The Recording Studio Dr. Hunsberger

The Authoritative Magazine About High Fidelity

AUDIO

JUNE 1970

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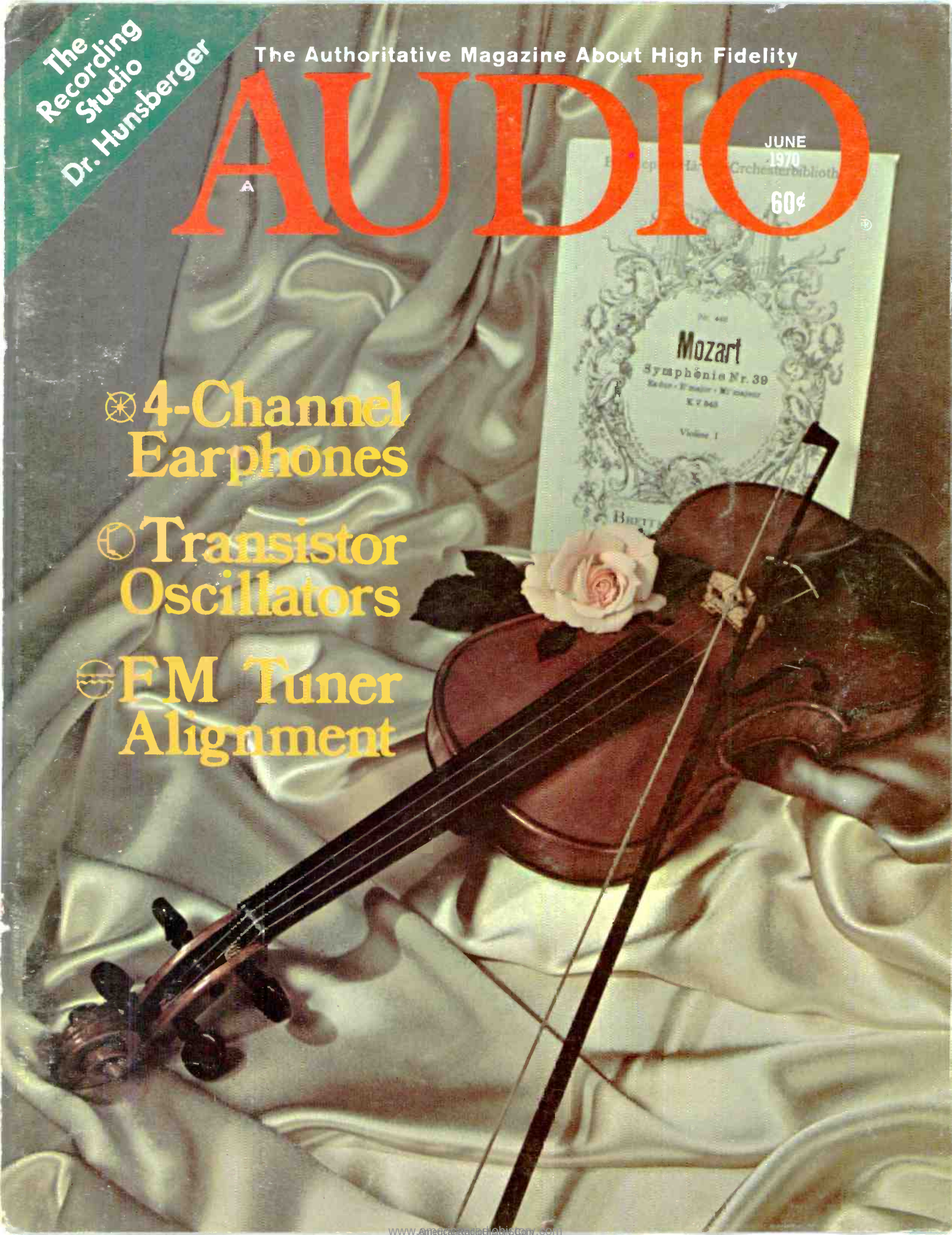
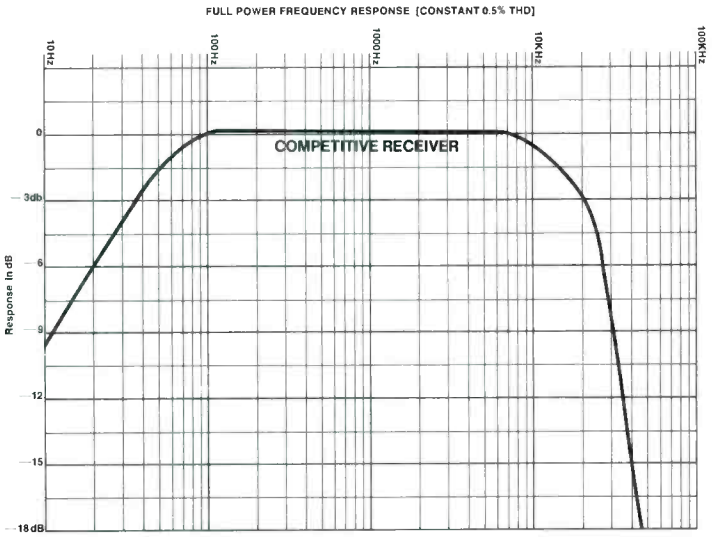


4-Channel Earphones

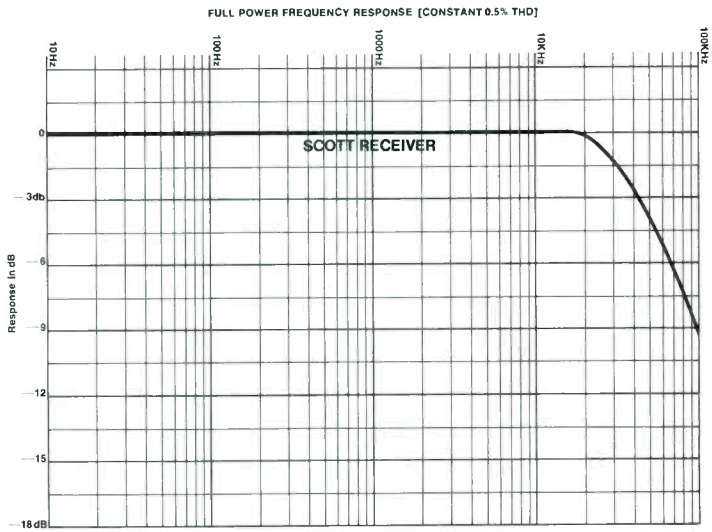
Transistor Oscillators

FM Tuner Alignment

Any high-power receiver gives you good midrange response,



Scott gives you power where it counts.



Today's low-efficiency speaker systems need plenty of clean, undistorted power to sound their best. And almost any modern receiver can put out the needed power in the midrange frequencies . . . that's easy. Where the real test occurs is in the vital low and high frequency ranges . . . that's where Scott beats any competition you can name.

For sustained undistorted power at low frequencies, Scott engineers have designed one of the heftiest, coolest-running power supplies in the business. The oversized transformer is specially designed for minimum heat rise and maximum efficiency. Giant power supply capacitors store more than adequate power for even the most strenuous bass passages. As you can see on the graph, Scott power is sustained even below 100 Hz, where other receivers tend to "sag."

Scott Full Complementary Output gives you lower distortion at critical high frequencies than any other amplifier circuit design. High-gain F/C/O transistors are specified by Scott for lower distortion at any given power output.

Laboratory test results and power charts can show you exactly where Scott receivers excel. But the most convincing proof is to listen to any Scott receiver connected to the speakers of your choice. Choose from three outstanding models: the 342C FM stereo receiver, at $269.95; the 382C AM/FM stereo receiver, at $299.95; and the 386 AM/FM stereo receiver, at $395.95.

H SCOTT

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RCA Recording Tape

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Number 80 in a series of discussions by Electro-Voice engineers

THE COMPUTER TURNS THE CORNER

JOHN R. GILLIOM
Chief Product Engineer, Loudspeakers

Almost all audio design engineers agree that—given the state of the art—a straight trumpet will outperform a re-entrant trumpet of the same effective length and flare. This is because re-entrant horns invariably exhibit losses at some point due to cancellation of energy at the bends of the horn.

But our first experience with computer-aided horn design indicates that most of the problems associated with re-entrant horns result from imperfect translation of standard horn formulas to actual products.

Optimum energy transfer is achieved when the horn flare follows precisely the desired formula (hyperbolic, exponential or other). But folding a horn twice presents a formidable problem in layout to achieve this end. For instance, literally hundreds of calculations are required to achieve a single bend—yet these are necessarily based on a gross approximation that can only be refined by repeating the calculations again and again.

As a result, most horns are actually compromises between the ideal theoretical shape and the practical limitations of available design time. Obviously, where extensive computation is needed for design, the computer becomes an essential tool.

In order to utilize the computer, a two-stage program was written, taking into account every basic design parameter. Included were throat diameter, overall diameter, overall depth, material thickness, inner tube length, surface characteristics, desired flare rate, number of bends, etc. Once all these factors agreed with the basic design objectives, the computer then was asked to print out coordinate points for the surface boundaries.

These dimensions were stated in a specially-devised format that permitted easy translation by a draftsman into a finished drawing. In this way, the Electro-Voice PA12 paging horn was born.

Laboratory tests showed a dramatic improvement in measurable sound characteristics when compared with conventionally designed horns of this class. In addition to smooth high frequency response and higher level (especially at high frequencies and at cut-off) intelligibility was markedly improved. It is interesting to note that these performance gains were made without an increase in cost.

Aside from the period needed to write the basic program, design time for the horn of the PA12 was dramatically shortened. The final printout of dimensions took only 11 minutes of terminal time, using up just 31 seconds of computer time. It is anticipated that further use of the basic program for other horns will provide similar benefits for the complete family of E-V re-entrants.

For reprints of other discussions in this series, or technical data on any E-V products, write: ELECTRO-VOICE, INC., Dept. 603A 602 Cecil St., Buchanan, Michigan 49107

AUDIO

Successor to RADIO, Est. 1917

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FEATURE ARTICLES

EQUIPMENT PROFILES

RECORD/TAPE REVIEWS

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Garrard introduces an automatic turntable especially for the discerning poor.

At Garrard, we recognize that as high fidelity components have become more refined, they've also become more costly.

As Alan Say, our Chief Engineer, puts it, "A house, a motor car and a stereo rig are the three weightiest purchases many chaps make in a lifetime.

"And, today, it can be a toss up as to which is number three."

Unfortunately, there are those with an ear for good music, and the desire to indulge it, who are *not* blessed with limitless means.

For them, we offer the SL72B.

At $89.50 it is, without question, the world's greatest value in an automatic turntable.

Son of SL95B

Our SL72B is a slightly modified SL95B, at present the most highly perfected automatic turntable you can buy —regardless of price.

The turntable is a bit smaller, the tone arm is simplified, and we've eliminated the ultra-precise counterweight adjustment screw.

But the 72B has the same revolutionary two-stage synchronous motor as our 95B. With an induction portion to reach playing speed instantly, and a synchronous portion to guarantee *unvarying* speed.

It has the same patented sliding weight anti-skating control to provide permanently accurate settings.

It has the same viscous damping of the tone arm descent in both manual and automatic play. And can be cued in either mode.

It has the same two-point record support, a Garrard exclusive that assures the gentlest possible record handling.

All in all, a degree of refinement quite impossible to find in any other turntable near its price.

Mass produced, by hand

Despite our place as the world's largest producer of component automatic turntables, Garrard steadfastly rejects mass production methods.

At our Swindon works, final assembly of the 72B, like the 95B, is in the hands of nineteen men and women.

Hands, not machines.

Each person who assembles a part, tests that finished assembly.

And four of every nineteen final "assemblers" do *nothing* but testing.

Before each unit is shipped, it must pass 26 final checks that cover every phase of its operation.

Thus, remarkably few compromises have been made to achieve its remarkable price.

$40 saved is $40 earned

Still, the 72B is *not* the ultimate automatic turntable.

Our 95B bears that distinction.

But at its price of $89.50, the 72B represents a saving of $40.

A significant difference to all but the affluent.

To quote Alan Say, "If a penny saved is a penny earned, $40 is a bloody raise in pay.

"The 72B is the automatic turntable with *almost* everything for the man with everything save money."

From Swindon, with love

The care that goes into a Garrard is preserved by a heritage that often spans two and three generations at our works in Swindon, England.

That care does not vary with turntable price.

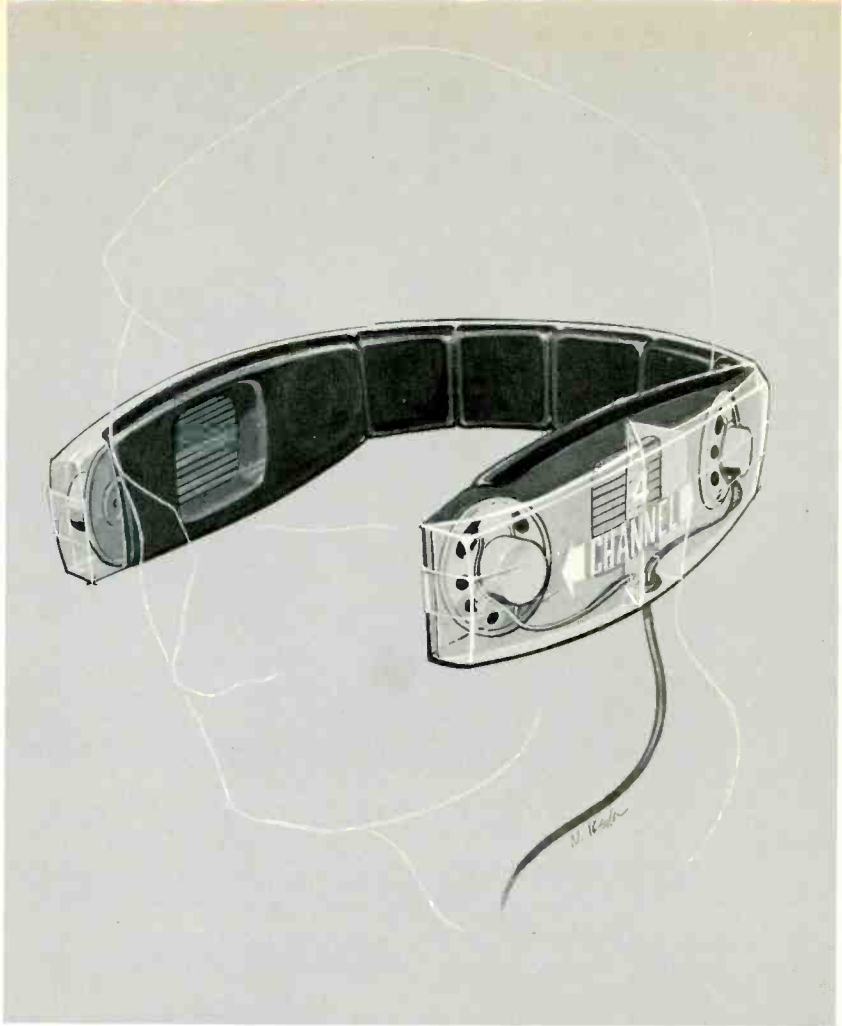
You can select with confidence from six component models starting with the 40B at $44.50 and running to the SL95B at $129.50.

Your dealer can help you match a Garrard to your system.

Garrard®
British Industries Co.

Check No. 3 on Reader Service Card

4-channels on earphones!



4-channels on earphones—without growing another pair of ears? Yes, it's true, the earphones shown above are not a dream—they really work! They were invented (and patented) by Jon Fixler whose original idea was to improve ordinary two-channel stereophones. He states "Stereophonic headphones suffer from one rather annoying characteristic, that is: the listener perceives the sound as emanating from the center of his head. Thus, while stereophonic phones do produce differential left-right characteristics, they do not produce a true panorama of sound." The original concept was to remedy this defect by using multiple transducers to produce a more spacious sound. Well, of course the reason why the sound is unrealistic with stereophones is simple: when you listen to two loudspeakers your left ear hears sound from both left and right loudspeakers and vice-versa. Thus the sound is unnatural (not so with true binaural signals—but that's a different story). Some years ago, Ben Bauer of CBS came up with a phase- and frequency-dependent crossfeed system that mixed the two channels and restored the status quo. (See AUDIO, November, 1962)

However, the multiple transducer system was a definite improvement—probably because of acoustic mixing, and it was natural that the inventor should turn his attention to the possibilities of 4-channel sound. Various methods were tried but the illustration above shows the final version. The dynamic transducers are mounted on a sub-panel and the sound travels round the front and then out via the small grille. A partition is mounted at the rear of the speakers to act as a separator. It is a little difficult to see how the system works but it is claimed that is possible to localize sounds coming from a room (in which are placed four microphones) with a high degree of accuracy. As soon as production samples are available, we will carry out complete tests and will publish our findings. Until then, those enthusiasts who really *must* listen to quadraphonic sound on earphones will have to use two pair! Æ

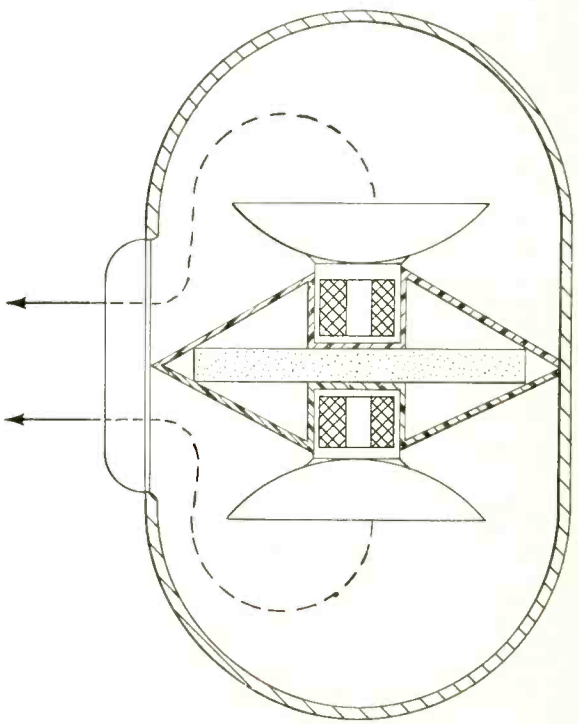


Fig. 1—Taken from the patent specifications of the original two-channel version. The drawing shows one earphone with two transducers, one of which can be used to inject signals from the other channel to reduce the left-right effect. Transducers are apparently closed-back types and the low-frequency response will be somewhat attenuated

His and Hers Pioneer Outperformers

The honeymoon is over. She wants to listen to a Mendelssohn Prelude and Fugue and he's all set for an evening with Vivaldi. Pioneer has the perfect solution. His and Hers AM-FM stereo receivers.

The SX-1500TD, (shown above) with 180 watts (IHF) music power, is Pioneer's top of the line performer. In addition to the exclusive microphone mixing feature, this many-faceted unit provides six sets of inputs. Pre and main amplifiers may be used independently. You can connect up to three different speaker systems. Its advance design circuitry, employing an FET front end and four IC's in IF strip offers outstanding sensitivity, superior selectivity and superb signal to noise ratio. Housed in a handsome oiled walnut cabinet, the SX-1500TD is priced at $399.95, including microphone.

The SX-770 (shown below) offers 70 watts (IHF) of music power. You can build a complete stereo system around this versatile AM-FM receiver. It incorporates an FET front end and two IC's in IF strip. Two speaker outputs plus 5 sets of inputs promise endless hours of listening pleasure. Boasting many refinements found only in much more expensive units, the SX-770 features a Lunar Glow tuning scale. Elegantly styled in an oiled walnut cabinet. $249.95. Of course, you'll have to decide who gets which Outperformer.

You may also wish to consider the SX-990 (130 watts—IHF, $299.95) or the SX-440 (40 watts—IHF, $199.95). Hear them all at your Pioneer dealer. For further information write direct.

PIONEER®

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Audioclinic

JOSEPH GIOVANELLI

FM Oscillator Problem

Q. I have a stereo receiver.

On occasion, and lasting for varying periods of time, we lose our FM sound, but only at the lower frequencies beginning at about 92.5 MHz. Above this frequency the sound is never lost.

It is not a question of the antenna because the FM radios in the same area do not exhibit this problem. I have taken the set to an authorized service station and to the manufacturer, but the same trouble still occurs. Can you tell me what the problem is? Andrew A. Sandor, M.D., Corona Del Mar, Cal.

A. When a tuner operates properly at some frequencies and not at others, this condition can be traced to a fault in the h.f. oscillator circuit. As the tuning dial is turned to reduce frequency, the amount of feedback in the oscillator tends to fall off somewhat. If the oscillator is just on the edge of operation, any reduction in feedback will cause it to cease oscillating. That is the reason your tuner works at the higher frequencies, but does not work at lower frequencies.

From what I have seen so far, most of the troubles of this kind are caused by bias resistors which have changed in value. The bias network should be replaced. This replacement will likely solve your problem. It is also likely that the calibration of the tuning dial has shifted. The oscillator will need to be realigned.

Presumably, the service shop already tried a new oscillator transistor. Assuming that the bias is correct, that would be the next logical step.

These oscillators are often of the grounded-base variety. The base is not directly grounded, but is bypassed to ground. This bypass capacitor might be defective. If all else fails, replace it.

Of course, if you have an oscillator which is marginal in its operation, coupled with a home in which the line voltage is somewhat low, then the tuner might not operate properly in your home, but might work all right in the service shop. That might be why you did not have any success when sending in the equipment for servicing. Oscillators are usually regulated by Zener diodes in order to hold their voltage. However, if something in the power supply has shifted so that the Zener is not working properly, then your tuner's oscillator voltage will not be stable.

Minimum Speaker Driving Power

Q. I am confused as to what the minimum power input to a speaker means exactly.

For instance, if a speaker requires 20 watts rms minimum, does this mean that 20 watts are needed before the speaker will "drive"? If it does not, will the sound be distorted if less than the hypothetical 20 watts are applied? Also, assuming that 20 watts are not needed to drive the speaker but are needed for good response, will volume have to be high? Sgt. Spence Blakely, APO San Francisco, California.

A. When we talk about the minimum amount of power for a given speaker, we are discussing the minimum power which will provide reasonably loud listening in an average listening room. If you do not plan to do much loud listening or if your listening room is a small one you will run your speakers at considerably less than this 20-watt minimum you mention. The reason for providing this kind of information in the speaker specifications is simply to give the potential buyer the information needed in selecting his amplifier. You know that you need a minimum of 20 watts per channel in order to drive our hypothetical pair of speakers. Unfortunately, we do not always know if this is 20 watts rms or 20 watts music power. I would say, therefore, that you should assume that the speaker manufacturer means the rms rating if no other indication in this regard is provided.

When the speaker is run at less than this 20-watt level, it will sound fine. It should not be distorted.

Two- and Three-Way Speaker Systems

Q. What is the difference between a two way and a three-way speaker system? Sgt. Spence Blakely, APO San Francisco, Cal.

A. A two-way speaker system is one which includes a woofer and a tweeter. The sound spectrum is divided between these two speakers.

A three-way system contains a woofer, and midrange and tweeter speakers. The audio spectrum here is divided up into three narrower slices than was true of

(Continued on page 69)

"The Dolby System is essential

for the recording of chamber music,"

notes Leonard Sorkin, First Violin of the Fine Arts Quartet.

The music of the string quartet is, by its nature, small-scaled and intimate. Unlike the symphony orchestra, the string quartet can actually perform in an average living room. Much of the scoring is open and exposed, with extreme pianissimos and passages of great delicacy. Thus, when recordings of string quartets are played in the home, listeners are acutely aware of any intrusions of tape hiss or print-through. The Dolby System effectively supresses these distracting noises.

For the recording of the Karel Husa Quartet No. 3 (winner of the Pulitzer Prize for music in 1969) on Everest Records, Leonard Sorkin felt that it was especially important that the unusual and subtle timbres demanded by the composer should not be marred by tape noise. According to Mr. Sorkin, "The Dolby System was the solution to this problem."

String quartet, symphony, opera, multi-track pop/rock . . . whatever your recording endeavor, you can make a better recording with the Dolby System.

DOLBY LABORATORIES INC
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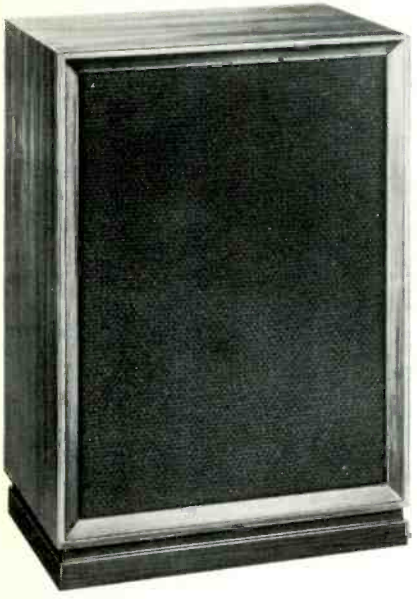
What's New in Audio

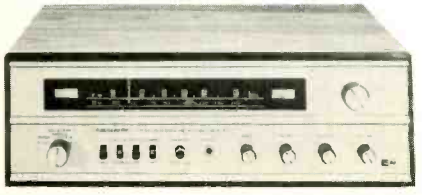
Allied 2395 Speaker System



This is the top-of-the-line speaker system and it has a 15-inch bass unit, a horn-loaded mid-range speaker plus a wide-angle dome radiator. Power handling capacity is quoted as 100 watts peak and dimensions are 29½ by 20¼ by 14 inches. Price $149.95.

Check No. 4 on Reader Service Card

Radio Shack STA-65 Receiver



Rated at 36 watts IHF per channel, this is an inexpensive AM/FM receiver featuring two tuning meters, FET front end, IC-based i.f. stages, connections for local and remote speakers and provision for a 3-head tape deck. Price $189.95.

Check No. 6 on Reader Service Card

Robins 4 and 8-track head demagnetizers

The picture shows an 8-track demagnetizer which is built into a standard

cartridge case. Model TD-12 operates on house current and model TD-15 is a d.c. model for auto use, plugging into the cigarette lighter socket. Price, TD-12 $13.35, TD-15 $16.65.

Check No. 8 on Reader Service Card

Sony Condenser Microphone

This is model ECM-19B which is an electret cardioid type. Output impedance is 250 ohms and output level is −54dB (rel. to 1 volt/10 microbars). It comes complete with a 1.5-volt battery. Price $29.50.

Check No. 11 on Reader Service Card

Ampex Auto Cassette Units

The model shown is the Micro 42 stereo player which has mono recording facilities. Output power is quoted as 20 watts peak. Model Micro 40 is similar but has no recording facilities. Price, Micro 42, $119.95. Micro 40, $99.95.

Check No. 28 on Reader Service Card

PE Automatic Turntables

This is model PE 2040 de-luxe model which has a 4-pole, 4-coil induction

motor, fine speed control, low-mass tone arm set in ball-bearings, with variable stylus force. Weight of the platter is 7.1 lbs. Model PE 2038 is a less expensive version with a 4.4 lb. platter. Price, PE 2040, $145, PE 2038, $115.

Check No. 30 on Reader Service Card

Catalogs

Folkways have a 46-page catalog of records mainly intended for schools and libraries. Included are foreign languages, social studies, science, and music appreciation.

Check No. 32 on Reader Service Card

Nortronics says "Every tape recorder owner ought to have his head examined." This is the message of a new leaflet which tells you how to check for head wear and what to do about it.

Check No. 36 on Reader Service Card

The Super Natural from JVC

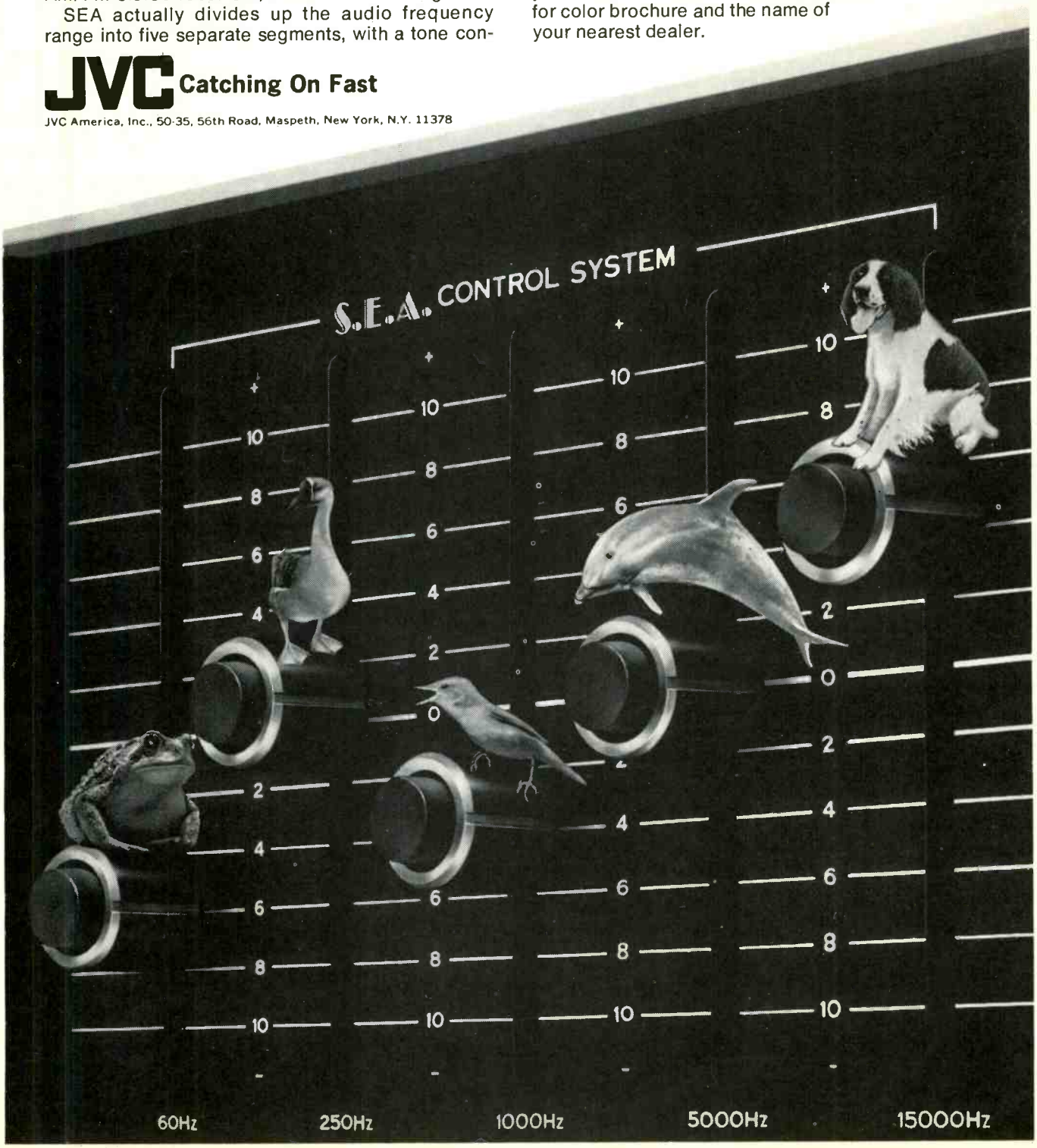
Now, JVC brings you Super Natural Sound: From a bull frog's croak to a Beethoven Symphony, you can enjoy stereo so true to life that it's hard to tell from the real thing. All made possible by a revolutionary new development—a JVC exclusive—called the Sound Effect Amplifier (SEA), shown below. And SEA is just one of many great advanced features that you will find built right into JVC's 5001, 5003, and 5040 AM/FM stereo receivers, without extra charge.

