the authoritative magazine about high fidelity

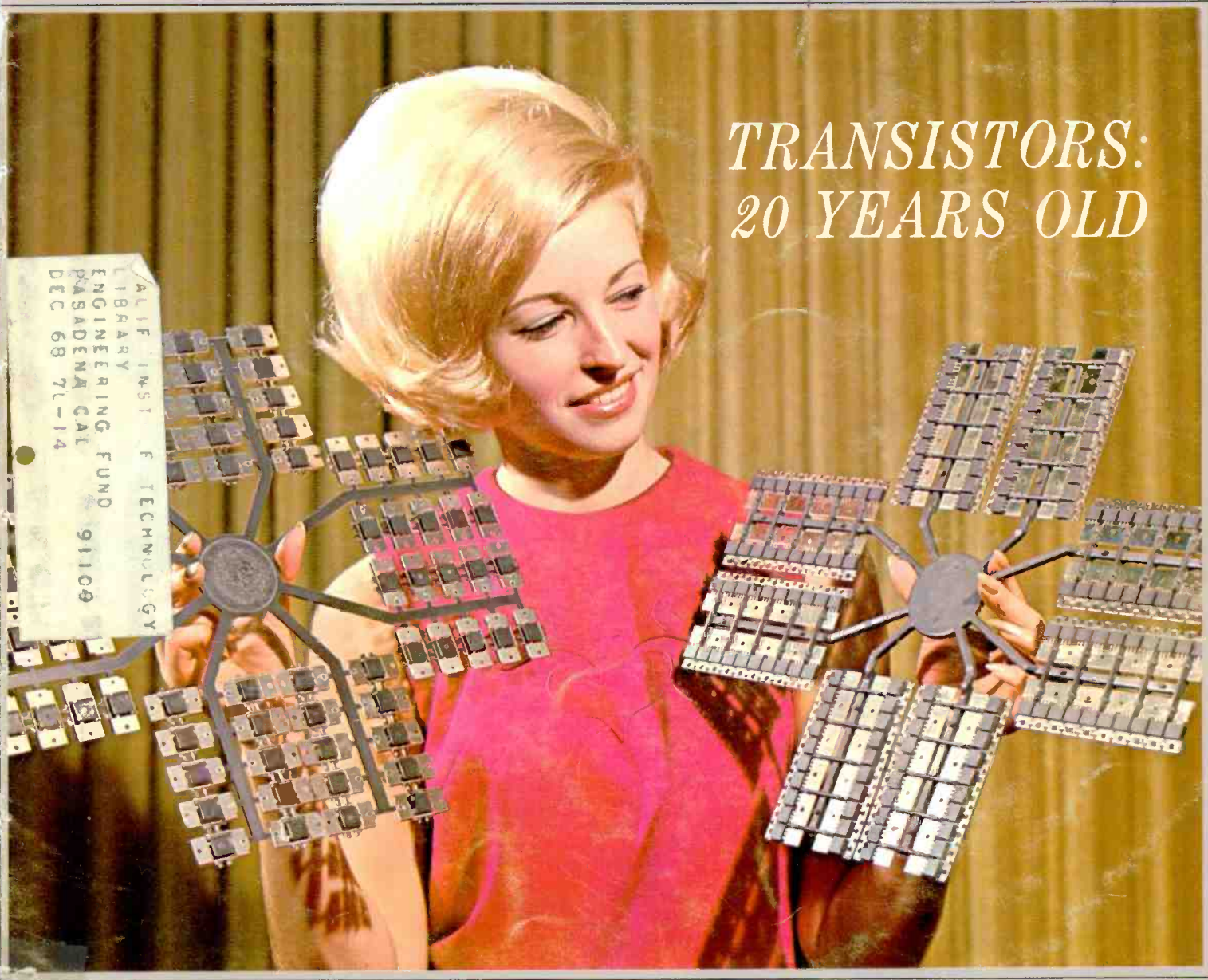
STEREO EQUIPMENT & RECORD REVIEWS

AUDIO

ON SALE APRIL 1968 60¢

The Truth About Stereo Amplifier Power Ratings!

Be Your Own Critic of Synthesized Music



Also: ABZs of FM, Tape Guide, Audioclinic

If you could look through your speakers, is this what you'd see?

Listen carefully. Chances are your speakers add their own distorting coloration to the music. Maybe it's a boomy bass, or an overemphasis on treble. Most speakers do it, and some are designed to do it. You may not even mind the effect. But is this really the absolutely faithful reproduction you paid for?

If you enjoy adding emphasis to selected parts of the music, that's your prerogative. But don't let your speakers do it for you! There are controls on your receiver or amplifier that do the job much more predictably and pleasingly.

The best speaker is still the one with absolutely even response; with no coloration of the highs or the lows. This is the kind of speaker that Scott makes.

Scott engineers design every component part of Scott speaker systems. It's far more difficult than using ready-made components, but Scott won't accept the bias built into "off-the-shelf" parts. Scott's Controlled Impedance speakers are designed specially for use with today's solid-state equipment. Custom-designed woofers, tweeters, midranges, and cross-over circuitry are carefully matched in solid, air-tight enclosures. And each individual speaker system must survive the scrutiny of both electronic instruments and trained ears before it's allowed to leave the Scott factory.

As a result, Scott speaker systems are completely honest; what goes into them is what comes out of them. They won't cover up for a poor receiver or turntable. Neither will they distort the perfection of a good component system. And that's what Scott believes great speakers are all about.

Choose from five Scott Controlled Impedance speaker systems, priced from $49.95 to $274.95, at your dealer's.

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H. H. Scott, Inc., Dept. 35-04
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Improve your listening with Scott 20/20 Speakers.

April 1968 Vol. 52, No. 4

AUDIO

Successor to RADIO, Est. 1917

FEATURE ARTICLES

MUSIC REVIEWS

EQUIPMENT PROFILES

AUDIO IN GENERAL

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Coming in May

FEATURE ARTICLES:

Batteries for Tape Recorders – Walter Salm examines the variety of batteries used to power portable tape recorders.

The World of Outdoor Hi-Fi– With summer almost upon us, here is a timely roundup of audio equipment designed for outdoor use.

FM Receiving Antennas – Len Feldman takes some of the mystery out of antennas used for FM receivers in this installment of ABZs of FM.

Music of the Twenties & Thirties Re-Visited–Stuart Triff discusses recent reissues of old recordings made in the Twenties and Thirties by Crosby, Merman, and others.

. . . And More

EQUIPMENT PROFILES:

Harman-Kardon Model Five-Twenty Stereo FM Receiver

Sony/Superscope Model TC-230 Stereo Tape Recorder

Plus: Regular monthly columns on music and equipment.

ABOUT THE COVER–The first transistors, developed more than 20 years ago, were primitive by today's standards. The plastic-packaged transistors illustrated on the cover of this issue, high-power silicon transistors from RCA Electronic Components and Devices, are shown as an assembly of 60 36-watt transistors and an assembly of 80 83-watt transistors before they are cut apart to form individual devices. This construction technique is used so that plastic may be fed into molds.

