poor high-frequency response, it seems likely that you could improve it by simply changing to CrO2 tape without any change in bias. You might conceivably hear more distortion.

"Standard-Tape" Response

Each of the individual performance curves shows both the playback response from a readily-available "Standard Frequency" tape, along with the record/play responses under the available conditions. Since it appears that the latter curves are most often better than the "standard," the "standards" should be compared with each other, rather than considering them "absolute." The only thing these curves tell us is that the "standard tape" is not really "flat." However, it does provide a comparison between machines, so long as you bear in mind that a correction curve plotted on, say, the machine with the "flattest" record/play curve could be applied to the "standard."

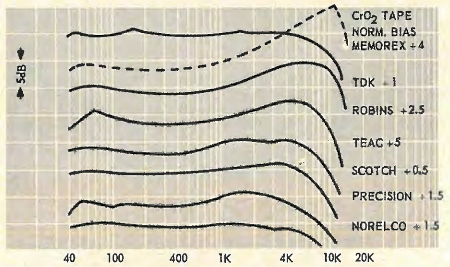


Fig. 1—Response of various tapes.

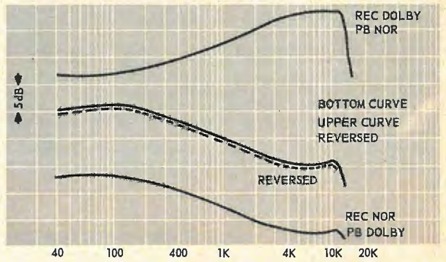


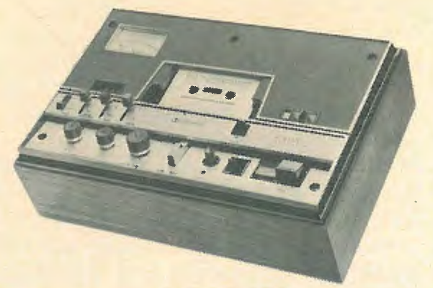
Fig. 2—Dolby action.

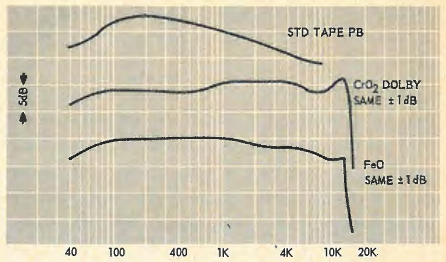
MANUFACTURER AND MODEL NO.	Dolby Sys.	CrO_2 Tape	Bias Freq. kHz	S/N dB	THD at "0" %	Wow %	Flutter %	Level 3% dB	Mic Input mV	Line Input mV	Line Output V	C-60 FF/Rew secs	Dimensions W x D x H in.	Weight lbs.	Price
ADVENT 201	yes *	yes	100	54 60*	.08	.08	0.14	+2	none	30	0.5	44	13¾ x 8½ x 5¼	14	280.00
CONCORD MK IX	yes *	yes	103.8	52 58*	2.5	0.15	0.25	+3	1.0	80 380	1.5	101	16¼ x 10¾ x 4¼	15	249.79
CRAIG 2708	no	no	64.6	42	2.0	0.2	0.3	100 mV	5.0	30	1.5	99	9 x 7⅝ x 3½	5.3	94.95
HARMAN-KARDON CAD-4A	no	no	103	40	2.5	.06	0.17	+2	0.5	72 650	1.0	95	12½ x 9½ x 3¼	10	159.95
HARMAN-KARDON CAD-5	yes *	yes	101.4	53 59*	2.5	.07	0.19	+4	0.5	60 640	1.3	90	12½ x 9½ x 3¼	10	229.95
JVC-NIVICO 1660-2	no	no	55.4	45	2.2	.08	0.16	+3	6.0	70	0.55	95	11 x 9¼ x 3¾	3.1	139.95
KENWOOD KX-7010A	no	yes	56.5	43	1.5	.06	0.16	+8	2.7	95	2.2	63	10¼ x 8¾ x 4	7	149.95
LAFAYETTE RK-760A	no	yes	101.8	50	1.5	0.25	0.45	+8	1.0	90	0.8	115	9 x 13½ x 5¼	6	99.95
NORELCO 2401	no	no	88.3	53	2.0	.07	0.15	+5	0.25	160 (phono)	1.6	100	15⅛ x 9⅜ x 4¾	11	229.95
PANASONIC RS-275US	no	no	98.8	50	1.5	0.2	0.28	+8	0.5	25	1.0	70	16½ x 11⅞ x 4¾	18¾	249.95
PILOT PTD-100	no	no	96.1	46	2.5	0.12	0.22	+8	0.15	30	0.5	80	12⅞ x 9 x 3⅞	9⅞	169.95
SONY TC-165	no	yes	88.1	50	1.2	0.12	0.15	+7	0.25	420	0.9	66	15¾ x 10⅞ x 5	15½	259.95
TEAC A-24	no	no	86.4	50	2.0	0.15	0.22	+2	0.25	800	0.5	64	13⅝ x 9⅝ x 4¼	11	199.50

Cassette Deck Survey

ADVENT 201

Controls: Stereo/mono rocker switch, noise-reduction (Dolby), CrO_2, VU meter lever switches, power slide switch, record push button. Individual record level controls for each channel, plus an inclusive control for use after balance is set; fast-forward and rewind lever, must be held in position during winding; pause lever; play and stop keys. Input and output phono jacks on left side panel, plus a covered phono jack providing +18 volts for accessory mic preamp; also output level control and Dolby calibrating-oscillator push button. Uses synchronous motor, heavy flywheel. Speed variation from 85 to 135 volts, -1.4 to +0.5 per cent. Uses one 3" meter; switch selects either channel or higher of both; meter characteristic rises 12 dB from 100 Hz to 10 kHz to indicate probability of overload more accurately. Employs 2 FET's, 33 transistors, 42 diodes. Push-pull bias oscillator for low distortion. Requires external mic preamp when recording from microphone (optional accessory, $20.00) and has no headphone jack provision, although output can be monitored with high-impedance phones if desired.



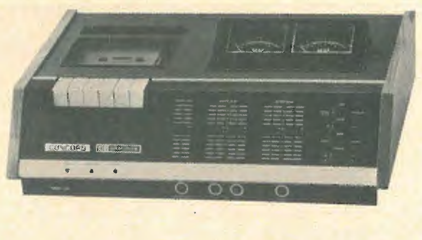


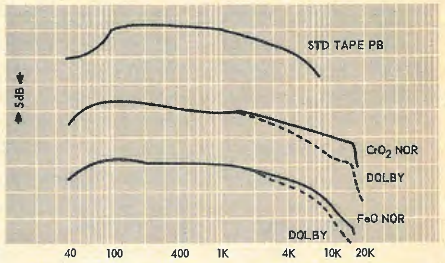
This model has the lowest distortion of any measured, and record/play frequency response ±3 dB from 40 to 15 kHz with CrO_2 tape. Response with FeO tape nearly the same, although droops 4 dB from 1000-Hz level at 10 kHz. Cassette compartment not provided with cover so as to give easy access to cassette. An all-around high-quality construction with excellent performance either with or without the Dolby system in use. User's instruction book exceptionally complete in describing operation and the Dolby system. Another useful feature is the schematic on the bottom of the cabinet, along with description of servicing controls. Dolby recording-level controls accessible through openings in back of cabinet. Dolby test tape available (optional) for setting playback controls.

Check No. 18 on Reader Service Card

CONCORD Mk IX

This model has some interesting features—sloping front tilting back 40 deg. from the vertical, and two 2½" VU meters in a panel which tilts upward 30 deg. from the top surface of the unit; and separate record and play level controls, together with a "mixing" pot which enables the recordist to add another signal equally onto both channels while simultaneously recording separate signals onto the two channels individually. All level controls are of the linear or "slide" type so popular nowadays. Operation is by the conventional piano-type keys—record, rewind, stop, play, fast-forward, and pause. On the lower front panel are two mic input jacks, a "mixing" input jack, and a headphone jack, all of the ¼-in. phone type. Four push-push switches provide for regular or CrO_2 tape, mono or stereo, Dolby in or out, and power on or off. On the rear are four input phono jacks—two low-level and two high-level—and two output phono jacks. Response with CrO_2 tape is ±4 dB from 40 to 15,000 Hz, and from 40 to 10,000 Hz with FeO tapes. Dolby performance is rolled off about 4 dB below normal at 10,000 Hz, possibly because of no provision for adjusting the Dolby record level to accommodate the individual tape being used. No circuit information is provided, although the user's instruction book is quite complete. It is not unusual for manufacturers to avoid potential problems which might be caused if the average consumer had access to service information. After all, cassette machines are quite compact, and servicing should best be left to "qualified" personnel. The d.c. drive motor provided constant speed regardless of the line frequency and varied only ±0.1 per cent over a line-voltage range from 85 to 135 volts.

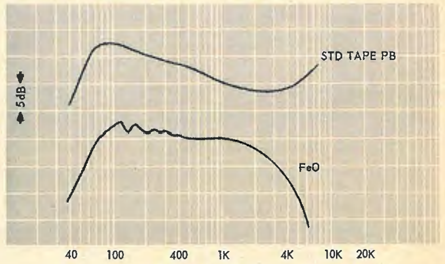




Check No. 19 on Reader Service Card

CRAIG 2708

This exceptionally compact machine might easily be a good starter for the new cassette user, since its automatic level control circuit eliminates the need for monitoring the recorded level, regardless of the source. This circuit keeps the level in both channels to proper values depending on the average of the two, and is the result of an a.v.c. action of one transistor which rectifies the average of the two signals and feeds a d.c. voltage back to another transistor in each channel which acts as a variable resistance in the signal circuit. Two additional transistors flash an overload light when the recording level gets out of the range of the controlling circuit. The unit employs a single-ended bias/erase oscillator operating at 64.6 kHz, which should be well out of the range of interference from the deadly 76 kHz second harmonic of the switching frequency in multiplex circuitry. The motor is a synchronous type, with speed constancy of ±2 per cent over the 85 to 135-volt supply range. The unit employs a total of 13 transistors—one in the regulated power supply—9 diodes, one of them a Zener, and two as power supply rectifiers.

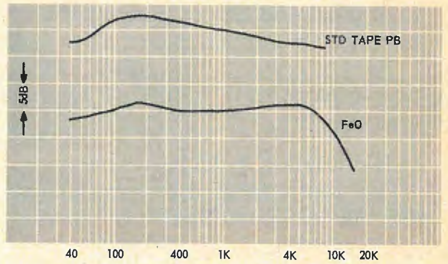


The top surface of the unit accommodates five piano-type keys—first is the record key, red for identification; next is the play key, then rewind, fast-forward, stop, and pause keys, all black. The eject button is at the left of the keys, and the rocker switch for power is at the right, along with the power pilot light and the record signal indicator lamp which should flicker during the recording, showing that the input levels (from either line input phono jacks on the rear or from the microphone jacks alongside them) is sufficient to produce suitable recordings. The output signal is available from a pair of leads terminating in phono plugs which are to be plugged into a receiver or amplifier for playing through the complete music system. Since there are no controls on the machine to adjust either recording or output levels, it is necessary to set the latter with the controls on the receiver or amplifer used with the recorder; the record levels are controlled automatically by the internal circuitry.

Check No. 20 on Reader Service Card

HARMAN-KARDON CAD-4A

The CAD-4A is a slightly modified version of the CAD-4 which has been on the market for some time—differing principally in the use of slide controls instead of knobs, and in some minor circuitry particulars. The unit, a deck, is compact and simple to operate. Six piano-type keys perform all the tape-handling operations—record, rewind, stop/eject, play, fast-forward, and pause. At their left is a rocker switch for stereo or mono modes, and at the far right another serves as an a.c. switch. Microphone jacks are located under the operating keys, and six phono jacks on the back provide for high and low line inputs and for line outputs. The level controls operate only on the record mode, but a signal is available at the output jacks on both record and play modes. Small indicator lamps just in front of the operating keys indicate when the motor is running, when the unit is in the record mode, and when the input signal is overloading.



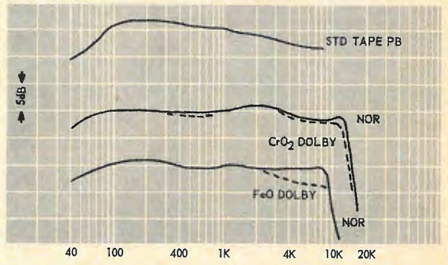
The motor-running signal light indicates green while the machine is in either record or play modes (the record indicator is red, and the overload light is white) as long as the take-up spindle is rotating. At either end of the tape travel (at end of tape or when rewind is completed) the green light dies out, indicating that you should depress the stop key. Thus the stop is not automatic, but the end of tape motion is clearly shown. This indication is effected by a three-transistor circuit.

The motor is d.c. driven, controlled by another three-transistor circuit which holds speed within ±0.1 per cent over the range from 85 to 135 volts, and regardless of line frequency. The recording signal is monitored by two 1½-in. VU meters which are illuminated when power is on. The overload indicator light flashes on whenever the input signal reaches a level of +2 dB on both meters, and at about +4 if the overloading signal appears on only one channel. The CAD-4 is a very quiet machine, and simple to operate. Response is within ±3 dB from 40 to 11,000 Hz. Transistors, 18, diodes, 6.

Check No. 22 on Reader Service Card

HARMAN-KARDON CAD-5

Identical in size and similar in appearance to the CAD-4A, the later CAD-5 provides the facility for CrO_2 tape and includes the Dolby system. Being in the same size housing, and with the additional circuitry, it is a masterpiece of miniaturization to accommodate its semi-conductor complement of 2 FET's, 43 bi-polar transistors, and 19 diodes—two of which are Zeners, along with the multitude of capacitors and resistors. An extra rocker switch next to the power switch actuates the Dolby system, and an additional indicator light—blue—shows when the Dolby circuit is actuated. The motor on the CAD-5 is also driven by d.c. and controlled in the same manner by the three-transistor circuit. Similarly, the motor light works in the same manner.

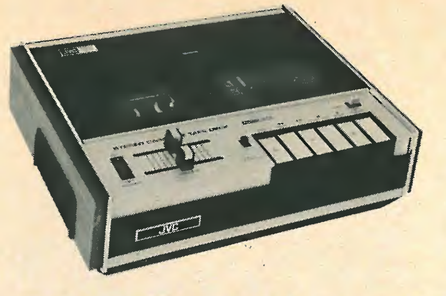


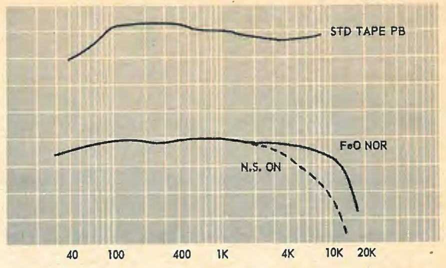
Other differences are the presence of the Dolby oscillator pushbutton on the rear, along with a push-push switch for CrO_2 tape. Input and output jacks are the same as in the earlier model.

Frequency response with CrO_2 tape measured within ±2 dB from 40 to 13,000 Hz, with Dolby response differing less than 1 dB at the upper end. With FeO tape, response was within ±2 dB from 50 to 9000 Hz, with Dolby response drooping about 4 dB at 9000.