SEA actually divides up the audio frequency range into five separate segments, with a tone control for each. So you can boost or decrease bass, middle ranges and ultra-high's, mix and match sounds, just like in a studio. And, you can compensate for component characteristics, balance acoustics of any room.

SEA stereo receivers also have the latest IC and FET circuitry. Extra-wide bandwidths, low distortion and excellent S/N ratios. Listen to them today at your local JVC dealer. Or write us direct for color brochure and the name of your nearest dealer.

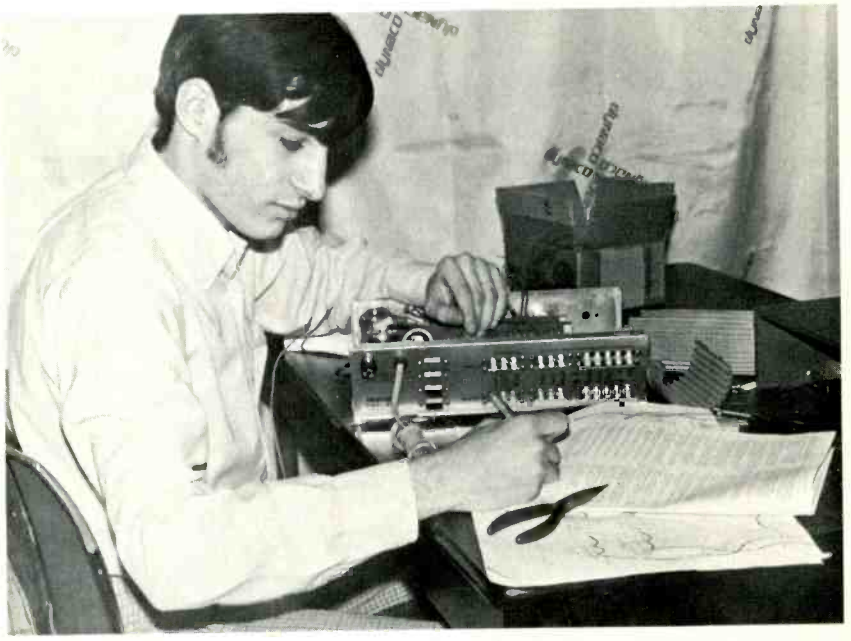
JVC Catching On Fast

JVC America, Inc., 50-35, 56th Road, Maspeth, New York, N.Y. 11378



Check No. 9 on Reader Service Card

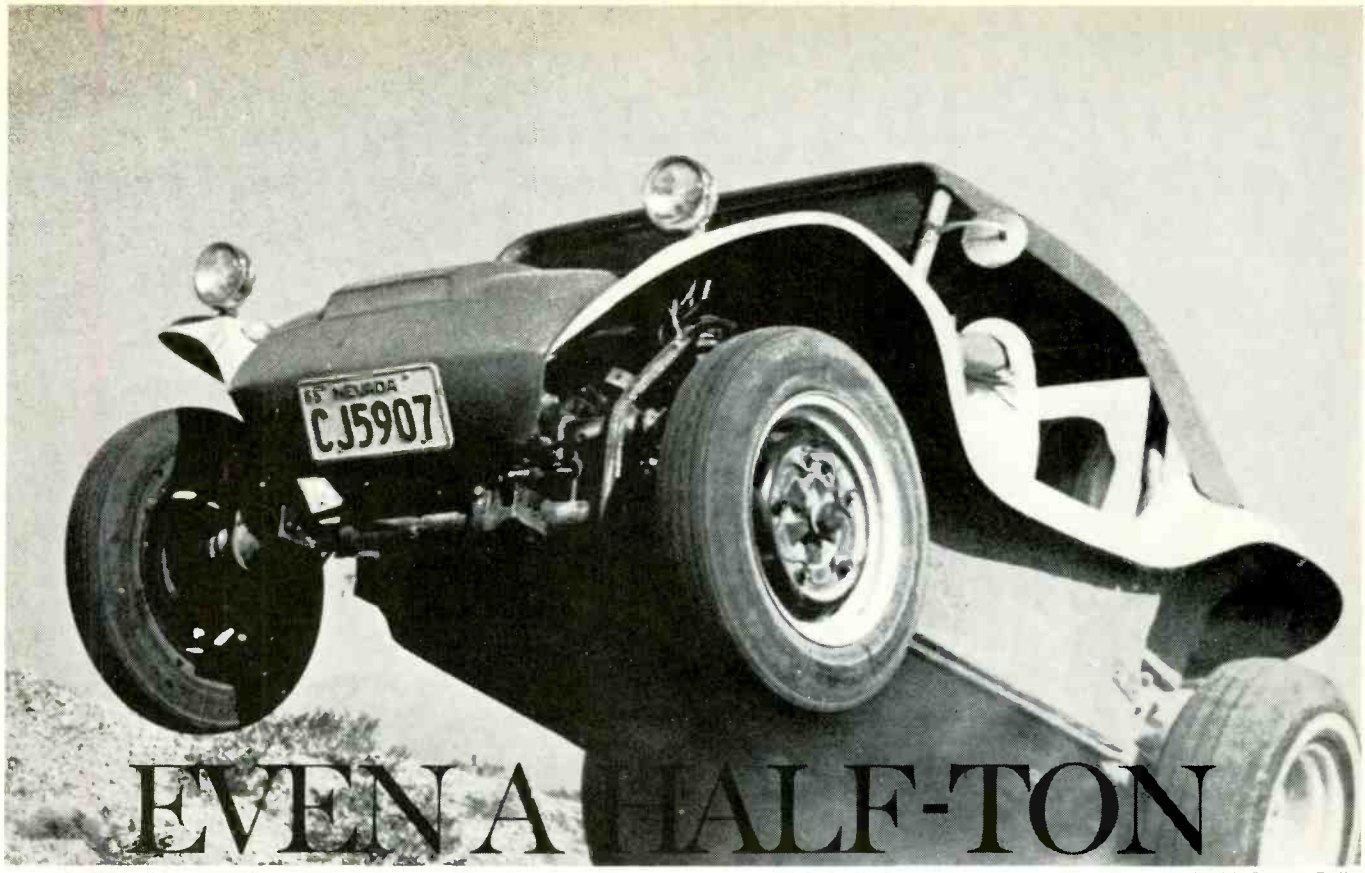
orchestra are quite good . . . one rarely covers the other. However, this is very difficult recording, and considering the huge forces involved, some of the lapses can be forgiven such as the tenor appearing somewhat outsized among all the vastness of the perspective, and some variations in the depth perspective of the choruses. The choruses appear young and enthusiastic and are heard with excellent articulation. The Utah Symphony under Maurice Abravanel plays with considerable finesse and commendable precision. Many of the orchestral details of the work are newly revealed in the four-channel medium. You hear things that just weren't there in previous recordings. Not only is the orchestral sound clean, but much of it takes on a new dimension of reality when heard in the perspective of the four channels. Abravanel's performance is fairly simple and straightforward. And perhaps for this reason it is quite effective, even though he doesn't give us the insights into the score provided by the late Charles Munch. But it is never fussy, nor fustian for that matter . . . Abravanel gives the great climaxes their just due without ever letting them get out of hand. I have a few quibbles. For one thing, the strings—most especially the firsts—needed more strength, which would have lent better detail. The other is that tape hiss at good room-filling playback levels was somewhat obtrusive. Probably my awareness of the hiss was heightened by the fact that you can hear it from the rear as well as the front speakers and that is rather disconcerting. Apart from these minor flaws, hearing this monumental work in the four-channel medium is like discovering it all over again, and it is a thrilling experience indeed. One final note . . . don't be put off by some of the poor four-channel demonstrations you will hear in some hi-fi shops. Search around for a demo that is properly set-up and conducted by someone who knows what he is doing, before you pass judgment. Æ



Evanston High School Hi-Fi Show

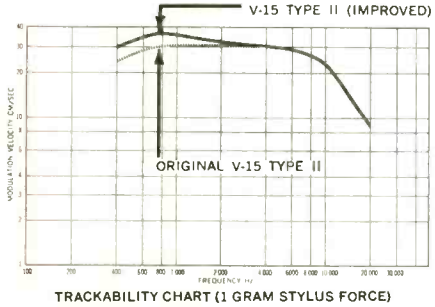
One of the most interesting Hi-Fi Shows of the year took place a few weeks ago in Evanston, Illinois. Called the MID-WEST-HI-FI STEREO SHOW it was organized by students of Evanston Township High School and it featured CCTV, 4-channel sound (using tape and Scheiber records) and live-versus-recorded sound with the co-operation of their own Jazz group. There were 24 exhibitors including Shure, JBL, and Moog as well as local dealers such as Musicraft who had a Hi-Fi Shopping Center, Audio Consultants, and Gill Custom House who were showing Crown recorders (and helping with the quadraphonic demonstrations). Tape recorders were well in evidence and the new Revox and 4-channel TEAC both attracted a lot of attention. Attendance was around 4,250 and the students themselves not only organized the whole affair but they were also responsible for the CBS television news coverage and articles in local newspapers. All in all, a very successful show and our congratulations to the organizer, W. L. Kaffenberger, and his hard-working team. May next year's event be even more successful.

Our photograph shows David Silver assembling a Dynaco PAT-4 preamp. In spite of distractions we are glad to report that he finished it before the Show ended.



EVEN A HALF-TON DUNE BUGGY SOMETIMES WEIGHS ¾ GRAM

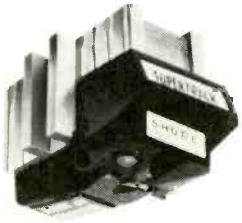
The "Mint 400" Del Webb Desert Rally



TRACKABILITY CHART (1 GRAM STYLUS FORCE)

The same inertial forces that make a vehicle airborne when cresting a hill affect the tracking force of the phono stylus. Record surfaces, unfortunately, are a morass of miniscule hills and valleys. When the stylus is nominally tracking at 1 gram, this force significantly *increases* as the stylus enters a "hill," and *decreases* as it begins the downward "plunge." In addition, frictional characteristics of the tone arm or record changer mechanism may further affect uniformity of tracking forces; however, the *Shure V-15 Type II Improved Cartridge* retains its trackability throughout the audio spectrum. It accomplishes this difficult task within a critically determined latitude of tracking forces (¾ to 1½) to insure continuous contact with the groove walls regardless of the varying tracking forces caused by the hills and valleys in a record groove.

Here is why fractions-of-a-gram are important to record and stylus-tip life: ¾ gram tracking exerts a pressure of 60,000 lbs. per sq. in. on the groove walls—and this rises to 66,000 lbs. per sq. in. at 1 gram, and 83,000 lbs. per sq. in. at 2 grams. At 2 grams you have added over *11½ tons* per sq. in. to the groove walls *over ¾ gram tracking!* Think about it.



SHURE V-15 TYPE II (IMPROVED)

Shure Brothers Inc., 222 Hartrey Avenue, Evanston, Illinois 60204

Check No. 13 on Reader Service Card

Dear Editor.....

A DC Loudspeaker

Dear Sir,

Robert Berkovitz, in his "Loudspeakers—Past and Present" (Audio, April 1970) fails to mention the Direct Coupling (DC) Loudspeaker invented by Sanford Fisher and myself back in 1958.

An essential feature of the loudspeaker system was a tank of pressurized air (in excess of 300 psig) and vacuum pump. These were controlled by an elaborate arrangement of electrically-controlled valves (the prototype used valves from an old washing machine) which were energized by a sensitive integrator circuit (using tubes, alas—transistors were still too expensive and unreliable back in those days!) which would open the valve connected to the air tank when the average d.c. level of the signal was positive, and would open the valve connected to the vacuum pump when the average d.c. level was negative. The design goal of the entire system was to have a valve response time of less than 1/40 of a second (25 milliseconds). Used with a regular speaker system that could reproduce down to about 20 Hz, the valve arrangement would extend the frequency response down to pure d.c.

We felt then (and still feel today) that flat response down to pure d.c. was essential for a hi-fi reproduction of wind and brass instruments, as well as organ music. When one stands directly in front of a trumpet player, for example, there is a steady flow of hot air which represents a d.c. wave. For utmost reproduction, we therefore must provide for d.c. reproduction in the entire hi-fi system.

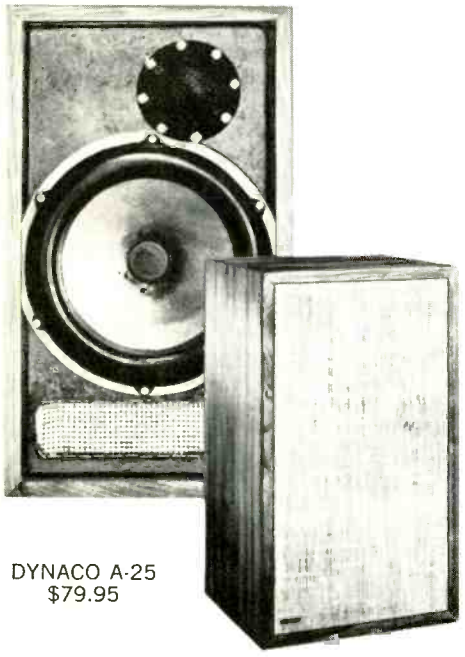
Sadly, the Direct Coupling Loudspeaker never achieved the popularity we hoped for, primarily because engineers in the amplifier and recording industries never produced the other needed components with d.c. response—amplifiers, cartridges and cutting heads, and records. I am presently working on a complete recording chain capable of response down to d.c.

PETER A. STARK
Mt. Kisco, N.Y.

I can well understand the reluctance of recording and broadcast engineers to throw out their transformers and coupling capacitors. . . . However, the DC response theory is an interesting one and it would seem to be a promising field for research. My wife says "isn't it enough to have four loudspeakers in the room without having the hot breath of trumpet and tuba players down our necks?—Ed.

"...(the Dynaco A-25's) are quite probably the best buy in high fidelity today."

The Stereophile Magazine.



DYNACO A-25
$79.95

Dynaco designed the A-25 loudspeaker system to have the most accurate reproduction of any speaker available, regardless of price, yet at a low cost to the consumer. Here's what two of the most respected publications say about the results of our efforts.

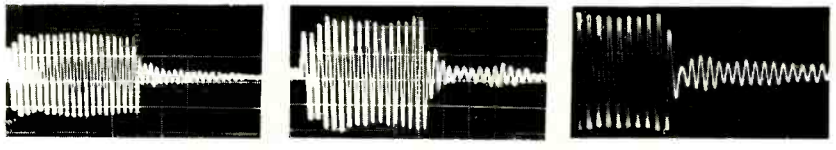
The Stereophile, Vol. 2, No. 9

". . . (when) some really deep stuff came along . . . what came out of the A-25's simply defied belief, for they went **deeper** even than two of our standard systems . . . We were certainly **not** prepared to find these piddling little Dyna systems going **flat** down to 35 Hz and rattling windows at a hair below 30 Hz! . . . these A-25's are better than anything else we've ever encountered for less than $200 each . . ."

Julian Hirsch in Stereo Review, June, 1969

". . . the Dynaco had a remarkably neutral quality. Many speakers have response irregularities that . . . leave no doubt in the listener's mind that he is listening to a speaker. The A-25 had less of this coloration than most speakers we have heard, regardless of price . . . nothing we have tested had a better overall transient response . . . Not the least of the A-25's attraction is its low price of $79.95.

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



Send for literature or pick some up at your dealer where you can also hear the A-25

dynaco INC. **3060 JEFFERSON ST., PHILA., PA. 19121**

IN EUROPE WRITE: DYNACO A/S, HUMLUM, STRUER, DENMARK

COMING IN JULY

A New Multichannel System—Dave Hafler describes a method of adding dimensional information to a conventional two-channel stereo recording.

CES—a look at some of the new products at the Consumers' Electronic Show.

FM Tuner Alignment—Part 2 of Arthur Boynton's article deals with distortion measurements.

Getting Hooked on Chamber Music—Part 2 of Richard Freed's article which was held over from our last issue.

EQUIPMENT PROFILES include:
Advent speaker system
Sherwood SEL 200 Receiver
Tandberg 6000 Tape Recorder

PLUS

Record and Tape Reviews and all the regular features.

About the cover: As the poet has it "In a day Blossoms and June and Rapture pass away" Perhaps, perhaps. Others speak of "undying vibrations of music" and so on. The violin, which is a particularly good example of modern craftsmanship was made by Gerlandus Terrano of Naples and it was lent to us by Helmuth Keller, the well-known violin maker of Philadelphia.

Tape Guide

HERMAN BURSTEIN

4-Track to 2-Track

Q I have a ° ° ° ° tape recorder. It is four-track, and I would like to make it two-track. I bought the four-track so that it would play pre-recorded tapes, but I found these to be of poorer sound quality than records and decided to buy a turntable. Would it be possible to replace the four-track heads with two-track ones without difficulty, or are there other factors to be considered?—B. Reichelt, River Edge, New Jersey.

A. It is possible to replace the quarter-track heads satisfactorily with half-track ones. At the same time you will have to take careful measures to achieve accurate vertical and azimuth alignment of the heads. Furthermore, the half-track record head may have different bias and record drive current requirements than the quarter-track record head. Your tape recorder contains the necessary internal controls for making the bias and record drive current adjustments; follow the manufacturer's instructions in these respects.

Flywheel Rotors

Q. Certain tape recorders, such as the ° ° ° ° professional machines, use outer rotor hysteresis-synchronous motors. The flywheel is eliminated due to the flywheel action of the rotor. The motor shaft is used as the capstan. I have heard that the use of this arrangement is not desirable, although the ° ° ° ° recorders claim very impressive performance and the machines I have heard sound very fine indeed. Can you give me your opinion on this? I would also appreciate any assistance you could give me as to locating a manufacturer of such a motor: The one used in the ° ° ° ° is a two-speed unit of 900 and 1,800 *RPM.*—William B. Neel, APO San Francisco.

A. The proof of the pudding is in the eating. If the ° ° ° ° machine's method of achieving flywheel action results in performance that "sounds very fine indeed," doesn't this endorse the method used? I think that the situation is similar to the one for phono turntables; some manufacturers have used very large motors, while others have used very small ones, but with good engineering both have achieved results that can be called excellent. There is usually more than one way to achieve high quality, and this holds for tape transports as well as for other mechanical devices.

Sorry, but I do not have the information you seek on a manufacturer of motors. I suggest that you consult an industrial electronic supply house. Or, why not order a motor from the manufacturer of the °°°° tape machines?

Mike Static

Q. I have a ° ° ° ° tape recorder with the microphone which comes with this machine. In taping, and holding the mike in my hand, I get a lot of static. Is there a mike that would eliminate this noise?—S. Valenza, Jackson Heights, N.Y.

A. Microphones are usually sensitive to scraping or rubbing off their cases. Possibly the static to which you refer is due to such scraping against your fingers, clothes, etc. See what happens if you hold the microphone firmly, without allowing it to rub or brush against anything. If the problem remains, I suggest that you arrange to use the microphone in a stand. Or try other microphones which may be less sensitive to scraping and rubbing.

Noise From The Left

Q. I have a minor problem with my tape recorder. It is definitely electrical rather than mechanical. On some tapes I hear a ticking sound in the left channel. It is not regular but might be described as a crackling sound. It is not of great amplitude,

(Continued on page 71)

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

When you're #1 in tape recorders, you don't make the #2 tape.

If you've got a few hundred bucks tied up in a first-quality tape recorder, you're not going to want to gum up the works with second-rate tape. Especially when just a few extra pennies buy the finest Sony professional-quality recording tape.

Not only will Sony tape make any recorder sound its best, but it'll keep it sounding that way. Because our tape won't shed or cover tape heads with a performance-deteriorating oxide coating. Head-wear, too, is minimized, thanks to Sony's exclusive Lubri-Cushion process, which impregnates the tape with long-lasting lubricants.

Sony tape comes in all configurations: Open reel. Eight-track. Cassettes.

Open-reel tape is available in 3¼", 5", and 7" sizes. The new Sony SLH-180 low-noise, high-output tape is available on 7" reels only. And "Easy-Threader" tabs make every Sony open reel self-threading.

Our professional-quality tape is also available in eight-track stereo cartridges plus new Easy-Matic cassettes for both functional and stereo units, with 60, 90, or 120 minutes' recording time.

To hear the best, play the best. Sony Professional-Quality Recording Tape. From the people who offer the number-one line of tape recorders—Sony/Superscope.

SONY SUPERSCOPE®

You never heard it so good.®

Editor's Review

The annual Consumers Electronics Show will be held from June 28 until July 1 and the IHF will collaborate by organizing three seminars. These will deal with Trends in Sound and Music Reproduction, Marketing, and Business Techniques and they will take place at the New York Hilton on June 29 from 9 to 11:30 a.m. "Trends in Sound Reproduction" will cover the present and future of quadraphonic sound, and one of the panelists will be Len Feldman.

* * *

Opera Today Inc., an organization which is experimenting with new forms for opera presents its first New York production at the Armory, 56 West 66th St. from June 8 to the 14th. The opera(?) is called "Spatial Variations on a piece by Benjamin Britton" which involves a tenor and four dancers performing to a quadraphonic recording. It will take place inside a dome of translucent circles on which motion pictures and slides will be projected. The audience will thus be 'enveloped by the presentation'. The initial recording was made at Sound 80 in Minneapolis because, says Artistic Director Patricia Collins, "It has the most advanced capability we know in recording quadraphonic sound."

* * *

"Who says no one listens to FM classical music stations?" asks Allen Rockford, of WONO, Syracuse, New York. It seems that this station had a week-end Marathon to raise funds for the Syracuse Symphony Orchestra and they finished up with more than $16,000—way above the $15,000 target. Contributions ranged from 6 cents donated by a two-year-old to three gifts of $500. Last year's figure was just over $10,000 so *somebody* out there must be listening . . .

* * *

The Acoustic Research Contemporary Music Project was initiated some months ago and its purpose is to sponsor recordings of present-day composers whose works would not otherwise be heard. The prospectus states "the aim of the project is to provide composers with direct access to as large an audience as modern technology can offer, and to give listeners an opportunity to hear music of today, chosen by composers on the basis of musical criteria alone." The first series, consisting of fourteen broadcasts and six records, will be available in September and will include works by Milton Babbit, Edwin Dugger (both using synthesizers), and contemporary chamber music by Stefan Wolfe, Arthur Berger, and Peter Westergaard. The records will be made by Deutsche Grammaphon and the low price of $2 each is made possible by Acoustic Research assuming the responsibility of for distribution.

* * *

Altec Lansing held Spring Clinics for its sound contractors in three locations during April—Washington, Kansas City, and San Mateo—to familiarize them with their Random Access School System and other systems designed for use in hospitals. Further information relative to Acousta-Voicing, with particular attention to loudspeaker directivity patterns and efficiency, was presented as part of the company's training program in the many aspects of sound-system design. The Clinic was attended by over 100 at Washington, and similar numbers were expected at the other two locations. I have been lucky to obtain an article on the general subject from Altec's Don Davis, and it will appear in the August issue.

* * *

According to Schwann, the most popular classical record of 1969 was the Angel recording of Vaughan Williams' *Sea Symphony* (LPO and Sir Adrian Boult). This symphony was often played as a finale in Gilbert Briggs' live-vs.-recorded music demonstrations. At one affair in London's Festival Hall, there was not enough power available from the amplifiers to do justice to the tremendous climaxes, so for the last few minutes the recording was reinforced by the Festival Hall organ. In announcing this, Gilbert said, with a poker face, "You may have noticed the organ in the background—but what's 3 dB between friends?"

* * *

To those who still find themselves thinking in cps instead of Hz (I do myself sometimes) I append the following formula which I have jealously guarded for some months. It appeared originally in *Electronics News* and they claim it came from—of all people—the National Forestry Service!

$$F_h = F_c \left[\frac{\cosh\theta_h \sqrt{1-\tanh^2\theta_h}}{\sin^2(e-\pi\theta_c)+\cos^2(e-\pi\theta_c)} \right] \frac{3}{2}$$

F_h = Frequency in hertz

F = Frequency in cps

According to the NFS—it makes hertz to cycles conversion a "sinh." G.W.T.

A lot of people don't know that a cartridge that's great for one high fidelity system could be disastrous for another.

That's why Pickering has done something fantastically simple.

We've developed *Dynamic Coupling Factor*—henceforth known as *DCF*.

All it is is a complicated name for an uncomplicated way to select the best cartridge for your system. It is your guide to the selection of that cartridge based on its intended application in playback equipment—just as horsepower is the guide to the proper engine for a vehicle.

It works like this. You own an XYZ model record changer. What cartridge do you pick? Not the $29.95 model because it isn't designed for the capability of your XYZ player. Not the $60.00 cartridge either, for its quality cannot be realized in that unit.

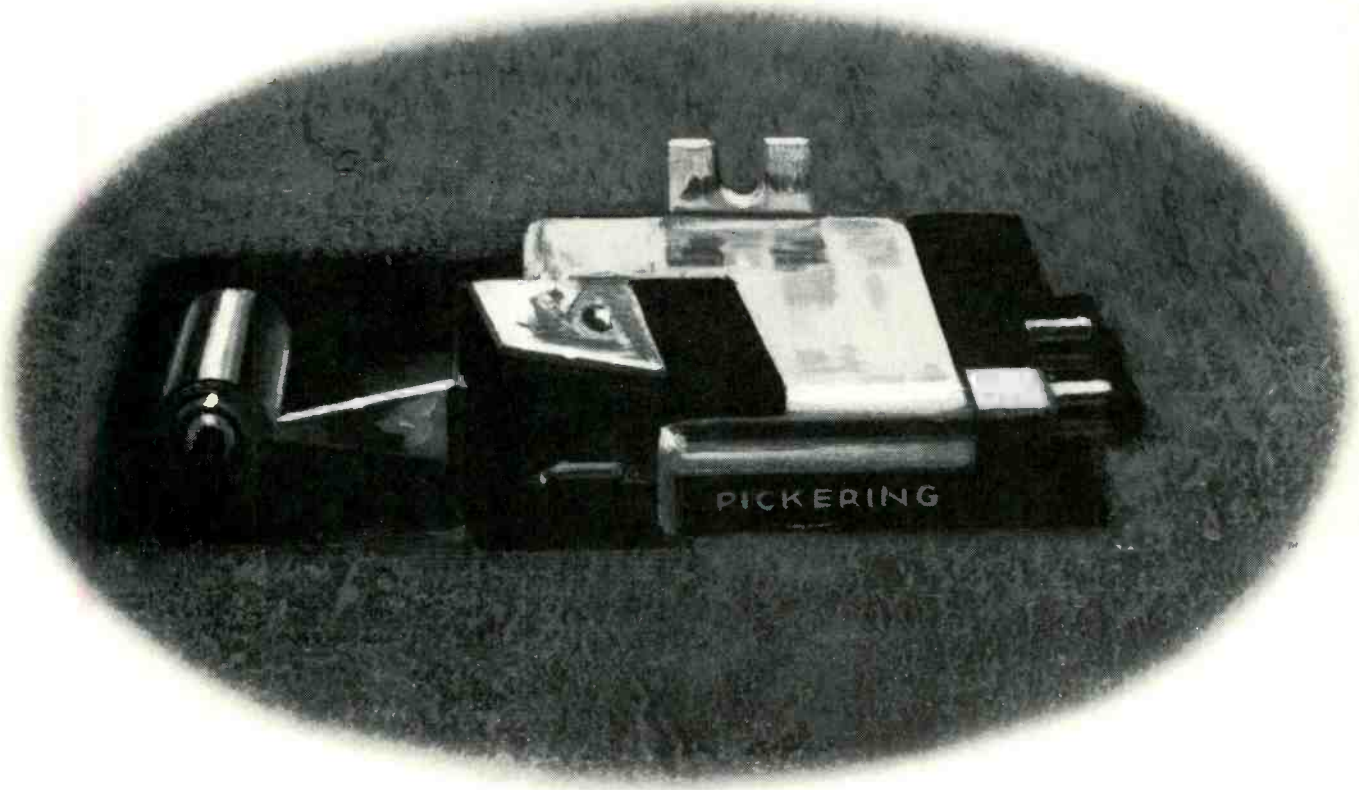
Our chart—available to you free—reveals that you need our model XV-15 with a *DCF* rating of 400 for optimum performance. This means that you will get 100% of the music from your records. Not 50% or 75% but *all* of the music capable of being obtained from your particular playback unit.