Audioclinic

JOSEPH GIOVANELLI

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

Styli and records

Q. I am considering the purchase of a new cartridge. My present one does not track as well as it could (confirmed by borrowing cartridges from friends.) I am interested in the least record wear as well as good reproduction. My record collection is about 90 per cent stereo. That percentage will go higher as I add to the collection. I have considered two cartridges in separate, plug-in heads for the two types of records. I wonder if this is necessary.

My concern is over the styli available, both elliptical and conical. Can they both be equally good for the records?

Will you clear up some of my confusion by suggesting which is the more desirable type and size for the two types of records. I will appreciate any assistance you can give me.—Paul E. Scraggs, Clark, N. J.

A. As you know, some cartridges are designed to complement fairly poor equipment. They are massive compared to the better cartridges. Therefore, they track at heavier forces than the better cartridges. As the tracking force increases, record wear will increase, given the same stylus configuration in all cases. However, if we increase the stylus dimensions, the amount of tracking force will be spread out over a larger surface, meaning that the record will take less of a beating.

Cartridges and arms are improving all the time. We now can think in terms of tracking forces which are less than one gram in a few instances. This means that we are now in a position to employ styli having small dimensions, indeed. We would want to use such styli because they are capable of entering even the smallest groove variations and tracing them properly. The result is less distortion and better high frequency response, even at the center portion of the disc.

If we take a conical stylus, we finally arrive at a dimension which will be so small that the actual stylus tip will rest on the bottom of the groove. This is a state of affairs we do not want. We are not concerned with the bottom of the groove. The information we want to recover is in the groove walls. If the stylus rests at the bottom of the groove, it is not free to move easily. Further, it is obvious that some noise will be added, merely by the fact that the stylus contacts areas of the discs which are contributing noise but no desired program information.

If, now, we make the stylus elliptical, we have the best of two worlds. We have a stylus of small dimensions which will trace all groove variations. However, the stylus is wide enough from left to right so that it cannot fall into the groove completely. The sides of the stylus must come to rest on the wall of the groove before the tip can touch the groove's bottom.

Remember that the amount of force bearing down on the walls is quite large with an elliptical stylus because all of it is concentrated on two very small points. An elliptical stylus will therefore cause severe record wear if the tracking force is not reduced to compensate for this added force. Today's cartridges are capable of tracking at forces small enough to keep record wear very low and still track better than anything we have previously known.

If you have an old changer, you will not be able to make use of one of the newer types of cartridges. However, you can still find one which will work well for you and keep wear to a minimum.

I would imagine that if you must track your cartridge at more than 2 grams because of troubles in the mechanical portion of the changer, you should not use an elliptical stylus.

If you have a good stereo cartridge, it will play your monophonic records better than most any monophonic cartridge that was available when monos reigned supreme. If you use a spherical (conical) stylus, you should think in terms of a diameter not less than 0.7 mil. This has nothing to do with record wear, but has to do with the fact that many monophonic recordings were made with a somewhat wider

(Continued on page 4)

After dinner, light up a Garrard

You snap the illuminated switch of your Garrard Power-Matic Base, sit back and relax. You've put a demanding record on the turntable, but you haven't the slightest apprehension about what you're going to hear. You know that the Garrard SL 95 will track any cartridge to bring out everything the recording contains.

The perfectly balanced ultra-low mass tonearm, the precision stylus force setting and the anti-skating compensation insure it. The oversized turntable is matched to Garrard's synchronous motor to give you absolutely constant record speed, unwavering pitch. The sophisticated, yet simple controls permit you to cue and pause, safely and accurately. Now the music comes to a crescendo that you know would be beyond the capacity of lesser units to track—and your confidence in the Garrard is justified once again. The sound comes clear, pure, whole, in all its original integrity. It's a thrill that only a true lover of good sound can experience. Garrard is made for that listener.

The SL 95, at $129.50 less base and cartridge, is one of four in Garrard's new Synchro-Lab Series™ of automatic turntables priced from $59.50. Other Garrard models from $37.50. Optional Power-Matic Base is $15.95.

For complimentary Comparator Guide describing all the new Garrard models, write Garrard, Dept. AD-5, Westbury, N.Y. 11590.

Garrard®
World's Finest

groove than is used today. Stylus diameters smaller than 0.7 mil may result in the stylus bottoming in the groove of some monophonic discs.

The same holds true for the elliptical stylus. Its *major* axis should not be less than 0.7 mil. Again, this is not so much a question of record wear as it is one of groove geometry. The only question lies in the ability of the cartridge to play properly some older monophonic recordings.

Because some music and performers are available on monophonic discs only, you always want to keep the above in mind. All too often we think only in terms of the stereo effect or whether the sound is good. True, these considerations are of interest to us as serious listeners. However, some performers just did not make records when stereo was finally on the scene. Maybe the fidelity of these recordings is not good, even for monophonic recordings. If the artistry is great enough, let's forget high fidelity and concentrate on the beauty of the performance rather than on the fact that it might not have much high frequency response above 5 kHz.

AUDIO NEWS

Berlitz Language Cassettes

Language phrases from famed Berlitz Phrase Books have been assembled in tape-cassette form. Five languages are offered in this form: French, Italian, German, Spanish and Russian, each with up to 50 minutes of basic phrases. Each of the pre-recorded cassettes is priced at $6.95.

Industry Changes

■ Victor J. Amador upped to vice president of BSR McDonald. ■ Russ Molloy, founder of Bel-Canto Stereo Tapes in 1954, joins Telex. ■ Thomas J. Nicholson appointed executive vice president and general manager of Vega Electronics. ■ Donald H. Palmquist advanced to marketing manager at Altec Lansing. ■ John H. Trux appointed vice president of marketing for Bell & Howell's tape division. ■ Joseph S. Tushininsky, chairman and president of Superscope, Inc., assumes similar responsibilities for its subsidiary, Marantz Inc.

PRICE?