Check No. 23 on Reader Service Card

JVC-NIVICO 1660-2

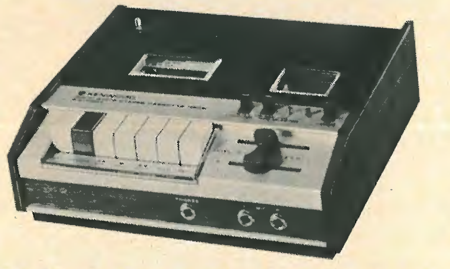


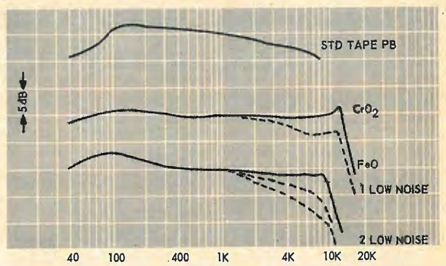


Slightly smaller than the previous models described, the JVC-Nivico 1660-2 is fitted with a rocker switch at the top left to control power, followed by two horizontal slide controls for record-level adjustment. To their right is a tiny slide switch to turn on the noise-suppressor action, and then the conventional operating keys—record, rewind, fast-forward, play, stop, and pause, with an eject button above the pause key. The dual VU meters are 1½-in. models, and their scales are illuminated green when power is on. No indicator light is provided for the record mode. The unit has an automatic eject feature which operates four seconds after the end of the tape, either forward or reverse, but can be defeated by depressing the stop key. Line input and output phono jacks are mounted on the rear panel, along with a DIN receptacle for direct connection to receivers or amplifiers similarly equipped. Microphone jacks are located on the left end of the walnut-finished case, and the black plastic top and brushed aluminum control panel complete its attractive appearance. Adjustments for input level are also located on the rear panel. The unit employs an induction motor which provides constant speed over the line-voltage range from 110 to 130 volts. The meter characteristic rises 10 dB over the range from 100 to 10,000 Hz to show clearly the possibility of tape overload as the higher frequencies are approached. Frequency response measured within ±2½ dB from 40 to 13,000 Hz in the flat position, while the noise suppressor rolled off response about 10 dB at 10,000 Hz. The auto-eject feature was judged useful for those who will use the unit for playing recorded tapes consistently, and it is undoubtedly a convenience in normal use. We had relatively little information about this machine, so everything described or charted is the result of inspection and measurement.

Check No. 24 on Reader Service Card

KENWOOD KX-7010A

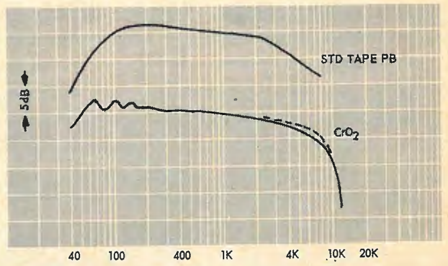




This model is another compact unit with the smoothest piano-key operating controls of the group. There are seven such keys—eject, record, rewind, play, fast-forward, stop, and pause. To their right are two horizontal slide controls for level setting, during both recording and playback. Above are three small tab switches—hi-filter, tape selector (CrO_2/FeO), and power—an orange pilot lamp to indicate when the machine is switched for CrO_2 tape, and a red one to indicate when power is on. The machine employs a hysteresis-synchronous motor, and maintains a speed constancy of ±0.1 per cent over a line-voltage range from 85 to 135 volts. Level indication is shown by a dual VU meter, with 1½-in. movements. The semi-conductor complement is 14 transistors and 4 diodes. The rear panel of the unit is equipped with a line-voltage switch, allowing use with supplies from 100 to 240 volts; as well as with a fuse, two phono jacks for line input, two more for line output, and a DIN receptacle for connection with receivers or amplifiers so equipped, using a single cable. The front apron accommodates a headphone jack for use with conventional 8-16 ohm phones, a pair of phone jacks for microphone inputs. Frequency response is within ±2 dB from 40 to 12,000 Hz with CrO_2 tape and within ±3 dB from 40 to 9500 Hz with FeO tape. The hi-filter droops response about 4 dB at 10 kHz with CrO_2 tapes, and the curves for FeO tape show the effect of using the hi-filter during *both* recording and playback modes, showing a droop of 8 dB compared to the 4-dB droop when used in only the playback mode.

Check No. 26 on Reader Service Card

LAFAYETTE RK-760A

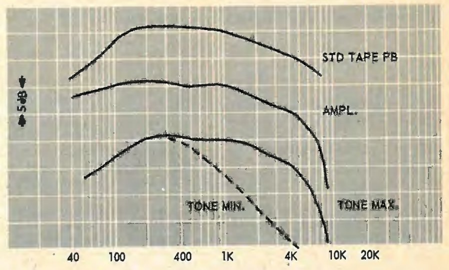


Most of the machines previously discussed have been wider than they were deep—this one is just the opposite, and therefore might possibly fit into an available space better than the others. The operating keys—seven in number—are located on a short sloping front panel, flanked by two push-push switches, one for power and the other for the stereo/mono operation. The seven keys are: "up" (eject), record, stop, play, rewind, fast-forward, and pause. On the vertical front of the cabinet is a brushed aluminum panel on which are two sets of dual-concentric controls—the left pair for microphone level control, and the right ones for line level. Two microphone jacks, the record indicator light, and the CrO_2 switch are also on this panel, which also accommodates the illuminated dual VU meter, with its below-"0" scale in green and above "0" in red. The line-input and line-output jacks are on the rear panel. The drive is by a hysteresis-synchronous motor, with speed variation less than 0.1 per cent over a voltage range from 85 to 135 volts.

One useful feature of this unit is the ability to mix signals from microphone and line simultaneously. Thus the microphone jacks do not cut off the line input when a mic is plugged in, but the two inputs are fed to their separate level controls for each channel. The transistor complement is 10, along with 10 diodes. Frequency response for both types of tape were similar, with both rolling off by about 5 dB at 8000 Hz.

Check No. 27 on Reader Service Card

NORELCO 2401MA



This is the only complete *recorder* tested, with power amplifiers built in. In addition, it is the only machine tested which could be called a "changer." Six cassettes can be held in a smoky plastic holder, which fits onto the cassette compartment when in use or stores in the storage compartment when not.

On the top surface to the left of the cassette holder is the VU meter, and just in front is the counter. A single meter is used to indicate the combined levels of the two channels. To the right of the counter are six rectangular push buttons which control the operations: record, start/eject, pause, stop, rewind, and fast-forward. The start/eject button starts a cassette playing or rejects a cassette while playing. To record, one depresses the start/reject button, unlocking the record button; then the pause button is depressed, followed by the record button, then the pause button again to start tape motion. The stop button is used to stop changer operation in the playback mode, with the cassette then being rejected and the machine stopped in neutral. Rather a complicated operation, but simply learned.

To the right of the buttons are four controls—volume-on/off, balance, tone, and record level. "Volume" controls the playback to speakers, but not line-level output.

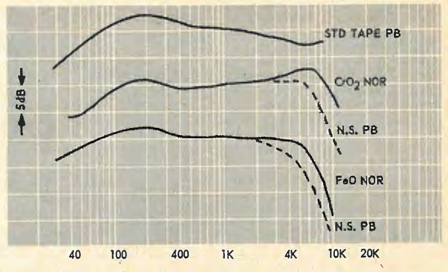
On the rear of the unit are phone jacks for speaker outputs, a three-circuit jack for line output (to an external amplifier), another three-circuit jack for stereo microphone input, and two phono jacks for line-level inputs. Microphones suitable for this unit are crystal or ceramic types, and a stereo pair is furnished.

The changer action consists of two functions—raising or lowering of the spindle assembly and removal of the cassette from its well by a traveling belt which carries a hinged arm that folds down to clear the cassette as the belt passes to the left, then rises and carries the cassette out of the well as the belt moves back to the right. This effective mechanism changes cassettes in only 8 seconds, depositing the played cassette in the storage compartment.

The amplifier outputs are rated at 4 watts per channel into 8-ohm speakers. The semiconductor complement is 20 transistors and 7 diodes. The synchronous motor delivers a speed constant within ±0.1 per cent from line voltages from 85 to 135. Frequency response at both line and speaker outputs is down about 5 dB at 5000 Hz and 10 dB at 7000 Hz with the tone control in the maximum position. In the minimum position, the speaker output is down 15 dB at 3000 Hz.

Check No. 28 on Reader Service Card

PANASONIC RS-275US



This model uses two motors, both d.c. driven. The sophisticated commutatorless capstan motor is driven by a section employing 8 transistors and 9 diodes, fully regulated. The spooling motor is a simple commutator-type d.c. device. The machine is really a deluxe model, of exceptionally fine appearance, with solenoid and relay operation instead of the usual mechanical switching. It is fitted with two large 2½-in. VU meters, four slide controls for record and play levels, four rectangular push buttons and a long bar-shape button for the stop function. The first four are for rewind, fast-forward, play, and pause (which must be held down during the pause period). In addition, there is an eject button (mechanical), and an illuminated white record button. Furthermore, there are switches for normal or low-noise tape, for noise suppression, and for stereo or mono modes. The power switch is located at the right front corner of the top plate.

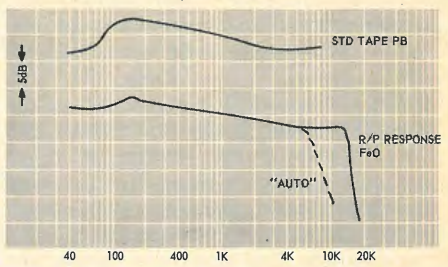
One useful feature is the memory rewind mechanism. Suppose you start a recording part way through a cassette and want to play back from only that point. You press the counter reset button and move the memory switch to the on position. You make your recording, stop the transport, and depress the rewind button. The tape is then rewound back to the "0" position on the counter and stops, ready to play what you just recorded.

Relay operation is common on high-quality reel-to-reel recorders, but most cassette machines are made to less costly specifications. This system requires six relays and two solenoids, with a separate power supply to furnish the current requirements. The semiconductor complement is 29 transistors and 26 diodes, with 8 transistors being used in the motor-drive circuit, three in the photoelectric auto-stop system, two for bias oscillator, one for voltage regulation, and two to drive the low-impedance stereo-headphone circuits with one more for the memory rewind feature.

The low-noise/standard tape switch changes bias somewhat, and in the low-noise position, response curves were made with CrO_2 tape, while FeO tape was used for measurements made in the standard-tape position. With CrO_2 tape, response was within $\pm$ 3 dB from 60 to 10,000 Hz, while with FeO tape it measured $\pm$3 dB from 60 to 5000 Hz. The noise suppressor switch provided a 6-dB droop beginning about 2000 Hz and reaching 6 dB at 6000. The provision of separate controls for recording and for playback is certainly a convenience and gives the machine a more-professional application.

Check No. 29 on Reader Service Card

PILOT PTD-100



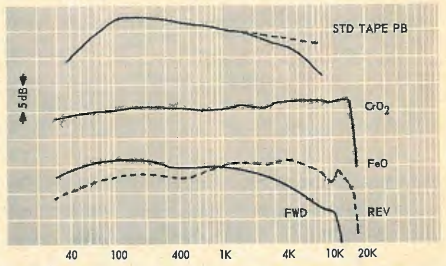
Lacking a schematic, we conclude that this machine has a synchronous motor, since its speed remains constant within $\pm$0.1 per cent over an applied voltage range from 85 to 135 volts, and changes in proportion to the frequency. Interesting features include an automatic stop actuated photoelectrically and which releases any depressed key a few seconds after the take-up spindle is stopped. Another is the auto shutoff switch—the power switch has two positions, ON, and AUTO/OFF; after a cassette is started to play, the switch can be rocked to the auto/off position which will permit the cassette to play until it finishes, then the entire unit turns off automatically. Another unusual device is the auto/manual pushbutton switch. In the normal or "up" position, level control is manual for both recording and playback; in the depressed position, the recording level is controlled automatically, and the playback level is fixed. At the left are two miniature phono jacks, followed by a standard phone jack for 8-ohm stereo headphones. Enclosed in a panel are the two slide level controls, and below them the auto/manual pushbutton switch, of the push/push variety. The two illuminated 1½-in. meters are located on either side of the panel, with an uncalibrated scale, white up to the "0" point and blue above.

Next are the usual piano-type keys—record, rewind, fast-forward, play, stop (and eject), and pause. The record indicator light is located above the record key. Under the cassette is an illuminated window which provides a better view of the status of the cassette's two reels. At the far right is the power/auto shutoff switch. On the rear panel, accessible through a cutout in the cabinet, are four phono jacks, two for aux input and two for line output. In addition, there is a three position lever switch governing output.

Frequency response measured within $\pm$3 dB from 40 to 12,000 Hz in the manual position, but in the automatic level control mode, the highs rolled off above 6000 Hz. To make these measurements, a signal 20 dB below "0" was fed into the input with the auto circuit on, then with it out and the control at a midway spot. The circuit boosted the level noticeably, so that instead of being way down on the scale at approximately -20, it was boosted up to an indication of nearly "0" at 1000 Hz. Obviously, this would lead to more problems in the high-frequency range, but in the normal mode, the response was excellent.

Check No. 30 on Reader Service Card

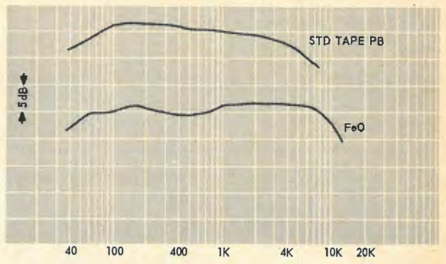
SONY TC-165



This is the only machine in the lot which provides for automatic (or even manual) reverse record and play. Two lights indicate the direction of tape motion by arrow-like jewels and another shows the record mode with a long bar. Similarly shaped buttons actuate the directions, with the center bar being the stop button. Then there are five keys—eject, rewind, play, fast-forward, and record. There are also switches for CrO_2 or standard tape, for limiter, for two levels of headphone monitoring, as well as one which sets the operation for a single forward play and then stop, or for a forward play, a reverse play, and stop, or for continuous play as long as the machine is left on. A pair of slide controls adjust record levels, and a push-push pause button holds the machine in whatever mode it was set for, yet without the tape movement. There are 36 transistors and 30 diodes in the device, and two microphone jacks on the front panel accommodate dynamic mics. Line input and output phono jacks are located on the rear of the walnut-finished cabinet. There are two erase heads—each covering its half of the tape—and one four-track record/play head. The synchronous drive motor held speed within -2.5 per cent at 85 volts to +0.6 per cent at 135. Frequency response with CrO_2 tape was within $\pm$2 dB from 40 to 14,000 Hz in the forward direction, slightly less in the reverse direction. With FeO tape, response was about the same, extending only to 12,000 Hz. With the limiter switch on, response at 10 kHz was down an additional 6 dB.