Technically, what we've done is taken virtually every high fidelity record player and pre-analyzed the vital variables for you; those affecting cartridge design and those related to the engineering features of the various turntables and changers.

So now all you need to be well informed on cartridges is to send for our *DCF* application guide containing our recommendations for what cartridge you use with which record player.

And next time you walk into a high fidelity salon, tell the man: "I'd like a Pickering XV-15 with a *DCF* of 400." Or whatever.

Pickering cartridges are priced from $29.95 to $60.00. For your free *DCF* chart, write *DCF*, Pickering & Co., 101 Sunnyside Blvd., Plainview, N.Y. 11803.



PICKERING

"for those who can hear the difference"

How To Align Your Stereo Tuner

ARTHUR BOYNTON

Part I. Modifying the FM Generator

Since the July 1964 issue of AUDIO Magazine, I have been trying to realize excellent stereo performance from FM tuners. The article published by Mr. Daniel R. von Recklinghausen in the August 1963 issue of AUDIO pointed me in the right direction. He made it clear how important it was to obtain a linear phase-shift in the FM i.f. pass band. As my article hints, the linear phase-shift concept can be approached by using a sweep generator, and being careful! What was not emphasized was the care required in other areas, alignment of the r.f. section, alignment of the stereo decoder section and accurate alignment of the i.f. section.

IT HAD BEEN ASSUMED that most technicians understood r.f. alignment, as I had found this technique to be widely practiced by electronics technicians during my tour of duty with the U.S. Navy.

The real challenge was trying to solve the riddles of achieving excellent performance from the stereo decoders, (multiplex portion of stereo tuners, or separate multiplex adaptors).

This challenge started when I had the opportunity to examine and adjust various Heathkit, EICO, Scott, and Harman-Kardon units belonging to friends. In spite of the remarkable improvement that I was able to coax from each of these tuners, my desires were never fully satisfied. The purchase of a Scott multiplex adaptor for my Scott C330 AM-FM tuner did open up a new era of listening pleasure for me. But even here, I could not recapture what I felt to be a truly adequate representation of the broadcast signal. This purchase also introduced me to a new twist in tuner alignment.

The Scott people recommended using a 100-per cent, 400-Hz, frequency-modulated r.f. carrier to align their tuners. This I could not do with my sweep generator.

Thus the need was felt to obtain a stereo generator. As I enjoy building kits, a Heathkit unit was chosen. Was I ever disappointed when I discovered that my particular needs exceeded the quality level of this popularly priced unit!

Since a quality alignment job requires an accurate source of stereo signals, this section will be devoted to those steps I went through to improve my Heathkit Stereo Generator—beyond all expectation! The discussion in Part 2 shows you how I use my equipment to best advantage. And you can do likewise.

As the unit stood, there was no way for me to improve upon the adjustments of my Scott tuner system. Since Scott uses the technique of measuring residual distortion for part of the adjustments, the signal-to-noise ratio of the generator must be good. The hum, noise, and distortion must be somewhat lower than the minimum values to be expected from the best stereo tuners. Another operation requires an accurate left and right signal, with crosstalk lower than the capability of the tuner to resolve the signal. For a reading of 1 per cent, the total hum, noise, and distortion must be down 40 dB. So my attention was turned to the stereo generator to improve the quality of its signal.

Getting Rid of the Hum

Hum was the first order of business. The goal was to have the hum low enough so that it would provide a reading of no more than 0.5 per cent when using the residual distortion measuring technique. (The signal was monitored at the Composite Signal/Audio jack for all of the measurements.) So the single diode rectifier was replaced with a full-wave bridge. The ripple was reduced, mostly because the frequency was doubled. The hum persisted. Shielding of V5 prevented any excess 60-Hz pickup when my hand was near, but there was still hum! The power line to the switch was next shielded as these wires are strung through the audio area. While the hum was reduced a little more, it was still annoying.

Poking around the filter coils (L5, L6, and L7) showed me that the hum was getting in through them! The magnetic field of the transformer was inducing a 60-Hz field into the coils, in spite of a copper strap around the transformer, and proper transformer orientation!

An attempt at shielding the coils by wrapping them in tape and then aluminum foil and tape again was tried. This had no effect against magnetic fields, only electrostatic fields. While no improvement was obtained, the shields were never removed.

Reversal of the connections to coil L7 reduced the hum by making the induced voltages in L5 and L6 oppose the induced voltage in L7. See Figs. 1 and 3. This was a tremendous improvement, but its discovery didn't stop my relentless search.

By changing the filament string to twisted pair, and providing an above-chassis ground return for V5, the hum was almost licked. Balancing of the filament string to ground through a pot, or biasing it to +30 volts made no further improvement, so these items were not included in the final fix. Providing an extra B+ decoupling filter for V5-A finally reduced the hum to 52 dB below full output. (Reference is 0.4 volts rms at the Composite/Audio output jack, which is equivalent to 0.86 volts rms at the external input jack, which comes next.)

Now the distortion needed working on. The internal audio generator just didn't have it. So a phone jack was installed just below the audio output for an external audio input. It is wired so as to disconnect the internal signal whenever a phone plug is pushed in. See Fig. 3 and 10.

The Audio Generator

At this point, it must be mentioned that my Heathkit AG-9A audio generator was modified to obtain lower hum and improved distortion and frequency response of the 1 Hz to 100 Hz band. Both connections to the electrolytic capacitor ground were moved to the same ground lug. This eliminated the series resistance of the aluminum can. An 80-μF, 525-V capacitor was also connected across the B+ filter output. A 100-μF, 50-V capacitor was also connected across the meter terminals. The first fix reduced the hum, the second solved the amplitude reduction and distortion at low frequencies, and the third stabilized the meter for more accurate readings at low frequencies.

Since the audio generator distortion was only 0.005 per cent, the stereo generator was again considered. Close exami-

nation of V5-A revealed that there was no negative bias on the grid. The installation of a 200-ohm cathode resistor solved part of the distortion problem. Then the frequency response of this stage suffered. It was important to retain full response, as the composite audio signal comes through here. A .02-μF capacitor across the cathode resistor provided the necessary compensation. You can determine the exact value your unit requires by feeding a square wave into the newly installed external audio jack and picking and choosing capacitors to obtain the fastest rise time without *any* overshoot. Make sure your scope will properly display this waveform first!

Then V3-A was found to distort. Any attempt to select a proper value of resistance for R20 failed. It was too touchy. Different tubes needed different values of resistance. Putting 390 ohms between R21 and the cathode, and connecting the formerly grounded end of R19 to the newly created resistor junction provided proper bias. Of course, R20 was removed and C8 remained connected to the cathode.

Low-frequency response of the stereo signal still suffered, so a 40-μF, 50-V capacitor was put in position C8. The series resistance of 1500 ohms is equivalent to the capacitive reactance of the 2-μF capacitor at 50 Hz. Since I wanted the 3 dB point to be around 5 Hz, the value of 20 μF was selected and installed. REMEMBER: *The objective is to have a unit that will provide better signals than the best tuner is expected to capture.* Hence the purist approach.

The Residual 38kHz Signal

Now the problem of reducing the residual 38-kHz signal was staring at me. In order to make the decoder under test rely on the 19-kHz signal for sync, the 38-kHz signal had to be down by at least 40 dB. This would also improve the distortion seen in the composite signal. The designed method of obtaining a null balance of the stereo generator could not come close to the requirement. Besides, there was a peculiar distortion in the composite waveshape that could not be straightened out. Once again, it was discovered that the filter coils were picking up radiation, this time from the oscillator coils, T2 and T3! Reversal of the primary and secondary windings of T3 reduced the induced radiation slightly. The next idea was to try to create balanced and opposing fields around L5 and L6. Finally, relocating the T3 coil provided the desired effect. The location for the maximum null occured at the screw location for terminal board R. See Fig. 1. So these two items were swapped. Now the induced 38-kHz was minimized to an

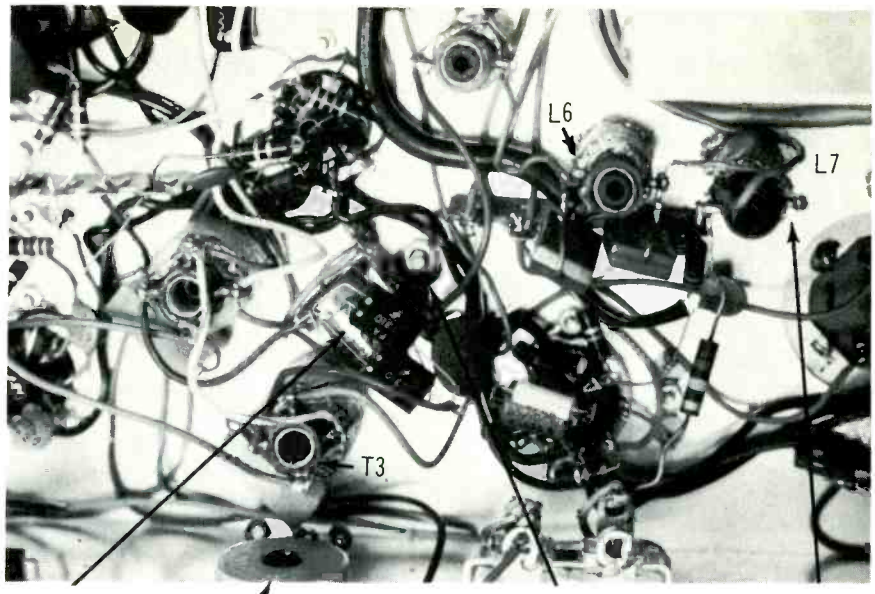


Fig. 1—38-kHz transformers, low-pass filter coils, and modulator diodes.

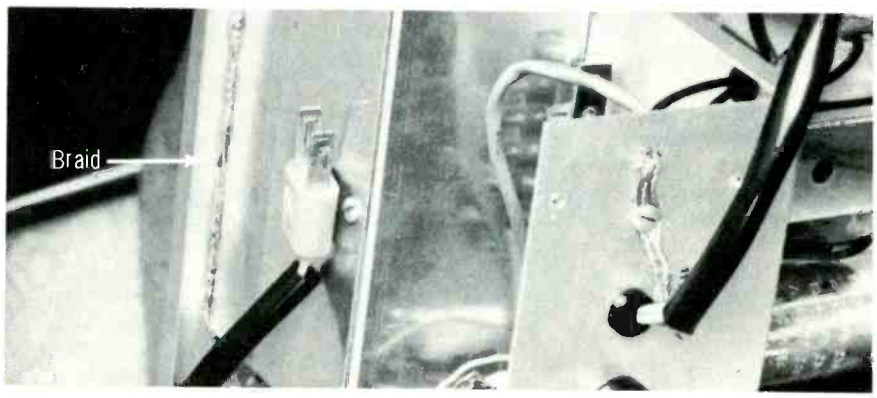


Fig. 2—The effective r.f. shielding.

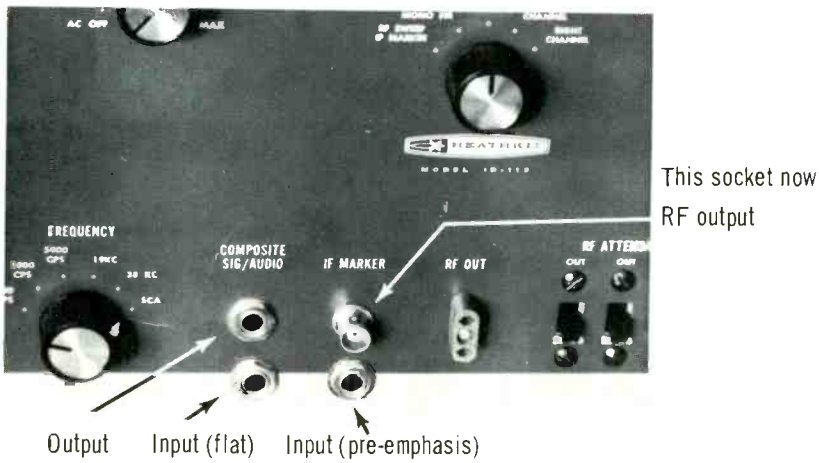


Fig. 3—Stereo generator front panel where the new jacks were added. The R F OUT socket was disconnected and the r.f. signal was brought out through the BNC connector labeled "I F MARKER."

acceptable value. See Fig. 8. It is 40 dB below 0.4 volts rms at the Composite/Audio Output jack.

The next item to come under scrutiny was the switching diodes. Since an accurate shape of the composite signal was still not being achieved, the diodes were examined. They were found to have different—forward voltage drops, and it was determined that the 10-k pot, R54, was included for balancing purposes. Also, the filters had to be adjusted to different positions, depending upon what audio frequency was being fed through in order to achieve a maximum amount of separation.

A new circuit was devised, and special matched-pair diodes were purchased. These were the Fairchild FA 2310 E units. The imbalance between the two diodes was guaranteed to be no more than 1 mV. Note the way the diode pairs are wired. See Figs. 4 and 12. This is done so as to bring the audio point as close to ground as possible, and minimize the residual 38-kHz signal without any need for an adjustment. The circuit is so connected that on one half of the cycle, the 38-kHz signal is shorted across the coils. When the diodes conduct, the audio point is effectively grounded. During the opposite half cycle, the diodes do not conduct, and the audio signal passes into the filter. Unlike the previous circuit, this one allowed a clean composite signal to be generated for any frequency between 5 Hz and 15 kHz. See Figs. 5a, 6a, and 7. At last, one setting of the filter coils worked for all audio frequencies!

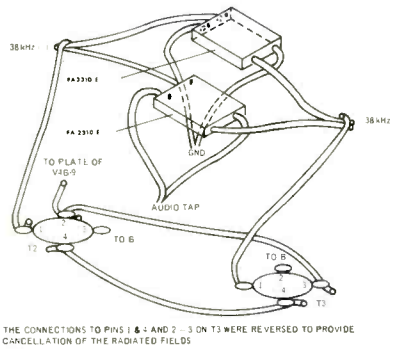


Fig. 4—Showing diode wiring. The connections to pins 1 and 4, 2 and 3 on T3 were reversed to reduce hum.

The filters were not adjusting properly. The slugs had to be screwed out too far for proper response. Elimination of C23 and C25, and changing C27 from 430 pF to 100 pF resulted in a filter capable of providing the proper shape to the base line of the composite signal. See Fig. 4. It is necessary to adjust the filters so that the base-line deflection is no more than 1/1000 of the other channel signal swing in order to achieve 60 dB of separation. See Figs. 5b, 6b and 7b for the results. Due to circuit irregularities, some compromise must be made on maximum separation at one frequency, vs. equal separation at all frequencies. To see these results, you need a high-quality scope, capable of handling wide signal swings without overloading. The scope *must* be on d.c. coupling, or the flat base line will sag causing misleading results.

The 19-kHz Signal

The 19-kHz signal was the next item to come under examination. It was distorted. This problem was also partially solved by the reorientation of the oscillator coils. Another improvement in the distortion occurred as a result of putting a 180-k resistor in series with the padder adjustment, C11. The biggest benefit of the series resistor was the reduction of the amplitude of the pilot signal, without having the trimmer almost ready to fall apart. With the pilot level pot all the way up, the trimmer is adjusted for a level of 10 per cent of the full signal swing. (100 per cent modulation of full signal swing occurs with 0.86 volts rms being fed into the external audio jack. The output is 0.4 volts rms.) It is important that the pot be in the wide open position when making alignment checks of the separation portion of the stereo decoder. Any other position causes an unknown amount of phase shift which *destroys* separation. Turning the signal down is valuable only for determining when the decoder will no longer sync with the generator.

To get proper control of the phase for the left and right channels, the 19-kHz phase-shifting networks must be modified. The Phase Test, Right and Left signal 19-kHz phase-shift networks are all referenced to the signal coming from L4. The Phase-Test position provides a 19-kHz signal in phase with the 38-kHz reference point. The generator provides a ±45-deg. phase shift for the left- or right-channel signals. When the decoder doubles the 19-kHz signal to 38-kHz, the phase shift will become ±90 deg. For ease in measuring while aligning the generator, the reference from L4 is used. It becomes imperative that no phase shift through R25 and R26 should occur.

To make the modification, (1) connect a 150-pF capacitor across R26. This balances the capacitance encountered by the wire leading from the switch to the grid of V3-B, (2) Replace R27 with a 5-k pot, and (3) C9 with a 1-nF padder in parallel with a 680-pF capacitor. Connect the scope horizontal to the 19-kHz signal coming into the phase-shift network, and the vertical to the grid of V3-B. The scope will display a straight line on a 45-deg. slope when the value of the 150-pF capacitor is correct. (Use 10:1 probes, as the probe capacitance of a 1:1 unit is sufficient to give you false readings. The scope must be of sufficient quality to ensure that no phase shift occurs when the vertical and horizontal amplifiers are attenuated in the uncalibrated mode. This condition is easly checked by putting both probes on the same signal. The result will be a straight line if the phase shifts are equal or nonexistant. See Fig. 8.) Don't go past here until you are satisfied that the line is straight.

Switch the Mode to the Left channel and adjust the pot for a 45-deg. phase shift. Then switch to the Right channel and adjust the padder for a 45-deg. phase shift in the opposite direction.

For in-phase signals, the cosine of 0-deg.=1.0, and for a 45-deg. phase shift, the cosine of 45 deg.=0.707. Assuming that the scope is adjusted so that the widest part of the loop is 10 units long, and centered about the horizontal axis, the portion of the horizontal axis inside the loop will be 7.07 units long, when the phase shift is 45-deg. Care must be taken to get the pattern centered vertically before taking the horizontal measurement. See Fig. 8.

With the ticklish left-right reference business done, it is now an easy matter to align the phase setting with the 38-kHz oscillator. Modulate the generator with 400 Hz at 0.86 volts. Put the mode switch in Phase Test. Turn the pilot carrier pot all the way up. Check the 10-per cent carrier adjustment and reset if necessary. Adjust L4 for minimum deflection in the center-line, or base, of the composite signal. See Fig. 8b. A slight compromise will probably have to be made to balance the upper and lower portions of the base line.

In order to prevent any loss of separation in the r.f. section, the modulation control has to be bypassed. The pot has been reconnected as a load resistor. Also, the Deviation-Sweep Width-Audio Level-Composite Level, (modulation level) control must be in the wide open position. Any other setting will introduce high-frequency losses that will completely invalidate the stereo separation.

The frequency response of the r.f. modulator was checked out using a Tektronix Wave Analyzer and a chart of Bessel functions. The results demonstrated that the r.f. modulation is flat up to 75 kHz. No changes needed here! This is adequate to transmit a good stereo signal. What it really means is that the signal you see at the composite audio output you can expect to see at the detector of a high-quality, *properly* aligned FM tuner.

In order to have equal amplitude signals for stereo left or right or center as compared to mono, the audio attenuator was changed. It was also relocated so that the signal would come from the external audio input jack. The audio attenuator is made up of the 620-ohm and 220-ohm resistors. The sum of these two resistors (840 ohms) works with the 12-k ohm pre-emphasis circuit. If you wish to change the amount of attenuation of the monophonic signal, keep in mind that the sum of the two resistors should be about 840 ohms if you do not wish to change the values in the pre-emphasis circuit also.

In order to test frequency response of tuners and multiplex units, a second audio input jack was added. It is wired in series with the first input jack. When the audio is plugged in here, an RC network is introduced that provides the necessary 75-μsec. pre-emphasis for FM broadcasting. When using this jack, stay with the 0.86-volt input. The output at low frequencies will be down 20 dB from 100 per cent modulation, increasing toward 100 per cent modulation as the audio test frequency is increased. If you increase the low-frequecy amplitude to achieve 100 per cent modulation, then the high frequencies will be overmodulated, causing no end of grief for most tuners.

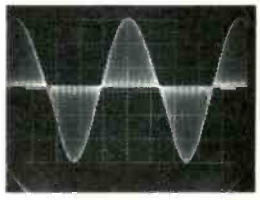
To obtain a wider swing in the sweep mode, point F has been removed from the filaments and reconnected to a voltage divider which is connected between one of the power transformer secondary high-voltage leads and ground.

In order to keep local stations suppressed during the tests, the supplied twin lead was scrapped in favor of a 75-ohm coax, hence the BNC jack in the i.f. Marker position. To match the cable to the 300-ohm input of most tuners, a half-wave stub can be used. The half-wave stub should be 4 ft. 3 in. long for frequencies around 100 MHz.

The only way that a signal should be able to get into the tuner is via the antenna cable. However, the whole front of the stereo generator was alive with r.f., resulting in totally unpredictable control of the signal strength.

A strong source of r.f. radiation was coming from the tuning knob. An r.f. shorting bar had to be installed over the shaft of the r.f. tuning capacitor. In spite of the original grounding of the shaft, it acted like an antenna. This is because the ball bearings, rolling in grease, do not act as an efficient r.f. conductor. The shorting bar is just a piece of soft metal from the bottom of a can, with a hole punctured in it. The edges of the hole have been torn back. The bar has

400 Hz
500 μsec/div.



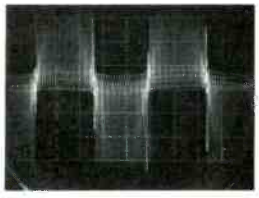
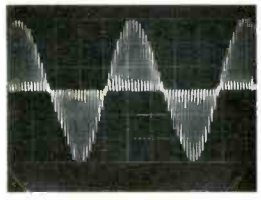


Fig. 5a—vert, 100 mV/div.
Fig. 5b—vert, 5 mV/div.
(60 dB separation)

1 kHz
200 μsec/div.



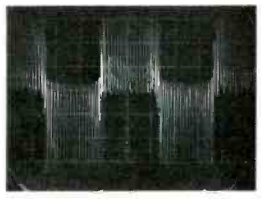
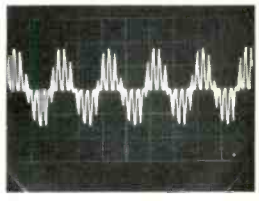


Fig. 6a—vert, 200 mV/div.
Fig. 6b—vert, 5 mV/div.
(54 dB separation)

5 kHz
100 μsec/div.



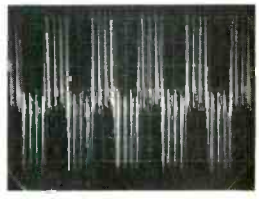


Fig. 7a—vert, 500 m/V div.
Fig. 7b—vert, 5 mV/div.
(54 dB separation)

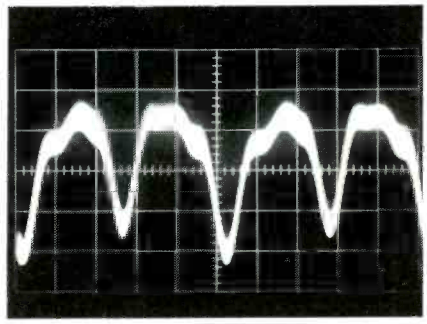


Fig. 8—Residual 38 kHz at the Composite-Audio jack when no signal is present. Vertical scale, 2 mV/div; horizontal, 10 μsec/div.

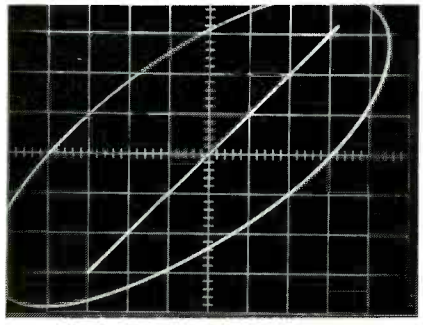


Fig. 9a

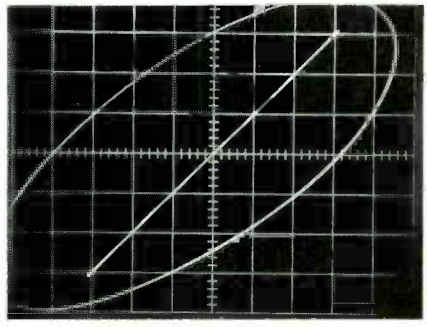


Fig. 9b

Fig. 9a shows the correct phrasing of the 19-kHz signal; Fig. **9b** is incorrect. First: check the Phase-test position—the resultant curve should be straight and at a 45-deg. angle. With the scope adjusted so that the horizontal portion of the trace is 10 units long and centered vertically, the distance inside the loop along the horizontal centerline is measured. For a 45-deg. phase shift, it should be 7.07 units long. "A" is very close to this value, but the distance in "B" is slightly longer.

been forced over the tuning capacitor shaft. This forces the fingers to press against the shaft and ground it. Holes were drilled in the shorting bar to accommodate the capacitor mounting screws.

While the radiation was reduced, it was by no means gone. It was finally noticed that there was a gap between the r.f. oscillator shield and the front panel. Filling the crack with wire braid (working it all the way around the three sides of the shield box) eliminated the front panel radiation. See Fig. 2.

To help guarantee that a poor-quality tuner would not pick up any signal from the power line, another filter capacitor was connected from the incoming line to ground. It is connected at the outer lug of the fuse. The capacitor value is 5-nF, 600-volt, mica. The fuse was another of the early modifications, more to protect the shop from fire than the instrument from self destruction. The power cord was also shielded with wire braid and covered with a plastic sheath. It is connected to the chassis with one of the terminal mounting screws located near the power cord entrance.

Some attempts were made to obtain reasonable results from the r.f. attenuator switches. Different values of resistance and various grounding combinations were tried, and finally an attempt at shielding the switches from each other and the r.f. generator was made. Unfortunately, the switches are very capacitive with the result that attenuation relies upon phase shift, and not a straight loss as desired. Now these switches are left in the up position and an external r.f. attenuator box is used.

(To Be Continued)

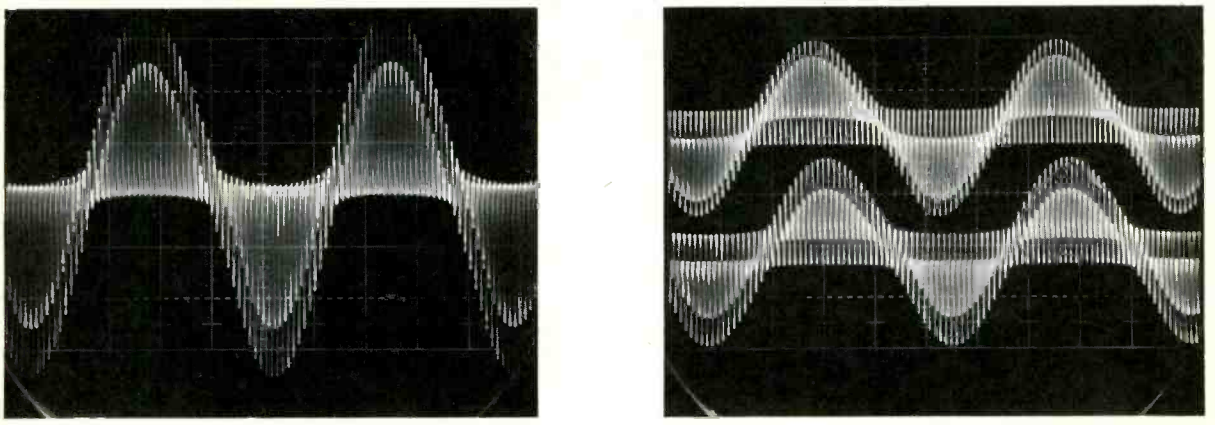


Fig. 10a—Stereo generator output at Composite-Audio jack, 400-Hz signal. The 19-kHz pilot carrier is set to the required 10% modulation. The lack of straight base lines shows the degree of 19- and 38-kHz phase inaccuracy. The phasing adjustment was set for reasonably matched closure of both upper and lower baselines. **Fig 10b** clearly shows that each baseline has both a straight and a curved portion.

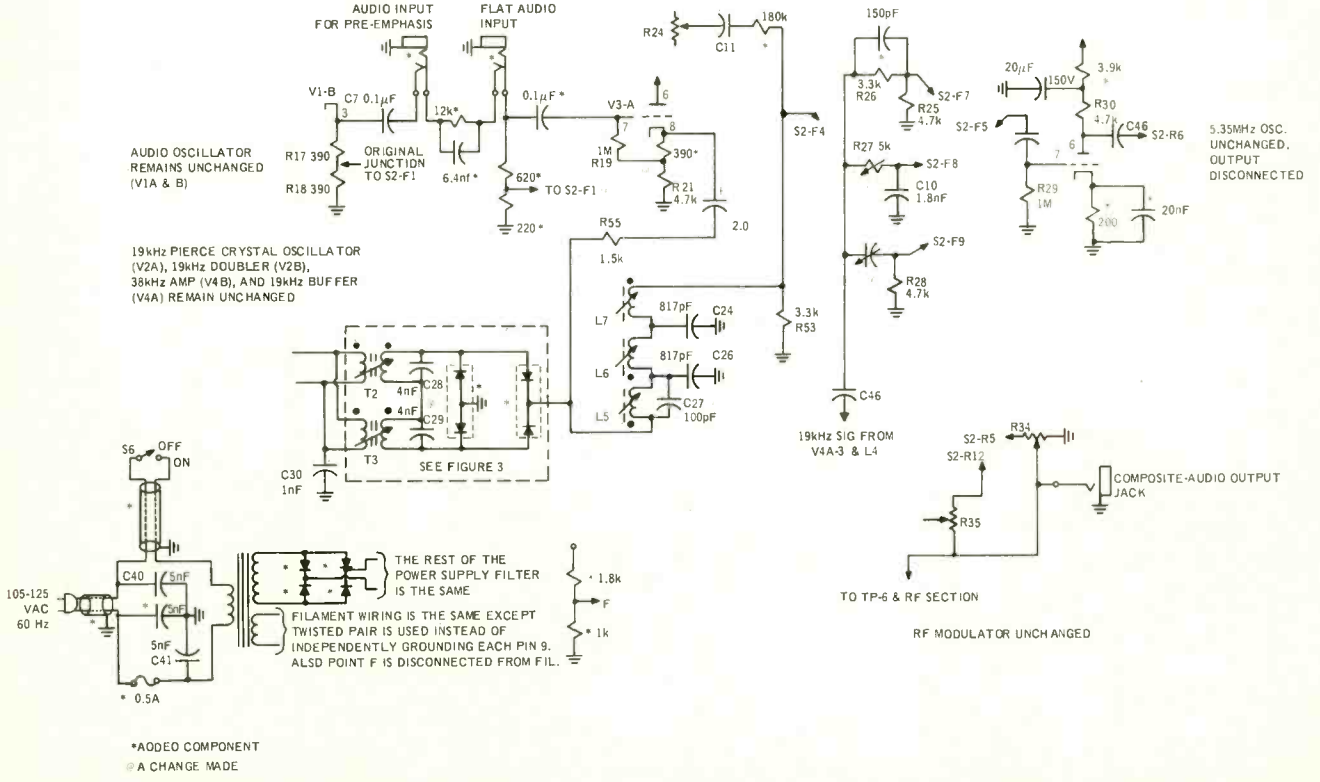


Fig. 11—Basic schematic of Heathkit Stereo Generator.