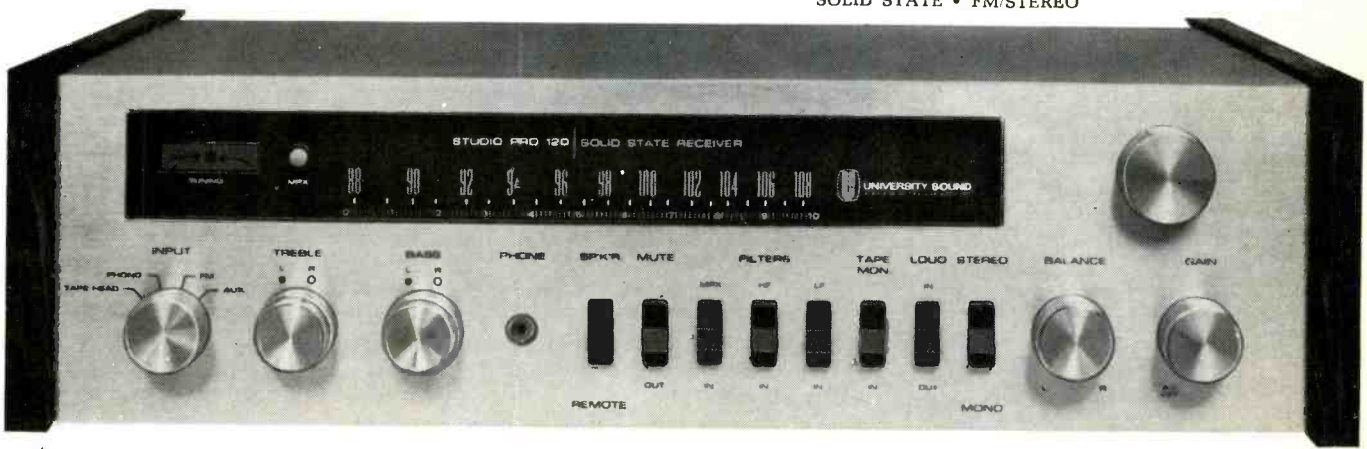
High price does not guarantee high quality. The Studio Pro 120 at $379.50** is equal or superior to many receivers costing up to $600.
Here's why.
By designing around the most advanced electronic devices commensurate with the state of the art such as, MOSFET front end, integrated circuits, all silicon transistors, encapsulated circuit breakers, 98 semi conductors, etc., we have built in all the quality that is possible for anyone to achieve. By developing new production line techniques with computer controlled material flow, we have been able to establish the exciting price and quality of the Studio Pro 120.
Each Studio Pro 120 has its individual quality control program supervised by the most demanding engineers in the business. Each will live up to the claims we make. We had the specifications certified by two of the nation's leading independent testing firms so you can believe them implicitly.*
Stop by your University dealer today and hear this great new pacesetter in the receiver world. *Write desk* D-83

**Manufacturer's suggested resale price.

UNIVERSITY SOUND
A DIVISION OF LTV LING ALTEC, INC.
9500 W. Reno Oklahoma City, Oklahoma

UNIVERSITY STUDIO PRO 120 - THE *Certified* RECEIVER

SOLID STATE • FM/STEREO



*AMPLIFIER SECTION: IHF Power Output: 120 watts total, IHF Standard at 0.8% THD, 4 ohms (60 watts per channel). RMS Power Output: 8 ohms: 30 watts per channel at 0.3% THD. Frequency Response: +0, -3 dB from 10 Hz to 100 kHz. Power Bandwidth: 10 Hz to 40 kHz, IHF Standard. Intermodulation Distortion: Less than 0.5% at any combination of frequencies up to rated output. Tone Control Range: ± 18 dB at 20 Hz and 20 kHz. Damping Factor: 50 to 1. Noise Level: (Below rated output) Tape monitor: -83 dB — Auxiliary: -80 dB — Phono: -60 dB — Tape Head: -63 dB. Input Sensitivity: (For rated output) Tape Monitor: 0.4 Volts — Auxiliary: 0.4 Volts — Tape Head: 1 mV at 500 Hz — Phono: 4 mV at 1 kHz. Input Impedance: Phono and Tape Head: 47,000 ohms — Tape Monitor: 250,000 ohms — Auxiliary: 10,000 ohms. Load Impedance: 4 to 16 ohms. FM TUNER SECTION: Sensitivity: 1.6 μV for 20 dB of quieting, 2.3 μV for 30 dB of quieting, IHF. Frequency Response: ± ½ dB from 20 to 20,000 Hz. Capture Ratio: Less than 1 dB. Image Rejection: Greater than 90 dB. IF Rejection: Greater than 90 dB. Separation: 40 dB at 1 kHz. Selectivity, Alternate Channel: 55 dB. Drift: .01%. Distortion: Less than 0.5% at 100% modulation ± 75 kHz deviation. Multiplex Switching: Fully automatic logic circuit. GENERAL: Dimensions: 4½" H x 16⅜" W x 12" D (including knobs). Weight: 17 lbs. Amplifier Protection: Three 1-ampere circuit breakers. Complement: 31 Silicon & MOSFET transistors, 21 Diodes, 2 Integrated circuits (each containing 10 transistors, 7 diodes, 11 resistors).

WHAT'S NEW IN AUDIO

Harman-Kardon Introduces Tape Decks

Harman-Kardon has expanded into the tape-deck field with two 3-speed, 4-track, open-reel units, Models TD-3 ($199.50) and Model TD-2 ($149.50).

Model TD-3 features three tape heads for separate record, playback and erase, while the TD-2 has a two-head assembly for record/playback and erase. Among the other features accounting for the TD-3's higher price are sound-on-sound and tape monitor facilities, and a hysteresis-synchronous motor.

The TD-3's one-micron gap playback head gives the machine extended high-frequency playback capabilities. According to the manufacturer, the

TD-3's frequency response range is 30 to 22 kHz at 7½ ips, 30 to 15 kHz at 3¾ ips. This compares with the TD-2's 30 to 20 kHz and 30 to 13 kHz, at respective speeds.

Signal-to-noise ratio for both decks is said to be 50 dB; wow and flutter is under 0.1% at 3¾ ips; cross-talk, better than 60 dB. Bias frequency is 96 kHz. Both models are compactly designed, measuring 11⅝-in. W x 9⅔-in. H x 6-in. D. Weight is 16 lbs. Equalization is set automatically for each speed. Each deck incorporates a three-digit tape counter with pushbutton reset, pause control function, and two VU meters, and includes an oiled-walnut cabinet.