Check No. 31 on Reader Service Card

TEAC A-24



Differing considerably in controls, this is a well-built, more-or-less conventional machine with no provision for CrO_2 tape, but with consistently reliable performance. In addition to the usual operating keys—record, stop/eject, rewind, fast-forward, play, and pause, there is a dual 1½-in. VU meter and the power rocker switch on the sloping control panel, with two microphone jacks under the VU meter, and a headphone jack to their right. On the top surface are located a single selector knob—mic/DIN, tuner, line, and play—and two sets of dual-concentric controls, one for record level and one for playback level. On the rear panel are located a pair of tuner input phono jacks, a pair of line input phono jacks, a DIN receptacle, and a pair of line output jacks, also of the phono type. A synchronous motor holds speed constant within $\pm$0.1 per cent from 85 to 135 volts, and a tricky reed switch senses when the takeup spindle stops turning and actuates a solenoid which stops the unit, restoring all the operating keys to the normal position.

Frequency response measured within $\pm$2 dB from 45 to 10,000 Hz with FeO tape, which is excellent, considering the smoothness of the curve. The overall semiconductor complement is 15 transistors and 5 diodes, with separate transistors being used to drive the headphone transformers to accommodate the usual 8 to 16 ohm phones, two more in the automatic shutoff circuit, and one for the bias oscillator. An indicator light shows when the machine is in the record mode, and regardless of the position of the keys, it will not be on unless the selector switch is in one of the recording positions and *not* in the play position. All in all, a solid, reliable machine.

A similar machine, the Model 350, incorporating Dolby circuitry, has just been announced at $279.95.

C. G. McProud.

Check No. 32 on Reader Service Card

Mathematics 4 Beginners

Part Two of a series by Norman H. Crowhurst

WHEN GEORGE found Henry not too busy, he took him up on his promise to show how to calculate a circuit to meet specified requirements. To make it convincing, Henry had George pick some figures. Henry sketched out the circuit of a bridge, with the center arm removable, and had George suggest voltages at the center with and without the center arm connected.

To make it a little different from the previous situation, Henry suggested that the supply voltage points be labeled +10 and -10, instead of 0 and +20, with the other voltages to suit. (This makes zero kind of central and may make the whole thing easier to think about.) George's first suggestions for voltages at the top were +5 volts without and +3 volts with the center resistance connected and -7 volts with and -2 volts without at the bottom.

Henry pointed out that you cannot quite have *any* combination. This would mean that current at the top junction would flow from the junction into the center resistance, while at the bottom, it would have to flow from the junction into the center resistance. To be consistent, the same current flowing through the center resistance, must produce both voltage change effects, which means that if it flows in at the top, it must flow out at the bottom.

So Henry settled for swapping the voltages at the bottom: -7 volts without and -2 volts with, the extra resistor connected across the center. To get started, one more thing is needed: a value for the center resistor. They mutually agreed on 1,000 ohms, as a nice round value, and then George wanted to know how to get started.

"First thing," Henry suggested, "we need to know the current that the 1K resistor will take. Do we know the voltage across it?"

"Well," George pondered, "it has, when it's connected, +3 volts at its top end, and -2 volts at its bottom end. That means it has 5 volts across it, right?"

"Right," Henry replied, "So what is the current.?"

"Five milliamps?" George wondered. "But now how do we start on the other four values?"

"When the center resistor is *not* connected," Henry suggested, "we can tell the *ratio* of the resistors in the top arms from the voltage values then, and likewise the ratio of the resistors in the bottom arms. But each of those does not pin the values down. What does that is the change in voltage when the center resistor takes 5 milliamps out of the junction."

"Oh," George took up the notion, "then 5 milliamps out of the top junction changes the voltage from +5 to +3, which is a change of 2 volts. This means the effective resistance of the two top arms together, using—what was that principle you told me about last time?"

"Thevenin," Henry filled in.

"The effective resistance of the two produces a 2 volt change at 5 milliamps, which represents 400 ohms. Now, as the open-circuit state has 10 - 5 = 5 volts at the left, and 10 + 5 = 15 volts at the right, the right resistor must be 15/5 = 3 times the left resistor, in the top arms, right?"

Henry nodded.

"Now what?" George wanted to know. "I don't quite see the next step."

"What's the formula for parallel resistance?" Henry asked.

George wrote it down (see calculations). Henry said, "Now if you take R1 to be the smaller resistor, you know R2 is 3 times that, so what is 400 ohms?"

"Oh, I begin to see, now," George said, figuring it out. 400 ohms is ¾ of R1. Which means R1 should be 533 ohms, right?"

"Right," said Henry.

"Let's see, we have values at 510 and 560. 510 is closer to 533 than 560, isn't it? Can we use that value?" George asked.

"Carry on figuring, assuming we can," Henry suggested.

"Then the other resistor for the top arms will be three times 510 ohms," George said, "would 1,500 ohms be close enough?"

"Well," said Henry, "to be accurate to our calculations, one should be 533, and the other sould be three times that, or 1,600. And we could undoubtedly, if we had to, pick values from the 510 and 1500 bins that were those numbers exactly. It's a question of tolerance. Meanwhile, let's look at the lower arm values."

George started in. "The voltage changes from -7 to -2, which is 5 volts. At 5 milliamps, which we have already determined is flowing in the 1K, this means the source resistance, made up of the bottom two arms in parallel, is also 1K—5 volts at 5 milliamps. Now, the ratio: there is 10 - 7 = 3 volts across the right resistor, and 10 + 7 = 17 voltages across the left resistor."

George started to figure of the basis of the right lower resistor, making the left one 17/3 times that value. He finished up, "So 1K is 17/20 times the lower right resistor."

He divided 17 into 20, and came up with 1,176 ohms as the calculated value for the lower right resistor. "Would 1.2K do for that?" He asked.

"See what the other one figures to," suggested Henry.

George figured 17/3 times 1.2K and came up with 6.8K. "Very convenient!" he commented. "Now we have all the values, don't we? But how close will that come to the values we set out to begin with?"

"That is really still this matter of tolerances," Henry responded. "You could, as a matter of interest, assume that every value is exactly what its rated value says and calculate the voltages on the basis of that, to see how close your approximations are.".

George was doing this, while Henry was talking.

"However," Henry was going on "this question of tolerances is something that often gets overlooked. People all too often dip down a resistor box, and assume that the resistance actually has the value with which it is coded, spot in, although it is given a tolerance, plainly enough, by that silver or gold band. It's quite instructive to see the effect that variation within tolerances can have on a circuit."

Just then the whistle blew again, so George concluded, "Let's have a closer look at that next time." Æ

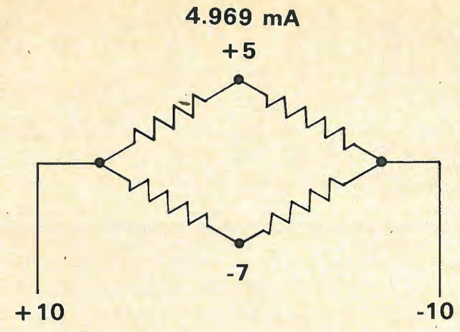


Fig. 1a—Bridge without center arm.

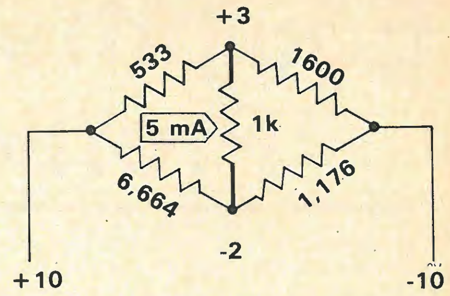


Fig. 1b—Bridge with center arm.

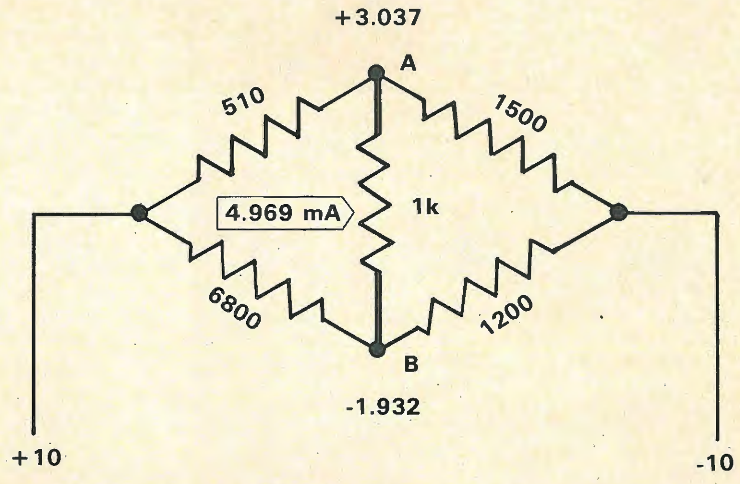


Fig. 2—Bridge with resitances calculated.

calculations

With 1K connected: +3 to -2 = 5V change.
1K = 5V ÷ 5mA
Top arm ratio: (10+5) : (10-5) =
15:5 = 3:1
+5 changes to +3 = 2V change with 5mA
2V ÷ .005A = 400 ohms
R1 × R2 ÷ R1 + R2 = 400 ohms
R2 = 3 R1
400 = 3 ÷ (3+1) × R1 = ¾ R1
R1 = 4/3 × 400 = 533
R2 = 3 × 533 = 1600
Bottom arm ratio: (10+7) : (10-7) = 17:3
-7 changes to -2 = 5V change with 5mA
5V ÷ .005mA = 1000 ohms
R1 × R2 ÷ R1 + R2 = 1000 ohms
R2 = 17/3 × R1
1000 = 17 ÷ (17+3) × R1 = 17/20 R1
R1 = 20/17 × 1000 = 1,176 ohms
R2 = 17/3 × 1,176 = 6,664 ohms
2 11 space

Actual, assuming rated values are exact.
Without 1K connected:
Top arms: 20V ÷ 2.01K = 9.95 mA
9.95 mA × 510 ohms = 5.075 V
10 - 5.075 = +4.925, instead of +5
Bottom arms: 1.2k and 6.8k make exact 17:3 division, and -7 V is correct as specified.
With 1k connected, source resistances (R1 × R2 ÷ R1 + R2)
(510 × 1500) ÷ 2010 = 380.6
(1200 × 6800) ÷ 8000 = 1020
Total resistance across A-B is
11.925 V = 380.6 + 1000 + 1020
= 2400.6
Current: 11.925 ÷ 2400 = 4.969 mA
4.969 mA × 1020 ohms = 5.068 V,
which taken away from the original 7 V equals -1.932 V instead of -2 V.
4.969 mA × 380.6 ohms = 1.888 V
taken from +4.925 = +3.037 V,
instead of +3 V.

Equipment Profiles

- TEAC 7030 SL Tape Deck 36
- Pioneer SX9000 38
- Panasonic SP10 Turntable 42

TEAC 7030SL Stereo Tape Deck

MANUFACTURER'S SPECIFICATIONS

Speeds: Two, 15 and 7½ ips. **Heads:** Four, two-track erase, record and playback, and four-track playback. **Reel Size:** 10½ in. max. **Motors:** Three; dual-speed hysteresis-synchronous for capstan drive, two eddy-current for reel spools. **Wow and flutter:** 15 ips, 0.04%; 7½ ips, 0.06%. **Signal-to-noise Ratio:** 60 dB. **Crosstalk:** 60 dB at 1000 Hz. **Frequency Response:** 15 ips, 30 to 22,000 Hz ± 3 dB; 7½ ips, 30 to 20,000 Hz ± 3 dB. **Inputs:** Microphone, 600 ohms, 0.25 mV min.; Line, 50,000 ohms, 0.1 V min. **Output:** Approximately 0.3 V for load impedances of 10,000 ohms or more. **Fast winding time:** 90 seconds for 1,200 feet. **Dimensions:** 20⅞ in. H., 17½ in. W, 8¼ in. D. **Weight:** 62 lbs. **Price:** $799.50

According to TEAC, the SL suffix means "*S*uperior sound, *L*ow noise" and so the 7030SL is really a refined, up-dated version of the older A-7030U, which was a very good machine anyway. The reduction in noise is partially due to the use of a higher bias level to match the new density tapes, such as Maxell UD35, Scotch 203, BASF LP-35LH, and TDK-150 SD which have appeared on the scene during the past few months. In order to take full advantage of these low-noise tapes, not only must the bias be increased but the recording level has to be greater, head design changed, and characteristics of the amplifiers modified accordingly. All these features have been built into the TEAC SL series, which includes the 6010SL, a four-track machine, the 7010SL with large 10½ reel facility, and the 7030SL, which has 7½ and 15 ips speeds as well as provision for large reels. It is a two track machine, but has a four-track head for playback—the best of both worlds so to speak. In appearance, it looks like the A-7030U, but a second glance shows that there are some extra controls on the right hand side. One of these is a meter level switch that allows extended scale operation by increasing the range by 3 dB. Thus, accuracy is maintained when using both high and low density tapes without fear of the pointer hitting the stops.

The operating controls, reading from right to left, are: push-button POWER SWITCH, TAPE SPEED, REEL SIZE, 4-TRACK PLAYBACK switch, and CUE button. Then follows the REWIND and PLAY buttons which are located above a long STOP bar. On the extreme right is the RECORD button and indicator light. Underneath, in the amplifier section, are the dual headphone and dual line input controls, microphone and headphone sockets. On the right are the tape monitor switch and output level controls, and underneath are levers for mode, meter, and bias level. In the center, in between the two large VU meters/ are indicator lights showing the position of the bias and recording level switches. Now, taking a look at the mechanics, the counter on the left is driven by a belt from the supply reel and just above it is a stabilizing roller, fitted with an unusually heavy flywheel which acts as a kind of mechanical filter to smooth out any variations in tape feed. The arm above the roller is connected to a sensing pillar which operates in conjunction with metal foil on the tape. Thus, tape can be automatically rewound or stopped at any desired point. On the right, under the spool, is the capstan, pinch roller, and automatic shut-off lever. Figure 2 shows the head arrangement. The two-track erase and playback heads are on the outside with the two-track and four-track play heads in the middle. A new ferrite material used for these heads is said to account for the wider frequency range and better crosstalk. These new heads are, incidentally, guaranteed for life.

Circuit Details

The playback input circuit (for one channel) is shown in Fig. 3. The first transistor—a special low-noise silicon NPN—is coupled to a PNP type which is connected as an emitter-follower. The network R1, 2, 3 with C1, 2, and 3 forms a twin-T bias rejection circuit, and it will be seen that the equalization loop is taken from the emitter of the first transistor to the emitter of the output. This stage is followed by a two-transistor amplifier with a third for the transformer-coupled headphone output. The record amplifier is fairly conventional using three ICs per channel with separate transistors for meter amplifiers and two more for the 100 kHz push-pull bias and erase oscillator. The use of special now-noise integrated circuits accounts for a significant reduction in record and replay noise. The power supply is stabilized by two transistors plus a zener reference diode, and four rectifiers are used in the usual bridge arrangement. No less than seven relays are employed for various functions, including equalization switching. As might be expected from TEAC, the instruction manual is most comprehensive and well-illustrated with photographs and diagrams, so that a non-technical user will have no difficulty in getting best results. And, of course, the usual accessories are provided—a plastic cover, Allen keys, a 10½-in. reel, spare fuses, rubber reel stops, patch cords, oil, even a polishing cloth!