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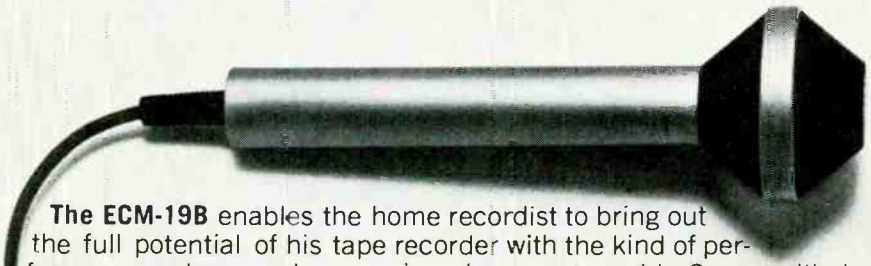

The ECM-19B enables the home recordist to bring out the full potential of his tape recorder with the kind of performance only a condenser microphone can provide. Comes with desk stand, swivel-mount for standard mike stand, 1.5-volt dry battery, and 10-foot cord with mini plug. Price—only $29.50.

The ECM-22, the electret version of the famous Sony C-22, is designed for the semi-professional as well as the home recordist. No other microphone in the world offers so much performance for your dollar. Comes with swivel-mount, stand adapter, wind screen, vinyl case, and 20-foot cadmium-bronze, two-conductor shielded cable. It also incorporates a three-position switch for on or off, and to select either flat frequency response or frequency response attenuated 6 dB per octave below 200 Hz. Price—only $99.50.

The ECM-21, also for the home recordist, is ideal for rock groups who want high-quality PA performance at a budget price. Comes with swivel-mount desk stand, wind screen, 1.5-volt dry battery, and 20-foot two-conductor shielded cable. Price—only $49.50.

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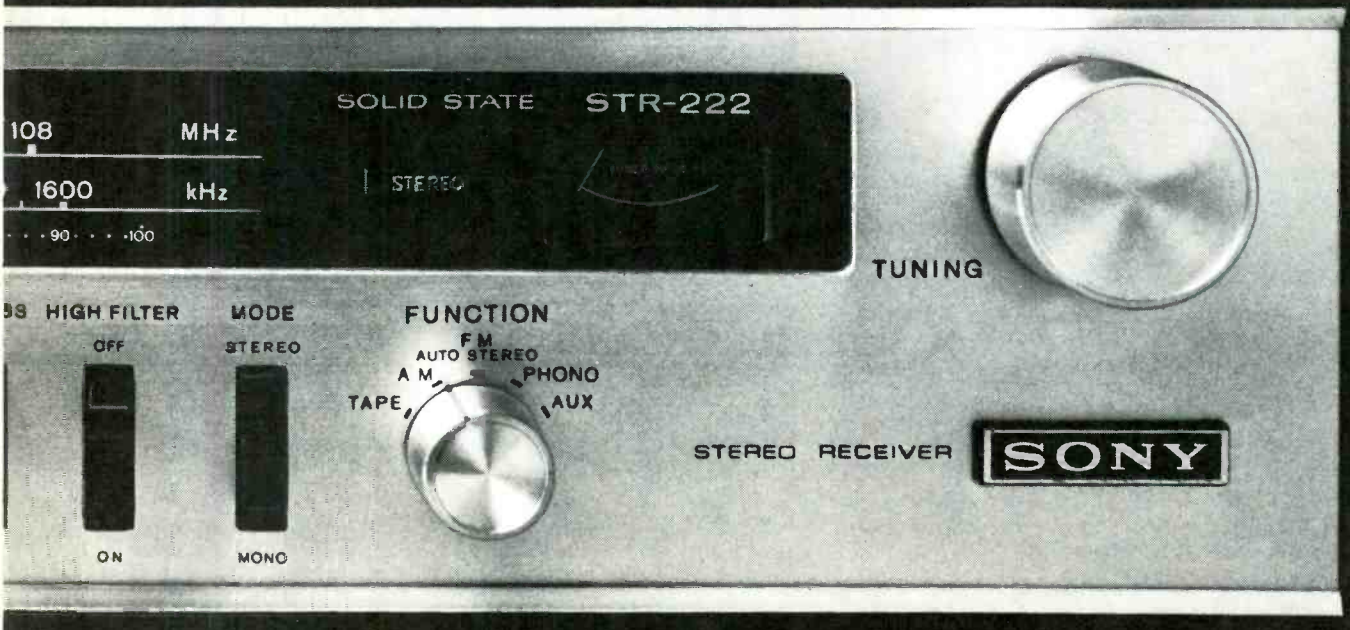

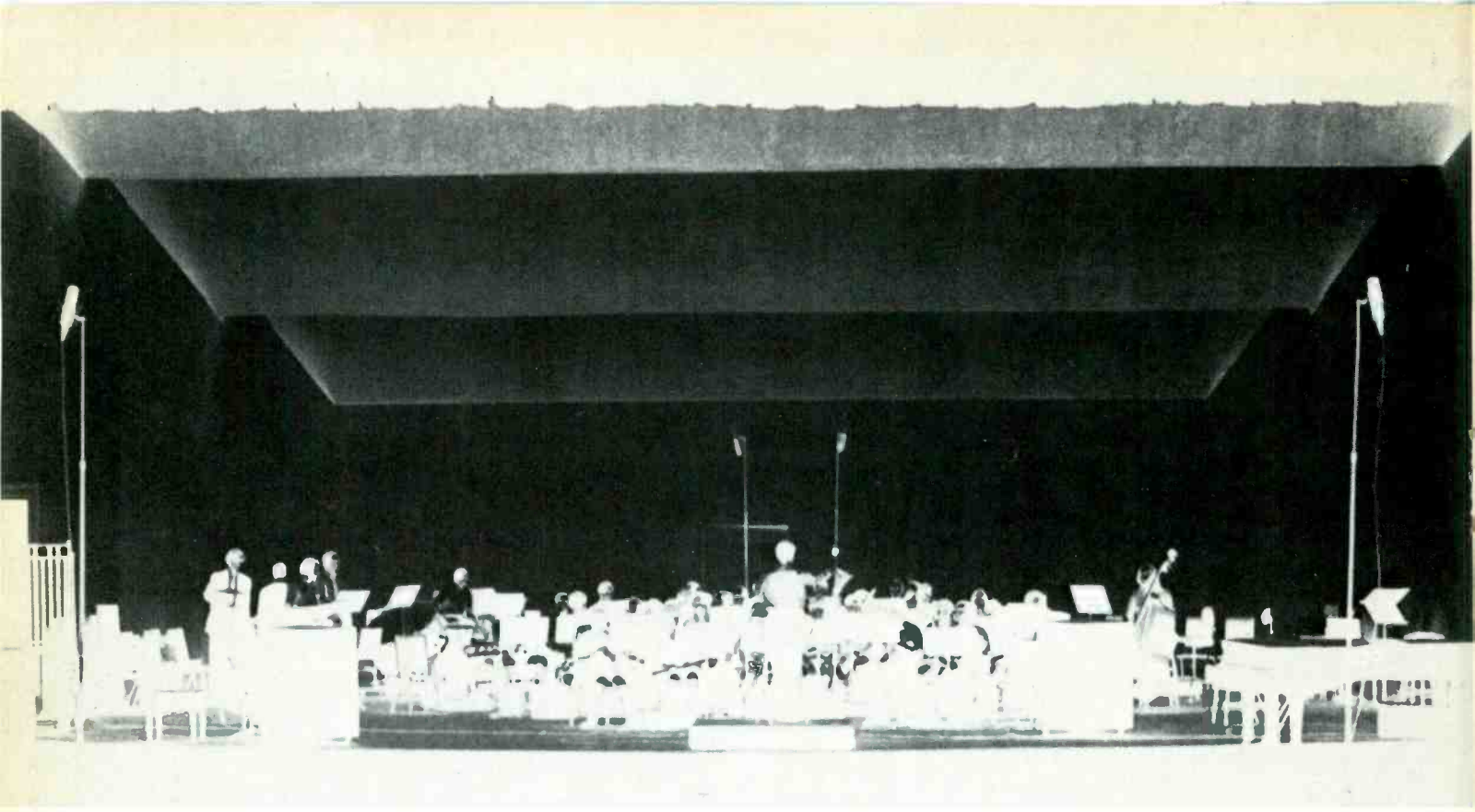

the recording studio

DR. DONALD HUNSBERGER *

The development of professionally-equipped and operated recording studios in music schools throughout the United States has been a recent and most vital addition to the training of the performing musician. The recording studio has been integrated into traditional music education quite rapidly, considering the rather slow acceptance of many other technological advances afforded the educator during the recent emphasis on scientific development.

In most instances the resident engineer and the studio fulfill varied needs in the daily life of the music school: recording of recitals and concerts, and similar documentation which maintains the performance history of the institution; playback of concerts, both for the individual performers and the massed ensemble; duplication of recorded material for classroom use (as in language laboratories), for individual use by the student in remedial theory instruction, for reference use by outside institutions in evaluating a student's performing ability; classroom recording services for writing skills programs; and, frequently, the operation and maintenance of sound reinforcement systems as well as playback equipment situated in faculty offices and studios.

*Eastman School of Music

The photo above shows the Eastman Wind Ensemble recording on stage of Eastman Theatre using quadraphonic microphone set-up. Microphones being used are Neuman U 47's and U 67's. Distance from rear mics to stage mics approx. 40 feet. Dr. Hunsberger conducting.

These widespread demands for recording services have created a conspicuous need for professionally trained sound engineers. Never before have opportunities existed for professional-level engineers and technicians in educational institutions. To overcome some of this lack of trained personnel, the Eastman School of Music established a Recording Workshop in 1967 as part of its Summer Session institute training area.

The Recording Workshop offers two one-week courses in basic recording techniques, in both studio and location format, set-up procedures for all types of ensembles, basic through advanced experience in mixing techniques plus instruction in the electronic properties of recording and playback equipment. Phil Ramone, executive vice-president of A & R Recordings, Inc., and David Greene, director of quality control for A & R, are the guiding forces behind this pedagogical program. Professional ensembles, assembled for the Arranger's Laboratory-Institute held concurrently with the Recording Workshops, provide varied types of recording situations including combos, large studio orchestra and dance band. Recitals and concerts of the Eastman School Summer Session are also recorded by Workshop participants. Dates for the 1970 Workshops are July 20-24 (Basic Recording Techniques) and July 27-31 (Recording Workshop).

The Eastman School Recording Studio

The Recording Services Department at Eastman is operated by Harry R. Ritchie with the assistance of several student employees. Mr. Ritchie is a former Director of Recording for both the United States Marine Band, Washington, D. C. and the Sound Department of Washington Cathedral. The studio utilizes a custom solid-state console by Suburban Sound, Bethesda, Maryland, with 16 channels in, simultaneous 4 and 2 out, or, 8 and 2 dry out; a Scully 280-4 tape recorder plus Ampex tape recorders for 2-track, full- and ¼-track tapes; MacIntosh monitor amplifiers; AKG, Altec, and Neuman condenser microphones, and, Altec 604 E and A7 Voice-of-the-Theatre speaker systems.

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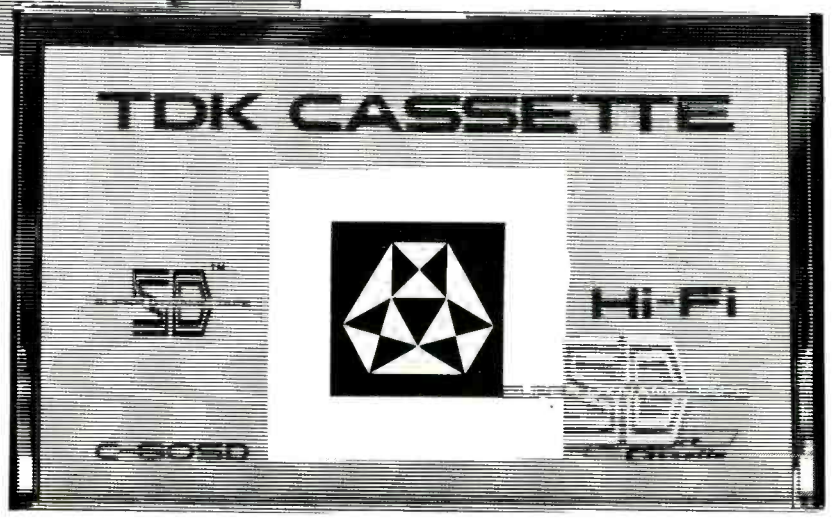

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The Studio and the Large Ensemble Program

Critical analysis of one's performance and participation in massed or chamber ensembles constitutes an important facet of growth and development for the performing artist. As a firm believer in this tenet, I make frequent use of taping and playback of both rehearsals and performances, to provide insight into musical problems such as interpretation, balancing of melodic lines and harmonic structures, development of rhythmic solidity, tonal colorations, and so on, and possible solutions to these problems. While employing these recordings basically for the *musical* development of the young performers, it is also possible to present information which contributes to the *technical knowledge* of the player; thus, Mr. Ritchie is called upon to discuss topics such as characteristics, patterns, and placement of microphones relative to producing the recorded sound of a theatre versus a studio; speaker characteristics; ensemble seating variations, and the like. The experience of being recorded must be a total one and each performer must become aware of what the microphone, mixing console, and tape machine can do *for him* as well as what it is capable of doing *to his detriment*.

The studio should function as a research laboratory as well as a documentation or reproductive center. An example of an extended series of recordings and experiments in recording will serve to illustrate the close relationship between the recording studio and the ensemble program.

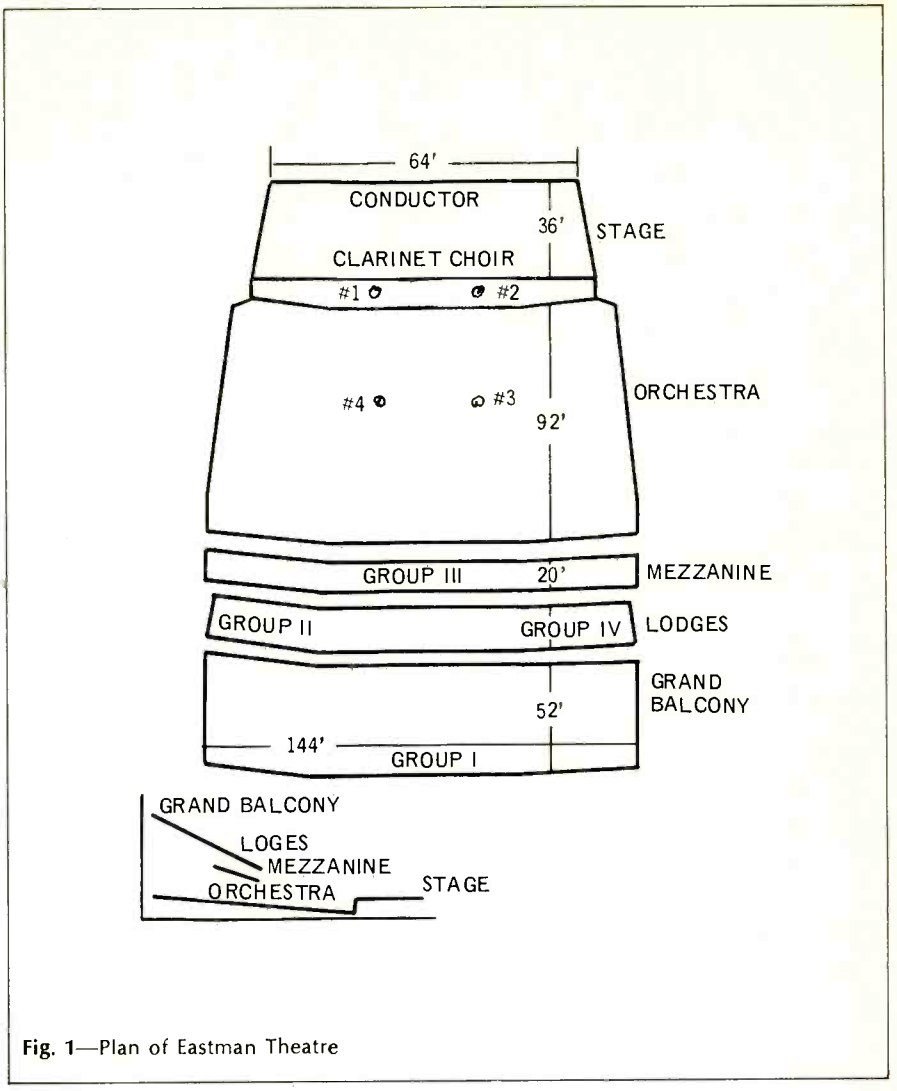


Fig. 1—Plan of Eastman Theatre

A Spatial-Music Concert and a Quadraphonic Recording

Henry Brant, composer-in-residence at Bennington College, was invited to the Eastman School to present a program of his spatial (geographically-separated) compositions with the Eastman Wind Ensemble on March 24, 1969. Coincidentally, Acoustic Research, Inc., was undertaking a series of experiments in quadraphonic recording, and the Brant concert was recorded in this mode. The combined experience of creating live spatial music along with a recording based on geographic areas of sound generation produced a most interesting session for the performers, the engineers, and subsequent audiences.

Among the works on the March 24 program was Mr. Brant's *Antiphony I*, scored for five separated ensembles, each with its own conductor. This work was conceived with a basic ensemble on the stage portion of the hall (two versions of this ensemble exist: a string ensemble or a clarinet choir, the latter used in this performance). The other groups were distributed in this fashion.

Group I
Piccolos, oboes, E-flat clarinet
Uppermost portion of the top balcony

Group II
Muted trumpets, muted trombones
Left side of the Loges

Group III
Horns
Mezzanine level, with bells projecting out over the front railing into the orchestra seating area

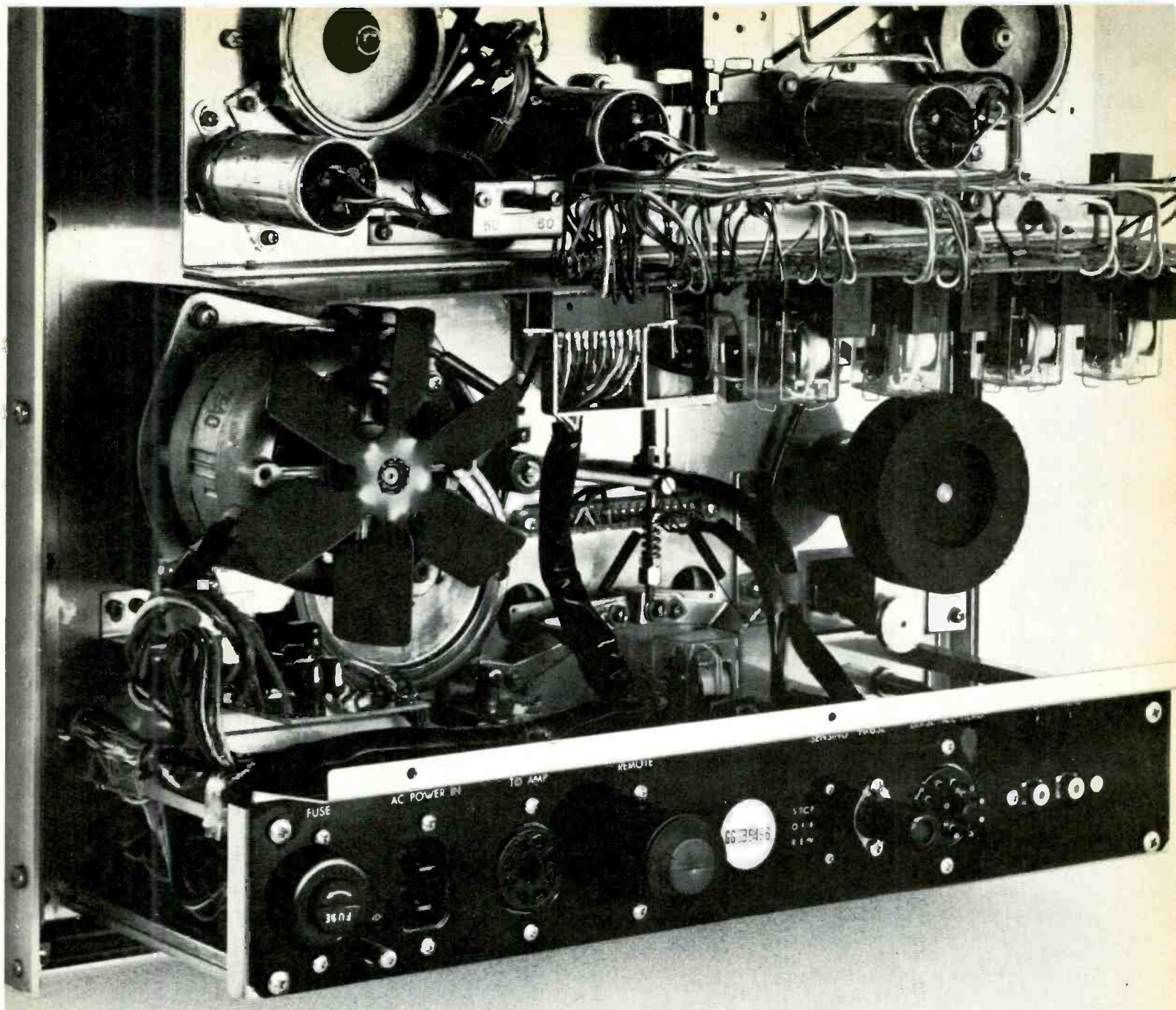
Group IV
Timpani, chimes, melodic keyboard percussion instruments
Right side of the Loges

All players faced their own conductor, who in turn, faced the stage area to receive entrance cues from Mr. Brant, who was conducting the clarinet choir. To accomplish this, Mr. Brant conducted facing the audience while the members of clarinet choir sat facing him with their backs to the audience.

The aural effect of the five widely-separated groups was exemplified by the high woodwinds in Group I which were located at the very top of the grand balcony, approximately 80 feet *above and behind* the audience. This was a true demonstration of a live spatial effect, in that members of the audience experienced not only high frequencies of sound, but also the illusion of height being projected from the location of the sound source.

The recorded effect in four-channel reproduction also provided a gratifying sense of direction of sound source. A plat of the Eastman Theatre, with the location of microphones in relation to the five groups and the audience, will help to explain further the basic physical distribution of performers and equipment. See Fig. 1.

During the week following the concert with Mr. Brant, the Eastman Wind Ensemble presented a program of more traditionally-oriented music which was



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also recorded in the quadraphonic mode; an edited version of the two concerts was prepared and presented to recording industry representatives as demonstration of two- vs. four-channel recording.

During the past year further experimentation was carried out by the Eastman Recording Services Department with various ensembles of the Eastman School. The most recent recording was made on March 12, 1970, and again involved the Eastman Wind Ensemble in the Eastman Theatre. This session resulted in an experimental quadraphonic recording which was presented as part of the first four-channel broadcast from a single source (AR has been sponsoring four-channel broadcasts over two stations in Boston since last fall). Following this broadcast over WNYC in New York, the tape was played at the March meeting of the New York Section, Audio Engineering Society, devoted to discussion of quadriphonic recording.

The Studio and the Classroom

In addition to the reproduction of rehearsals and concerts for analysis by the performers, the recording studio plays an important role in classroom activities of the music student. The theory department, where the student is trained to develop his aural comprehension and writing skills, utilizes the studio to prepare dictation tapes both for classroom playback and for individual remedial study by the student. Most theoretical training begins with the analysis, dictation and writing of four-part chorales, particularly those of Bach. By recording chorales on four tracks, with the soprano, alto, tenor, and bass voices isolated each on its own track, playback procedures may be programmed to offer almost unlimited combinations of dictation possibilities. (With the average playback deck in the classroom being ¼- or ½-inch stereo, a mixdown from four to two tracks with a prepared programmed teaching syllabus enables the theory instructor to realize the benefits of multitrack recording on his two-track machine).

As the theory class progresses from recreative writing skills to original composition or arranging, good use may be made of actual classroom recording and playback as well as more extensive involvement of the full facilities of the recording studio for highly sophisticated recording problems.

Orchestration Analysis

An exciting adaptation of multitrack recording and playback becomes evident in orchestration and composition study, and in analysis and styles courses. It would be possible, for example, to utilize a twelve-track mixer and recorder to trace the development of orchestration techniques by simultaneously recording each orchestral voice or section on its own isolated track. (This procedure is used daily in recording techniques, but the end result is a mix-down into mono or stereo mode.) The instructor would then play back the tape and isolate or highlight any particular voice desired. In a simulated demonstration the original score would appear in the form shown in Fig. 2.

The orchestral voices are recorded thus:

Track	*Orchestral voice*
1	Flutes
2	Oboes
3	Clarinets
4	Bassoons
5	Horns
6	Trumpets
7	Trombones
8	Timpani
9	Violins I
10	Violins II
11	Violas
12	Celli/Bass

The page of full score would have marked areas which illustrate a particular orchestration situation. For example, if one wished to illustrate the orchestration of an early classical symphony, staves (and tracks) 1, 3, 6, 7, and 8 would be blacked out. By adding staves 6 and 8 (and tracks 6 and 8) the features of outdoor performance would now be present. If one wished to demonstrate the classical wind serenade band, he would use tracks 1, 2, 3, 4, and 5. It is easy to visualize the tremendous possibilities inherent in this form of technological adaptation into traditional music study. Unfortunately, too many schools do not possess either the equipment or the trained personnel to make their recording studios meaningful participants in the daily lives of their students.

Conclusion

The time has arrived when the recording industry must join forces with educational institutions to find ways to educate the ever-increasing number of persons necessary to provide professional-level sound recording and technical assistance in music schools, fine arts centers, secondary schools, and university campuses. The versatile sound engineer, equipped with both a musical education (theory, history, and actual performance) and engineering skills related to acoustics, circuitry analysis, and equipment maintenance, will fill a definite need in the educational processes of today and tomorrow. Æ

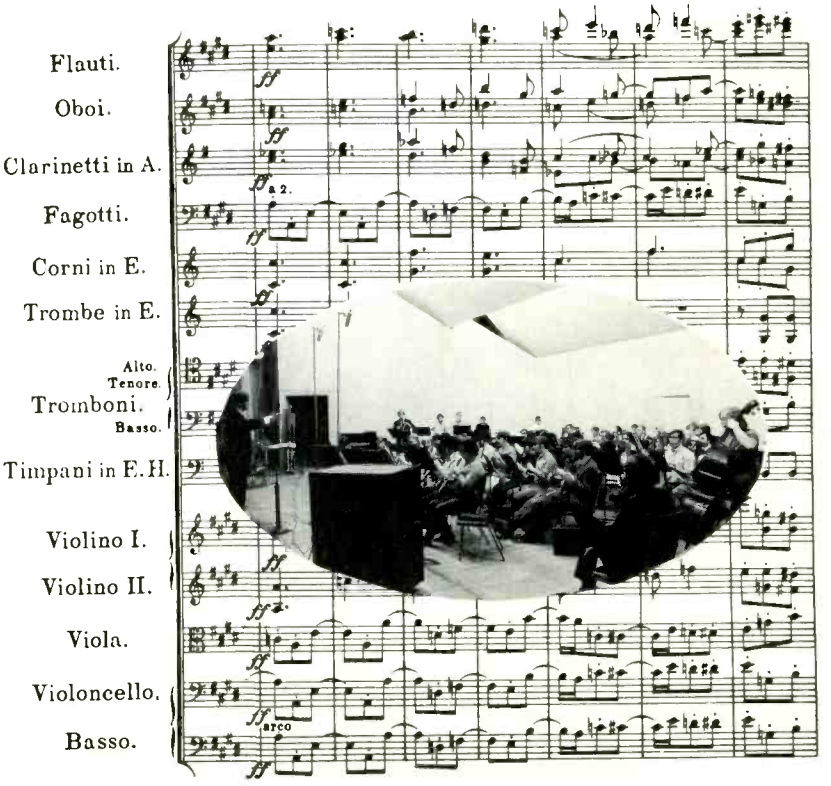
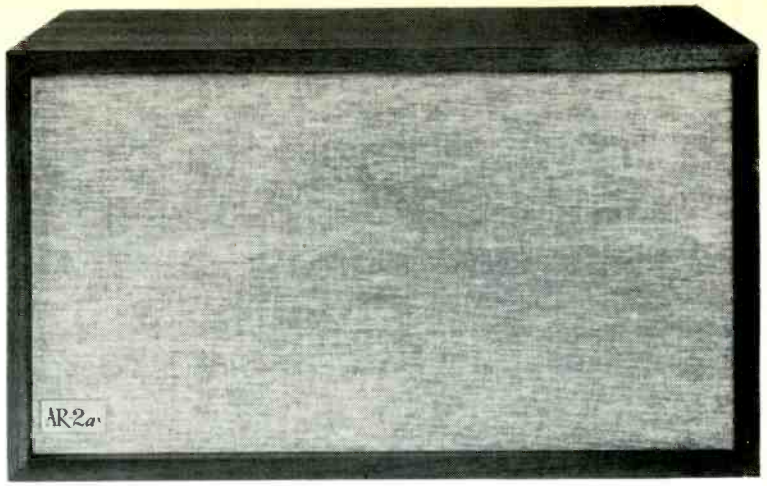
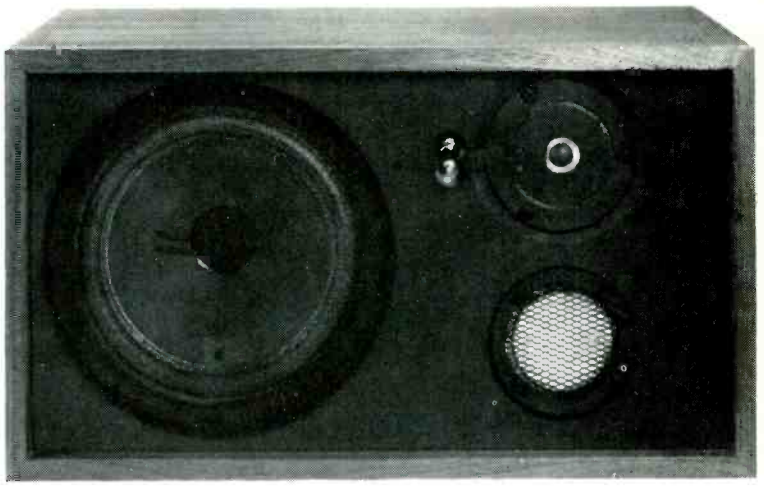


Fig. 2—Score from Schubert's Symphony in B minor

The AR-2a^{x}: an evolutionary new speaker system.