Check No. 60 on Reader Service Card

Neumann "FET-80" Condenser Mikes

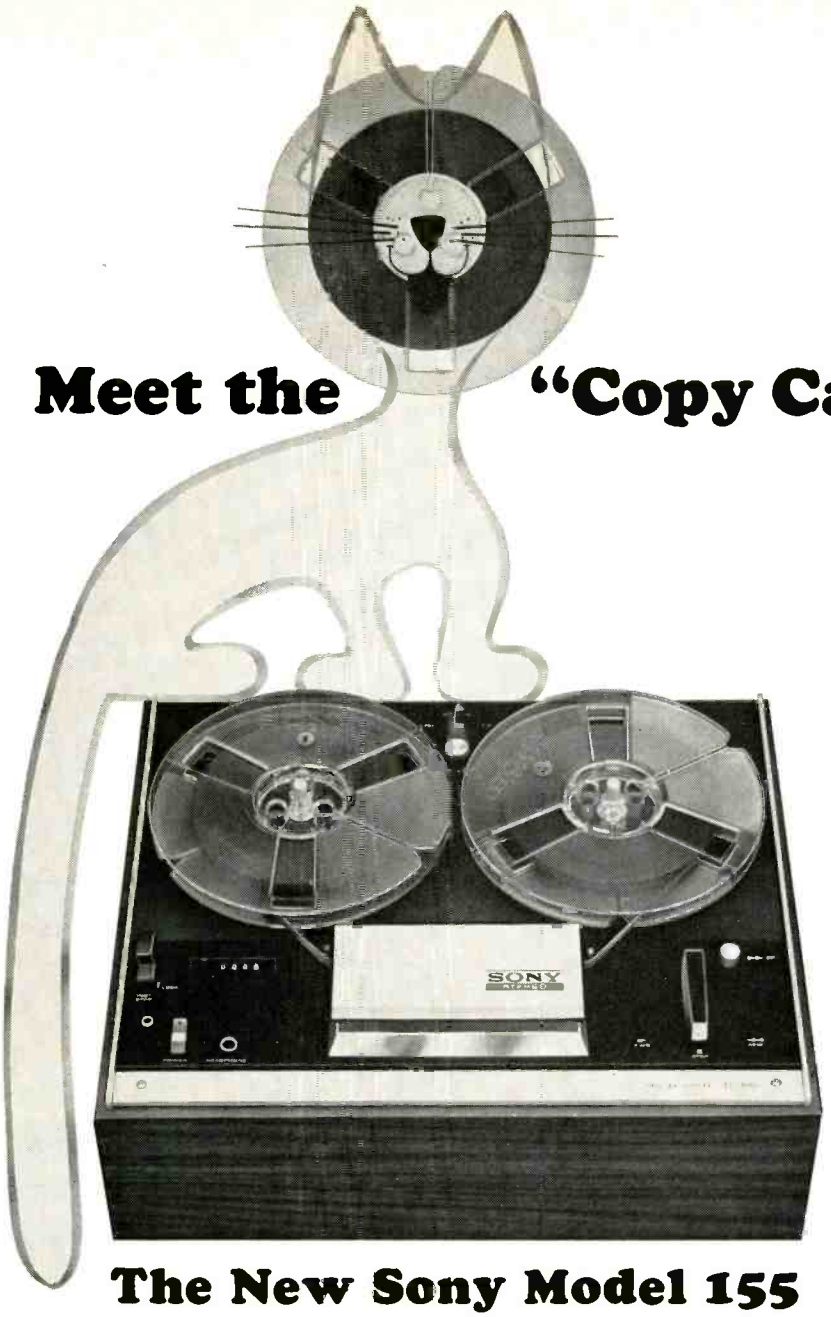
Gotham Audio Corp., N. Y., announces a new series of Neumann condenser microphones, called "FET-80." The FET-equipped microphones include solid-state versions of well-known tube-equipped counterparts. The model

U-87, successor to tube model U-67, is a 3-pattern switchable microphone with additional switches for overload protection and proximity correction; model KM-84, the "FET-80" successor to tubed model U-64, also has another version, KM-84, which features low-frequency roll-off for close-miking applications and for public address use. The Neumann KM-86, a miniature 3-pattern side-addressed microphone, is the successor to the "Linear Admittance" KM-66.

The Neumann "FET-80" microphones are available in systems powered from the N-452 dual microphone a.c.-powered unit or the BS-45 battery-supply accessory. The condenser element polarizing voltage is obtained directly from the supply voltage; r.f. circuits are not used.

Also introduced is a condenser lavalier microphone, designed for high-quality broadcast interview and film sound "fish pole" applications. It is normally equipped with the cardioid KM-85 capsule with low frequency rolloff, but can be delivered with full low-frequency response with a KM-84 capsule.

Check No. 62 on Reader Service Card



Meet the "Copy Cat"

The New Sony Model 155 Playback/Dubbing Stereo Tape Deck!

If you now own a stereo tape recorder, you can become a "copy cat" for only **$99.50** For the cost of about fifteen pre-recorded tapes, you can own your own complete 4-track stereo tape duplicating system and build a fabulous stereo tape library at a fraction of the cost of pre-recorded tapes! The Sony Model 155 is a complete stereo transport deck *with* solid-state playback pre-amplifiers *specifically designed to be used together with your present stereo tape recorder for dubbing!* ■ The Model 155 has features and performance never before heard of at under $100.00! For example . . . Three speeds . . . Special filter for virtually flutterless performance . . . Retractable pinch roller to permit tape threading with one hand ease . . . Stereo headphone jack for private listening, and . . . the flexibility of vertical or horizontal operation! These are all features normally found on only much higher priced equipment. ■ The Model 155 can also be used just for stereo tape playback through your existing components or package stereo music system. Imagine . . . Sony quality true-fidelity stereo tape playback for under $100.00! Complete with handsome walnut finish, low-profile base and optional dust cover. Let the Model 155 Playback/Dubbing Stereo Tape Deck make a "copy cat" out of you! And, as always . . . you can count upon the extraordinary "Sound of Sony"!

AMERICA'S FIRST CHOICE IN TAPE RECORDERS

SONY® SUPERSCOPE® The Tapeway to Stereo®

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Check No. 7 on Reader Service Card

Tape Guide

HERMAN BURSTEIN

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

Tape copying

Q. When copying a tape, what are the best volume control settings for the playback machine and for the recording machine?—Jerry L. Porter, North Bend AFS, Oregon.

A. The optimum settings of the playback and recording gain controls depend on their location with respect to preceding and following electronic stages. If the playback gain precedes an electronic output stage, a high setting is desirable to maximize the ratio of audio signal to noise of this stage. If the playback gain control is at the very output, its setting is immaterial so far as S/N of the playback machine is concerned. Of course, we assume that the playback machine still delivers enough signal to drive the recording machine.

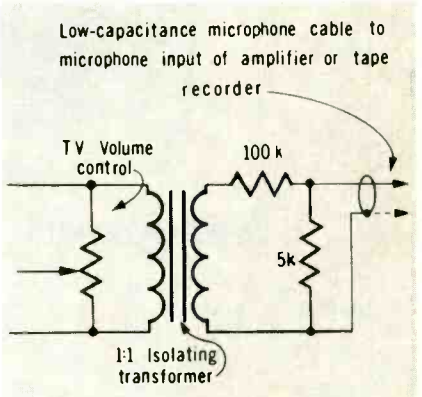
If the recording machine's input jack (high-level) goes directly to the recording gain control, with no intervening electronic stage, then it is immaterial what setting of this control is used (assuming there is no significant high-frequency loss at mid-setting of the control, as sometimes happens with poorly designed amplifiers). The control will always be set so that the same amount of signal is delivered to the following stages to achieve proper recording level. But if an electronic stage precedes the recording gain control, you may have the problem of finding an optimum setting: too much input signal may overload the first stage; too little input signal may result in too low a ratio between the input signal and noise of the first recording stage. If you know from the recording machine's specifications, or through experience or other means, that the first recording stage will not overload even for signals much greater than can be delivered by the playback machine, it would be safe to set playback gain at maximum to achieve maximum S/N with the recording machine.

In the absence of specific knowledge about the playback and recording machines' design and signal-handling capabilities, the safest thing is to start with the playback and recording controls in about mid-position. Then let trial and error and your ears guide you.