Performance

Naturally, a machine in this price category should have a high standard of performance and this reviewer was not disappointed. Not only were the figures up to specifications but the machine was a pleasure to use. All the controls worked smoothly, and the various design refinements gave that feeling of luxury hard to describe. For instance, a muting delay circuit eliminates switching thumps and an electronic interlock keeps the recording bias applied to the head after the tape movement ceases, to avoid recorded clicks. That kind of thing *is* attention to detail. One of the features I found particularly useful is not really a refinement but rather a "must" for the serious recordist—the tape monitor switch. Not only does this give an indication of sound quality by instantly comparing the input and output signals, but actual levels can be compared too, as the VU meters are also switched. Very useful for channel balancing. As the microphone and line inputs have separate controls, signals from a tuner, record, or other source can be mixed in if so required. One of the first tests made was the operation of the automatic stop and rewind functions by using a metal sensing foil. (Selection is made by a switch at the rear.) To make the test more stringent, I used half mil tape—but I did not succeed in breaking it! One reason is this: on changing direction, either manually or automatically, the pinch roller and capstan contact is slightly delayed to allow the capstan to change direction and attain normal speed before tape travel is resumed. TEAC thinks of everything! The 15 ips speed was formerly the choice of professional users, but advances in

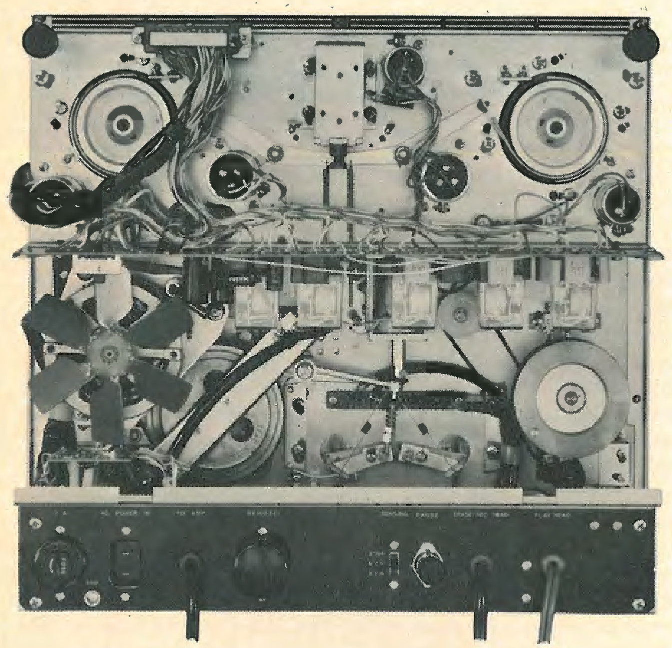


Fig. 1—Showing transport section from rear.

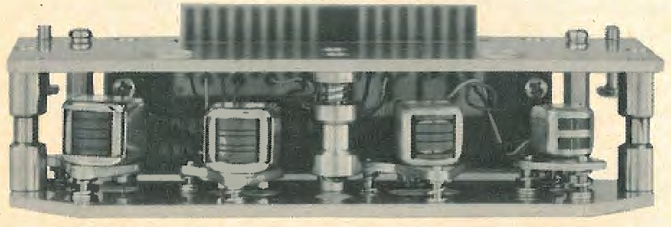


Fig. 2—Close-up view of head assembly.

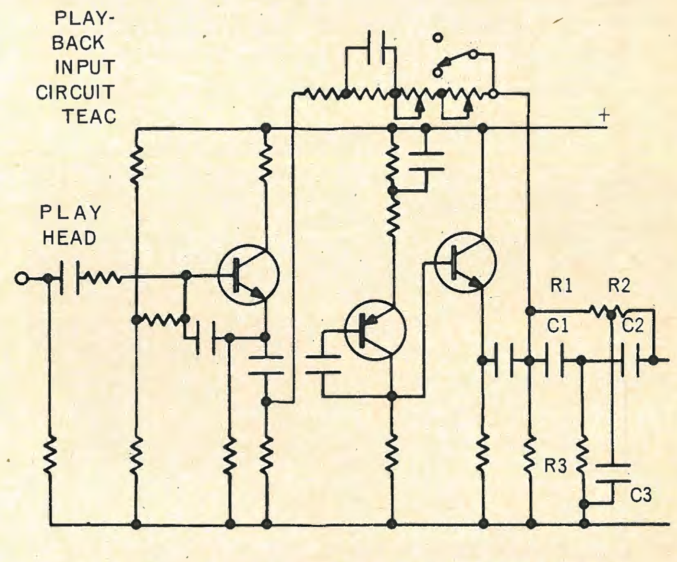


Fig. 3—Playback input circuit (one channel only).

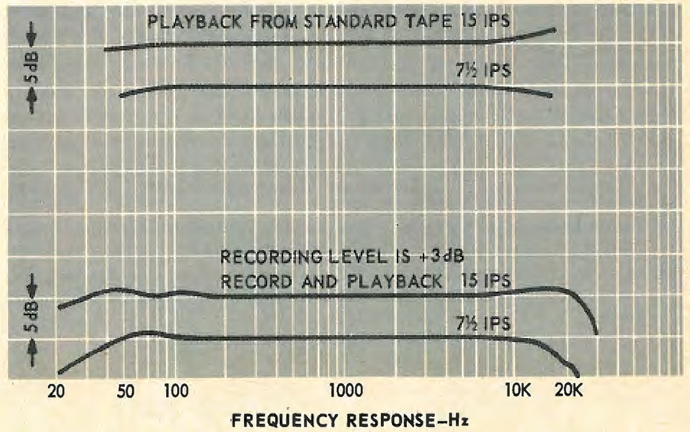


Fig. 4—Response curves for playback of standard tapes and for recording and playback.

technology have resulted in such a high standard for 7½ ips (now superior to 15 ips of only three years ago) that some will question the inclusion of the higher speed. Several off-the-air recordings were made and, as might be expected from the restricted frequency range, it just was not possible to tell the difference. The same applied to disc transfers—the superiority of 15 ips was only just audible with high quality records, such as the Audiophile series or the Sheffield direct-disc recordings. But, of course, the higher speed will score when it comes to home recording—providing top quality microphones are used.

Test Figures

Figure 4 shows the frequency response at both speeds taken with standard tapes. The record/play measurements were made with BASF LP-35 LN, using the high bias setting. It will be seen that response at 7½ ips is only 3 dB down at 20 kHz and the 15 ips response -3 dB at 28 kHz and only -0.5 dB at 23 kHz! Distortion was very low, measuring 0.45 percent THD (100 to 10,000 Hz) at 0 dB on the VU meter which was actually +3 dB on the extended range. At the +6 dB level, distortion increased to 0.65 percent, rising to the standard 3 percent at approximately +11 dB. Signal-to-noise ratio came out at 62 dB for 15 ips and 59 dB for 7½ ips (ref +3 dB level), which is excellent. Wow and flutter was just under 0.03 percent at 15 ips and 0.05 for 7½ ips. Crosstalk measured 60 dB, falling to 55 dB at 10 kHz. Sensitivity at line input for +3 dB recording level was 115 mV and tape output under these conditions was 890 mV with high impedance load.

The machine—as received—was labeled "bias set for Scotch 203" but this seemed quite close to optimum conditions for BASF tape so the preset controls (located at the rear) were not adjusted. However, in brief tests made with Audiotape 10 and Memorex tape changes had to be made. With the bias switch at normal, voltage was too low and the high setting was *too* high. A higher than optimum bias produces a high frequency attenuation and a lower bias results in an undesirable rise at the top end.

Summing up: The 7030SL can be confidently recommended to the serious recordist who wants a versatile, well-designed and beautifully made machine, capable of a very high standard of performance. Incidentally, there are a number of accessories available, including a sound-on-sound echo unit, remote control unit, dynamic microphone and a condenser (electret) microphone. *T.A.*

Pioneer Model SX-9000 AM/FM Stereo Receiver

MANUFACTURER'S SPECIFICATIONS

Tuner Section. FM IHF Sensitivity: 1.6 μV. **S/N Ratio:** Better than 65 dB. **Selectivity:** 40 dB. **Image Rejection:** 90 dB. **Capture Ratio:** 1 dB. **Stereo Separation:** 40 dB @ 1 kHz. **THD (Stereo):** 0.8%. **AM IHF Sensitivity:** 9.5 μV. **Image Rejection:** 78 dB. **Amplifier Section. Music Power:** 150 watts total (IHF). **RMS Power** (both channels driven): 50 watts/channel, 8 ohms; 60 watts/channel, 4 ohms. **THD:** Less than 0.5% at rated output. **Damping Factor:** 30. **Frequency Response:** 10 Hz to 35 kHz ± 1 dB. **Power Bandwidth:** 10 Hz to 35 kHz. **Input Sensitivity:** Phono 1 & 2, 2.5 mV; AUX 1 & 2, 160 mV; Microphone, 1.6 mV; Main Amp, 500 mV. **Hum and Noise:** Phono, better than 80 dB; AUX, better than 100 dB. **Bass Control Range:** +12.5 dB, -14 dB @ 50 Hz. **Treble Control Range:** +9 dB, -11 dB @ 10 kHz. **Low Filter:** -6 dB @ 50 Hz. **High Filter:** -12 dB @ 10 kHz. **Power Consumption:** 310 watts, max. **Dimensions:** 20-9/16 in. W. x 7⅝ in. H. x 13-9/16 D. **Price:** $499.95 (includes walnut cabinet).

This new receiver entry from Pioneer Electronics (U.S.A.) Corp. includes all of the useful features found on their earlier receivers, plus some new control features and circuits that we have not seen on any integrated receiver before. The front panel is a bit deceiving, since all the controls located in the lower portion of the black and gold panel are normally covered by a hinged door which swings down to expose them. With this door closed, the panel looks sleek and simple and only the most often used controls are visible. These include the tuning knob, coupled to an effective flywheel, concentric master and source volume controls, a seven position selector switch, a four position "tone color" selector (about which more in a moment), four pushbuttons for speaker selection (including choices for one or two pairs of three speaker pairs and an "off" position for headphone listening) and a pair of tape-monitor buttons to actuate either a front-panel or rear panel (or both) pair of tape-input and tape-output jacks. The separate "source" and "master" volume controls are a welcome addition from the past. We have long maintained that the incorporation of a "loudness-contour" circuit is somewhat meaningless unless a means is provided for adjusting the *input* or source level so that the so-called Fletcher-Munson loudness compensation curves (for low-level listening) can be made to correspond to their appropriate *absolute* levels. This dual control provides that means. The "tone color" selector switch is new too and provides four arbitrary tone compensation settings listed as "vivid" (a slight boosting of both bass and treble ends), "bass" (a boost of just the bass region), flat, and "soft" (a slight attenuation of the high end). All of these settings could, of course, be accomplished by the individual tone controls, but Pioneer has selected these fixed positions probably on the basis of listener preferences. We wish they had included a "presence" position (slight boosting of mid-range frequencies) which is *not* achievable by means of ordinary tone controls, but that omission does not detract from the usefulness of the other "ready-made" tonal settings.

The "blacked-out" dial area at the left of the panel includes two tuning meters—one for signal strength, useful in both AM and FM tuning, and the other for zero-center FM tuning. A "tone-color" illuminated graph is located above the dial scale and actually displays the response curve selected by the previously described "tone color" switch. There is also a "reverberation indicator" window, which displays an artist's representation of the amount of reverb being used, for the Model SX-9000 actually has a built-in reverberation unit, mechanical springs and all. Below the dial scale are a series of colored lights which denote main selector switch settings as well as reception of a stereo FM signal. In settings other than radio, the dial scale area goes dark and only the appropriate signal source light remains lit in the dial scale area.

The secondary controls (hidden behind the "trap door") include a power on-off pushbutton (this one accessible even with the door closed), *two* stereo headphone jacks, bass and treble controls, a reverberation control (OFF in its most counter-clockwise position), push buttons for LOW and HIGH FILTERS, MUTING and LOUDNESS, a pair of tape monitor in and out jacks (designed to accept a single ring-tip-sleeve plug), the balance control, a mode switch (with positions for STEREO, REVERSE, LEFT-ONLY to both speakers, RIGHT-ONLY to both speakers and L + R), a pair of microphone level controls, and a pair of microphone input jacks. With such an assortment, Pioneer was wise to cover the complex control area with the brushed gold anodized door!

The rear panel is pictured in Fig. 1. Pioneer has "out-designed" other manufacturers who have been featuring the very useful circuit "break" facilities between preamp and main amplifier sections. Instead of using a pair of heavy "jumpers" to re-couple the sections, like some others we have seen, Pioneer incorporates a simple slide switch which shorts the "preamp out" and "main in" jacks together when they are not needed for the insertion of accessory equipment. Two magnetic phono sets of input jacks as well as the usual AUX 1 and AUX 2 and tape monitor jacks and a DIN connector (for imported tape recorders which use this type of connector) are located in the lower left section of the rear panel. Speaker connections are made by means of polarized two-prong plugs, six of which are supplied in a separate accessory package. The plugs are equipped with screw terminals so that speaker cables can be permanently connected to them, correctly phased. Then, should it become necessary to disconnect speakers at any time (for moving equipment, etc.), the plugs are merely removed from the corresponding speaker sockets. Upon re-connection, correct phasing is assured. Although provision is made for using *three* pairs of speakers, switching is so arranged that only two out of three pairs may be heard at any time. This is done to prevent "loading" the output circuits with an impedance of less than 4-ohms. A center-channel output (requiring a third amplifier), two speaker-line fuses, a built-in AM ferrite antenna, connection terminals for an FM and an outdoor AM antenna, a pair of convenience a.c. outlets (one switched, one unswitched) and a main fuse and line voltage selector complete the rear panel layout. The line voltage-selector and fuse combination is useful even in this country for, in addition to making available 240 volt operation (for overseas use), there are settings for 110, 117 and 130 volt operation. Thus, if you are plagued with low or high line voltage, it is possible to choose the appropriate setting of the voltage selector and realize full power-output capability of the Pioneer SX-9000. Accidental misuse of this feature is prevented by the fact that it is necessary to completely remove the main line fuse and extract a plug before the voltage setting can be changed.

An internal view of the SX-9000 can be seen in the photo of Fig. 2. The sealed reverberation-spring unit is clearly visible at the right, as are the front ends, AM, FM, and MPX modular circuit boards. Nine additional circuit modules are located below the chassis surface. Four integrated circuits are used in the FM-i.f. module while a fifth, 14-pin dual in-line IC performs the function of stereo FM demodulation. The FM front end features an FET r.f. amplifier. In addition, the receiver contains 53 bipolar transistors and 22 diodes. Output transistors are conventional TO-3 types, mounted on adequate heat sinks and enclosed by a well ventilated perforated metal "cage," seen at the rear of the photo in Fig. 2. While the two separate variable capacitors (for AM and FM tuning) are exposed when the walnut case is removed (and hence subject to dust collection), the lack of a metal cover in these areas did not prevent the set from meeting FCC radiation limits, as evidenced by a notice on the rear panel certifying compliance in this regard.

Fig. 1—Rear panel view, Pioneer SX-9000 receiver.