1970 AR-2a^{x}



1964 AR-2a^{x}

1959 AR-2a

1957 AR-2

The AR-2 series of speaker systems made by Acoustic Research has long been considered a standard of high-fidelity performance where cost requirements made technical compromise necessary. The best speaker system in the series, the AR-2a^{x}, was the result of a series of refinements of the original AR-2. The most important such change has probably been the conversion of the older unit to a three-way system.

Now, the AR-2a^{x} has been changed to incorporate the same two speakers as are used in the AR-5 for reproduction of the lowest and highest frequencies (the AR-2a^{x} midrange speaker remains the same). Both of the new speakers are among those most recently designed at Acoustic Research.

The high-frequency unit is the same miniature hemispherical device as is used in the AR-5 and AR-3a, and is only ¾-inch in diameter. It is the best high-frequency speaker we know how to make. The low-frequency speaker cone uses a newly developed material and process of manufacture which make its absorption of high frequencies very high, suppressing a form of coloration frequently found in conventional cones its size. The circular suspension ring around the cone is also of a new material, silent and highly stable. The voice-coil is a new high-temperature design, triple-insulated and wound on a form of Dupont Nomex.

We believe that the AR-2a^{x} is now equal or superior to any commercially produced speaker system except the AR-5 and AR-3a. We base this judgment on its lack of distortion, wide bandwidth, reliability and uniformity of both on-axis and total energy radiation.

Detailed measured performance data for the AR-2a^{x} is available. Prices are $109 to $128 depending on cabinet finish.

AR

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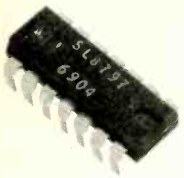
THE WONDERFUL WORLD OF INTEGRATED CIRCUITS



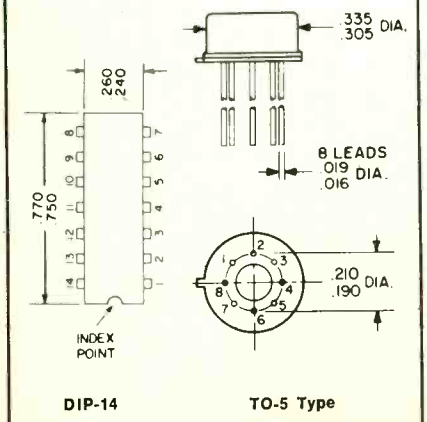
EDWARD J. GATELY, JR.

INTEGRATED CIRCUITS have not found wide application in audio circuitry to date, although they are in the process of revolutionizing the digital computer industry. Because of the size of the computer industry, IC manufactures have concentrated their efforts on developing digital IC's rather than units suitable for audio use. Some audio units have been made available, but until recently their cost has made them too expensive for all but the most exotic applications.

NOTES

While the author describes the 709-series of IC's in the DIP-14 (dual in-line plastic) package, they are also available in the 8-lead TO-5 type package, which some may prefer. For their information, the pin numbers of both types are shown in the diagram below, and the corresponding numbers are shown in the table.

DIP-14 pin numbers	TO-5 pin numbers
1 (not used)	—
2 (not used)	—
3	1
4	2
5	3
6	4
7 (not used)	—
8 (not used)	—
9	5
10	6
11	7
12	8
13 (not used)	—
14 (not used)	—



To be suitable for audio use an IC must:

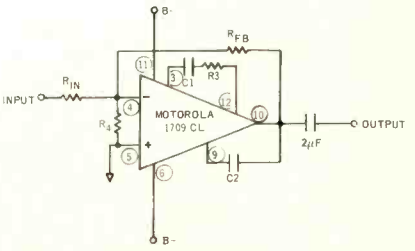
1) Have a cost under $2.00 in 100 quantities.
2) Have an output voltage swing of 10 volts rms.
3) Have an input noise comparable to presently available low-noise transistors—at least −125 dBm when used as a microphone preamplifier.
4) Have a slew rate of 1.7 volts/microsecond. Slew rate is a measure of a circuit's ability to follow large rapidly changing signals; a high value is required if the circuit is to deliver maximum output voltage at high frequencies.
5) Have a power output of at 0.5 watts when used as a 600-ohm line driver (+24 dbm).
6) Have a minimum open loop gain of at least 10,000 (80 dB).

A recent survey of the Integrated Circuit market indicates that the Fairchild μA709, Motorola 709 series, and Signetics N5709 units meet all of the above requirements except numbers 4 and 5. For most applications, the slew-rate limitation can be designed around and where appreciable power is required, it can be obtained by buffering the IC output with a complementary emitter-follower circuit.

The 709-series Integrated Circuits are operational amplifiers featuring a differential input operating from a plus and minus 18-volt bipolar power supply (or a 36-volt single-voltage power supply). They will deliver 10 volts rms into a 10k-ohm load. When used as a microphone preamp their noise is consistantly below −127 dBm; a performance equal to the best low-noise transistor circuitry. When operated as a unity-gain amplifier their slew rate is 0.25 V/μsec which limits the pass band to 2.5 kHz at 10 volts output or 1.6 volts output at 20 kHz. However, when operated at a gain of 20 dB a full 10 volts output can be obtained at 10 kHz. Open-loop gain of these units is 45,000 or 93 dB. Since audio circuits rarely require a gain of more than 40 dB from a gain module, more than 30 dB is available for negative feedback. This, combined with the inherent linearity of IC devices, means that distortion is rarely above 0.1 per cent at 10 volts output. When commercial temperature ranges (0° to 75°C) and plastic packages are accepted, 709-series devices are available at $1.85 in hundred quantities, and $2.80 in single-quantity orders.

Figures 1 through 10 show the application of one of these 709-series devices to the most commonly encountered audio circuits. The Motorola 1709CL was specifically chosen because of its wide availability at reasonable cost, and because of its 14-pin DIP package. This package is generally easier for the new IC experimenter to work with. It is recommended that all circuits be constructed using a 14-pin DIP IC socket. Suitable ones are available from Barnes, Augat, Cinch, and others.

Within reason any bipolar power supply can be used up to 18 volts which is the design maximum for ICs. Exact bipolar balancing is not required; however if serious symmetrical clipping is to be avoided, the supply should be balanced within 10 per cent. For the beginning experimenter, it is recom-

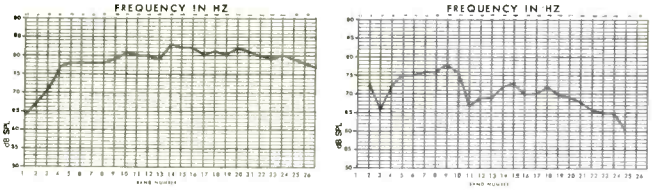


GAIN X	GAIN dB	R_{IN}	R_{FB}	R_3	C_1	C_2	R_4
1	0	10 K	10 K	1.5 K	5,000 pF	200 pF	1 K
10	20	10 K	100 K	1.5 K	500 pF	20 pF	–
100	40	10 K	1 MEG	1.5 K	100 pF	3 pF	–
1,000	60	10 K	10 MEG	–	–	–	–

Fig. 1—Typical inverting amplifier.

Every studio has its own ups and downs.

No two studios look alike in size, shape and location of speakers—in acoustic environment. So naturally no two studios look alike in frequency response either—in acoustic response.



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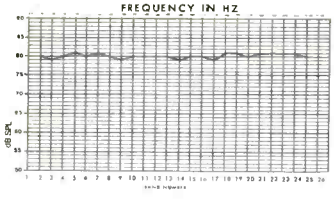
Acousta-Voicing doesn't remove any of the usable program material.

Instead, it takes all the over-emphasized frequencies and equalizes them with all the normal responding tones in the room.

Acousta-Voicing lets you hear exactly what was recorded when tracks are played-back.



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Just some of the places Acousta-Voicing is performing include Century Records, Capital, Universal/Decca Recording Studios and the Academy Awards Theater.

And recently Brendt Albright, the Administrative Engineering Manager at Universal/Decca Recording Studios, told us, "Finally we have a single reference point of perfect sound to work from in all our recording studios...Acousta-Voicing takes the educated guesswork out of balancing tracks."

Here are some Acousta-Voicing specifics.

Acousta-Voicing is the only sound equalization system of its kind to use calibrated, fully-adjustable, critical, bandwidth, band rejection filters.

This allows each loudspeaker to be individually tuned in the room where it's installed. So the sound quality is vastly improved. So the sounds you hear from all your studio monitors are identical.

Now you can give artists exactly what they want.

- Acousta-Voicing produces honest sounds—because it's the only accurate way to neutralize acoustical environments in all studios.
- Acousta-Voicing retains these honest sounds all the way to the final track—because equalization can be performed at various stages along the way

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- Acousta-Voicing frees your studios for more recording dates—because time-consuming dub-downs are eliminated.

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Your local dealer will be pleased to demonstrate Marantz systems. Then let your ears make up your mind.

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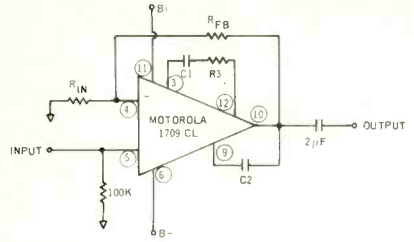
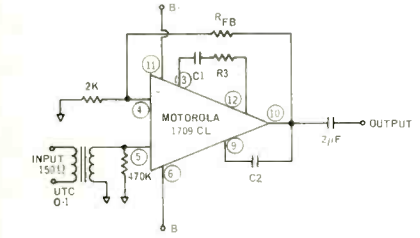


GAIN X	GAIN dB	R_{IN}	R_{FB}	R3	C1	C2
2	6	10K	10K	1.5K	2,500pF	100pF
10	20	10K	100K	1.5K	500pF	20pF
100	40	1K	100K	1.5K	100pF	3pF
1000	60	1K	1 MEG	–	–	–

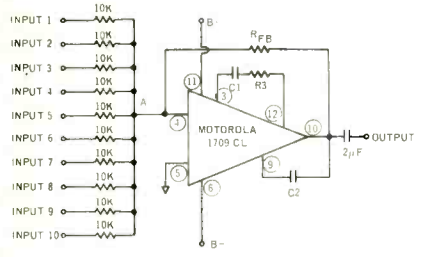
NOTE: WHEN CONNECTED FOR 6dB GAIN, SLEW RATE IS 0.5V /μS LIMITING OUTPUT AT 20 kHz TO 3.2V.

Fig. 2—Typical non-inverting amplifier.



GAIN X	GAIN dB	R_{FB}	R_3	C1	C2
100	40	10K	1.5 K	1000pF	50pF
1000	60	100K	1.5 K	100pF	5pF

Fig. 3—Microphone preamplifier.



GAIN X	GAIN dB	R3	C1	C2	R_{FB}
1	0	1.5K	500pF	20pF	10 K
10	20	1.5K	100pF	3pF	100K
100	40	–	–	–	1 MEG

NOTE: KEEP RESISTANCE BETWEEN POINT A AND GROUND EQUAL TO 1K OHMS IF LESS THAN 10 INPUTS ARE USED. MAY BE ACCOMPLISHED BY GROUNDING UNUSED INPUTS.

Fig. 4—Mixer-amplifier.

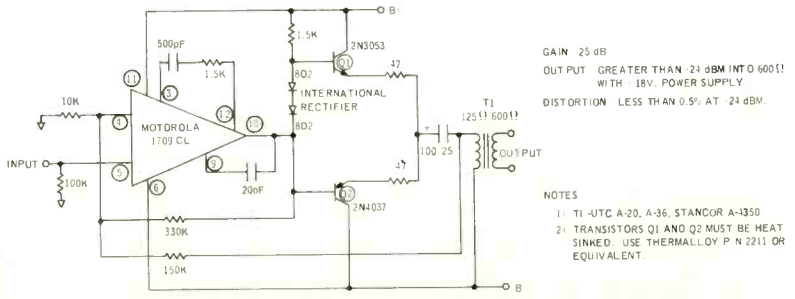


Fig. 5—Typical line amplifier.

mended that diodes be placed in the positive supply line to guard against polarity reversals. One reversal usually destroys the IC permanently.

Because of the large amounts of feedback normally used with ICs, some means must be incorporated in the circuitry to ensure that they amplify rather than oscillate. This usually takes the form of compensation circuits. These are the small RC networks shown between pins 3-12 and 9-10 in the 14-pin package or between pins 1-8 and 5-6 in the 8-lead TO-5 package. Compensation values have been worked out for each of the circuits shown. No problems with parasitic oscillations should be encountered if the leads to and from the compensation capacitors are kept short and the output lead is not routed near the input leads. Recently several ICs have been introduced which do not require external compensation networks. To date these have been relatively expensive and have degraded slew rate specifications. It is hoped that these objections can be overcome in the near future so that IC circuit designers will no longer have to compute compensation values for every different application.

Operational amplifiers are normally supplied with a differential input stage. One of the two inputs is labeled inverting and the second non-inverting. This means, if the inverting stage is grounded and a signal applied to the non-inverting input, the output signal will be in phase with the input signal. Conversely if the non-inverting input is grounded and a signal applied to the inverting input then the output will be out of phase with the input signal. For identification purposes the inverting input is labeled with a minus sign and the non-inverting input is labeled with plus sign.

Figure 1 shows the simplest possible IC audio amplifier. The gain of the circuit is the ratio of R_{fb} to R_{in}. Although other values could have been selected, R_{in} is shown as 10k ohms as this would have negligible loading on a previous IC stage and still be a value which would minimize thermal-noise generation. To avoid slew rate problems when operated as a unity-gain amplifier, R_4 attenuates the input signal by 20 dB and the amplifier then adds 20 dB of gain to make up for this loss. This attenuate-amplify technique is not required at gains in excess of 20 dB.

When signals are obtained from phono cartridges, tape heads, input transformers, and similar devices an input impedance of 10 k ohms would be too low. Therefore the circuit shown in Fig. 2 must be used. This circuit utilizes the non-inverting input which has an input impedance of about a megohm. A resistor of 100k ohms has been shown between this input and ground as it is customary to have a ground-return path. A 1-meg value could have been shown just as well. The user is cautioned that when operated at gains below 20 dB, voltage output capability of this circuit at high frequencies is limited by slew rate.

Figure 3 shows an application of the non-inverting amplifier to microphone preamp service. This 60-dB configuration will give plenty of gain when used with dynamic microphones. The 40-dB version is intended for use with high-output condenser microphones. Even with this reduced gain, preamplifier overload problems could occur when high-output microphones are used in extremely close miking situations. Under these circumstances a 30-dB or even 20-dB gain preamplifier circuit could have overload problems.

Multi-input mixers and consoles require a noise-free method of adding or combining many signals. When more than about six signals must be added, the loss through the mixing network necessary to avoid crosstalk and interaction leads to noise problems. If active mixing is employed these problems can be minimized. Active mixing is accomplished by use of an inverting amplifier and summing the signals at the input. A circuit for active mixing is shown in Fig. 4. The action of the feedback is such that in the unity-gain connection the apparent (virtual) resistance between point A and ground is about 100 ohms. This relatively low resistance limits thermal noise, crosstalk, and input-circuit interaction.

When 709-series ICs are called on to deliver power signals, they just are not up to the job. However, by using this IC as a driver amplifier for a complimentary pair of emitter followers, an excellent 0.5-watt amplifier can be designed. The circuit shown in Fig. 5 is an example of such a design. Note the use of a parallel feedback network. Such a network accomplishes the following:

1) The inner feedback loop around the IC itself assures d.c. stabilization of the circuit as well as reduces distortion.

Our amazing new low-cost speaker is made with a revolutionary substitute for money: Brains.

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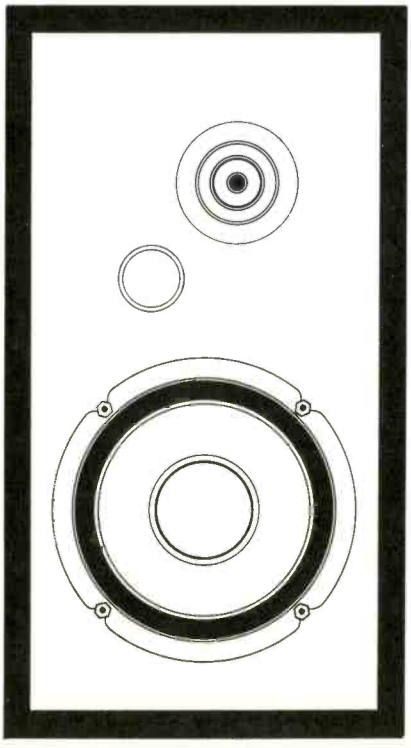
A year or two ago, a speaker like this would have been just about impossible. Every manufacturer knew that inexpensive speakers were supposed to sound mediocre, so that's how they made them, give or take a few sales features.

Luckily, our young engineers are somewhat naive about these things. All they know is physics, mathematics, electronics and acoustics. As far as they're concerned, a correct crossover frequency costs no more than an incorrect one. The right distance between the drivers no more than the wrong one. Proper phasing no more than improper. And so on, down the line. They act as if they believed that at least seventy-five percent of speaker design is knowledge, not money.

So they specified a 10-inch woofer, a 3-inch tweeter, a choke, a capacitor and a volume control. They put these into a 23" by 12" by 10½" cabinet and fussed and fussed. Without any preconceived notions as to how good or bad such an austere design should sound. They stopped only when they could no longer improve the performance.



The result is a $69.50 speaker that not only covers the range from 45 to 17,000 Hz without peaks or harmonics but also has extremely low *time delay distortion*, which is Rectilinear's chief criterion of speaker quality.

What's more, the **Rectilinear XI** is a high-efficiency speaker. It can be driven to window-rattling levels with a puny 10 watts.

A triumph of brain over brawn, you might say.

(For more information, including detailed literature, see your audio dealer or write to Rectilinear Research Corp., 107 Bruckner Blvd., Bronx, N.Y. 10454. Canada: H. Roy Gray Co. Ltd., 14 Laidlaw Blvd., Markham, Ont. Overseas: Royal Sound Co., 409 N. Main St., Freeport, N.Y. 11520.)

Rectilinear XI

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Sound & Decor Styles

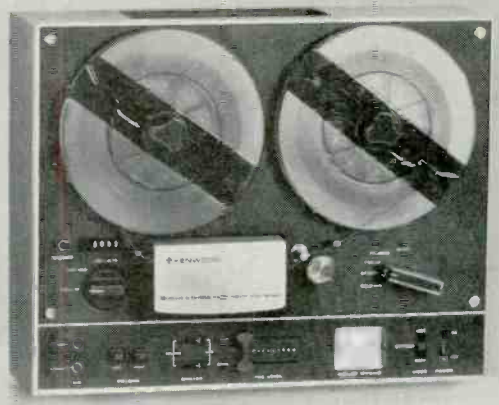
Dr. Y. F. Yeh, Singapore, has Acoustech amplifiers and a Dyna FM tuner built from kits. The turntable is a Thorens and the cartridge is a Stanton 581. Tape-recorders are a Revox G36 and an A77. The speakers (not shown) are JBL 002's in Apollo enclosures.

Richard Stahl, Rochester, New York. A very nice installation with a Dynaco 120 amplifier, FM-3 tuner, and PAT-4 pre-amplifier. The tape deck is a Tandberg 64 and the AR turntable is fitted with a Shure V-15 cartridge. Two AR-3a speakers are against the opposite wall. On the right is Judy Stahl. As I said—a very nice installation.

Steve Golub, New York, is 23 and has a very exotic looking installation which includes a Sony TA-2000 amplifier and ST-5000W tuner, C-M 35D amplifier, Revox A77 tape deck, Transcriptors turntable with Shure V-15 cartridge. The speakers are Electro-Voice Marquis enclosures with 12 TRZ's. Steve is a drummer and records his own band on the Revox.

THE DEPENDABLES!

TAPE DECKS by KENWOOD



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MODEL KW-5065...4 heads, 3 speeds, recording bias adjustment system, 400 Hz test signal oscillator, sound-on-sound/echo recording with level control, noise filter, automatic shut-off

MODEL KX-7010...stereo cassette deck with exclusive micro-gap head for superior sound reproduction, pop-up cassette ejector, pause control, hi-filter switch, dual VU meter, 3-digit counter with reset button

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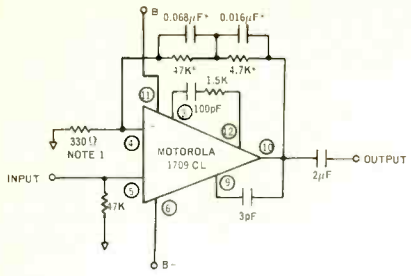
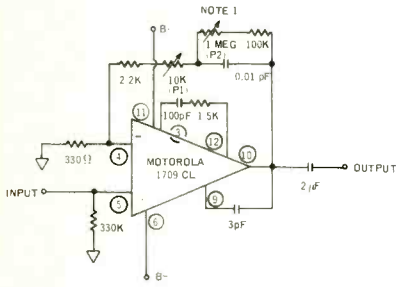


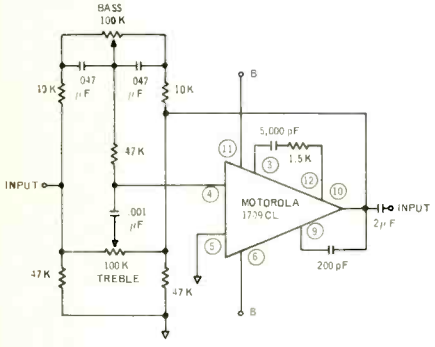
*SELECT 5% COMPONENTS TO BE WITHIN 1 dB OF RIAA CURVE.
NOTE 1: THIS VALUE SELECTED TO ASSURE OVERLOAD GREATER THAN 200mV AT 1 kHz. DECREASE VALUE FOR MORE GAIN.

Fig. 6—Magnetic phono pickup amplifier.



NOTE 1: 10K AND 1 MEG POTS ALLOW ADJUSTMENT TO CURVES FOR 3¾, 7½, AND 15 IPS

Fig. 7—Tape-head preamplifier.



REF: DICK CRAWFORD, "INTEGRATED-CIRCUIT TONE-CONTROL STAGE" AUDIO, NOVEMBER, 1969.

Fig. 8—Typical tone-control stage.

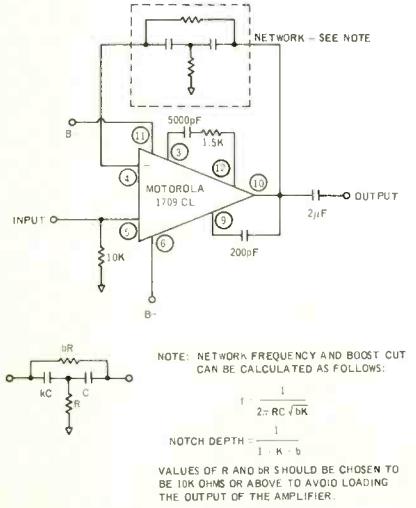


Fig. 9—Peak-boost equalizer.

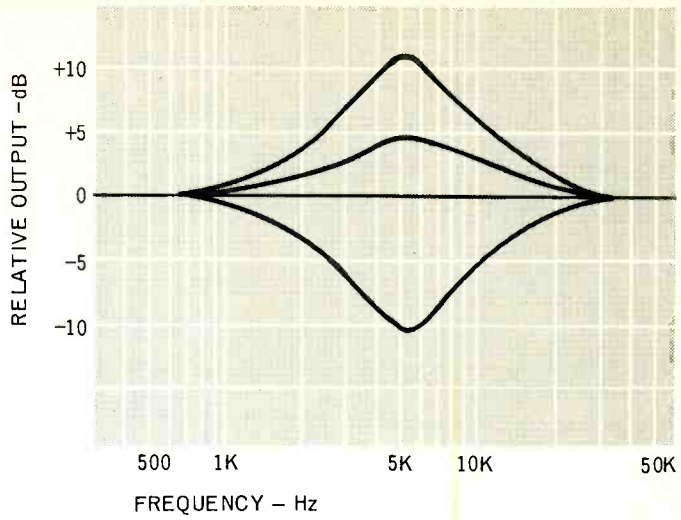


Fig. 11—Boost and curves obtainable with the circuits of Figs. 9 and 10.

2) The outer loop reduces any distortion in the output stage.

The output transformer is returned to the negative power lead to assure that the output electrolytic capacitor is voltage-stressed properly.

If an output transformer having an impedance ratio of 125:8 ohms were used in place of the one shown this amplifier would make a fine 0.5-watt speaker amplifier. For cueing or similar applications this amplifier would be ideal.

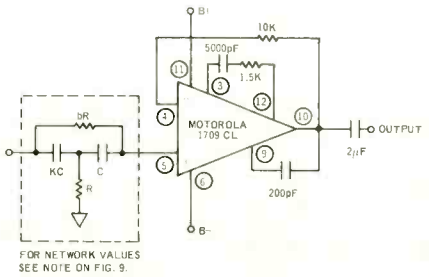
Phono pickup and tape-head amplifiers are similar to the non-inverting circuit shown in Fig. 2 except that the feedback loop contains the necessary reactive components to accomplish the required equalization. Typical circuits are shown in Figs. 6 and 7.

Equalization circuits for signal conditioning vary from simple tone-control circuits to elaborate peak-boost or -dip amplifiers. A typical tone-control stage is shown in Fig. 8. This circuit is adapted to the Motorola 1709CL from a circuit by Dick Crawford published in the November, 1969, issue of AUDIO. Most professional applications of equalizers require much-more-flexible equalizers than the common tone-control type. Figure 11 shows two peak-type boost curves and one peak-type dip curve which are typical of curves frequently encountered in professional applications. A peak boost of about 6 dB at 3 kHz will be used frequently to sharpen up dialog. When such equalization is used on a vocalist, the singer sounds as though he or she was 6 feet in front of the orchestra.

Peak boosting can be accomplished by using a series-resonent circuit in the feedback loop of an amplifier. Since circuits using audio-frequency chokes are subject to various ills, the LCR circuit is usually replaced with a bridged "T" network. The formulas for calculating the values of this network for various frequencies and notch depths are given on Fig. 9.

To obtain dip-type curves, the same networks are inserted between the signal source and the non-inverting input of the amplifier. Professional program equalizers often provide equalization whose boost or cut can be stepped in 2-, 4-, 6-, or 12-dB steps. On the high end, peak frequencies may be selected at 1.5, 3, 5, 10, or 15 kHz At the low end of the spectrum additional peak frequencies of 40 and 100 Hz may be offered.

In this article we've shown all the common audio-signal-processing circuits adapted to IC circuitry. Integrated circuits are equally adaptable to the circuit requirements in other audio components such as tuners. Before many more years go by, all good audio equipment will be built around these new devices extensively. The next time you need a specialized circuit to solve a special requirement, why not use one of the IC circuits shown here? You'll be amazed at the simplicity of application compared with discrete-component circuits.



FOR NETWORK VALUES SEE NOTE ON FIG. 9.

Fig. 10—Dip equalizer.

Suggested for further reading:

1) Ralph Gittleman "Applications of the Audio Operational Amplifier to Studio Use."—*JAES*
2) Dick Crawford "Build An Integrated Circuit Tone Control Stage." —AUDIO Nov. 1969
3) James N. Giles, Fairchild Semiconductor "Linear Integrated Circuits Applications Handbook."