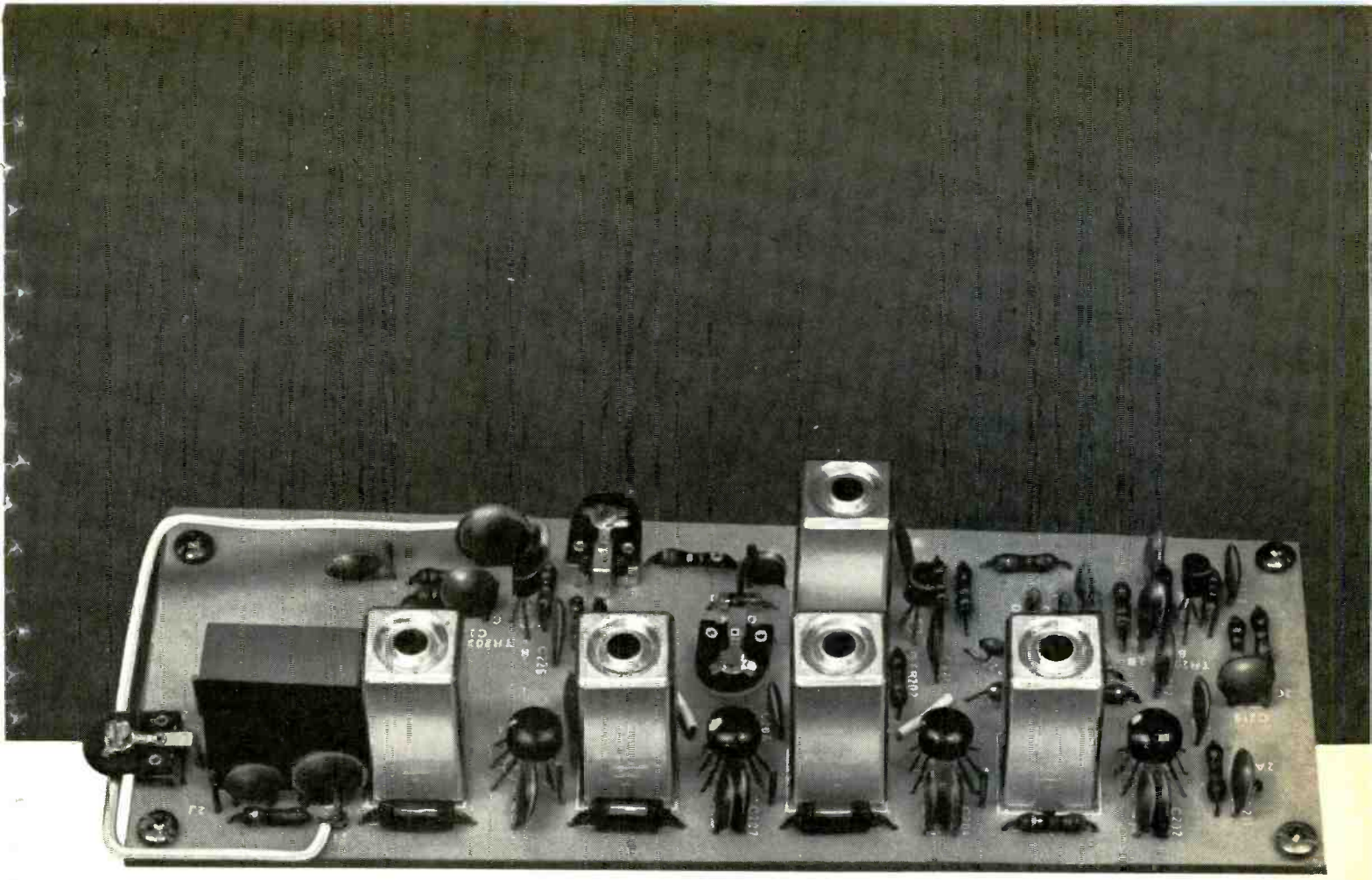
TV sound, again

How may one feed TV sound into a tape recorder? This question has been asked before and continues to be asked. The problem gets especially knotty if the TV set has no isolating transformer, but goes directly to the 117 V a.c. supply. Reader Ir. H. N. Hansen (of Laren Nh., Holland) has the suggestion shown in the accompanying sketch. A 1:1 isolating transformer (in his case, Philips A3-161-86-1) is placed across the volume control. The 100K resistor prevents undesirable loading of the FM detector. And the 5K resistor presents a small source impedance that permits a fairly considerable length of cable to the tape recorder—perhaps as much as 40 or 50 feet of low-capacitance microphone cable. Because the signal across the 5K resistor will be quite small, the signal must be fed into the microphone input of the tape recorder. However, one could use a larger resistor in place of the 5K one to obtain more signal, perhaps enough to drive the tape recorder through its high level input, with a consequent improvement in signal-to-noise ratio. At the same time, increasing the value of this resistor would require a shorter cable in order to avoid high frequency loss.

Sound takeoff from TV set, as outlined by reader.



Writes Reader Hansen: "I am getting superb hi-fi TV sound in this way. The tape recorder is permanently connected to the hi-fi amplifier, so this setup is a solution to the taping problem. In other words, the TV set has become a component of my audio system." Æ



Suddenly it's 1969...

Look closely at this photograph and you will notice four Integrated-Circuit* components which are part of the IF section of the new Sansui MD 5000 solid state, stereo receiver. These small hat-shaped objects are filled with a number of diodes, transistors and resistors integrated into a functioning sub-miniature circuit. They are just one of the latest advances introduced by Sansui along with such advanced audio circuitry as the specially selected FET FM front end. Consider these specifications: 160 watts IHF music power (75 watts per channel continuous power); 1.8 μV sensitivity; selectivity better than 50 db at 98 MHz; stereo separation better than 35 db; flat frequency response from 15 —40,000 Hz.

The MD 5000 includes output connections for three separate sets of stereo speaker systems which you can select separately or in pairs. In addition to inputs for tape, phono and auxiliaries, Sansui gives you extra input and output tape connections for recording or playback using extra recorders. You may monitor tape machine 1 or 2 from front panel when you record through your Sansui receiver . . . all the features which will make it the nucleus of your most comprehensive hi-fi music system for years to come. This new Sansui MD 5000 has been created for the sophisticated connoisseur who demands the ultimate in tonal magnificence and clarity of sound. $449.95.

Sansui

If you are not sure what Integrated Circuits can do for the performance of a hi-fi receiver, visit your local Sansui Audio Dealer. He will let you hear the difference.

Sansui Electronics Corporation • 34-43 56th Street • Woodside, N.Y. 11377

Sansui Electric Company, Ltd. Tokyo, Japan • Electronic Distributors (Canada) British Columbia

Letters from Readers

A Cutting Omission

• With reference to the article, "Stereo Disc Cutting," in January 1968 AUDIO, we were extremely disappointed that although virtually every major stereo disc cutting system manufactured of any note was referenced, absolutely no mentioned was made of the HAECO (Holzer Audio Engrg. Co.) Stereo Cutter Model SC-1.

W. M. KING
Miking
Santa Monica, Calif.

• . . . Grundy mentions three available cutterheads, omitting completely the outstanding Haeco iron-vane head built by Howard Holzer here on the West Coast.