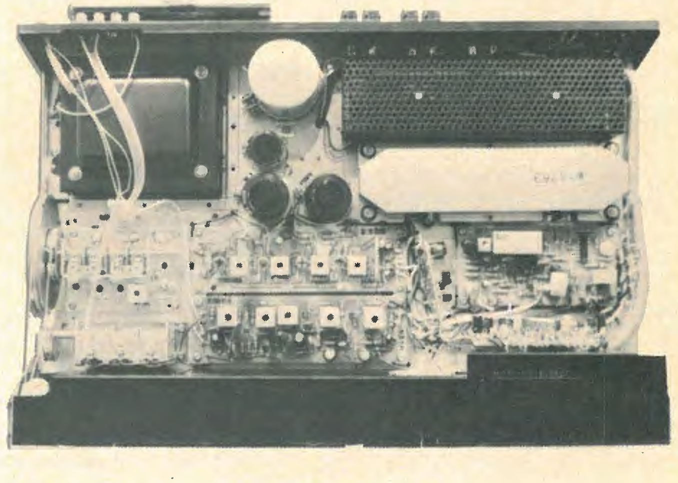


Fig. 2—Top view, Pioneer SX-9000.

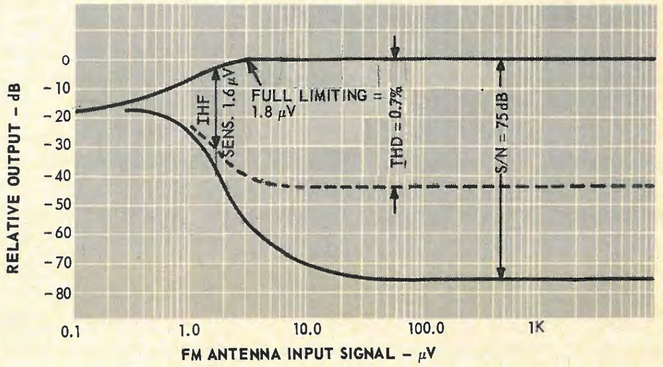


Fig. 3—FM performance characteristics.

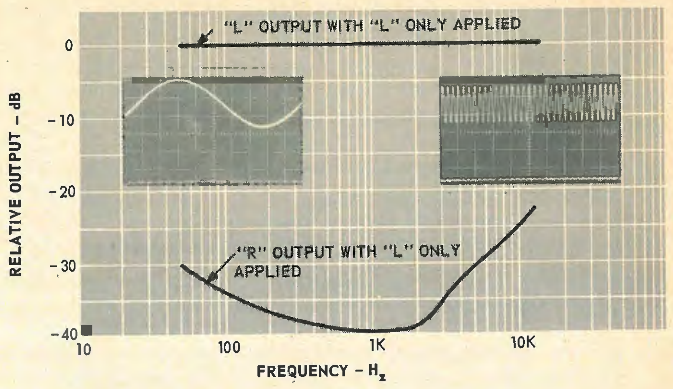


Fig. 4—Stereo FM separation characteristics.

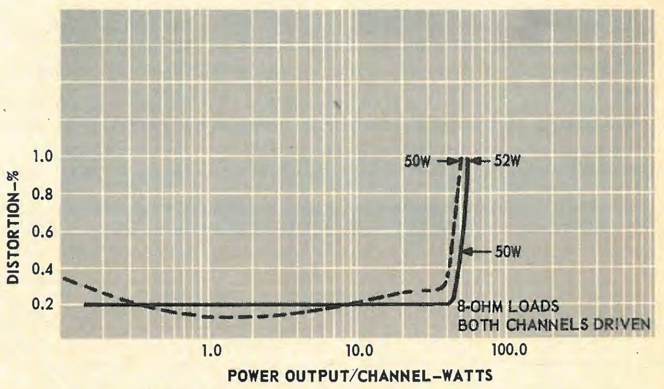


Fig. 5—Distortion characteristics.

Performance Measurements

The Pioneer SX-9000 is one of the most sensitive receivers we have ever measured, meeting its 1.6 μV claim for IHF sensitivity exactly. What's more, this figure is consistent from one end of the FM band to the other, which denotes extreme care in alignment and good design. This and other FM performance characteristics are shown in Fig. 3. Ultimate signal-to-noise ratio was measured as 75 dB, against a claim of only "better than 65 dB." Full limiting occurred at just under 2 μV while monophonic THD measured 0.6%. In stereo, the THD was 0.8% for 100% modulation. Selectivity measured 42 dB (a bit better than the 40 dB claimed) and, while this figure is not among the best we have seen, it seemed adequate in all of our listening tests in this "FM crowded" area. Pioneer has chosen to stay with conventional interstage transformers, as opposed to some of the newer crystal, ceramic or even multi-pole band pass filters, and this probably accounts for the rather wide bandwidth (and moderate figure of selectivity) observed.

Good stereo FM separation (shown in Fig. 4) was noted over the entire audio band, with best figures of 40 dB obtained at mid-band and a bit better than 30 dB at 100 Hz and 25 dB at 10 kHz. These readings compare favorably with other top-quality stereo FM circuits we have tested. Stereo light indication was positive and not erratic in the presence of inter-station noise. We did note, however, that separation was slightly affected by changing the amplitude of the pilot signal, with best separation occurring when pilot signal amplitude was 8% (FCC rules permit variation of this amplitude from 8% to 10%).

The amplifier section of the receiver does just about what is claimed for it–and that is quite a bit. With both channels driven into 8-ohm loads, a THD of 0.5% is reached at 50 watts per channel (see Fig. 5). At all power levels below 40 watts per channel, THD measured less than 0.2% while IM distortion was well below 0.3% for power levels below 40 watts, reaching 1% at 50 watts (rated output). Power bandwidth, shown in Fig. 6, extends from 19 Hz to 24 kHz, a bit less than claimed. In analyzing audio performance of audio amplifiers, we have had many requests from readers to include curves of distortion (THD) versus frequency for various power levels. Figure 7 shows these relationships for power levels of 1 watt, 25 watts and 50 watts. The 1 watt (nominal listening level) and 25 watt (half of full rated power) curves are virtually identical except at the extreme ends of the audio band. As can be seen, 50 watts is attainable at frequencies ranging from about 50 Hz to about 8 kHz at the nominal rated distortion of 0.5%.

The curves of Fig. 8 depict the composite frequency responses obtained with the various fixed settings of the "tone color" switch described earlier. These fixed settings actually involve two predetermined low-end curves and three pre-set high-end response curves. As can be seen from the tone control range curves of Fig. 9, the same response curves could easily be obtained by specific settings of the individual bass and treble controls. The "tone color" switch simply is a more convenient way to re-establish the settings shown in Fig. 8 by the simple rotation of a switch. Figure 9 also details the low-filter and high-filter response characteristics. The high filter follows the normal tone control (treble) cut position quite closely, at a slope of 6 dB per octave, and is therefore a bit of a redundancy. The low-filter, on the other hand, as a more suitable crossover point for rumble reduction and is therefore more useful, despite its modest slope of 6 dB per octave. Loudness-contour action (with volume control set at -30 dB from maximum setting) is also shown in Fig. 9 and it should be noted that both bass compensation and, to a somewhat lesser degree, treble emphasis are "designed in" to this loudness circuit. While we feel that treble emphasis in a loudness compensation circuit is not called for (according to our interpretation of the Fletcher-Munson curves), there are probably an equal number of people who feel that it is required and this remains a matter of taste. The availability of a dual concentric volume control (source volume and master volume) makes the loudness feature more useful than is generally the case with master-volume-only products since, by various combination settings of the two controls, it is possible to arrange for just the desired amount of loudness compensation for *any* program source played at lower-than-normal listening levels.

Listening Tests

In using the Pioneer SX-9000 for phonograph record listening, we were at once impressed with the excellent signal-to-hum-and-noise level of the preamplifier circuits. While Pioneer claims a figure of -80 dB (incredible) in this service, we suspect that they may be referring this figure to an input level of around 10 mV. If this is so, then our measurement of -70 dB referred to their own sensitivity of 2.5 mV is better (and *more* incredible) than their claims. This kind of S/N in a magnetic phono preamplifier is seldom realized even in the very best (and most expensive) separate preamplifier-control chassis. The fact is, you can turn off all program source material (at a volume control setting that provided room-filling sound) and put your ear directly to the loudspeaker and *still* hear virtually *NO* hiss or hum. That, to us, is perhaps more important in terms of overall dynamic range capability of a product than just having lots of power output—for it is

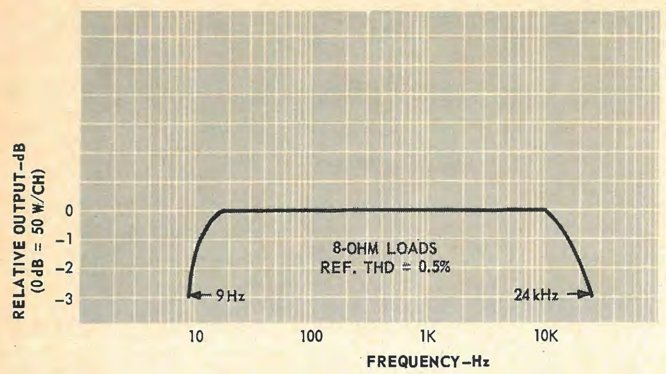


Fig. 6—Power bandwidth.

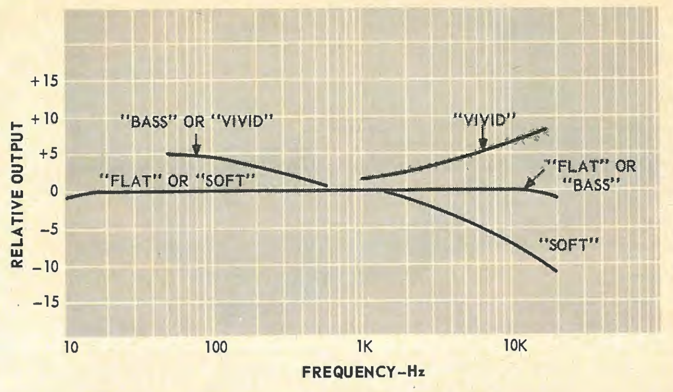


Fig. 8—Response in fixed "tone setting" positions.

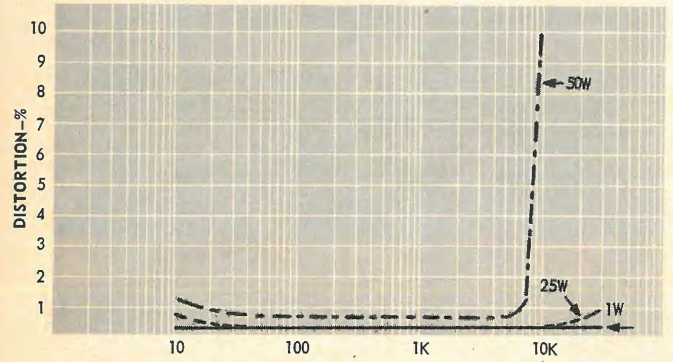


Fig. 7—Distortion vs. frequency at various power levels.

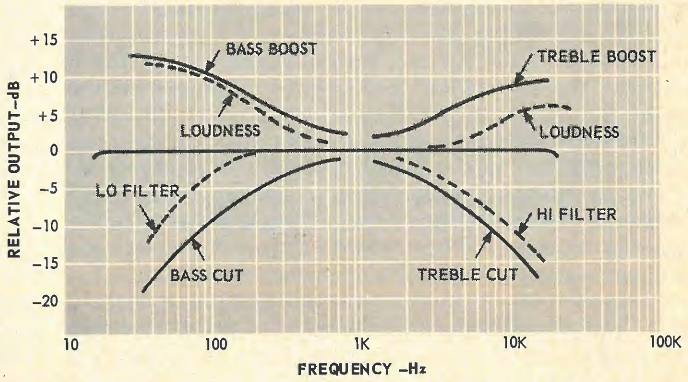


Fig. 9—Frequency response, tone, loudness, and filter characteristics.

the *low* end of the dynamic range scale that is often found wanting in electronic equipment of this type. At the power levels we tried listening to, sound was tight and clean, with no evidence of breakup at any point. As usual, we used low efficiency and medium efficiency speakers in our tests, often feeding sound to both sets simultaneously, as might be the case in a typical home installation.

As might be expected from the measurements made earlier, FM performance was very good, with 53 listenable station logged using our medium gain, directional outdoor antenna in a fixed position. Of these, 24 were broadcasting in stereo that was also deemed listenable in terms of background noise or quieting characteristics. There was no evidence of cross-modulation or alternate channel interference in our situation. We tried logging stations with the muting control activated and only lost three of the 53 previously received. Since muting had been measured as having a threshhold of between 3 and 4 μV, this means that the three stations lost must have been previously received at signal strengths of under 4 μV and yet they were quite listenable!

The microphone inputs, capable of being mixed with any other signal source, are a nice feature for anyone serious about doing recording work and either input can be used as part of a stereo mic set-up or as a monophonic mix to both channels thanks to the versatility of the mic level-switch controls. As for the reverberation feature, we are not too keen on this item in general and found that in the case of the Pioneer SX-9000 use of the reverb rotary control past about "9 o'clock" resulted in such unnaturalness of reproduced sound that we turned it off altogether. Obviously, there are many who like this kind of electro-mechanical enhancement, though we have found that the reverberant sound produced by suspended coiled springs contains a "metallic" coloration imparted by the springs themselves and their various resonances and sub-resonances. We suspect, however, that the addition of *this* feature did not add significantly to the price of the receiver and since there are so many good points and features incorporated within this receiver that we would certainly not criticize the addition of this feature, the use of which is after all a matter of individual taste and is of course defeatable by means of a simple rotary control. Besides, the moire-like wave-form pattern that appears in the "reverberation indicator" window as reverberation is increased and decreased is fun to watch! (So are the illuminated dash-lined response curves that show up in the "tone color indicator" window as different settings of the "tone color" switch are selected.)

In summing up, we would conclude that the SX-9000 receiver certainly justifies its "just under $500" price tag. It is particularly geared to those users who prefer a maximum number of control features along with basic, honest performance. Yet, for all its controls, the SX-9000 will look "clean" and elegant in your living room. *Leonard Feldman*

The Pioneer reverb unit was reviewed in the August, 1970 issue by Mr. McProud, who was enthusiastic about it.

Panasonic Direct-Drive Turntable, Model SP-10

MANUFACTURER'S SPECIFICATIONS

Turntable: Aluminum; die-cast; 12 in. diameter; weight, 6 lbs. **Motor:** 20-pole, 60-slot, ultra-low speed electronic commutator motor, 15 volts, d.c., 85 ma. **Power supply:** A.c., 120 V, 50/60-Hz. **Speeds:** 33⅓ and 45 rpm. **Speed-change method:** Electrical change. **Fine speed control:** Individual adjustment by variable resistor; ±2% adjustment range. **Wow and Flutter:** Less than .03% WRMS. **Rumble:** Better than -60 dB. **Build-up time:** Within ½ rotation at 33⅓ rpm. **Dimensions:** 14" wide, 14" deep, 4" high. **Weight:** 20 lbs. **Suggested Minimum Price:** $299.95, less base, arm, and cover; optional wood base, $34.95; cover, $14.95.

The turntable proper—which is the subject of this profile—is available in the 14-in. square configuration for installation in the purchaser's cabinet or housing, but the one sent to us for testing was mounted already on an attractive walnut-finished base measuring 21⅜ in. long by 16 in. deep by 6¾ in. high over the SME-3009 Series II arm which was also furnished with the turntable. Already installed in the larger base was the turntable, and the cutout was already made for the mounting for the SME arm, and, in fact, the mounting was in place.