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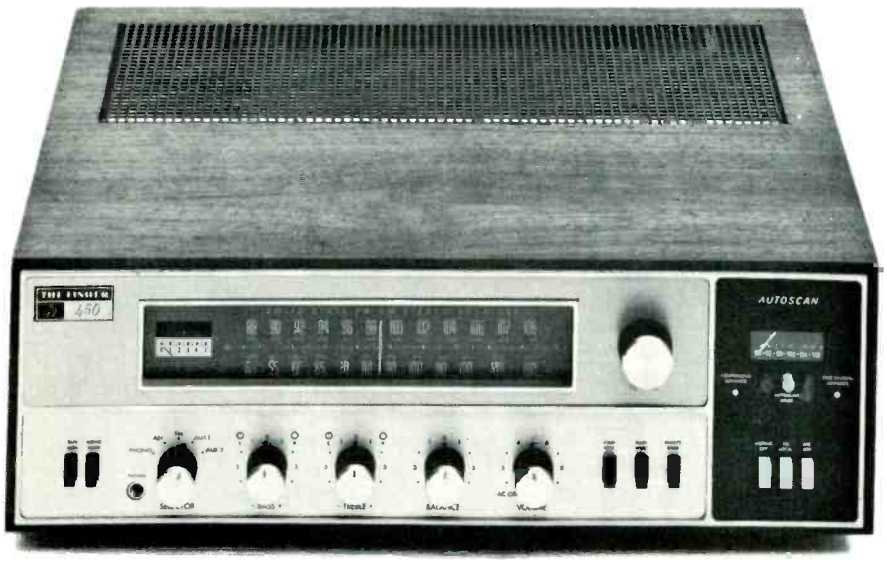

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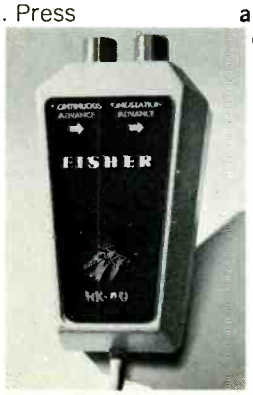

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Transistor Oscillators

NORMAN H. CROWHURST

In a previous article, we developed a feedback oscillator with high stability and limited frequency range, the essential features of which are repeated at Fig. 1. Transistor Q1 is the high-gain stage utilized for oscillation, Q2 is a phase splitter, Q3 a saturating transistor that controls positive feedback, Q4 a d.c. amplifier controlling the saturating transistor, and Q5 an emitter follower to isolate the control-voltage rectifier from the main output.

This circuit gives a sinusoidal output signal of 4.5 volts peak to peak, using a supply of 16 volts. When I designed this circuit, I wanted a larger signal than this, without having to use a larger supply voltage, so the next problem was to amplify this to an adequate, stable magnitude, without distorting it.

One method is to use another phase splitter (Fig. 2) in which the emitter load produces a duplicate of the input 4.5 volts peak to peak, and the collector produces an enlarged version. If the collector resistor is double the emitter resistor, the signal voltage will be doubled, to 9 volts peak to peak.

As the signals at emitter and collector are in opposite phase, the two must be additive, in terms of the total load resistance, 180 + 360 in the values shown. So the total swing is 4.5 + 9 = 13.5 volts peak to peak. This is cutting it fine, from a 16-volt supply, but with careful biasing of the transistor it may be possible.

If the transistor has a mean beta of 100, with limits 70 and 140, the emitter resistor will reflect at the base as a mean value of 18K, varying from 12.6K to 25.2K. To allow margin for this operation, the emitter needs to be biased to +3 volts (a little more than half 4.5 volts) and the lower resistor in the base can be 4.3K, to swamp the base input variations.

The average value from base to ground will be 18K in parallel with 4.3K, or 3.5K, varying from 3.2K to 3.67K. Using a 15K resistor from supply plus to base, will set the base voltage at an average of 3.5/18.5 times 16 volts, or 3 volts, the required value, with variation from 2.8 to 3.15 volts, which remains just about workable.

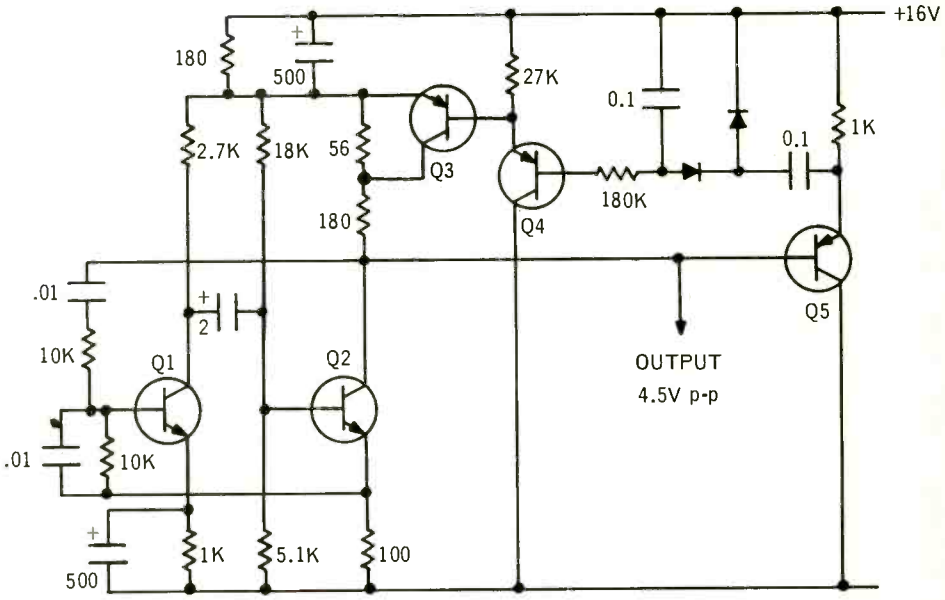

Fig. 1. The basic, stable oscillator, developed in the previous article, that forms the starting point for this one.

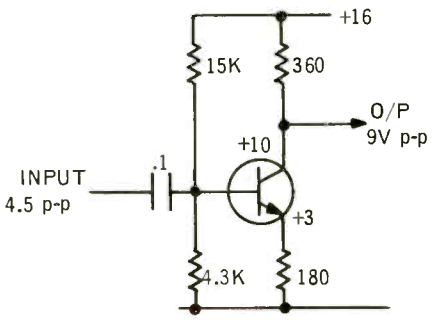

Fig. 2. A stage that gives a stable gain of 2:1, with well-stabilized operating position. It is limited to an output less than two-thirds of supply voltage.

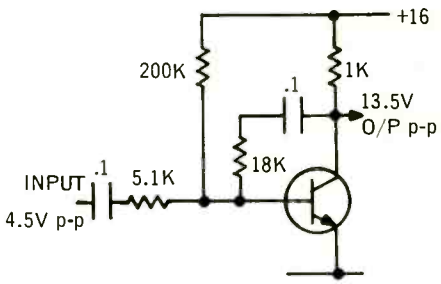

Fig. 3. A method of getting a bigger output swing, not much less than supply voltage, peak to peak, but in this simple form, stability of operating point is a problem.

The drop in the collector resistor will be double that in the emitter, an average of 6 volts, varying from 5.6 to 6.3 volts. Extreme values of beta will cut the operational margin fine, to say the least.

A bigger output swing could be achieved, if the emitter did not subtract the input swing from it, which leads to the notion of eliminating the emitter resistor (Fig. 3). Here, the relative amplitude of output against input is obtained by negative current feedback from collector to base.

We have assumed the transistor has a beta of exactly 100. The 200K bias resistor will provide exactly 80 microamps base current, causing the d.c. collector current to be 8 milliamps and collector voltage 8 volts. Now, the 0.1 μF and 18K provides a.c. feedback. Here it is easiest to figure in peak volts: 13.5 volts peak to peak is 6.75 volts peak. The total collector load is 1K in parallel with 18K (assuming no other load for the moment) or 950 ohms.

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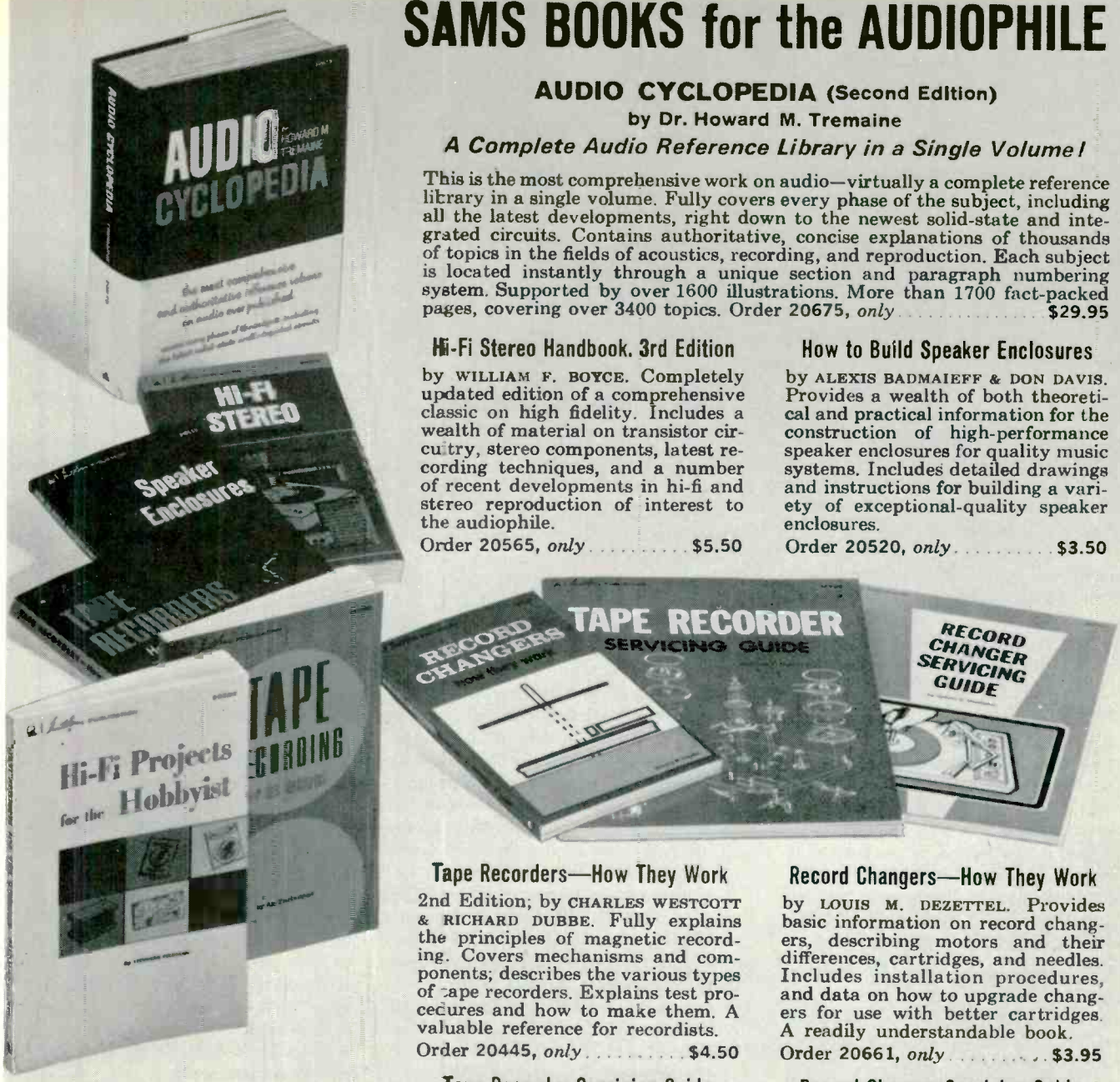

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A peak voltage of 6.75 across 950 ohms requires a signal current from the transistor's collector of 6.75/950 = 7.1 milliamps. This means, with a beta of precisely 100, that the base input signal must be 71 microamps. The signal current through the 18K feedback resistor will be 6.75/18K or 375 microamps. So the total signal input at the base needs to be 375 + 71 = 446 microamps.

The available signal voltage input is 4.5 volts peak to peak, or 2.25 volts peak. This sets the input resistor at 2.25 volts/446 microamps or 5.05K, which is pretty close to a preferred value of 5.1K.

This circuit will work fine, *if* the transistor's beta is precisely 100. From the a.c. point of view it is not too critical: the feedback factor is 446/71 = 6.3, or about 16 dB. But for the d.c. operating point, it is extremely critical. For betas of 70 and 140, the 80 microamps base current will yield collector currents of 5.6 and 11.2 milliamps, which will change the collector voltage from its nominal 8 volts, to 11.4 volts and 4.8 volts respectively. More than a volt deviation from the nominal 8-volt operating point is not permissible.

This could be improved a little, by using d.c. feedback from the collector to the base. Figure 4 shows one way, although the decoupling is not necessary, because the d.c. feedback being less than the a.c., it can be figured as part of it. However, looking at it this way enables the two to be treated separately, and the a.c. feedback calculations for Fig. 3 can stand for this circuit.

The easiest way to figure this arrangement for d.c. is to regard the transistor as a resistor, controlled by its beta. If the beta is 100, its resistance is the d.c. feedback resistance of 100K divided by 100, or 1K, so collector voltage is half supply voltage, or 8 volts. If beta is 70, the transistor's d.c. resistance is 100K divided by 70, or 1.43K, and collector voltage rises to 9.4 volts. If beta is 140, the transistor's d.c. resistance is 100K divided by 140, or 175 ohms, and collector voltage drops to 6.7 volts. This is still an unacceptable deviation for this purpose.

Figure 5 shows a way of providing amplified d.c. feedback for such a stage. Q1 is the original amplifying stage, while Q2 and Q3 provide d.c. feedback. First the d.c. must be isolated from signal. As we plan to use an 18K resistor for a.c. feedback, reversing the positions of the 0.1-μF capacitor and this resistor allows the same pair of components to pick off a d.c. value, at the base of Q2.

Transistor Q2 acts as an emitter follower, direct coupled to the emitter of

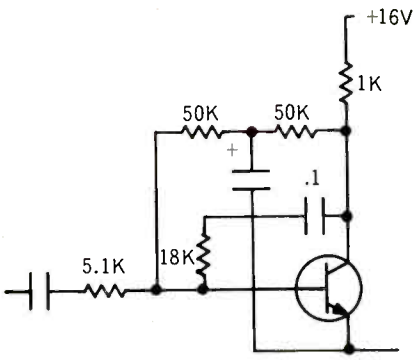

Fig. 4. Changing the circuit of Fig. 3 to provide d.c. feedback, reducing the operating point variation with transistor beta.

transistor Q3, whose collector current thus follows the emitter current of Q2. Transistor Q3 has its base coupled to a mid-voltage reference point, which thus controls the emitter voltage of Q3. The only variation of the collector voltage of Q1 from the mid-voltage value is due to the drop in the 18K resistor, plus any variation due to the base current of Q3.

First assume Q1 and Q2 both have a beta of 70, combined gain 4900. For Q1 to have a collector current of 8 milliamps, its base current must be 114 microamps, and the base current of Q2 needs to be 1.6 microamps. The drop in 18K is about 30 millivolts. Now assume they both have a beta of 140. Q1 base current must be 57 microamps, and base current of Q2 must be about 0.4 microamp, so the drop in the 18K resistor is about 7.2 millivolts.

With the base current of Q1 thus controlled, the drop in the 10K resistor, due to base current from 57 to 114 microamps, varies from 0.57 to 1.17 volts, at the collector of Q3.

The extremes of current at Q3 base are 0.4 and 1.6 microamps. With no current, the voltage is +8 (half supply) and the internal resistance as a voltage source is 500K. The drop in voltage will vary from 0.2 to 0.8 volts. This is the major cause of d.c. voltage variation. If it is too much, smaller resistors than 1 megs can be used.

For the a.c. feedback, the base of Q2 also shunts the feed through the 0.1-μF capacitor to the base of Q1. The resistance at the emitter of Q3 is 500K divided by the beta of Q3, which produces a minimum value of 3.6K. This reflects through the base of Q2, multiplied by the beta of Q2, which yields a minimum value of 250K. Obviously this is no serious shunt to the base input of Q1, and lower values than 1 meg could be used for the voltage divider.

The time constant formed by the 10-μF and the 10K-resistor is 0.1 second, which is the time it takes for the voltage at Q1 collector to adjust to its working value, giving a high stability. It is otherwise decoupled from the collector circuit by the collector impedance of Q3.

Another Approach

This is one of many design approaches to a sine-wave generator, based on the use of frequency discriminating networks and gain control, in this case in the components of the circuit of Fig. 1. Change of frequency necessitates change of the circuit values in the base circuit of Q1 in Fig. 1, where the values shown produce 1600 Hz.

And stability at its best is a sort of "bouncy" thing, because gain requires adjusting very critically, even though it is done automatically by d.c. feedback. If the gain is a whisker too high, amplitude builds up, if it is a whisker too low, it dies away. Only when amplitude has adjusted itself right, do the gain and amplitude remain steady.

(Continued on page 63)

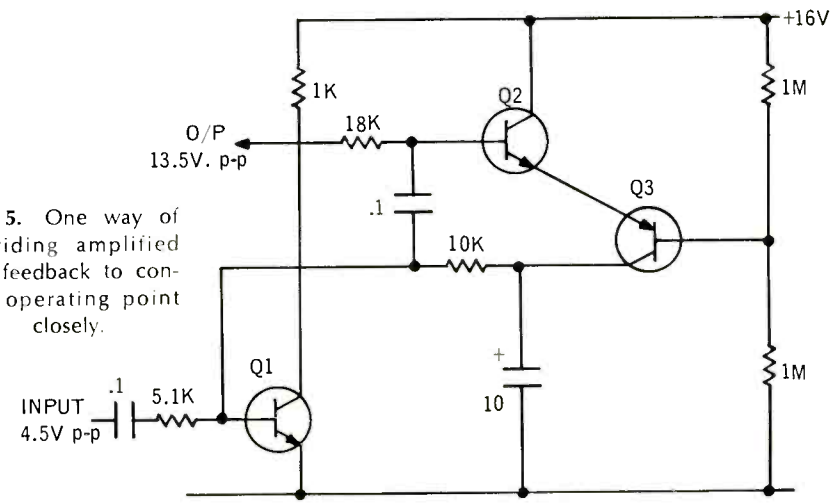

Fig. 5. One way of providing amplified d.c. feedback to control operating point closely.

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The Best of Herbie Mann
Atlantic Jazz Anthology SD 1544

For its new Jazz Anthology series, Atlantic Records has departed from the conventional techniques that are prevalent in most "best of" collections. It is clear that a serious attempt has been made to consider the output of each artist and select landmark recordings that deserve to be kept available. While the packaging effectively employs high-contrast photos in distinctive layouts, the two-color jackets provide a degree of production economy that has allowed for a more ample liner-note budget. The present set boasts a fine set of notes by Leonard Feather that traces the Mann career from its early days to the present and a discography that provides dates and personnel for each of the six numbers of the disk. The memorable performances include *Memphis Underground, Philly Dog, A Man and a Woman, This Little Girl of Mine*, and 1961 and 1965 versions of *Comin' Home Baby*. The recorded quality is variable, since it encompasses groups of varying sizes and in both live and studio sessions. But it is always acceptable and frequently splendid.

Performance: A *Sound: A*

The Best of the Modern Jazz Quartet
Atlantic Jazz Anthology SD 1546

For the six pieces in this set, Atlantic has spanned a decade in the life of this group, beginning with the familiar 1956 recording of *Fontessa* and concluding with a 1966 performance of *Pyramid (Blues for Junior)*. The balance of the platter consists of *Golden Striker* from *No Sun in Venice, Bag's Groove, Django*, and *Sketch*. While none of the group's earlier work with Connie Kay's predecessor, Kenny Clarke, is included in this collection, what has been selected is certainly a deserving set of highlights from a notable series of recording triumphs. Leonard Feather, again, turns in a readable and informative set of liner notes, and the sound is rich, clear, and well separated.

Performance: A *Sound: A*

The Best of John Coltrane
Atlantic Jazz Anthology SD 1541

While Atlantic made a number of long playing sets with Coltrane in 1959 and 1960, the great tenor saxophonist was under contract to another company at the later period of his career before his tragic death in 1967, and it is interesting to contrast Coltrane's early interpretations of Rodgers and Hammerstein's *My Favorite Things* and his own *Naima* with his 1966 recordings of the same two works on *Coltrane/Live at the Village Vanguard Again* (Impulse A-9124). For many, the more concise framework of the earlier versions, together with superior technical quality of the studio recording, would justify characterizing them as among Coltrane's "best." I, for one, would have to disagree. Fine as this set may be, Coltrane went through a complex spiritual reorientation following the period of these earlier recordings, and there are depths of expression in his later work that cannot even be anticipated in the present set. It is, nonetheless, a worthy document. The balance of its contents are Coltrane's *Giant Steps, Equinox, Cousin Mary*, and *Central Park West*.

Performance: A *Sound: A*

The Best of Mose Allison
Atlantic Jazz Anthology SD 1542

While hardly a performer to be classed with Coltrane, the MJQ, Herbie Mann, or Eddie Harris, Allison is, nonetheless, a talented blues singer and pianist, and this collection, culled from five earlier albums, is a fine example of polished, modern blues singing at its very best. Neither the liner notes nor the sound on this disk are on quite the same plane as the earlier mentioned sets in this new series, but this recording does have lots of entertainment value, and it includes a full dozen blues, eight of them by Allison himself.

Performance: A *Sound: B*

The Best of Eddie Harris
Atlantic Jazz Anthology SD 1545

Spanning the years from 1965 to 1969, this set includes two unamplified tenor sax recordings by Harris, two with a Varitone amplified sax, and two with a Maestro amplifier. The variety of instrumentation will hold well deserved interest for many listeners, but it is the consistently high musical standards of this artist that justify the inclusion of this reissue set in Atlantic's new series. Although his plugged-in horns haven't been around very long, Harris has fully grasped the tonal and expressive possibilities of each, and he uses them to put over thoroughly musical ideas with no suggestion of gimmickery. Included are *Theme in Search of a Movie, Love Theme from "The Sandpiper" (The Shadow of Your Smile)*, and Harris' own *Listen Here, Freedom Jazz Dance, Live Right Now*, and *Movin' On Out*.

Performance: A *Sound: A*

Bill Black: Raindrops Keep Fallin' on My Head
Columbia Stereo CS 9957

For years now the Bill Black Combo has been recording for a local Memphis label called *Hi*. With the inexplicable increase in popularity of this musical style, the Black group has been snatched up by Columbia, and it is no doubt possible that broader distribution of their recording will now be assured. From this listener's viewpoint, more's the pity. I didn't like the Bill Black Combo before, and I can hear no improvement on their latest release. Their arrangements are deathly-dull conventional. The group plays with highly polished professionalism, but that hardly seems like enough justification for such a campy collection of chestnuts. Unless you have developed that special variety of sophistication that finds the *Memphis Sound* a fresh new delight, you would be well advised to give this platter a wide berth.

Performance: C *Sound: B*

Equipment Profiles

Fig. 1

MANUFACTURER'S SPECIFICATIONS:

Maximum reel size: 8¼ in. **Speeds:** 7½, 3¾, 1⅞ ips. (Available with 15 ips instead of 1⅞.) **Motors:** Three. **Wow & Flutter:** Less than .08% at 7½ ips. **Signal-to-Noise Ratio:** Better than 55 dB referred to 2% distortion. **Tone Controls:** Continuously variable bass and treble controls for each channel applicable to playback. **Inputs:** Two per channel—Microphone, 10 k ohms, 300 μV to 15 mV; Line, 2 Megohms, 50 mV to 10 V. **Outputs:** 600 ohms, 2 V; low-level, 300 mV into 10 k ohms or greater; loudspeaker, up to 10 W into 8-16 ohms. **Dimensions:** 16¾ in. wide, 17½ in. high, 10 in. deep. **Weight:** 49½ pounds. **Price:** Chassis only, $599.00; walnut case, model 724A-W, $699.00; portable case, leather-cloth covered, model 724A-P, $699.00. (Also available in mono.) Imported from England by Elpa Marketing Industries.

The Ferrograph Series Seven represents the first major change in the Ferrograph line in many years, and it is apparent that the changes are well thought out and long overdue. Along the top of the chassis are the carrying handle which retracts flush with the case when not in use, and a strip which contains all the input and output jacks, the fuses, a remote-controlled socket, and the power receptacle, as shown in Fig. 2. The front panel is divided into four sections, with the upper one mounting the power switch and the mechanical speed-control knob, the two reel hubs, the digital counter, and the record button, which is a bar-shaped "button" in red, so as to be plainly visible. Among the numerous features in this unit are the reel-height adjustment screws, which permit moving the reels inward or outward so as to wind the tape without its rubbing against the flanges. The reels furnished with the machine are aluminum-flanged, 7 in. in diameter, and they have tape hold-down clamps in the hub which can be released by depressing the opposite end of the clamp through a hole in the flange. The speed for which the transport is set is observed through a window above the knob. The power pilot light is just below the speed-control knob, and another pilot "reset" light serves to indicate when the machine is ready by its absence. When the light is on, something is wrong, as when the mechanical speed-control knob is on one speed while the equalization-control is on another—a safety feature. When the red reset light is on, the motors will not run, and after correcting the problem, the FUNCTION lever must be moved to the STOP position to deactivate the relay which controls the reset light.

The next section of the front panel accommodates the FUNCTION lever, a release button—which must be moved to allow the FUNCTION lever to be moved to the STOP, PAUSE and RUN positions. As the lever is moved from these positions to the FAST position, the release button locks the lever out of the operating positions. The tape-head assembly occupies the center portion of this panel, and on its right is the auto stop guide and the FAST control knob. When the function lever is in the FAST position, the two spooling motors are in series across the line with their junction connected to the arm of the control, while the ends of the potentiometer are connected across the line. Thus, all of the line voltage can be fed to either the rewind or fast-forward motor, providing control of fast spooling from full speed to slow enough for finding a desired spot on the tape for editing.

The next section of the panel has, from left to right, the upper track microphone jack, the equalization selector (which must be in the same speed setting as the mechanical speed-control knob for

the machine to run) a dual-concentric record-level control for the upper track, the upper track VU meter, a switch which selects either upper track, stereo, or lower track, the lower-track, VU meter, the lower-track dual-concentric record-level control, the speaker level control—also dual concentric—and the lower-track microphone jack.

Below this section, and accessible by tilting outward a section of the aluminum extrusion, is another series of controls which might be termed "auxiliary." At the left is the upper-track "source-tape" switch, a recessed (screwdriver-operated) tape-level control which permits adjustment of the meter to indicate the same on both tape and source, the drum-type bass and treble controls, the recessed upper-track bias control, a meter switch which may be switched to output, source, or bias, the transfer switch which enables the user to feed a signal from one track to another, followed by the lower-track bias, tone, and meter controls.

Thus it is seen that the machine is equipped with practically all of the possibilities of operation that the recordist could want. It is exceptionally flexible, and with it one can add echo, record sound-on-sound and sound-with-sound, as well as using the machine for the usual applications of a normal recordist.

Operation

To thread the tape, the head cover is raised and the pressure pads moved away from the heads by a lever at the bottom of the head assembly. This lever also moves the auto-stop arm upward to permit straight-line tape threading from supply reel, past the heads, and across to the outlet slot, and thence to the take-up reel. The pressure pads return to the normal head-contacting position when the threading lever is depressed or when the head cover is closed. Figure 4 shows the heads and the retracted pressure-pad arms. One of the features of the Ferrograph is that it can be put into the record mode or released from it while running. The record function is engaged by depressing the RECORD bar, and it can be released at any time by simply moving a latch (above the FUNCTION lever) to the left. This permits insertion of some new material into a tape which has already been recorded without the need for cutting and splicing. Another valuable feature is the control of bias from the panel, and the indication on the VU meters of the bias current. More about this later.

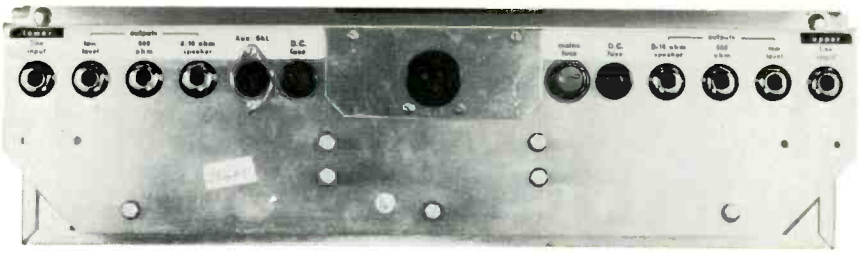


Fig. 2—Showing rear panel

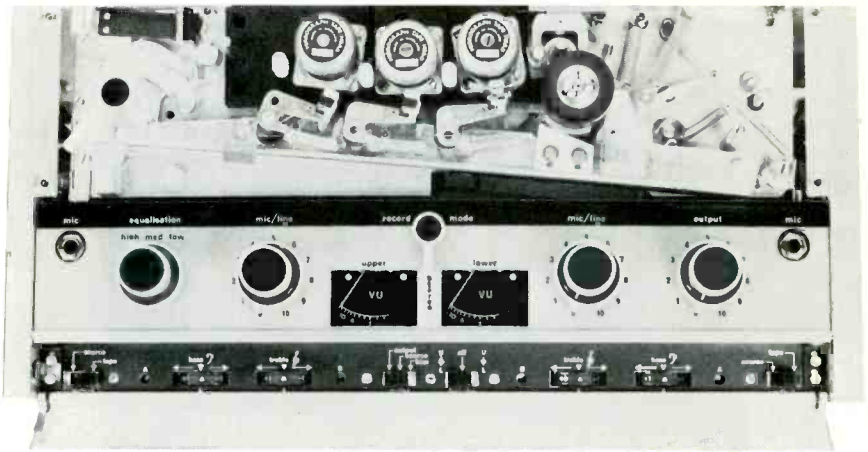


Fig. 3—Control panel and auxiliary controls

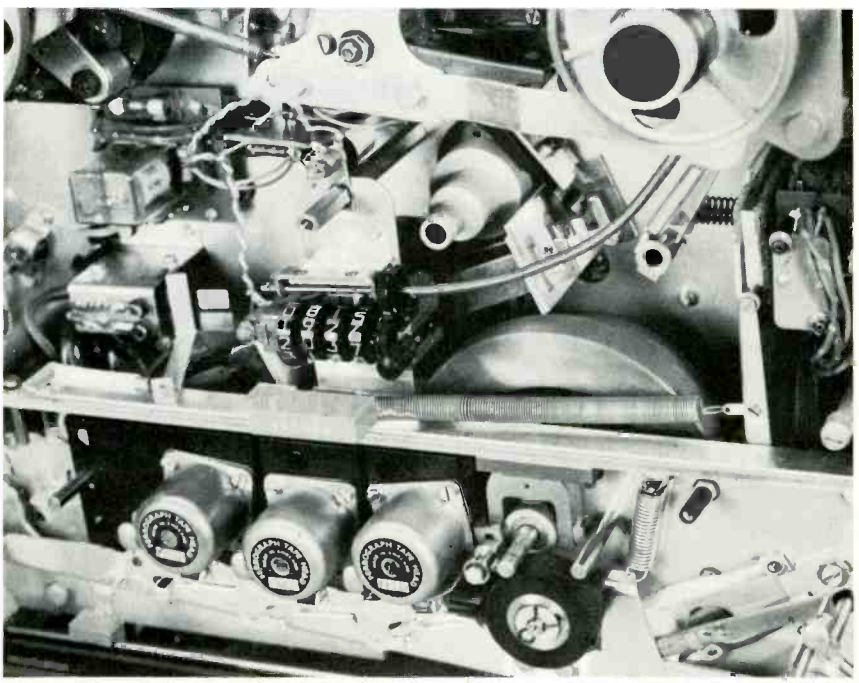


Fig. 4—Showing heads, capstan and flywheel

Construction

Figure 4 shows the drive from the capstan motor to the capstan itself. The motor is fitted with a heavy stepped pulley of massive dimensions. An idler wheel is drawn into contact with the proper step and the heavy flywheel, also massive (it is 3¾ in. in diameter and has a rim thickness of ½ in.). Drive to the digital counter is by a flexible cable from the takeup-reel shaft. Solenoids serve to pull the idler into engagement with the stepped motor pulley and the flywheel, and to pull the pressure roller into contact with the capstan. Metal-foil strips can be applied to the tape to stop the machine where desired, and in case of tape breakage or end-of-reel runout, the auto-stop arm stops the motion. Figure 5 shows the underside of the unit, with the replay and tone-control and meter boards to left and right, and the record equalization components at the center, and Fig. 6 shows the record amplifier of one channel at the bottom, and the output amplifier section at the top. Figure 7 shows the capstan motor, together with its capacitor at the center, and the power transformer is visible through the rectangular opening at the top.