DAVID W. BERKUS
The Custom Fidelity Company
Pasadena, Calif.

The HAECO Stereo Cutter Model SC-1 is indeed an admired and respected system, certainly deserving inclusion in the list of mastering-quality cutters published last January. Mr. Howard S. Holzer, President of Holzer Audio Engineering Co., points out that the HAECO Model SC-1 is now in use by more than 40 companies.—Ed.

Crosstalk Measurements

• I was interested in David Hafler's letter (February issue) concerning crosstalk measurements. His point regarding termination of the unused channel is a valid one; measurements taken with one channel unterminated can be completely misleading. I have reviewed amplifiers for British journals for some years and in my experience crosstalk has to be measured from channel A to channel B as well as B to A to be accurate. It might be thought that these figures would be identical; not so. A high-level circuit on one channel can couple to a low-level circuit on the other. Only in rare cases are the layouts completely symmetrical.

GEORGE W. TILLOTT
New Milford, Conn.

The Electronic Crossover Crossup

• The schematic and the parts list on page 22 of your February issue have errors in them. *(Sorry about that—a new and, we hope, completely correct schematic is shown on page 74—Ed.)*

A lot of people including me, do not have an amplifier lying around . . . if you were making the thing from scratch, you probably would have made the circuit boards bigger and included a separate power supply. I am delighted that you published the article as I have been a nut on the subject of crossovers for years.

Right now I'm using R-C filters and they work fine, furnishing 6 dB/octave between midrange and tweeter, and 12 dB/octave between woofer and midrange. 12 and 18 would probably be better with horns.

F. J. MANN
Eldridge, Calif.

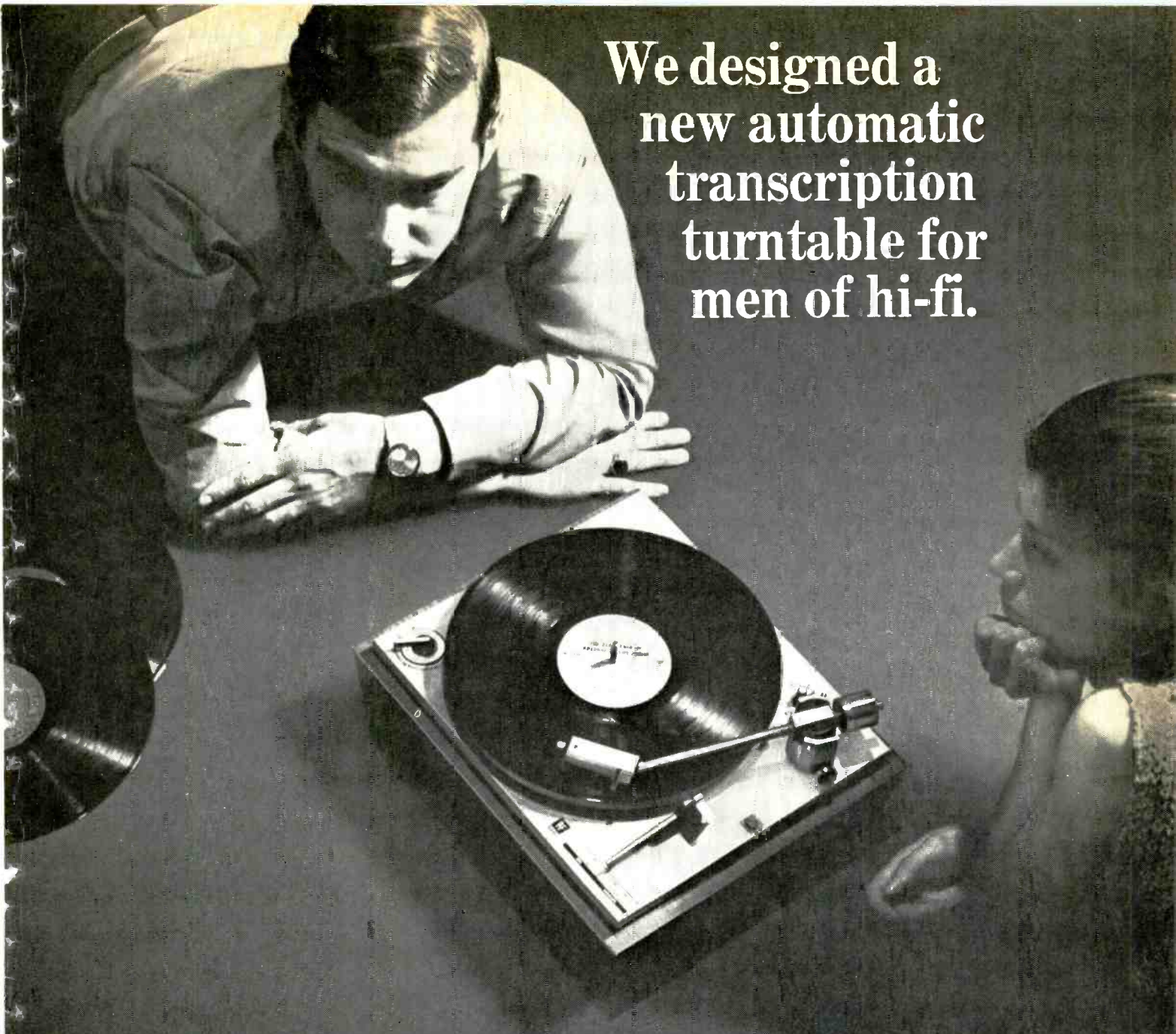
• I was happy to see you have arrived at the "Electronic Crossover." Welcome. I have been there for some time via a tube circuit published by Crowhurst. The tubes are 12AU6's and suffer from high-impedance which called for tremendous modifications before the calculated values were obtained—cut and try, plus cathode followers. Best of luck with your new amplifiers.

VICTOR REITER, JR.
San Francisco, Calif.

• . . . On page 66, in reference to the woofer section, it says "all that is needed is a high-pass filter." This should read "low-pass." The lead from the emitter of X1 and R5 to R11 and C15 is shown connected to the +28 V. bus in error. Also the junction of R20 and R21 is shown connected to the emitter of X6 rather than to its base.

HORACE E. WEST
Vancouver, B. C.

(Continued on page 74)



We designed a new automatic transcription turntable for men of hi-fi.

But, we didn't forget the ladies.

A his and her automatic turntable? Well, why not?

For him, the PE-2020 is a turntable that tracks like a manual, acts like an automatic and works like a charm. An exclusive little device in the cartridge shell lets him dial the perfect tracking for each record in the stack, at a precise 15° vertical stylus tracking angle. What this all means is maximum precision. Minimum distortion. And minimum record wear.

For her, the PE-2020 is styled to fit beautifully into any decor. But beyond its form is its function. The PE-2020 operates so simply for her. Thanks to an exclusive command center. Just one handsome lever is all she touches to start, stop, repeat, cue, pause and lift.

There's also an automatic anti-skating device. An automatic scanner. A four-speed setting control with pitch control . . . and much more. The PE-2020 only $129.95 less base.