This whole structure was suspended on a sub-base just slightly smaller than the top section by means of four large spring mounts, each of which was damped with a sleeve of viscous-coated plastic. These mounts were attached to the base, and the sub-base was then put in place and attached by machine screws.

Thus the turntable chassis, which was firmly attached to the main base, and the main base itself, were very flexibly mounted to the sub base, which rested on the table with its own rubber feet. Truly a well assembled vibration-isolating combination.

The underside of the turntable chassis is a model of neatness. All one sees is the round black motor housing, three rectangular black boxes, and one trapezoidal black box. Several neatly placed cables interconnect these separate black boxes. We succeeded in getting the cover off the motor and the power supply boxes. The trapezoidal box contains some of the electronics as well as the stroboscope-viewing mirror system. The electronics were the two vernier controls for speed adjustment, while the mirrors permit viewing the stroboscope (on the underside of the platter) from the top. All we could see in the power supply box were the transformer case, a large transistor—undoubtedly the "pass" element of the regulated power supply, the ends of a few capacitors, a resistor, a fuse, and a few wiring connections.

Under the motor cover we found the bottom of a printed-circuit board with a hundred or so soldered pads. This cover we replaced quickly. The smallest black box contains three medium-power transistors in the switching-circuit assembly, and some other bits and pieces.

On the top side, with the platter removed, we see the solid rotor frame of the motor which carries the magnet rotor and the position detecting rotor—a toothed wheel, in effect. In addition, the opening for the stroboscope-viewing mirror system and its line-frequency mask which has two positions for the two line frequencies—50 or 60 Hz—and which allows the user to view only one set of stroboscope patterns on the underside of the platter. At the lower left corner of the motor chassis are a rectangular power switch "button" which actuates a push-push switch to turn on the a.c. supply and a small round sliding knob which selects speeds—33⅓ or 45 rpm. At the right front corner is the window through which the stroboscope is viewed, and in front of it are two thumb-wheels for fine adjustment of speeds—one for each. The six-pound platter fits onto the rotor frame, with two red triangles indicating the point at which the platter should be placed for minimum wow and flutter. The instructions imply that this positioning is not particularly important unless extremely critical applications demand the absolute minimum of which this unit is capable. We found, however, that the flutter was noticeably greater with the marks displaced by 180 deg., so all performance measurements were made with the two points aligned. Note that the platter has two large holes to facilitate lifting—a feature we wish *all* removable platters offered, for some are difficult to remove. The center opening is normally covered with an aluminum disc which may be removed for lubrication. The heavy rubber mat covers the opening anyway and provides a ribbed surface for the records.

The underside of the platter carries the two stroboscope pairs, one for each of the two possible line frequencies, and with one ring for 33⅓ and one for 45 at each of the frequencies. The platter also carries the usual drilled holes showing that it had been dynamically balanced.

Motor Operation

Although no complete schematic is furnished, a simplified one is, and by comparison with the schematic of the motor drive system in the RS-275US cassette deck, we are able to offer a brief description of the system. First, there is the oscillator circuitry which generates a signal of approximately 50 kHz which is fed to three coils of the position-detecting section. As the rotor turns, the coupling between the primary (oscillator-fed) coils and the three secondary coils changes. The signal coupled into the secondary coils is rectified and the resulting position signal is fed to three transistors which switch currents through the three driving armature coils (in the stator) to provide the power to rotate the magnet rotor on which the platter rests. Three speed-generation coils are wound bi-filarly on the drive coils and thus have signals generated in them from the drive coils. These speed-generation coils feed three diodes whose resulting d.c. voltage is compared with a regulated voltage from the power supply, and the differential is fed back to the switching transistors to stabilize the speed to the desired value. Varying the d.c. comparator voltage changes the speed slightly for the vernier controls, or from 33⅓ to 45 or vice versa by action of the speed-change switch. In all, it is a very complicated motor, but it offers the advantage of requiring no high-speed rotor and the necessary speed-reducing mechanism to provide the relatively slow speeds of the platter, and it is obvious that the elimination of rotating elements of, say, 1800 (for the motor) and about 240 for the idler is likely to reduce the possibility of introducing flutter at these frequencies. Furthermore, the elimination of a.c. components of line frequency from the vicinity of the cartridge reduces the possibility of hum pickup. Obviously, the reduction of all rotating elements to the single speed of the platter must be an advantage.

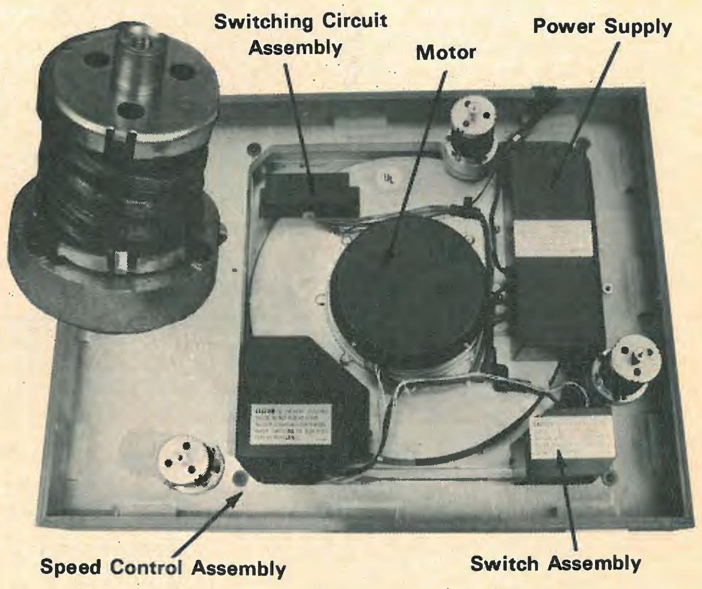


Fig. 1—Underside of the turntable, showing the "black boxes" and the massive isolation mounts consisting of viscous-damped springs. Inset shows one of the isolation mounts.

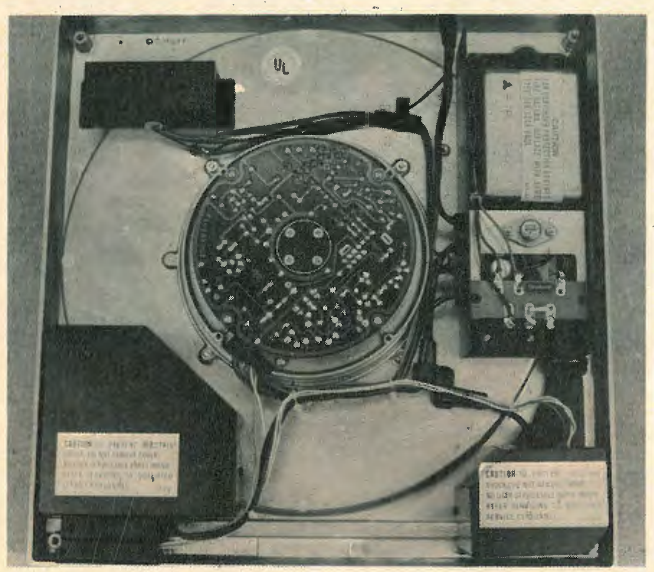


Fig. 2—Underside of the turntable with covers removed from power supply section and the motor. Note caution notices on the other boxes against removing the covers.

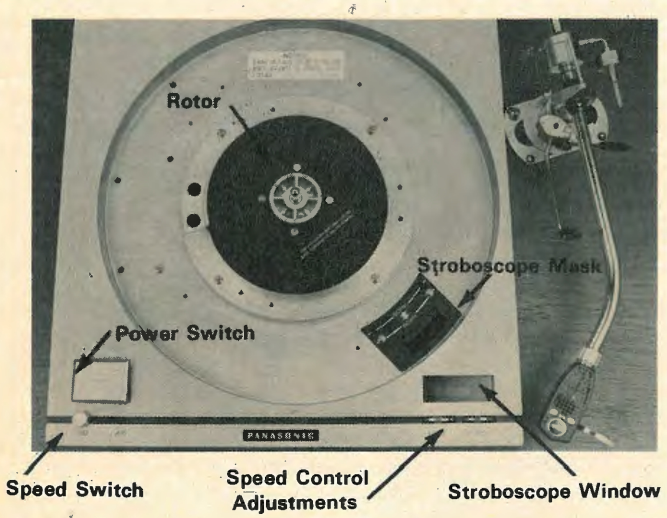


Fig. 3—Turntable with platter removed. Large round section is the magnet rotor—the only moving part of the turntable (when the platter is removed.)

The turntable is provided with a fixed clamp which holds the motor rotor in place—that is, it cannot be removed. In addition, there are three clamps which are used for shipping and which actually hold the rotor stationary. These must be removed, along with a number of other securing screws, all of which are painted blue, and these secure other portions of the mechanism for shipping purposes. Furthermore, there are several more screws which are painted red, and which according to instructions, should not be removed. And in case you select the unit mounted in the cabinet with provision for the SME arm, do not count on being able to play the unit for at least an hour after you get it home—the mounting of the arm is in itself a time-consuming operation. But it is likely to be worth it. Among the many advantages of this type of turntable are the elimination of any intermediate mechanisms between the motor and the platter. Turntable rotation can be stopped at any time without causing any damage—only a slight increase in motor current, which normally results in a power consumption of 0.1 watts. Total power consumption is about 6 watts, which is well under that required by the usual type of turntable.

The d.c. drive motor is not affected by fluctuations in power frequency, although since the neon lamp which illuminates the stroboscope is lighted by the power line directly, any variation in the line frequency will cause an *apparent* speed variation according to the stroboscope. There is *no* speed variation of the platter regardless of the line frequency over a reasonable range, nor of the line voltage over the range from 85 to 135 volts. In other words, as long as the motor is running, the speed will be constant.

Performance

We measured all the usual parameters of turntable performance. Wow, separately measured from flutter, was a low .04 per cent. Flutter measured at .06 per cent, and with the platter displaced 180 deg. from the line-up marks, it was 0.11 per cent. Rumble was just about as low as we could measure—using the NAB method, it was 57 dB below the 1000-Hz 3.54 cm/sec standard for stereo records, which corresponds to the NAB specified velocity of 1.4 cm/sec at 100 Hz to be used as reference for rumble measurements. Note that this 57 dB is the unweighted value. Weighted, the measurement was beyond our capability.

The turntable reached normal speed within ¾ of a revolution when started from a standstill. Holding the platter with power on and then releasing it gave a somewhat quicker response, estimated at about ½ a revolution, and with no fluttering or hunting after reaching normal speed.

Although the figures for wow and flutter are extremely good, it is quite possible that a few hours run-in time would reduce them still further. But, of course, we are talking about very miniscule quantities—we have long lived with the average type of turntable which rarely gets below about .08 in flutter or wow. The Panasonic must therefore be classed very close to the top in turntables—one any of us would be glad to put into our systems. One thing is sure—few of us could possibly have a better one.

C. G. McProud.

Q8 vs SQ

A Platter For Four Seasons

Edward Tatnall Canby

The Big Announcement. From left, John T. McClure, director, Columbia Masterworks; Benjamin B. Bauer, vice president, CBS Laboratories; Clive J. Davis, president, Columbia Records, and Stan Kavan, vice president, planning, CBS. Photo courtesy Columbia Records

As ANYONE around here knows, I am an old disc man, a record reviewer forever, a collector since the days of the acoustic 78. I love the disc like my left hand (I'm a lefty). I'd hate to see it go. This year I have been distressed by the possibility that we might, at least, have to leave it behind. That is, if we moved on into four-channel stereo without it. A bad thought. I didn't like the idea at all. But would we? That depends mainly on the coding/decoding idea, as per our January issue.

Tape is fine—no hassle. But remember that for every tape offering there are a thousand via disc. Who needs them all? I will tell you straight. The disc is our only present source for real diversity and variety in listening. It could represent the last stand, in listening terms, for the non-robot individual, the man who does his own choosing and learns excitement in the process. We have a lot to lose in the disc.

And so last spring, as a new decoding system was trumpeted every other week and excitement really began to rise, it became clear to me that a four-channel showdown was near, and with it the disc's fate. We would have a coded four-channel disc, or no disc at all. The disc had to keep up. But still no disc! I began to jump every time the phone rang.

Then came that telegram. It was from RCA—and Fisher too. Big names. A fancy press "do" at the Four Seasons restaurant in New York. To be sure, it was to be about "discrete" four-channel developments. That would mean tape. But who could say for sure? You *could* call a disc "discrete" if you really wanted to. Maybe, my emotions told me, it was a disc. Maybe this was the big moment. Anyhow, I wasn't going to miss the fun, nor was anybody else. The place was jammed.

Just to show you how my mind was working, let me describe what happened. I walked into the Four Seasons in mid afternoon, a bit early and via a wrong door. They have lots of them. I was in the main restaurant, which was all set up for a spread. On the tables, great expanses of snowy napery. Nobody at them; drinks were being served in an adjoining room. At the door were the RCA execs, and there, sure enough, was the legendary Avery Fisher himself, beaming like the traditional cat with the canary inside. But my quick eye was caught by something at those waiting tables. At every place was something that looked like a dinner plate, or maybe a press kit, *in the shape of a phonograph record.* Rows and rows of them.

So that's the game! I promise you my heart began to pound. Why a disc? Obviously, it was a press gadget for the show just now beginning. And just what RCA might produce, too. (RCA is famed for its joyous publicity kits.) Produce, that is, if they were launching a new disc. My mind was already racing ahead.

So this is it! The die is cast. A big company did take the plunge! It could only be a four-channel disc. I began to feel that here was a historic moment. 1948: the LP record. 1958: the stereo disc. 1971, a bit delayed, the disc in four channels. It was with considerable awe that I moved on in to hear the ceremony begin. The big feed would be afterwards, of course.

Ah well. You can guess. An hour later, filled with good liquor and much the soberer for it, I came back out the same way and took a hard look at those "records." They were still there. Untouched. Our demo had been in the room next door. They were merely the restaurant's regular serving plates, black ceramic with a light center.

As a matter of fact, RCA and Fisher were perfectly straightforward, and what they had to say was important for both companies. They didn't mention disc. The party was to celebrate a tape tie-in for the production of Fisher four-channel home equipment embodying the RCA Q8 (formerly Quad 8) cartridge, which plays four discrete tracks at a time. When someone asked Avery Fisher whether the Q8 system was suited to the kind of hi fi his products have always produced (mainly via discs and disc broadcasts), he replied that his equipment could speak any sonic language. That is surely the truth and a nice riposte, if I may say so. But it left the disc high in the air and me too.

As if to prove the point, I found a press release waiting for me at home, to the effect that Electro-Voice and Peter Scheiber, through his Audiodata Company, had agreed in principle "to cooperate in the area of four-channel matrixing systems for broadcasting, recording and home entertainment equipment," and they would pool their efforts to "seek encoding standards in the industry based on the E-V system" of four-channel decoding. Just how the present E-V system would combine with the Scheiber system was not said, but two implications were clear. (1) Two of the main contenders for the crucial standard code/decode system to come had combined forces and (2) therefore the showdown was getting closer. With it would go the fate of the disc, which will depend on coding and decoding for four channels.