Performance

The Ferrograph is an interesting machine to use, with its wide range of features which provide convenient operation. The important information about performance is shown in Fig. 8, which shows the frequency response from a standard tape at 7½ and 3¾ ips, and the record/replay response at all three speeds. Wow and flutter measured .07 per cent at 7½, 0.15 per cent at 3¾, and 0.18 per cent at 1⅞ ips, all of it in the range from 6 to 250 Hz. The 3-per cent distortion point occurred at 9 dB above the indicated zero recording level (at 7½), although Ferrograph refers to a 2-per cent distortion as their reference. Distortion ranged in the vicinity of 1 to 1½ per cent at zero recording level from 100 to 10,000 Hz, and was 1.1 per cent at 10 dB below zero level. Signal-to-noise was measured at 59 dB below the 3-per cent point, unweighted, and crosstalk measured −51 dB. For those who are interested, we also measured IM distortion at 6 dB below zero level and noted it at 3 per cent. This measurement has not usually been reported in previous PROFILES, but some readers have indicated an interest in this figure. Bias frequency was measured at 101.5 kHz.

Input signal required for zero recording level measured 0.15 mV at microphone input, and 24 mV at the line

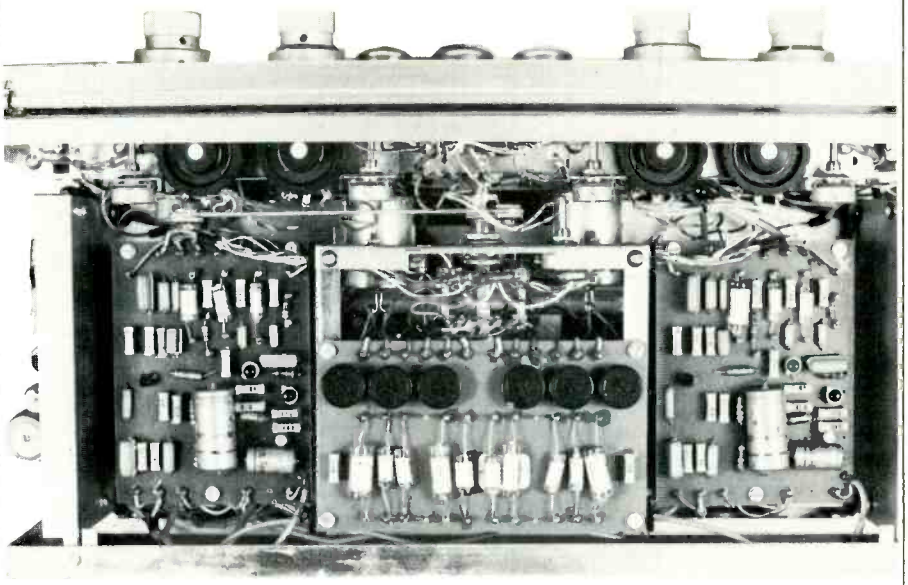


Fig. 5—Underside, showing circuit boards.

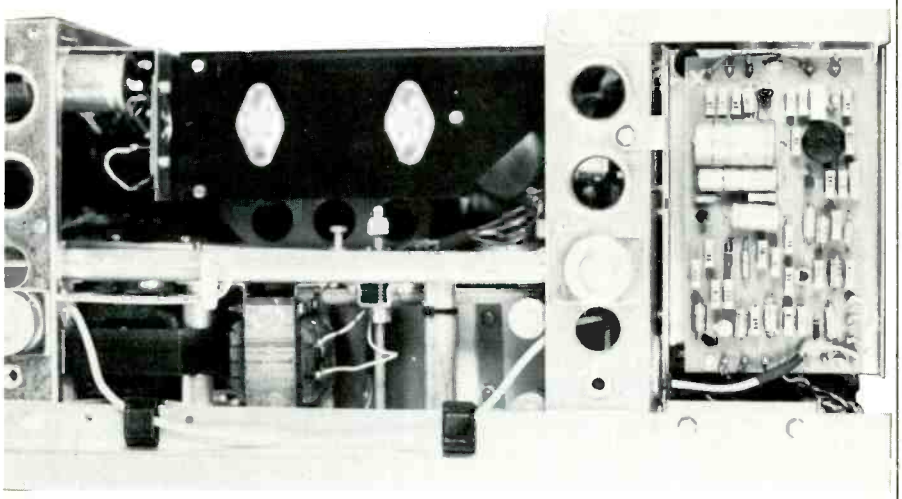


Fig. 6—The record amplifier of one channel is at the bottom and the output amplifier section at the top.

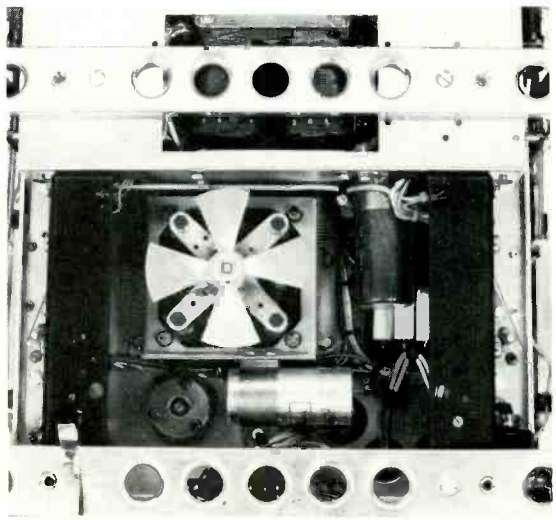


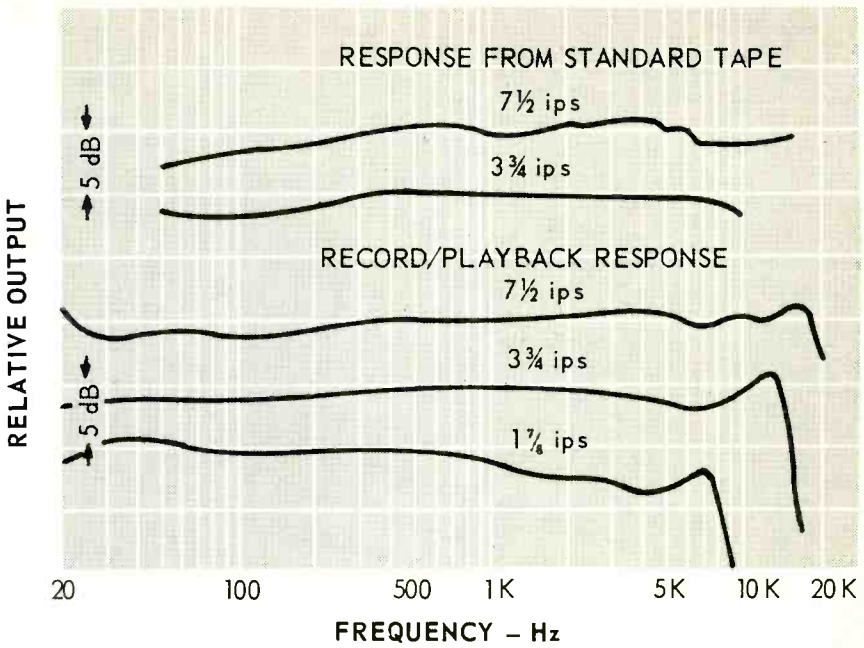
Fig. 7—The capstan motor with its starting capacitor.

input, with both controls at maximum. Line output for the same level was 2.2 volts, and the power amplifiers delivered a maximum of 15 watts into 8 ohms at a distortion of 2.0 per cent. The built-in speakers—one for each channel—are 4x7-in. oval models. The complete unit employs 34 transistors, 2 FET's, 8 diodes, and two bridge rectifiers.

Ferrograph is to be complimented on the elaborate instruction book furnished with the machine. It is a hard-cover book containing 75 pages of text material and five blank pages for notes. In addition, a complete schematic is furnished, as is a complete parts catalog. If we may be said to have any objections to this unit, it would concern the use of phone jacks for inputs and outputs—but this is a personal prejudice! We think the Series Seven Ferrograph offers many advantages to the serious recordist and can be recommended for consideration.

C. G. McP

Check No. 58 on Reader Service Card



Elektra Amplidyne SE-III Stereo Loudspeaker Equalizer

Fig. 1

MANUFACTURER'S SPECIFICATIONS:

Equalization Settings: High Control—one flat position and five high-frequency equalization settings; Low Control—one flat position and five low-frequency equalization settings. **Switches:** power, equalization in/out, tape monitor in/out. **Level Control:** Adjustable, located on rear panel. **Insertion Loss:** 0 dB. **Harmonic Distortion:** Less than 0.2%, 2.0 volts rms output from 20 Hz to 20 kHz. **Hum and Noise:** Better than 80 dB below rated output. **Dimensions:** Panel 15" wide; 3" high x 9¾ deep. Oiled Walnut Cabinet 16⅜ x 4⅜ x 10⅜ in. **Weight:** Approx. 15 lbs, including oiled walnut cabinet. **Price:** $129.95.

This is an interesting sort of equalizer which is designed to complement the most common deficiencies of some loudspeaker systems. The designers chose to provide only those types of equalization which would most likely be used, rather than overcomplicate the unit by providing practically every possible equalization that could be imagined. In fact, the device is intended to equalize only for loudspeaker deficiencies, rather than to serve as a sound-effects filter. To that end, the unit does its job admirably.

The circuit is, in effect, a boosting type of tone control which relies on movable hinge points, rather than having a fixed hinge as is usual with most tone-control circuits. It is provided with two six-position switches, one for the high-frequency end, and one for the lows. The first position is flat from 30 to 20,000 Hz, and is down only 1.5 dB at 20 Hz. The second positions provide 3-dB turnover points at 47 and 11,000 Hz; the third has its 3-dB points at 100 and 8600 Hz; the fourth at 225 and 6600 Hz; the fifth at 290 and 5300 Hz, and the sixth and last positions provide turnover points at 400 and 3600 Hz. Thus there are 35 possible equalization curves in addition to flat, as are shown in Fig. 2.

It is characteristic of most loudspeakers that they drop off at some frequency at

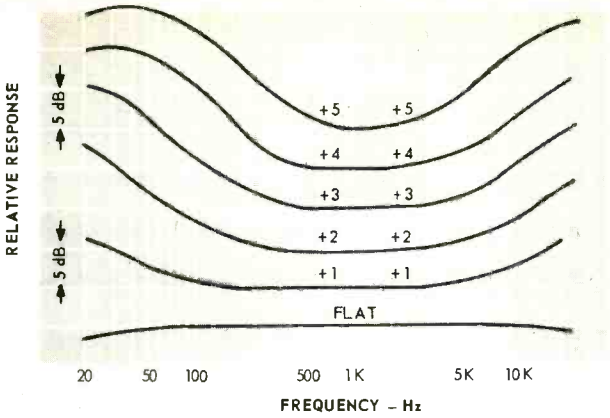


Fig. 2
Frequency response curves

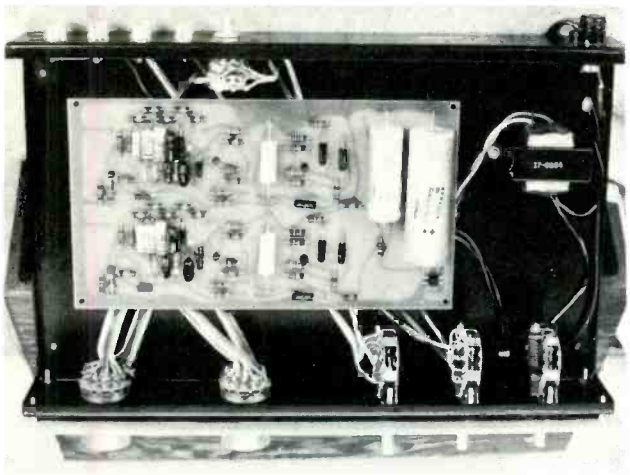


Fig. 3—Underneath view

both ends of the spectrum, usually at the rate of 12 dB per octave below the lower resonant frequency. Most high-quality speakers do not seem to drop off that rapidly, due to reinforcement of the low end by reflexing or some similar method which holds up the response to a droop of not much more than 6 dB per octave. A similar condition exists at the upper end of the audio spectrum. If we have the facility for increasing the response at the rate of 6 dB per octave above and below the points where the loudspeaker response begins to fall off, we can compensate for the droops fairly accurately, and achieve a relatively flat *acoustic* output from the speaker system.

The circuit employs three transistors per channel—an emitter follower, an equalized stage, and an output amplifier. The whole circuit for the two channels is built on a single epoxy fiberglass printed circuit board of ample dimensions, with connections to the switches made with strips of multiwire cable to ensure neatness. In fact, the unit is a model of neat construction, and its performance shows the result of careful workmanship and design. Distortion measured less than 0.1 per cent, and hum and noise was measured at 83 dB below the rated 2-volt output. Power is provided by a transformer, a bridge rectifier, and 4000 μF of

filter capacitors to supply the 20 volts d.c. required for the circuit. The low-end boost is provided by feedback, with high-value resistors across the switch points to eliminate switching clicks. The high-end boost is provided by switching small capacitors across a resistor between the first two stages.

Since relatively few integrated amplifiers and practically no receivers provide sets of jacks for preamplifier out and power amp in, the SE-III is provided with the phono jacks and switching to permit it to be inserted between the RECORD OUT and TAPE RECORDER MONITOR IN jacks on the receiver, which effectively permits connection between the preamp section and the power amplifier of the usual receiver or integrated amplifier. For those who use separate preamp/control units and power amplifiers, the connection is simply made between them.

Performance

We tried the SE-III with several different loudspeaker systems to determine if it did all that is claimed for it, and we found that it did. We could make relatively poor loudspeaker systems sound nearly as good as our reference system by moving the turnover points to the frequencies at which the poorer speakers began to fall off, and the results were excellent. The device also made the reference system sound like a much larger theatre system. On the whole, the Electra Amplidyne SE-III is a welcome addition to any system, even if your loudspeakers are above reproach—it could make them sound better than you would have expected.

C. G. McP

Check No. 60 on Reader Service Card

Decca MK1
Phono Pickup System

MANUFACTURER'S SPECIFICATIONS

TONE ARM: **Nominal Length:** 9 inches. **Distance from Turntable Center:** 8½". **Rear Overhang:** 2½". **Size of Mounting Hole:** 1½" diameter. **Height Adjustment:** 1 to 3 inches. **Cartridge Mounting Dimensions:** Standard ½". **Length of Leads:** 2'-9". **Accessories:** Extra lightweight pickup shells; small counterweight for ultra lightweight cartridges. **Price** $117:50.

CARTRIDGE Model 4RC: **Output** 7.5 mV at 5 cm/sec. **Frequency Range:** 30-20,000 Hz. **Frequency Response:** 30 Hz−16,000 Hz±3 dB. **Stylus Radius:** 0.5-0.6 mil. **Stylus Tip Mass:** Less than 1 mg. **Vertical Tracking Angle:** 15 degrees. **Compliance:** Lateral -15×10^{-6} cm/dyne. **Vertical** -4×10^{-6} cm/dyne. **Channel Balance:** Output from each channel within 1.0 dB. **Inductance:** 285 mH per channel. **Input Impedance:** 47 k ohms. **D.c. Resistance:** 4900 ohms per channel. **Recommended tracking force:** 3.0-3.5 grams. **Price** $65.00

DECCALIFT: **Power Requirements:** 6.3 volts a.c. at 0.1 amps. **Price:** $26.00. With 6-volt transformer, $31.00. **Price of complete phono pickup system:** $195.00
Imported by Paoli High Fidelity, P.O. Box 876 Paoli, Penna. 19301

The Decca Mk 1 phono pickup system is the best performing pickup system I have ever come across. It measures better and sounds better than any other pickup I have tested to date. But a considerable effort in both skill and time is required in order to install the system properly. This damps my enthusiasm in recommending it to everyone. Not that everyone wants to spend $195.00 for a pickup system, but there are others in this price range which are considerably less complex and easier to put together!

To start with, the Mk 1 system consists of three components which we shall describe separately. They are the International tone arm, the Model 4RC phono cartridge, and a motor-driven tone arm lowering/raising mechanism called the Deccalift. Aside from the Deccalift which does not affect the performance of the system when playing discs, we're not sure as to the contribution ratio of the arm to the cartridge and vice versa. It was simply too much work to test them separately with other components, for a second time. In any case, they work so well together that there is no reason to use them in any other way. Because of their excellent design, and standard mounting dimensions of both arm and cartridge, however, we are confident that they are each capable of high quality performance with other well designed arms and cartridges.

The Decca International arm is an elaborately conceived unit designed to eliminate needless mass and still allow correct bass response. The arm is only 9 inches long and the key to its fine performance is in its pivot design and magnetic suspension. The tone arm bearing is an inverted jeweled unipivot which, as its name implies contacts the arm at only one small point. This gives the arm remarkable freedom of motion, eliminating most of the friction. In fact, we were unable to measure any friction at the cartridge head using our dynamometer calibrated down to 0.03 grams.

The action of the pivot is damped by a silicone damping fluid that is poured, optionally, into the top of the tone arm during installation. The fluid does not increase friction in any measurable way, but helps damp out unwanted internal and external oscillations, including rumble. The fluid provides lateral, vertical, and torsional damping. The fluid is not put in at the factory so that it can't leak out in transit. But we strongly urge its use, even though the manufacturer says it's optional. Without the fluid, the arm becomes unstable at minor provocations such as a nick in the record being played. A further aid to the damping system is the magnetic sus-

pension of the entire arm in the barrel. The pickup arm literally floats on a magnetic cushion which isolates it for the most part from the motor board.

Effective and accurately adjustable anti-skating compensation is magnetically applied and arranged so as to neutralize the component of skating force which tends to draw the pickup toward the center of the disc. The compensation is maximum at the outside of the disc and automatically decreases as the arm travels inward toward the center of the record.

An offset counterweight is used to balance the arm in both the lateral and vertical planes. The weight is decoupled from the alloy tube by means of a resilient rubber sleeve. A bubble-level is built into the top of the tone arm. We estimate that this arm could enable good tracking at as little as 0.4 gram, if a cartridge designed to track at such force were available today.

The cartridge shell, or frame, as it could be called, is made of aluminum and weighs only 5 grams. In their effort to keep the weight down, Decca has come up with the barest cartridge support imaginable. While the support is effective and well fitting, all wires from the back of the cartridge, for instance, are visible and unprotected.

The arm which we received for review came together with the Decca-lift, which we're not crazy about, though it works. The device is a motor-driven lifting/lowering mechanism manually activated in either direction by means of a rocker switch. The switch can be mounted in the turntable, or at a remote location such as near the listening chair, or even in both places. While the device does lower and lift the tone arm as required, it does it so slowly and with so much delay between switch actuation and start of the arm motion cycle that one prefers to use the arm manually most of the time. Also, clicks and pops accompany the actuation. The design would be redeemed if an end-of-record sensor activated a lift cycle, at least. The lift mechanism consists of a 6-volt a.c. motor which is coupled via suitable reduction gears to the piston which lowers or raises the arm-supporting bar. Provision is made to

add indicator lights which show direction of actuation—only a slight consolation to the lift's delayed action. The motor shuts itself off automatically after either the lowering or raising cycle is completed.

The Decca Model 4RC cartridge is one of two recent Decca designs, the other being the elliptical Model SC4E. While it is magnetic, of the variable reluctance operating principle—which is not far removed from most popular moving-magnet designs—it is different in one important respect. It has no cantilever between the stylus and the magnet. Thus no motion is lost, nor additional resonance introduced. This permits more accurate tracing of the record grooves since mechanical to electrical conversion takes place just above the stylus. This, together with a hand-polished diamond stylus tip of very low mass, results in a most outstanding performer.

The recommended tracking force is 3 to 3.5 grams in a low-mass, low-friction arm, such as the Decca International. According to the manufacturer, this recommended force while higher than other high-trackability cartridges with elliptical styli, produces less record wear due to the lower effective tip mass and polish. We could detect no record wear during our tests—only a polishing effect, on new records, which concurs with what Decca says.

We installed the Mark 1 pickup system onto a Thorens Model TD124 turntable for our tests, tracking at just over 3 grams. The first thing we noticed was that turntable rumble was reduced from what we previously encountered in this turntable. We thought it might be a bass deficiency of the cartridge, until we ran the frequency response curves of Fig. 1. These curves, are an automatically plotted response to CBS Labs' STR-100 test record. Clearly, the cartridge is not bass deficient, and has the flattest response curve of any cartridge we ever tested. The difference between channels was less than 0.5 dB and the usual high-frequency peak is totally absent. The response rolls off steeply after 18 kHz, but is far better than the manufacturer's modest specifications. Separation was in excess of 20 dB throughout the midrange and reduced to 10 dB at 16 kHz, which is

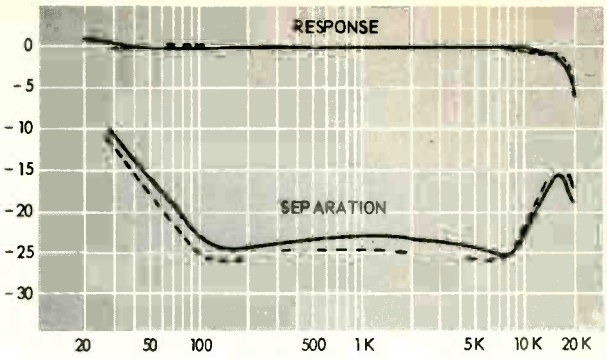


Fig. 1—Frequency response and crosstalk

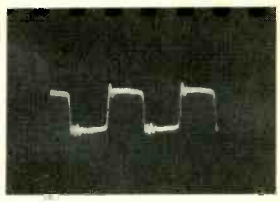


Fig. 2
Square wave characteristics

excellent. Figure 2 shows the square-wave response.

As might be expected, the sound reproduced via the Mk 1 system was outstanding. The clarity of brasses and percussion instruments was uncanny, and the cartridge tracked most high velocities extremely well. Bass, too, was clear and tight. The overall sound was reminiscent of earlier moving-coil designs, sans peaks. Distortion was judged to be very low.

We measured the cartridge's output voltage at 7.4 mV for both channels at 1000 Hz, referred to 3.54 cm/sec rms 45-deg. velocity, which is as specified and high enough to drive all available preamps. It is a little higher than most cartridges, resulting in an improved signal to noise ratio.

We must conclude that the pickup system, as awkward to install as it is and not readily available at most dealers, is the best thing for playing records to have come along in a while. Decca's installation instructions are not very good but the importer furnishes corrections plus additional clarifying information which makes installation possible.

Incidentally, these products are manufactured by Decca Gramophone Ltd. of England, which is in no way connected with Decca Records, a division of MCA, Inc. of New York.

Pioneer SR-202 Reverberation Unit

MANUFACTURER'S SPECIFICATIONS:
Transistors and Diodes: 11 and 2. **Output Voltage,** rms: 330 mV at 1000 Hz (Reverberation time MIN; input level, 200 mV. **Maximum Input Level:** 3.0 V at 1000 Hz (Reverberation time MIN); **Harmonic Distortion:** Less than 0.2% at 1000 Hz (Reverberation time MIN; output level 330 mV. **Frequency Response:** ±2 dB 20 Hz to 35 kHZ (Reverberation time MIN); ±10 db 20 Hz to 50 kHz (Reverberation time MAX.) S/N: 65 dB (at 330 mV output). **Reverberation Time:** 1.9 to 3.2 sec. (at 1000 Hz.) **Input Impedance:** 300 k ohms (at 1000 Hz.) **Dimensions:** 11 13/16" W x 4 1/2" H x 9 13/16" W. **Weight:** 8¾ lbs. **Price:** $95.00.

Here is a device that could well become the answer to the problem encountered by the serious enthusiast who has equipped his system for four-channel reproduction and who can not find more than three selections to play on the expanded system. Of course, more rock music will be available on records or tapes in the future, but what does he play *now*? *Anyone* would soon tire of Berlioz Requiem, we imagine.

But suppose the hypothetical enthusiast *has* equipped his system for four-channel reproduction. What does he do with his present collection of otherwise-good two-channel music? He already has those speakers at the back of his room, and he has nothing to play on them. (Except four versions of the Requiem.)

The SR-202 Reverberation Amplifier is a simple solution. He connects the rear speakers to their amplifiers tied to the output of the SR-202 and he is in business. He introduces a controlled amount of reverberation from any stereo or mono source and effectively doubles the size of his listening room, because he can introduce any desired degree of reverberation to his rear speakers. By suitable switching, he can add a multitude of effects to his reproduction with a minimum of expense or effort.

The SR-202 is a neat, small device which is normally connected between the record output jacks of the receiver or amplifier and the tape monitor jacks—or to one or *two* tape recorders. With no further connections, the user can add reverberation to the loudspeaker sound without making a tape recording, make a recording without reverberation and add reverb to the loudspeaker sound, add reverb to both the recorded sound and the loudspeaker output, record without adding reverb to either the recording or the loudspeaker, or simply feed the sound to the loudspeaker in the normal manner without recording at all. This is the result of the switching and the manner of interconnecting the SR-202 to the system.

The Circuit

The SR-202 Reverberation amplifier consists of an input emitter follower in each channel, with their outputs joined to provide a single signal to drive the spring reverberator unit. The reverberation unit had two outputs, and each is amplified by a two-stage booster amplifier and fed to the output through two switches which provide complete control of the functions of the device. A tapped primary on the power transformer permits operation from any line voltage from 110 to 240, and two a.c. receptacles provide for connection to auxiliary devices—one of them being switched. The d.c. output voltage from the power supply is regulated for consistent operation.

Performance

Response curves on the SR-202 would be somewhat superfluous, since the delay time plays havoc with the response in the 200-600-Hz range. Outside of that, however, the response is fairly smooth up to 20 kHz, as would be expected from a study of the basic principles of operation. The important part of the discussion is that the unit performs as it is expected to do. Reverberation does have the characteristic repetitive quality of any spring-type reverberator, but considering its size and its flexibility, we can only suggest that it is the answer to any user who longs for some signal to feed those so-far-underworked rear speakers. We firmly believe that the SR-202, an extra amplifier, and one or two rear speakers can add a lot to any existing system, even though it is not yet fully converted to four-channel operation.

C. G. McP.

Pioneer T-600 Tape Recorder

This very fine recorder was reviewed in our March issue and frustrated owners who vainly tried to persuade their T-600's to function at 1⅞ ips can relax. The caption was incorrect: it should have read "Record-replay response at 3¾ ips."

Transistor Oscillators

(Continued from page 50)

This problem is common to all oscillators of this type, because of the variables chosen as basis for the design: frequency and amplitude. Most modern generators employ a quite different basis, which can be made much more stable: time and amplitude, followed by wave shaping. This is known as a function generator.

A triangular waveform can be made by alternately charging and discharging a capacitor at a rate of constant current. The current is controlled precisely by circuit parameters. The points at which the direction of current flow is reversed are also precisely controlled, thus setting the amplitude of the triangular wave as a primary parameter. Finally, having a stable triangular wave, its shape can be changed precisely to sine-wave form.

This kind of circuit has no bounce and absolute stability of both period and amplitude. The older sine-wave oscillator used frequency networks (which originally were tuned circuits, but later were replaced by half bridges and other arrangements), to select the frequency of an essentially sinusoidal oscillation.

Deviation of parameters changed frequency rather than timing, and gain—that is, rate of growth or decay—rather than amplitude. The function generator reverses this procedure. The first thing set by the electronic circuitry is the timing and amplitude of the wave, which is then shaped as desired, where before the shape was first, and then frequency and amplitude were controlled to meet other requirements.

In the next article, we will show how a function-generator type of oscillator can be developed with solid-state circuit elements. Æ

Classical Record Reviews

EDWARD TATNALL CANBY

The Big Ones

Bach: St. John Passion. Grummer, Otto, Ludwig, Traxel, Wunderlich, Kohn, Fischer-Dieskau; Choir St. Hedwig's Cathedral, Berlin Symph., Karl Forster. **Seraphim SIC 6036 (3 discs) stereo** ($8.94)

Bach: St. Matthew Passion. Harper, Jahn, Equiluz, Rintzler, Stampfli; Vienna Academy Ch. Choir, Vienna Choir Boys, Vienna State Symph., Swarowsky. **Nonesuch HD 73021 (4 discs) stereo** ($11.92)

To review in any detailed sense such immense and all-embracing works as these great musical studies of the Passion of Christ is nearly impossible. Better, then, the highlights, to steer the inquiring listener in a useful direction.