Test and see the PE-2020 for yourself at your local Elpa dealer. If you don't know who he is and wish further information just ask us.

And when you visit him, be sure to bring her along. There's something in the PE-2020 for both of you. ELPA MARKETING INDUSTRIES, INC., NEW HYDE PARK, N.Y. 11040.

ELPA

the Elpa PE-2020

AUDIO, ETC.

EDWARD TATNALL CANBY

Interlude—the Cashette

I'll hafta laugh, once again. This is going to be an interim report, to my considerable amusement, on the great war between cartridges and the cassette. You may consider this as Act I, Scene II, the Comic Relief—though with serious undertones.

Well, how can I go very far into such a battle without sampling the goods? I got 'em all right—some of them. I've had an 8-track player on hand for many a moon. And RCA, indefatigible, never at a loss on the uptake, has positively flooded me with 8-track offerings, for which I offer my regretful thanks. Regretful because, as already mentioned, some kinds of music I just will not play. (Now don't jump to conclusions! One of the first 8-trackers I singled out for playing was a Chet Atkins catridge. He's tops in the Country Music field.) I have browsed over the whole 8-track spectrum, such as it is.

So—plenty of cartridges. Stacks of them. All sorts. Even a few classics of a safe and sane nature, guaranteed not to clip anybody's ears. But *cassettes?*

Back last fall, Ampex sent out a great wave of publicity concerning their new lines of cassettes to come, via the very extensive Ampex tie-ins with leading record companies. Terrific promise! I smacked my lips. Also, as a sampler, they mailed out their very first, a whole Great Classic in a single cassette, complete. *Scheherezade,* by Rimsky-Korsakoff! Some classic.

Scheherezade

Now I like *Scheherezade,* after a fashion. In fact, it was the very first consciously classical music I ever heard, at the age of maybe ten. My sainted and revered uncle, Lee Wilson Dodd, a man who I held in awe and worshipped from afar, had a big, dignified Victrola in his living room, a place where we kids were very seldom allowed. A wind-up, of course, for acoustic 78s—but this was back then. On ultra-special occasions we were allowed to hear that machine play a solemn piece that ought to have been the B Minor Mass of Bach or something, so reverential was the hushed little listening audience gathered around the Vic. It was always the same, "The Young Prince and the Young Princess," from that great mahstuhpiece, *Scheherezade. Dee* dah dah *dah,* diddle-diddle *dee* dah dah dah—I can hear it yet.

(But keep in mind that his really *was* one of the very earliest "classical" records, not counting operatics. My uncle was entirely right. That twelve-inch all-instrumental acoustic 78 was a work of art. The strains of *Scheherezade,* a classical symphony orchestra for the first time in a living room, and they sounded inexpressably noble to us, coming out of the grand old furniture piece with the adjustable doors and the curved roof, and the picture of Nipper, His Master's Dog, on the inside. . . .)

Well, we live and learn, don't we? And so now, XXX years later, I really don't find *Scheherezade* very awesome, even a la cassette. Just an old chestnut, well roasted. (Roasted, incidentally, by the famed Leopold Stokowski in this cassette. He probably roasted the old 78 too, in his slightly younger days forty-odd years ago. He's durable.)

To get back, I waited patiently all last fall, expecting a batch of shiny new cassettes full of delectable music to appear any minute in my mail box. None did. And I kept forgetting to do something positive about it, like, say, phoning the producers and *demanding* the things quick — by messenger, please. What is happening out there is CASSETTES. Perfectly good cassette player on hand, loaned to me by Ampex itself, and still nothing to play on it but *Scheherezade.*

My real thought, to tell the truth, was slightly panic-button. Maybe I've let this thing slide—maybe the market is flooded with all sorts of cassettes from everybody all over, and I've been off daydreaming? So I went into emergency. By phone, right in N.Y.C., where (some of) the action is. First I thought I'd better try Mercury-Philips. After all, it was Philips (of Holland) which developed the cassette. They ought to know.

—Oh no sir, we don't have any of those on hand here, and anyhow, we aren't sending them out to reviewers. Company policy.

But, I sputtered, I'm *not* a reviewer —at least not right now. That is, well, I *am* a reviewer but not when I write about cassettes because then I am a technical writer (well, what else could I say?) and—

I'm sorry sir, we do not ship cassettes to—Hey, now look here, little lady (or words to that effect), *I am a technical writer* (gulp) for AUDIO. And we are doing a, uh, study of cartridges and cassettes and I LIKE cassettes and so you really had better—

In that case, sir, she said, obviously relieved, I will refer you to our office in Chicago, where Mr. X is in charge of cassettes.

Just to be sure, I wrote to Mr. X, explaining what gave and asking for some samples of their very best and latest pre-, I mean *recorded cassettes,* preferably not including *Scheherezade.* Hopefully including some Bach. (Well, I didin't actually say this, I only wishful-thought it.) What I wanted to see was how the cassette could stack up, so to speak, as a real, honest tape alternative to the best LP records. That, after all, is a major point and, indeed, a very important one for cassettes, if they are to go beyond the immediate portable or automotive field.

Cashiered

Then I decided to go all-out. No use calling RCA. That would be like calling Tokyo in 1941 to find out about U. S. military competition. (I've just been reading a book called *Incredible Victory*—but that's beside the point.) So, tactfully, I by-passed RCA's phone and called Columbia. Who else?

Hmmm. 765 4321. Columbia really sewed that number up.

"CBS," she answers. "Columbia Records Reviewers Service?" I countered, "May I ask in what connection?" she came right back.

Well, *was* I flustered. Have you ever tried to explain a cassette to a telephone operator? Er, c-c-cassettes, I stuttered.

I will connect you with the cashier —. NO, *not* the cashier! I yelled. Cashettes! Just give me Reviewers Shervise, I mean Service. (That's the way I am on the phone.) So the poor, inoffensive reel-to-reel operator, who obviously wasn't going to lay her hands on any cashettes for a long time, plugged me in—

—Columbiarecords, Reviewerservice. May I halp you?

(Now the following, to protect the loyal employees of this branch of the CBS Empire, is deliberately garbled and merely like what was actually said, by virtue of a strange coincidence. But, so help me, it conveys a segment of the truth, as of a couple of months before you read this.)