Meanwhile, that secret wind was blowing again. Another and already widely-whispered behind-the-scenes coding system, developed by a major record company specifically for four-channel discs (and for its own disc product), was very much alive, though still officially non-existent. The details had long since been divulged inside the record industry. But the system was merely proposed. Nobody had said it would in fact be promoted. It was just *there*. But very well developed.

Now as noted earlier, a big record company has good reason to be doubtful about a major changeover to four-channel discs. On its operating scale, the investment is huge and the stakes uncomfortably high. The status quo, with ordinary two-channel stereo, can still look very good. And so while the battle of the rival decoders grew more and more frenetic outside, the one potential system that might precipitate the four-channel disc in earnest was still out of the running. The company was not convinced.

Sniffing this kind of a wind even at a distance, you can understand, was enough to give me the jitters. And you may guess that all the other record companies were acutely concerned, too, both large and small. Almost a matter of life and death. The wave of interest in the basic idea of four channels of sound seemed to be growing. If four-channel sound really caught on, and there were no four-channel discs to sell, things would be bad. On the other hand, suppose a four-channel disc was launched—and failed. What then? Agonizing. But, until somebody big made a move, not much could be done. And here was that somebody big, behind the scenes, just waiting.

Curious that in such a situation there are few technological secrets. Nowadays, the basic information tends to be openly traded, behind the scenes, between potential rivals. It isn't that RCA doesn't know what Columbia has, or vice versa. They hand each other the goods, so to speak, on a platter. What each company doesn't know about the others is what each plans to do. That's the real secret. And when. Even more important. It's like a military battle where each commander knows precisely what the other side has deployed and where—and there they sit, trying to outguess each other. A battle of wits and, if you ask me, a much deadlier one than the old guessing about the other guy's secret weapons. There are really no secret weapons now. Only secret intentions.

If a big company comes out with a system, can another biggie afford to launch a rival system? The answer is yes, if the fight is worth it. It often is. In 1948 Columbia launched its LP and in 1949 RCA threw in the 45. The Battle of the Speeds. Both systems won, each company in the end adopting the other's product. It turned out there was room for both, via different areas of emphasis. In principle, I'd say this could happen again today with four-channel sound. Between "discrete" and coded systems. But definitely *not* between rival disc decoders.

I suspect that our two basically different approaches, discrete and coded four-channel, can live with each other quite nicely and prosper, each in its own best areas and according to the nature of the various media, disc and tape. There are plenty of differences. Home listening will never be like automobile listening; Transistor portables are not the same as hi fi home systems. But not even the biggest company will be able to duck the eventual standardization on a single code/decode system, for all disc usage (and probably also for broadcast, cassettes and so on, since they all play through the same home equipment). So more power to discrete four-channel! and the same, hopefully, to coded disc.

You can see that RCA and Fisher were on solid ground when they announced their Q8 collaboration in the tape cartridge area. There's room for Q8, as there was room for eight-track in standard stereo, and disc has little to do with it. Indeed, Fisher's entrance into the Q8 field might have a crucial impact on what, according to some flying rumors, hasn't been a howling success story to date. RCA had every reason to throw a big press event for the Fisher announcement. It could be the making of Q8. But disc? That's another subject. Maybe for another press conference.

As for me, it was my fault, as a disc man, that I fell for the mere sight of the Four Season's handsome black-surround dinner plates. You ought to go in and look at them some time. Some day I intend to filch a couple, if I can afford the cover charge. No—not for my ceramics collection. For my record library.

So far so good. In mid-June came the explosion. It was bound to come. A big-company four-channel disc was in fact announced, and by *two* of the big ones—Columbia and Sony! I'd merely guessed the wrong company and the wrong moment. The Columbia SQ disc (for stereo quadraphonic) and its associated code-decode equipment from Sony is a complete system and, of course, not directly compatible with any of the earlier announced code-decode systems. So the fat was in the fire and the Battle of the Codes was set for its climax.

The CBS-Sony announcement came, in of all unlikely places, Montreux, Switzerland. In these jet days, important audio announcements are put forth wherever there is a handy convention or festival with a built-in audience of technicians, officials, and press. It could be at home or on the other side of the world. Wherever it is, it's for us.

If the SQ disc is to prevail it must of course be adopted by the entire disc industry, as was the original LP and the 45/45 stereo disc. Adopted either as is, or with whatever modifications (or, shall we say, whatever latitude in the stated parameters) can be agreed upon by those who decide such things. Once again, let it be said that there is room for only one coding system. The decision as to SQ should come along pretty fast I'd guess, even though we won't see the actual discs in the stores for a few months or more. If the handwriting is on the wall, it will be read, and quickly.

The SQ is naturally intended as the standard for discs. To the best of my judgment it is easily up to the best of the other coding systems so far launched and probably is superior, with some unique features that could put it well out in front on purely technical grounds, quite aside from its sheer corporate weight. It is neither oversimplified, nor too complex (and therefore tending to be both expensive and unreliable). Its basic home decoders can probably be mass produced out of ICs and deposited film at a much lower price than has so far been set for any decoder, though it is true that other systems might use similar techniques on a mass basis for a similar price. But most important, SQ, from all I have heard of it, will come closest to a *literal* re-creation of four discrete ordinal channels of information. For disc, this is vital.

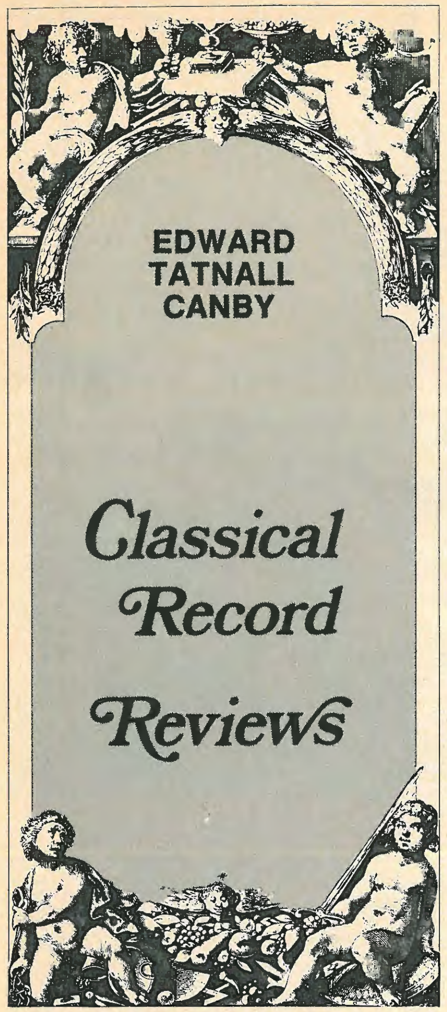
However much we enjoy the present psychedelic effects of "decoding" standard stereo material into four surround audio channels—and that is plenty—the true four-channel disc requires the matrix which comes nearest to literal transmission, channel by channel, from four into two and back into four. On this sober basis the SQ may well win out. Psychedelia is fun and it's legit. But it isn't enough.

Say no more. Matrixing of this sort is extremely subtle and demanding and requires feats of engineering and psychological know-how, involving everything from simple arithmetic to the physiology of musical hearing. I've been briefed until my ears run out on the workings of most of the current code/decode systems. But I have sense enough not to expound on the details. You'll read all about them soon enough, if you haven't already. I can only suggest that the mind, assisted by the ear, can vault ahead of such complexities to make useful judgments. That's what I'm around for, hopefully.

One SQ detail I must describe, because it has fascinated my mechanical sense. Ingenious! It's the SQ groove modulation, in four modes, compatible in playback both for standard stereo and for mono. Two of these modulations are already familiar, the standard 45/45 modes, linear motions of the stylus at the diagonals, for a pair of signals 180 degrees out of phase. The other two modulations, the new ones, are circular. Or rather, since the groove moves under the stylus, they are spiral. Two oppositely phased modulations here too. One is circular clockwise. The other is counterclockwise. As we used to say, put that in your pipe and smoke it.

Ben Bauer of CBS speaks of this as the "double helix" of the record groove, two intertwined spirals in terms of stylus excursion, remarkably like those spiral strands of DNA which are the coded bearers of all life's genetic information. Maybe not an exact analogy but pretty, even so. If you record two sine waves identical but opposite in phase via these two circular motions, they cancel out, just as the same two signals cancel each other via 45/45 modulation. Get it?

Well . . . I *think* I get it. Whatever happens to the SQ disc in the market place, the implications of this grooving system and the decoding circuits that go along with it will bounce around in our minds for a long time. It sort of hits you. Whether SQ works is something else again, but it had better. For the disc's sake. Without *something* like this, it hasn't a chance of a future.



Lauritz Melchior/Wagner. Philadelphia Orchestra, Victor Symphony Orchestra. RCA Victrola VIC 1500 mono ($2.98).

Wow! The steely-voiced Melchior, king of the Wagnerian tenors in this century, sang "Tristan" 223 times (the opera lasts five hours), "Walküre" 181, and so on down to 80 "Parsifals." Nobody was ever like Melchior and you ought to hear him, though (as I can remember) it's just as well you don't have to see him. His heroes were fat and plushy, double-chinned and hefty-hipped. But the voice did the characterizing with astonishing ease.

Most of these memorable old electrical recordings of the last 1930s are from a series with the Philadelphia, under the indefatigible Ormandy (still in Philadelphia), who makes a splendid accompanist. Two items were never released, the Wesendonk songs, closely related to "Tristan." The other items are with the less satisfactory Victor Symphony (perhaps Philadelphia musicians, who knows now?) under Edwin McArthur, who was a very wooden conducting accompanist for a number of Victor recordings of Wagner around 1940, including the one with the Melchior-Flagstad duets.

Excerpts range through "Die Walküre," "Siegfried," "Die Meistersinger," "Lohengrin," "Tannhäuser," and "Flying Dutchman"—quite a selection, ten famous numbers in all, plus the Wesendonk songs.

Performances: A- Sound: C+

Tchaikovsky: Eugen Onegin. Bolshoi Opera Production, recorded in Paris (Rostropovich). Melodiya/Angel SRCL 4115 (3 discs) stereo ($17.94).

It is often a pleasure to get into the unknown (to us) works of a big composer, especially when the exposition is virtually guaranteed to be competent and authentic, as here. Tchaikovsky operas are much rarer than Tchaikovsky piano concerti; *ergo* let's listen to a Tchaikovsky opera. Unless you *really* want to hear the Tchaikovsky Piano Concerto No. 1 a few dozen more times.

Two ways to listen to recorded opera, as we all know. Both work nicely, on occasion. One, you sit down with the complete libretto, read the pages of accompanying annotation for the complete background, then follow the story and the text, word by word, in the original and in the translation. A marvelous experience in many ways but it takes energy and time.

If you are for the moment lacking in same, then—just listen. Perforce, I tried that here. Too many stacks of other records, staring me balefully in the face. It worked *very* nicely. I enjoyed myself, just listening, without the ghost of an idea as to who was saying what at that moment. (Isn't that the way a lot of "live" opera-house listening is done?)

Two conclusions that may help you. (1) Russians do have superb voices! You can count on it. Big wobbles, enormous weight in all departments, superb musicianship too; and this sort of music thrives on the big sounds; this is surely a "right" performance. (2) To my mild surprise, the opera is far from the big, noisy, sob-story Tchaikovsky in its impact. Instead, it is a gentle, almost pure-toned work for the most part, somewhat conservative, as opera technique went for that time, much less robust than the rugged Mussorgsky opera sound but in a style not so far removed—the inevitable big Russian choral scenes and that telltale folk/church idiom which always appears in such circumstances from Mussorgsky right through to Shostakovich.

You take it from there. I recommend the album very highly, if you're interested.

Performance: A- Sound: B+

Brahms: Piano Concerto No. 2 in B Flat. a) Richter; Orch. de Paris, Maazel. Angel S36728 stereo ($5.98). b) Backhaus; Vienna Philharmonic Orch., Schuricht. Everest 3279 sim. stereo ($4.98).

The new and the old, an interesting comparison. A good part of a generation separates these two, the first a new 1970 release from British E.M.I. via the American Angel label, the second a reissue by Everest out of the notable pre-stereo London ffrr series of recordings that determined not only the fi but the recording style of a generation to come (London LL 628). At the two pianos, two stalwarts of big-time Romantic music, the late Wilhelm Backhaus, veteran of 60 years of recording, and the younger Russian powerhouse, Sviatoslav Richter. To spice the difference, we have for one orchestra a dignified *echt*-Vienna, for a proper Brahms background; the other a brand-new virtuoso French outfit, only a few years old.

Two big piano performances, as might be expected, but very different. I heard Richter first—an impressively crisp, dynamic performance, sharply etched and full of bounce without in any way inhibiting the grand Romantic expression. Marvelous rhythmic verve, top-notch phrasing and balance, the music both sprightly and massive. Richter uses a big, bright-toned instrument and is recorded sharply close at hand yet without unpleasant percussives. I found the French orchestra, in contrast, somewhat unrehearsed and non-dynamic, with—as so often in France—an indifferent ensemble and a lot of notes slightly out of tune. The French climaxes, again typically, were more hysterically loud than movingly impressive; for French musicians never do seem to be able to fathom those grand Germanic outpourings, whether via Brahms or Beethoven. The prominent "French" horn (as at the very opening of the Concerto) is one of those slightly braying French instruments, not, alas, the true horn which Brahms would have used; it tries hard to suppress the unmentionable French vibrato, so out of style for Brahms, but does not quite succeed.

Backhaus, still in his late prime, plays a very different Brahms, on a more massive, mellow piano, recorded further away. Both his playing and the recording are cast in another tradition, that of the grand line, driving forward with passion, merging, blurring, blending the ornamental details into the larger whole. It is authentic, but I couldn't help feeling I like the Richter approach better. It brings more to the ear! Backhaus seems to be playing with the pedal down. Richter achieves an almost harpsichord finesse in grand-piano terms.

All this, of course, is capped by the silent pair of conductors whose influence over the sounding orchestras is supreme and on the pianists merely cryptic. Schuricht is the man of the lean, forward drive, the no-nonsense strictly-paced horn opening. Maazel, of the Romantic-minded younger generation, plays the opening for leisurely effect with his French orchestra, much slower, with dramatic pauses, exclamation points attached.

Though Backhaus was the great exponent of the German tradition, I think Richter is more for our ears. And I find myself grateful for the clarity and balance of his new recording. We have moved far, even from ffrr.

Alas, I have misplaced my original ffrr LP release, but I remember the earlier Londons as slightly scratchy, the violins very close and wiry. Everest's reissue is definitely that way and somewhat distorted to boot. Thanks to the stereo simulation?

Performances: B+, B *Sound:* A-, C+

Ravel, Alicia De Larrocha, piano. **Columbia M 30115,** stereo, $5.98.

The usual "acclaimed" superlatives accompany pianist De Larrocha here but I will not go along with them. She is a fine piano technician, with a big style and lots of personality, but I do not like her Ravel.

For one thing, it never does to turn over pseudo-Spanish music *(Alborado del gracioso)* to a genuine Spaniard (and the same with Italian—as in Mozart's operas—or maybe Japanese, as in "Butterfly" and "Mikado"!). Just doesn't work out. Ravel is basically French even in his "Spanish" works.