Both Passions are here done in thoroughly modern fashion, which means a proper orchestra (if not 100 per cent "Baroque," then at least without the once traditional symphonic-style extras and with some of the correct older instruments—oboe da caccia, violas d'amore and da gamba, lute, recorders, harpsichord, older-type organ) a less-than-mammoth chorus, reasonably alert and flexible solo voices, and in general the currently preferred fast tempi—minus the draggingly slow impressiveness that used to be inevitable. Both these versions move along smartly, even in the vast opening movements in both, the chorale (hymn) settings are sung at normal tempo without the big (misguided) pauses and poignantly Romantic expression that used to be standard. Things have changed! These Passions can be listened to with ease. You won't have to immerse yourself in some kind of trance-like immobility for minutes and hours, as of old.

The absolute first condition of any Bach Passion performance is a good tenor narrator, the man who sings the dramatic connecting parts of the story in recitative, often in the highest tenor register, and through violent and difficult changes in harmony. Both recordings pass this test with full honors. In the St. John, Fritz Wunderlich is absolutely indefatigable, and never a trace out of tune or stained. On the St. Matthew, Kurt Equiluz is a gentler but impassioned narrator, whose slightly lesser strength often serves good dramatic ends in the tense music.

In both recordings there are excellent soloists for the arias, a more profuse selection in the St. Matthew. Marius Rintzler's Jesus in the St. Matthew is no less dignified than the better known Fischer-Dieskau's in the St. John. Heather Harper is her usual superbly musical self in one version's high soprano part; Elizabeth Grummer, with a more variably colored voice, does an excellent job in St. John. Somehow, the subsidiary voices, notably Pontius Pilate, have the fusty, somewhat pompous sound that these roles demand. Part of the drama. There is the marvelous contralto Christa Ludwig (St. John) . . . and so it goes.

The famed St. Hedwig's Cathedral Choir shows all of its classic purity of tone, in the Northern German manner, in the St. John recording. Though normally we expect more wobbly, less blended voices from Viennese choirs, the Academy Chamber Choir seems to have cleaned up its wobbles for this St. Matthew, and performs with almost as much leanness of tone as St. Hedwig's. Both are generally dramatic and (mostly) on the button in the sudden choral entrances that have been the bane of generations of absent-minded choral singers, lulled into daydreaming by the long intervening waits. Both orchestras are in excellent form—need one say more?

Seraphim's St. John puts choir and orchestra in a vast, somewhat distant church space, with solo voices somewhat closer but never too much so. The Nonesuch recording is somewhat dryer, with (to my mind) a slightly less satisfactory balance among the large forces. Only slightly, and a matter of opinion. As to conductorial interpretation, Karl Foster's St. John is unusually crisp, rapid and economical, notably in the big choral movements and the chorales, which fairly whiz along—never, however, in an un-phrased or hurried fashion. I found the speedy music a welcome and legitimate presentation.

Hans Swarowsky, a bigger, more dramatic conductor, moves fast too, but with more variables. His big chorus movements I find somewhat choppy and hammered-out—too much pounding staccato for my taste. (This is a familiar trait among older instrumental conductors who turn to Bach.) On the other hand, many dramatic moments in the solo arias are superbly handled and the orchestral accompaniments, in contrast, move with beautifully phrased and balanced intensity. Odd.

Performances: A− *Sound:* B+

Berlioz: Requiem. Charles Bressler; Utah Civic Chorale and A Capella Choir, Utah Symph., Abravanel. **Vanguard Cardinal VCS 10070/1 (2 discs) stereo** ($7.96)

Speaking technically, this release is state-of-the-art, at least in commercial terms, for the recording of enormous massed musical forces in large, resonant spaces. Berlioz' "musical army" (as the record notes put it) is hundreds strong, comprising not only two choruses and five separate instrumental ensembles but in the brass and percussion department —if the specs are followed—no less than 16 kettledrums and an immense battery of trombones, horns, trumpets. For the one famous movement, the *Dies Irae*, four brass bands are stationed North, East, South, and West in addition to the main forces up front; the kettledrums, each tuned to a different tone of the chromatic scale, give forth a thunderous rumble such as has never been heard in any other music, before or since.

Four-channel? Of course! What else? Not, however, on this disc, which man-

ages to convey an astonishing amount of the immense musical power, within the vast area of the Mormon Tabernacle, via a mere single pair of channels. If you are planning to rush into four-channel tape, hang on, and buy the Vanguard tape release—if and when—so that the brass bands can really surround you as good old Berlioz intended back almost 150 years ago. But the musical and acoustic gist of it all is most assuredly captured on this disc, and more successfully than I have heard in a number of earlier recordings. This one has Dolby as well as Vanguard's very best efforts in distortion-free taping and cutting and pressing. The much-widened dynamic range thereby makes possible the clean high-power attacks, the incredibly complex *fortissimi*, and at the same time the bug-eyed dramatic pauses, the total *pianissimi*, the musical whispers of horror. Quite something! Do play it all. Don't confine yourself, as the demos always do, to the one segment of the *Dies Irae* with the four brass bands!

Technical audio comes first but music is not far behind. It is a good performance, as dramatic as it ought to be, imaginative in that respect for a Western American approximation of the France of the 1830s. Not easy! Musicians sometimes snort about Abravanel's less-than-perfect orchestra. Many of us think, oppositely, that this transplanted European conductor has done wonders, bringing to unlikely Utah an unerring sense of the far-distant traditions of European music, such as many technically superior forces cannot muster up. Better good style than perfect note playing, if you ask me.

I almost forgot the lone tenor soloist, Charles Bressler, who is not at all lost in the hugeness thanks to Vanguard's mikes. He is good, and properly distant, yet never overwhelmed. (In four-channel stereo he should sound still further away and smaller, but probably doesn't.) (*He does.*—ED.)

As for the Utah singers, they are powerful of voice, which is the biggest requisite. A good many trained vocal organs are audible and the blend within parts is so-so—but no matter. Gusto is what matters, and long breaths. Only in the a capella (as Vanguard spells it) *Quaerens Me*, minus instruments, is the pitch nondescript though, to be sure, they do end up more or less where they started, without over-all flatting.

For cleanliness of impact under extreme stress, this recording can't easily be beat. State-of-the-art, I say.

Performance: A− *Sound:* A

Herold: Le Pre aux Clercs. Soloists, Orchestre Symphonique, Etcheverry. **Music Guild MS 873 stereo** ($2.98)

Here's a charming bit of early opera, from 1832 and Paris, sung (in excerpts)

by a decidedly all-French cast and orchestra. Based on a historical novel of the time of Charles IX (Merimee), it is, even so, a light or comic affair as is immediately evident in the listening. A joyous combination—intimations of Offenbach (who came later), bits of Mozart, and a great deal of Rossini, all done up in a typically French fashion in spite of the barely post-Beethoven idiom—the music is, as they say, gay and infectious, the necessary contrasts only moderately sad, the whole filled with solid tunes and decorated with a most extraordinary quantity of vocal ornament in the operatic style of that time.

Sometimes this last gets hilarious—for it really is beyond present capabilities in the vocal art! The tenor, a good man and powerful, practically splits a gut on a couple of the fancy cadenzas; if it were more serious music, he would be tragic. One of the girls, however, is excellent at the coloratura stuff and the others always make it musical, no matter how difficult. What with the typically nasal French voices, the very French (and nasal) woodwind playing, the catchy tunes, and the liberal quantities of pleasant orchestral music, this record flows along in a most enjoyable fashion in spite of rather lackadaisical (typically French?) recording, unclean and with the voices proportionately too loud and too close.

Performance: B+ *Sound:* C+

Elizabethan Lute Songs. Peter Pears, tenor, Julien Bream, lute. **RCA LSC 3131 stereo** $5.98

Love's labour lost, that's what this is. Too bad. A labor of love without question, as the heartfelt and well informed annotations by Peter Pears evidence. The finest lutenist in the business, too, Julian Bream, and songs by Dowland, Ford, Thomas Morely, Philip Rosseter. But Peter Pears' voice is dismally unsuited to the lute and to such music, now in his later middle age. A big, dark, blowsy, wobbly voice, and an exaggerated operatic-style projection and direction—fine for the contemporary music of Benjamin Britten and many another music of larger proportions but wholly out of place in the hauntingly simple songs the Elizabethans sang to the lute's quiet plucking.

Don't be put off if you are accustomed to vocal music. The intention can very well pass for the deed and Pears is an intelligent, careful singer. You can "read" the meaning of the music very well, if your ear is rightly tuned. But for the rest of us, and those who might just like to hear songs of the "Greensleeves" variety, only better, this record is no way to begin. You won't make head or tail of it, Bream or no Bream.

Performance: C+ *Sound:* B

The Velvet Gentleman (Music of Erik Satie). Camarata Contemporary Chamber Group. **Deram (London) DEX 18036 stereo** ($4.98)

This one had me baffled for awhile. Very serious looking, and that name "Camarata" sounded musicological, like Collegium Musicum. Did Satie write a piece for chamber group called "The Velvet Gentleman"?

I soon found out. This is Camerata himself, not "a" camerata! Cashing on Satie's sudden revival of late, Camerata has gone in for a serious-minded set of arrangements of Satie piano pieces, the little ones with the funny names. The "chamber group" turns out to be a vastly mood-music-type orchestra, a symphony-and-a-half by the sound of it, though solo instruments are, to be sure, featured heavily. Some Satie!

I do not doubt that this was an enterprise in good faith and seriously undertaken. But, first, the little Satie morsels, however cleverly orchestrated, just do

not stand up to big treatment. They topple into futility or bombast. And second, good Mr. Camarata hasn't quite been able to suppress his Mantovani-like (well . . . Camerata-like) tendencies towards schmalzy musical slush. It keeps hinting itself in the background. Though Mr. C. probably wasn't even aware of it.

Performance: ?? *Sound: Lush*

Prokofieff: Symphony No. 5. Moscow Radio Symphony Orch., Roshdestvensky **Melodiya Angel SR 40126 stereo** ($5.98)

Curiously, I found this performance of the best known of Prokofieff's symphonies—well known in Russia, too, since it was composed there in 1934—of a rather bland and indifferent expressiveness. Could it be that, though the Russians are now all excited by the earlier Prokofieff music, composed in the West and not favored in Russia until recently, this piece out of standard Russian repertory has palled and turned into a chestnut in the Russian concert halls? Could be. Over here, we don't hear it quite *that* often. And our dynamic conductors can make it really sing out. No, I don't recommend this version very highly.

Performance: C— *Sound:* B—

Pfitzner: Concerto for Violin and Orchestra in B Minor, Op. 34. Susanne Lautenbacher; Philharmonia Hungarica, Gunther Wich. **Candide CE 31026 stereo** ($3.98)

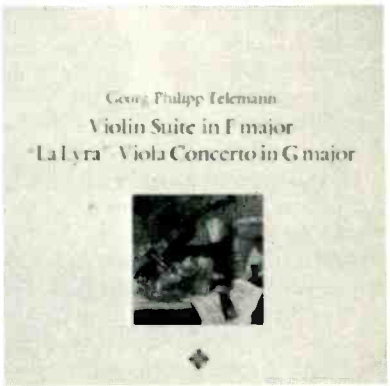
Well, one does live and learn! For years I have shied away from Pfitzner, the super-German late-Romantic composer of a hefty opera called "Palestrina" (of *all* composers!) much worshipped by the gentry in his home land. More of the Reger kind of stuff, I thought, or Busoni. Big, fusty, heavyweight, and deadly serious. Ugh. So I looked at this one, and looked the other way fast.

But in the end conscience got hold of me and I thought, well, I'll *try*. Can always turn it off. I almost did, too; the solo violinist, Suzanne Lautenbacher, tends to play out of tune and in the opening measures she must have had a fit of nerves—just awful! I gritted my teeth and held on. Soon, with Miss Lautenbacher under better control, I began to realize that this music was good. And, most interestingly, very clearly of its own time, 1925, in spite of a harmonic idiom back in the Brahms era. He was an arch-conservative in any outward sense, but the feelings and tensions of 1925 got through to him though not the snazzy, jazzy brittleness of that day's more advanced music. One hears, curiously, bits of Hindemith or Bartok. Sinewy lines, strong sequences of angular fourths. And one hears "twelve tone"—great leaps all over in the melodic line, out of Schoenberg. Yep, it's there. He was, after all, only 56, hardly out of middle age.

In spite of Lautenbacher—and much-too-close recording of her fiddle (exaggerating her faults unfairly)—I liked this music and recommend it highly. One new composer in *my* repertory.

Performance (orch.): B+ *Sound:* B—

Telemann: Violin Suite in F (with flutes, oboes, horns, trombones); Concerto for Viola; Suite "La Lyra" for Strings. Jaap Schroder, vl., Paul Doktor, vla., Concerto Amsterdam, Frans Bruggen. **Telefunken SAWT 9541-B-Ex stereo** ($5.95)



What an excellent series is this Telefunken "Das Alte Werk"! Though this disc was recorded back in 1967 and 1968, it is one of the finest examples of good stereo mike placing for a complex ensemble of instrumentalists that I have ever heard. The Violin Suite, for instance, involves in addition to the solo violin and string orchestra a battery of subsidiary soloists—2 flutes, 2 oboes, 2 high horns, trombones—plus the harpsichord continuo and its bass stringed instrument. The separation between all of these is superb, but so is the ensemble sound and the surrounding room ambience; and each instrument appears, in terms of recording, exactly as it must sound for the most musical effect.

Not all of the many Telemann movements in these two suites and one concerto are first-line music; the poor man was bound to run down once in awhile, considering the enormous quantities of music he composed. But the opening movements, and often the closing ones, are unfailingly interesting and forceful. Note that the conductor is the brilliant young recorder player Frans Bruggen,

who doesn't play his instrument here. The harpsichordist is the well known Gustav Leonhardt.

Performances: A– *Sound:* A

Paganini: 12 Sonatas for Violin and Guitar. Harold Cohon, Robert Shaughnessy. **Orion ORS 6907 stereo** ($5.98)

Hmmm. Strange little disc, this one. (Little in a figurative sense.) It seems that Paganini, the diabolical violinist, was crazy over the guitar and actually gave up the fiddle for five years, early in his career, to concentrate on guitar playing. Since nobody says much about *that*, we must assume that it didn't quite match his fiddling—and the evidence in these sonatas goes in that direction. The guitar mostly plays plunk, plunk, simple chords. The violin does all the pyrotechnics.

The sonatas are unpretentious and simple, if with occasional mildly hair-raising technicalities for the fiddler en route. They are short little works, in two movements, not unlike the little sonatas for harpsichord by Scarlatti, though far less brilliant and much less complex. Paganini as a composer was bland, and pleasant, nothing more. Harold Cohon plays impeccably in tune—which is a lot. The guitar, as I say, just plunks.

Performance: B *Sound:* B

The Legend of Leadbelly. Tradition 2093 sim. stereo ($5.98)

Eight of these ten Leadbelly cuts, on a rather skimpy LP for six bucks, are from the old Musicraft 78-rpm catalogue, recorded in 1939. The sound quality is the old so-so sort, no highs and lots of thumping bass, but Leadbelly's driving force and musicianship come through just the same. I hadn't heard his music for quite some time, and had forgotten what a powerhouse of musical energy that man was, even in a studio. Without any doubt, the man was a first-class musical creator and only the scarred circumstances of his life, cotton picking, killing, rotting in jail, kept him short of a modern black Beethoven or Mozart. A stage man, too. He "projects" sheer electrical voltage! Glory be—Leadbelly would be 85 if he were now living. Hard to believe. Some of his best and most vigorous stuff is on this record, along with (inevitably) Goodnight Irene. You can have *that* one. Josh White and Sonny Terry assist.

Performance: A Sound: C

FREAK OF THE MONTH

IVAN REBROFF (The Richest, Darkest, Lowest, Highest Bass in the World). Accompanied by Balalaika-Ensemble Troika. **Columbia MS 7373 stereo $5.98.**

Only literally true! At first hearing, this disc seems to be going to turn out as the usual semi-pops Russian offering. A typical East-type "folk" band (made up of pro players of course) in the background, "Volga Boatman," "Dark Eyes," and what-not in the foreground, out of one of those typically cavernous basso voices we hear in such varied Russian frameworks as the Don Cossaks, Russian cathedral music and, of course, "Boris Goudonov," the Moussorgsky opera. He's right in the tradition, a sensational basso of the kind you just don't find anywhere else.

But play on—just play on. Presently our friend converts into a tenor. A fine Russian tenor, of the sort you find only in Russia, in the Don Cossacks, in "Boris Goudonov," etc. etc.

Ahem. This remarkable Ivan then proceeds to become an alto, a splendid Rooshian alto, of the sort . . . etc.

And at last—you guessed it—he ends up a soprano, complete with canary-type cadenza. Oh wow! He really does. I broke up all over the place.

Of course, it isn't done quite in that order, I'll admit. But not until you've played several LP cuts do you come to the soprano segment. Nicely planned. The man keeps going up and down, back and forth, unisex style—and that super-basso cavern sound keeps returning to make the other sounds the more preposterous. We are, indeed, familiar by now with the male countertenor, in our milk-toast Western music. This Russo stuff is something else again, if not exactly profound in terms of the music projected. I can only think, somewhat helplessly, of that lady freak of awhile back, Gorgeous Korjus. She sang from alto profundo to canary-o super-altissimo, which sounded, alas, more or less like a squeak, or a rusty gate in need of oil. She was a mere woman. *This* guy, now . . . Incidentally, his name is spelled on the record jacket in semi-pseudo-Russian characters. Dunno what our printer will make of them.

The musical stars of tomorrow—where are they now? Some, as you may suspect, are performers whose names are vaguely familiar, artists who almost made it once but temporarily became trapped in the quagmire of a narrow musical trend. Others have gained fame in related creative fields and only now are turning—or re-turning—to clef-hanging. Still others are just cutting their musical teeth as they cut their first albums.

One who fits the last category is CARL OGLESBY, whose initial Vanguard album (VSD-6527) carries his name as title. A singer who also plays guitar, he penned each of the nine songs he delivers with poignancy and punch (despite his lyrics occasionally being mystical and obscure). Using a voice reminiscent of the huskiness in Carl Sandburg's, Oglesby produces a white folk-rock that barely misses the traditional folk motif. There is, however, something enigmatic about the tunes—for, although superficially resembling intense and topical Tom Paxton material, they also seem to have a casualness about them (almost as if they'd been performed thousands of times before). Oglesby's voice, complete with tremolo (in low register), adds to the aura: To the ear, he comes over almost as an old man (despite the obvious youthful vitality of the lyrics—and the cover photo).

The tunesmith begins with "Suburbs of Eden," a smooth, pleasantly folkish melody that grows on the audiophile with each subsequent hearing. "Le Chinois" is next, a tune that starts slowly and then moves into rock patterns, only to return to any easy pace. The down-tempo segments are accompanied by guitar work that can only be termed haunting.

Twangy guitars and a beat that simulates a moving train are spotlighted on the countrified "Staring at the Sunshine," while "The Prophet" is a narrative ballad (on which Oglesby seems to have mild difficulty in reaching some high notes). "Black Panther" closes the first side with a bluesy air.

On the flip half are "Portrait of a Lady," similar to the old English ballads so popular in the 1950s; "Dragon Song," which is virtually funereal in tone; "Cherokee Queen," another countrified offering, and "Lemon Light."

At worst, he's interesting; at best, he's a rising celestial body in the musical firmament.

* * *

Another singer who acts as if he's halfway between yesterday and tomorrow is RONNIE HAWKINS, a Cotillion artist who also lends his name as LP title. He too is somehow reminiscent of days gone by—but with more than enough contemporary flavor to make a go-go of it today. And Hawkins proves, on all eleven tracks, that he can *sing* (something many mod-ern vocalists forget about).

Because he concentrates on his voice (and doesn't spend time trying to compose as well), he borrows from many of the top *now* writers. Such as Bob Dylan ("One More Night," a straightforward country rendition), Gordon Lightfoot ("Bitter Green," pop-rock with strings that don't intrude), and Jerry Jeff Walker ("Little Bird," another pure country sound).

Hawkins hasn't forgotten the ring of the cash register, though. Today's *in* sound is a throwback to the rock 'n' roll of the '50s, so the singer showcases Carl Perkins' "Matchbox" and Chuck Berry's rockabilly shouter "Forty Days" (with real down-home piano).

The old-and-new-fashioned rock beat also appears on "I May Never Get to Heaven," which superimposes a gospel sound on a basic soul piece (and adds a background combo straight from the rhythm and blues era), plus "Who Do You Love."

Even what's left on the disc (SD-9019) shouldn't be ignored. Hear, for instance, Lightfoot's "Home from the Forest," with a country taste overlapping the stringed artiness. Or "Will the Circle Be Unbroken," a rousing spiritual in rock dress, replete with wild-voiced chorus. Or Dylan's "One Too Many Mornings," with Hawkins adding a Walter Brennan-like raspiness to his voice and King Biscuit Boy adding a harmonica sound that cannot be rated anything but superb. Or Solomon Burke's "Down in the Alley," a country-blues affair that will have the listener begging for more.

* * *

Newcomers are not, of course, limited to the music arena; comedy, likewise, needs future stars. Attempting the improvisational route used so successfully by the Second City troupes and the Elaine May-Mike Nichols team is ACE TRUCKING COMPANY (RCA Victor, LSP 4268). The patter *may* be wildly funny in person; on vinyl, however, it's a drag.

The group consists of four guys (Michael Mislove, Bill Saluga, George Terry, and Fred Willard) and a gal (Patti Deutsch, who doesn't seem to do very much). All but two of their dozen sketches are spontaneous creations; the two exceptions are the best, honed to professional presentation and timing.

The material frequently deals with sex and drugs, making it an obvious target for censors. But those who would ban it by labeling it disjointed acoustical dirt would be missing the point: It should be banned because it lacks cleverness, humor and magnetism.

The album's cover, not incidentally, may fake out some prospective buyers. Featuring a photo (duotoned, in tintype effect) of the group with an old van and an older horse, it may lead one to believe the contents are that of a new rock combo. One spin, however, will make it all too clear that the only thing that's rocky is the so-called comedy material.

The two tracks that contain standard bits by the quintet (although both started as improvisations) are "Paqua Velva," a spoof on the commercial (the lampoon spotlights a homosexual promoting the man's lotion), and "The Elec-

tric Chair," a death house scene appropriately described by one of the participants as "silliness."

Among the other sketches are "The Drugstore," in which a bashful teenager (are there any left?) seeks contraceptives; "$3 Quarterback," with another homosexual as the gridiron great; "The Soap Opera," parodying a medical drama (in which the doctor orders lunch in Latin); "Constipation," dealing with yet another homosexual (the emphasis becoming clear?); "The Honeymoon Night" (the switch this time is to voyeurs); "The First Buffalo Hunt," a cliche-ridden pastiche about pot-smoking Indians, and "Othello," another look at the drug scene, this time via a man-in-the-street interview.

One of the improvisations works, at least in part—"The Last Supper." But it is likely to offend anyone with *any* connection with religion. So it too must be written off as a mistake.

Stars of tomorrow? These five have the formula (Sex plus Violence equals Success); the only thing they lack is talent (but, then who ever claimed Raquel Welch had any?).

* * *

A married couple from Britain, John and Anne Ryder, is trying to make it in the States via a Decca disc, I STILL BELIEVE IN TOMORROW (DL 75167). They might just do it as a team (both were unsuccessful as soloists), for they offer pure pop and good two-voice unison arrangements. In addition, the orchestration throughout the LP (featuring arranger Cy Payne's heavy use of strings) has that chartbusting feel.

The album, naturally, starts with the title tune, already a pop-rock hit for the duo. "It's Getting Better" follows, spotlighting her solo voice (and both on choruses). Next is Fred Neil's "Everybody's Talkin'," which is every bit as good as the smash Nilsson version that recently won a Grammy as "best contemporary vocal performance, male."

"Seasons in the Sun," unfortunately, is over-produced. Though the verses are good (John and Anne alternate), choral eruptions mar the Rod McKuen-Jacques Brel classic. "Let It Be Me," with a somewhat odd tempo and excessive brass that comes close to drowning out the vocalists, also misses.

Noteworthy flip side cuts include the frenzied "All the Love I Have" (though words are muffled in spots); the countrified "Don't Forget to Remember;" the folk-rockish, breezy "A Thing Called Love;" "Early in the Morning," with a bouncy, carnival-like Latin flavor (and an added touch of melancholy), and "Some Town," a drivin', *heavy* tune that the Ryders penned themselves.

* * *

For those who enjoy good music and don't care whether the tunes stick to the mind or lend themselves to humming or whistling, Liza Minnelli's COME SATURDAY MORNING (A&M, SP4164) is a good bet. The singer-actress, who had to overcome some bad recordings, bad press, and badmouthings about her being Judy Garland's daughter, seems to have blossomed vocally—perhaps due to the confidence gained by critical acclaim for her performance in "The Sterile Cuckoo." The initial song on the LP, in fact, shows her gratitude for the film. "The Sterile Cuckoo," part of which is relegated to background status as the songstress narrates the words, indicates what is to come: Miss Minnelli is basically herself (but always there's a hint of Garland).

Later she shows she has a voice that can alternately boom like a cannon, trill like a nightingale, or whisper like a breeze.

"Raggedy Ann and Raggedy Andy" is an intricate piece of melancholy that utilizes heavy brass and strings, while "Leaving on a Jet Plane" is almost a nightclub-type rendition of the airy Peter, Paul, and Mary hit. "Love Story" is a Randy Newman variety special wrapped up in a few minutes (it rambles pleasantly, from bouncy pop that swings, to a novelty approach, to schmaltz, to pop-rock). Contrasting sharply is the Frank Loesser evergreen, "On a Slow Boat to China," steeped in nostalgia and aimed at those who ask what happened to the good, old tunes. "Don't Let Me Lose This Dream" eliminates the soul from the Aretha Franklin success but adds strings, a lush arrangement—and beauty. And a Jim Webb medley—"MacArthur Park" and "Didn't We"—is highlighted by cocktail piano background by Peter Allen.

She'll always be compared to her mother, of course, but it may not be long before they're put on an equally stellar level. Æ

AUDIOCLINIC

(Continued from page 6)

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(Continued on page 71)

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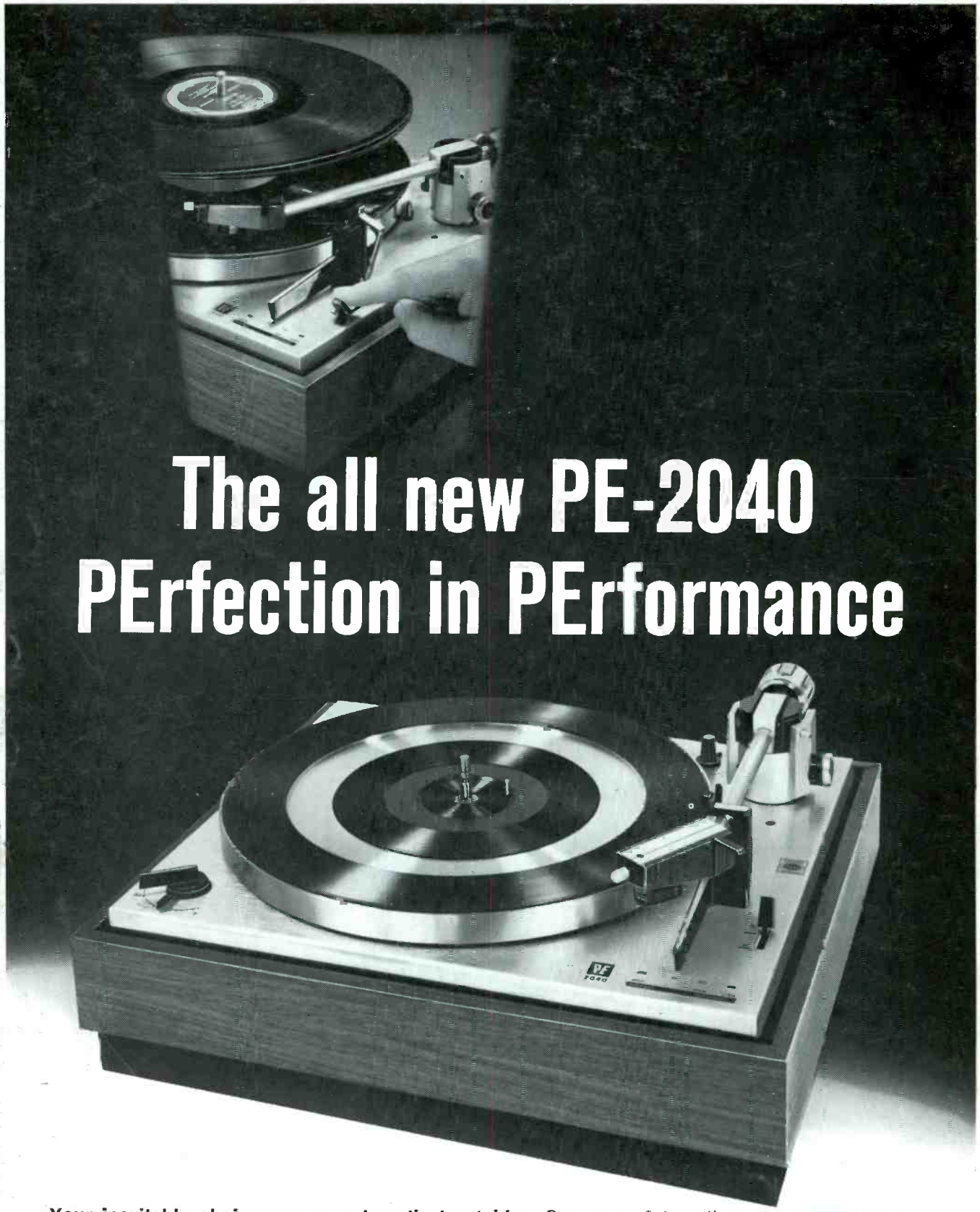

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