Much more important, and for the non-Spanish Ravel too, Larrocha plays with a peculiarly Romantic fuzziness, a large, sprawling sound, committing one sin I cannot understand, blurring those razor-edge Ravel harmonies together, slighting them, as though she did not hear their exquisite colors. I

don't think she does. Ravel was a classicist, economical, under-stating, whose style is all polished, concentrated musical jewelry, for all its outward bigness. She misses this, cold. You can't play Ravel in a big, blowsy fashion!

The program notes too. As if Ravel *really* were "detached" from his music! If he said so, it was for effect. Under the velvety exterior are volcanos of passion and every real Ravel player knows it. For all her splendid piano styling, Larrocha seems to me far off the beam.

Performance: B- Sound: B

Tchaikovsky: The Maid of Orleans—Highlights. Soloists, Chorus, Orch. Moscow Radio, Rozhdestvensky. **Melodiya/Angel SR 40156,** stereo, $5.98.

Fact into legend—and how wonderfully do our legends change! Here's a seldom-heard Tchaikovsky opera, straight out of the early "Romeo and Juliet" period and sounding in the main as a sort of opera equivalent of the famed Concerto No. 1 for piano (*the* Tchaikovsky concerto), a big, brash, loud, wide-open piece of stage drama so wholly unlike any Joan of Arc concept *you* ever heard of that you will jump in astonishment as you listen. No shy little Maid of Orleans here! Joan is a big, strapping Brunnhilde of a mezzo-soprano with a voice like a ton of bricks only more gorgeous—after all, we must remember, Joan was a female *warrior,* and so Tchaikovsky can't be all wrong. This female powerhouse meets the big guy from Britain, name of Lionel, and lo and behold, she melts, and instead of whacking off his head she bows down from her seven-foot height and admits (at length) that she loves him. Phew! Some love scene.

It's real Russian opera, full of gorgeous big solo voices abetted by powerful chorus, about as totally non-French as you can imagine. . . . Well, not entirely; for the style, as of 1879, is closer to the French powerhouse composers than the German, come to think on't. But Joan in *Russian!* Fun and games.

A big, opulent production, top of the Russian music establishment and as smoothly polished as it is burly and powerful. The usual excellent Russian stereo, too, old-fashioned in that the voices are further up front than is now normal in the West, with the orchestra a bit on the aenemic side in the background. Not much—it gets through.

Performance: A- Recording: B

JAZZ & BLUES

Martha Sanders Gilmore

Bee Houston

Musicians: Bee Houston, guitar and vocals; Richard Brown, baritone sax; Wilbert "Jiggs" Hemsley, tenor sax; Fred Cooper, drums; William Anthony, trumpet; Willie Molette, vocals; Eddie Jones, drums; Alex Nelson, tenor sax; Terry DeRouen, guitar; Sonny Campbell, tenor sax; Jay Hodge, tenor and alto sax, and Chuck Davenport, drums.

Songs: You Think I'm Your Good Thing; Busy Bee; Be Proud to Be a Black Man; The Hustler; Break Away; Things Gonna Get Better; Never; Lovesick Man; Freddy's Bag, and Anytime.

Arhoolie 1050, $5.98.

Although I am not bowled over by the belting bombast and brawn of this collection of rhythm and blues, Bee Houston is a formidable plectrist who deserves documentation. And under the aegis of a producer with the adventurous, non-acquisitive spirit (in terms of the dollar) of one Chris Strachwitz, Houston is in good hands.

My lack of enthusiasm may lie in the genre rather than within Houston himself who is a most presentable exponent of the tough, hard-driving rhythm and blues contingent which comes out of Los Angeles.

You may know Houston from his back-up days with Big Mama Thornton and a host of other blues artists such as Little Willie John, Bobby Bland, and Brook Benton.

From a family of musicians, Bee's vocal inflections strongly reflect his Texas proving ground. His voice, an earthy composite of gravel and grit, provides a firm foundation and conveys a true feeling for a lyric. Listen to Houston in "Be Proud To Be a Black Man" and "Anytime" for some slow-moving, straight-from-the-heart blues, rife with rhythmic spoken asides by Bee. His voice comes through fuzzy, like a grizzly bear's.

Bee Houston, the composer, is evident in eight of the ten selections on this recording. The remaining two came to us from the pen of Willie Molette who sings as well in an emotionally charged voice of a considerably higher pitch than Houston's. Molette delivers "Never" and "Lovesick Man" with a distinguished intonation and vibrato.

Houston shines most brilliantly in his instrumentals of which there are three in this LP. He achieves a twangy, biting, razor-sharp sound on guitar in "Busy Bee" (which lives up to its name), "Break Away," and "Freddy's Bag." The latter is as candid a revelation of Houston's talent as any track in the set, with Houston bumping along like a locomotive underneath Wilbert Hemsley on a deep-throated, blue-toned tenor saxophone. Hemsley's phrases are long and jagged, but his lines are fluid. More of Hemsley, please! Too good to be true, "Bag" is flawed by an unnecessarily abrupt fadeout as though the engineers were trying to make it all fit on the record and didn't know any other way to stop it.

All which brings us to comment on the all too frequent use of the fadeout device throughout this LP. We'd prefer that the musicians finish their own sentences!

Houston's technique is colorfully illustrated in "Break Away," a fast-paced boogie which achieves a bumbling, rumbling sound. Shimmers and shades of Sonny Sharrock are replete in the Houston sound, the guitarist sputtering forth rapidly repeated single notes which bear semblance to a mandolin. Curiously, having never associated mandolin with rock, we might add that the latter ingredient is also imparted in Houston's style.

Produced over a two-year period from 1968-1970, this disc was recorded in no less than three recording studios. The sound reproduction on side two by United/Western Studio in Hollywood is far and away the best of the lot. Otherwise, the sound is rather muddy, with the vocals not audibly discernible over the instruments.

Bee Houston is a hard-hitting handful who should be heard under more carefully controlled conditions.

Performance: B Sound: C

(Continued from page 24)

controlling transistor, as we saw from the circuit of the Philips design, at the end of the last article. By careful selection of the source voltage, i.e. its circuit derivation, the inherent flywheel action of regulation can be used to advantage. Figure 6 gives a British Radio Corp. modification to the Philips design shown in the Jan., 1971 issue of AUDIO. Note that here we have the control voltage for the base of the first transistor derived from a potentiometer network, with a preset variable, and the upper end of this chain is taken to the collector of Tr2. The circuit has two functions: voltage stabilization and motor regulation.

With everything normal, Tr2 base bias is determined by Tr1 collector current. This is set so that the correct voltage is fed to the motor while the effective forward resistance is lower than the 470 ohms in the emitter of Tr1. The two diodes, used here as temperature compensated devices and mounted near the heat-sink of Tr2, are forward biased to the constant voltage portion of their characteristics. A drop in supply voltage affects the emitter of Tr1 via the forward biased diodes. A smaller effect is felt at the base by the potentiometer chain so there is a net increase in forward bias. The collector current of Tr1 rises, driving Tr2 on harder and reducing its effective series resistance, which offsets the voltage drop in the supply.

As a motor governor, the circuit works the other way around, offsetting the change in potential across the motor which will be caused when a varying load affects the armature current. As the motor current rises, there will be an increased voltage drop across the paralleled pair of resistors (3 and 22 ohms). (Note that the 680 ohms resistor is here to give Tr1 its forward bias when the circuit is first switched on; without this, both transistors would remain cut-off.) Applied to the effective diode (base-emitter) of Tr1 via the two paths previously mentioned, it causes an increase again of forward bias, increases collector current, turns Tr2 on harder and feeds more voltage to the laboring motor. Variations of Tr2 base voltage around a mean value are ensured by the CR combination, the large value of the electrolytic helping to maintain the necessary average bias level.

Many more interesting circuits can be found, and in the next part we shall look at motor control and servo circuits in greater detail, using some of the information already gained and introducing one or two fresh concepts. Æ

Weingarten Looks At JOHN DENVER

IF YOU'RE feeling down these collar-wilting days, *don't* listen to John Denver's latest album, **POEMS, PRAYERS & PROMISES** (RCA, LSP-4499), for most of the tunes on it will depress you even more. But if pensive items give you pleasure, the disc's definitely worth a spin to hear the composer-vocalist-guitarist's folkish offerings.

Seven of the dozen tracks were penned all or in part by Denver, whose biggest success to date has been "Leaving on a Jet Plane." Best of his originals on this vinyl are the title tune, a melancholy yet joyful outing that looks backward and ahead, both while stopping momentarily and assessing the self; "My Sweet Lady," a love ballad; "Wooden Indian," a rock tale that deals with the Redman's plight and loss of identity, and "Take Me Home, Country Roads," a pleasant western-type ditty.

But don't overlook "Sunshine On My Shoulders," a beautiful song that is just a bit excessive in length, and "I Guess He'd Rather Be in Colorado."

The recording also includes a good rendition of the Lennon-McCartney smash "Let It Be," which here neatly combines folk and soul; a solo McCartney effort, "Junk," and the James Taylor hit "Fire and Rain."

Most interesting, however, is a narrative at the tail of the disc, "The Box," in which Denver tells in parable and hyperbole what happens when war is allowed to run loose.

Although the LP is good, it is a step below Denver's earlier **WHOSE GARDEN WAS THIS** (RCA Victor, LSP-4414), an album that featured the hit title tune, penned by Tom Paxton. Denver's arrangement of the song, more strident than Paxton's original, still is an effective plea against the destruction of our natural beauties.

The nine other tunes on that disc (one is repeated) are a reflection of what Denver terms his thoughts "about all the things that change as we grow older—things that we lose or forget, or that somehow pass us by."

* * *

Airto is the one-name monicker for a percussionist, flutist and composer who specializes in Latin-style jazz . . . and for his group. **NATURAL FEELINGS** (Buddah, BDS-21-SK) showcases nine melodies that range from normal Brazilian patterns to avant-garde jazz.

Voices are used as an additional instrument on tunes that already feature the unusual, "instruments, objects and gadgets" such as the Queixada, a jawbone of a donkey, and the Cuica, a small Brazilian drum.

Airto, not incidentally, is a quintet whose output is aided by the obvious professional talents of Gary McFarland and Bob Small.

* * *

Leonard Cohen, one of the most fascinating of the modern tunesmiths, provides an exercise in dreariness on his latest Columbia LP. Although the album's title proclaims it contains **SONGS OF LOVE AND HATE** (C 30103), there is little of the former to be found.

Cohen, who has a deep, deep voice that is highly individualistic and powerful, seems to dwell on the black side of life via his lyrics, with his music emphasizing minor motifs. The disc, in fact, is probably just what potential suicides need, that little something to push them over the brink.

There are eight cuts, all Cohen originals, backed by Cohen's acoustic guitar, vocalists Corlynn Hanney and Susan Mussmano (but don't hold your breath waiting to find them), and an orchestra straight out of "Dark Shadows."

* * *

Bill Anderson looks like something out of a 1950 yearbook; his close-cropped collegiate cut is almost as antiseptic as his singing. Still, there must be someone out there who enjoys his brand of country corn, for his records sell.

ALWAYS REMEMBER (Decca, DL75275) contains 11 cuts, including five written by Anderson and another three penned by Kris Kristofferson. If you're a fan, you'll like them; if you haven't heard Anderson before, save your money.

Somewhere, I'm sure, there's a Muzak machine that plays only country music; it's a sure bet that Anderson's on it.

* * *

Joe South, songwriter best known for "Games People Play," continues to pen tunes with lyrics that have meaning, usually in a social consciousness framework. His latest LP, Capitol's **SO THE SEEDS ARE GROWING** (ST-637), is not up to his past efforts, however.

There are 11 cuts on the disc, on which South both sings and plays guitar; six of the songs are his own.

Best number is "Motherless Children," and there are a couple of others worth hearing. Overall, however, it's the kind of thing only South buffs will truly enjoy.

A much better buy for audiophiles is **JOE SOUTH'S GREATEST HITS, VOL.1** (Capitol, ST-450), a compendium of chartbusters sure to please occasional listeners of South's countrified sound as well as fans.

* * *

Soft rock, with some jazzy backdrops, is offered by **DESIGN** (E 30224), a British vocal sextet that records for Epic under the same name as the LP.

The singers are harmonious, pleasing to the ear, and reminiscent of a handful of other easy-listening groups from the '60s, not the least of which is the Swingles.

Perhaps the most salient comment is one stolen from the lips of my wife. "They sound like Simon & Garfunkel singing with The Sandpipers," said she.

* * *

He has a shaved head, a semi-Fu Manchu mustache, a goatee and a gravel-like voice. He provides heavy blues vocally, and adds piano-playing to the effort. He is **BOBBY GOSH** (24-4061), and that's also the title of his Polydor disc, a recording with 10 cuts (for half of which Gosh himself penned the music).

Aided by Gene Orloff and His Strings, plus a small coterie of top-grade individual musicians, Gosh comes up with one of the better modern albums in a long while.

Best is "Fire and Rain," here a soulful rendition with plenty of impact. But almost equal in potency are a couple Gosh wrote in concert with Paul Anka, "Don't Know Where I'm Goin'" and "Double Life," and "A Song for Erik," which puts music to Rudyard Kipling's poem, "If."

* * *

Cold Blood is an eight-member jazz-rock ensemble with a good sound, one that reminds turntable addicts of the top days of the Stan Kenton outfits.

The group's latest, **SISYPHUS** (San Francisco, SD 205), spotlights half a dozen tunes that are heavy (in the vernacular) with jazz pyrotechnics.

Unfortunately, the vocal segments (featuring Lydia Pense) lack spark; they really shouldn't be mentioned in the same breath as the instrumental portions. Cold Blood, in my opinion, should dis-Pense with the singing and stick to the swinging.

Another jazz-rock group, the Abel quintet (led and produced by Abel Sanchez), is a smaller version of Blood, Sweat & Tears—and that means quality.

Sanchez, lead vocalist and guitar player, apparently is a one-man musical conglomerate: He also penned the nine tunes that appear on **PLEASE WORLD** (Fantasy, 8404).

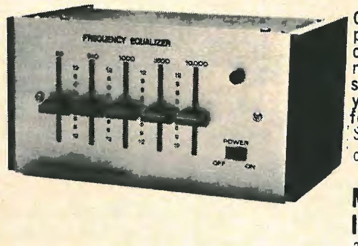
The sounds are myriad and exciting, ranging from soft to loud, from Latin rhythms to pure jazz, from ballad to rock, with a little big band aura tossed in for good measure. It's worth a listen no matter what your musical preferences are.

* * *

KEN LYON IN CONCERT (Decca, DL75197) emphasizes fun as the mustached troubadour sings several of his own compositions (there are 11 tracks in all) that spoof folksinging itself as well as the difficulties in owning a small foreign car. He also can be serious, though, as seen on "He was a Friend of Mine," a folk-gospel number that is anti-war and pro-mankind (the only message piece on the album). His brother Don is showcased on harmonica on "Bad, Bad Whiskey," an excellent blues.

* * *

THE BEST OF GORDON LIGHTFOOT (United Artists, UAS 6754), JOE SOUTH'S GREATEST HITS, VOL. 1 (Capitol, ST-450) and THE SUPER HITS, VOLUME FIVE (Atlantic, SD 8274) all are compendiums of hits. You pays yer money and takes yer choice, as the barker says. The third disc contains such stars as Aretha Franklin, R. B. Greaves, Wilson Pickett, Brook Benton, Lulu, the Rascals, and Led Zeppelin. Æ



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AUGUST 1971 60c

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