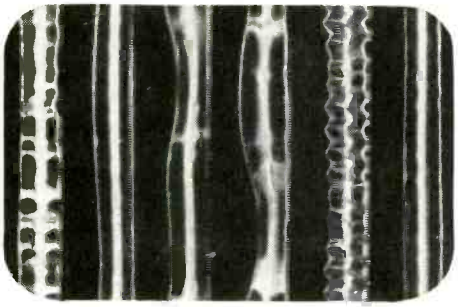
. . . Reviewerservice? Uh, this is Edward Canby of AUDIO, and I'm writing a piece on tape cassettes and cartridges. I was wondering if you could send me a few of your cassettes—

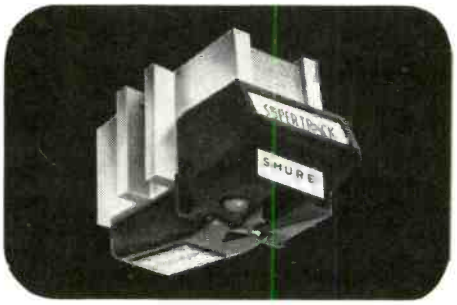
Oh sir, I'm sorry . . . like what did you say? I think you have the wrong extension,—NO, NO! You *are* Reviewerservice, aren't you? Yes sir—. And you handle both records and tape in that office, don't you? Oh yes, she said brightly. Tape! We do handle tape. I can give you our latest tape releases—. Uh, well, you see, I just wanted cas-

CLOSE THE TRACKABILITY GAP

(AND YOU'LL HEAR THE DIFFERENCE)

The photomicrograph above portrays an errant, hard-to-track castanet sound in an otherwise conservatively modulated recording. The somewhat more heavily modulated grooves shown below are an exhilarating combination of flutes and maracas with a low frequency rhythm complement from a recording cut at sufficiently high velocity to deliver precise and definitive intonation, full dynamic range, and optimum signal-to-noise ratio. Neither situation is a rarity, far from it. They are the very essence of today's highest fidelity recordings. But when played with an ordinary "good" quality cartridge, the stylus invariably loses contact with these demanding grooves—the castanets sound raspy, while the flute and maracas sound fuzzy, leaden, and "torn apart." Increasing tracking weight to *force* the stylus to stay in the groove will literally shave off the groove walls. Only the High Trackability V-15 Type II Super-Track® cartridge will consistently and effectively track all the grooves in today's recordings at record-saving less-than-one-gram force . . . even with cymbals, orchestral bells, and other difficult to track instruments. It will preserve the fidelity and reduce distortion from all your records, old and new. Not so surprisingly, every independent expert and authority who tested the Super Track agrees.





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At $67.50, your best investment in upgrading your entire music system.

Send for a list of Difficult-to-Track records, and detailed Trackability story: Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Illinois 60204

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settes. Sir, we only handle records and tapes here, I'll transfer you—JUST A MINIT, miss! (If she transferred me to the cashier I was going to scream.) A cassette is a kind of a tape, I said, and it would go through your office, wouldn't it? Oh yes sir, all the tape releases go through us and we'd know about it if—, *Cassettes,* I said, Do you have any yet? (I added the *yet,* as a sort of precaution.)

Just a minute sir, I'll ask . . . hey JACK, (voice off-phone). Like Cashette. Do we have anything like that? The gemman says, Cashettes. Like do we have any? (Mutter of male voice in background.) Sir, no one around here seems to have heard of anything like, er, what did you say? Cashettes. CASSETTES, I said as gently as I could shout. Well sir, I'm afraid we can't help you.

If Columbia *had* any, miss, your office would— Oh yes sir! All the releases go through our office. Would you like our latest tape releases now? I can get them for you in a jiffy. (I already had them, on paper. 4-track cartridges. 8-track cartridges. Period.)

Well, Columbia isn't—wasn't admitting to any cashettes. So I gathered. If not Columbia, then who?

Ampex New York

Now, all this could be a lot of malarckey and boloney and I hoped that this very cooperative CBS gal didn't tell me a lie, not even knowing. She was so sweet. Next, I phoned Ampex New York, and—just to show you—their Publicity *did* know all about cassettes. Phew! (I almost said "cashettes" to the Ampex gal—now where would that have got me?)

However, there were none on hand in the New York office. So she said she would contact the main tape office in the midwest area—by tieline, I figured —and would have a selection of the latest Ampex cassettes, not including *Scheherezade,* on the way to me in no time. In fact, she had it all set up when she called me back within an hour or so. Real cooperation.

As of right now, they are on their way.

I must end this bit of comicality with a serious coda. Just because the cassette is well behind the tape cartridge in terms of recorded (*pre*——) tapes, it does not follow that it is either unimportant or a loser. Far from it. There was a time, for instance—remember?—when the classical record stores were briefly flooded with 45 rpm 7-inch classical albums, well ahead of any noticeable volume of LPs from the same companies. The LP came up strong from behind, though, and the 45 retired to you-know-where. Maybe the same for the cassette, given awhile? Æ

The advantages of buying the Pioneer SX-700T am-fm stereo receiver start here

The guiding principle of all Pioneer stereo receivers is meticulous craftsmanship and value. The devotion to perfection literally begins at the power plug and extends to the priceless performance delivered to the speakers.

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COMPARE THESE SPECS: 60 watts music power (8 ohms); Distortion: less than 1.0% at rated output; FM sensitivity (IHF): 2.2 uv; Signal-to-noise ratio: 60 dB; Frequency response: ± 1 dB from 25 to 50,000 Hz; FM hum and noise: −75 dB; Channel separation: 35 dB (at 1,000 Hz); Full controls, such as simultaneous tape-record, tape monitor, headphone jack, etc.

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...More Value All-Ways!

Franchised Pioneer dealers will be happy to demonstrate the SX-700T and other Pioneer components to you. For more details and literature on the complete line, please write: **R. Von Sacken, PIONEER ELECTRONICS U.S.A. CORP., 140 Smith St., Farmingdale, N.Y. 11735.**

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EDITOR'S REVIEW

FM Rock

Many FM stations are swinging to "serious rock" and other hip music (Bob Dylan, underground chatter, W. C. Fields, Japanese Koto music, Indian ragas, and other offerings of this ilk), according to a recent issue of *Newsweek* Magazine.

One FM station executive advised that monthly billings shot up tenfold when this move was made. Another observed that AM rock-and-roll stations failed to "get with" the new music, noting that their audience has grown out of the Monkees . . . looking for music with greater depth.

We're pleased that FM is continuing to prove itself as an aggressive medium that recognizes broadcast needs that escape AM programmers. At the same time we're fearful that the Rock movement might overpower the FM airwaves, converting FM to a mass medium from a class medium. An 18-minute Guthrie folk tune is simply not palatable to most adults. Nor is good sound reproduction necessary to enjoy this form of entertainment. We wonder if *Newsweek's* report covered an isolated boomlet in hip music or the beginning of a trend. Letters from readers concerning the content of local FM station programming would be most welcome.

P.S. FM station revenues in 1966 displayed an increase of 31 per cent over the previous year.

AES Convention Panel Discussion

The Audio Engineering Society Convention in Hollywood, Calif., April 29-May 2, has a promising panel discussion scheduled: "Audio Quality and Its Deterioration: Electronic and Subjective." Moderated by Keith O. Johnson, Gauss Electrophysics, Inc., with panelists Allen E. Byers, United Recording Electronics Industries; John M. Eargle, RCA Victor Record Div.; John T. Mullin, 3M Company; and Carl S. Nelson, Capitol Records, the panel discussion will attempt to explain how types of electrically measurable distortion cause subjective sound changes or deterioration. Catch this one if you can. It should be especially interesting. *A.P.S.*

The Industry Mourns

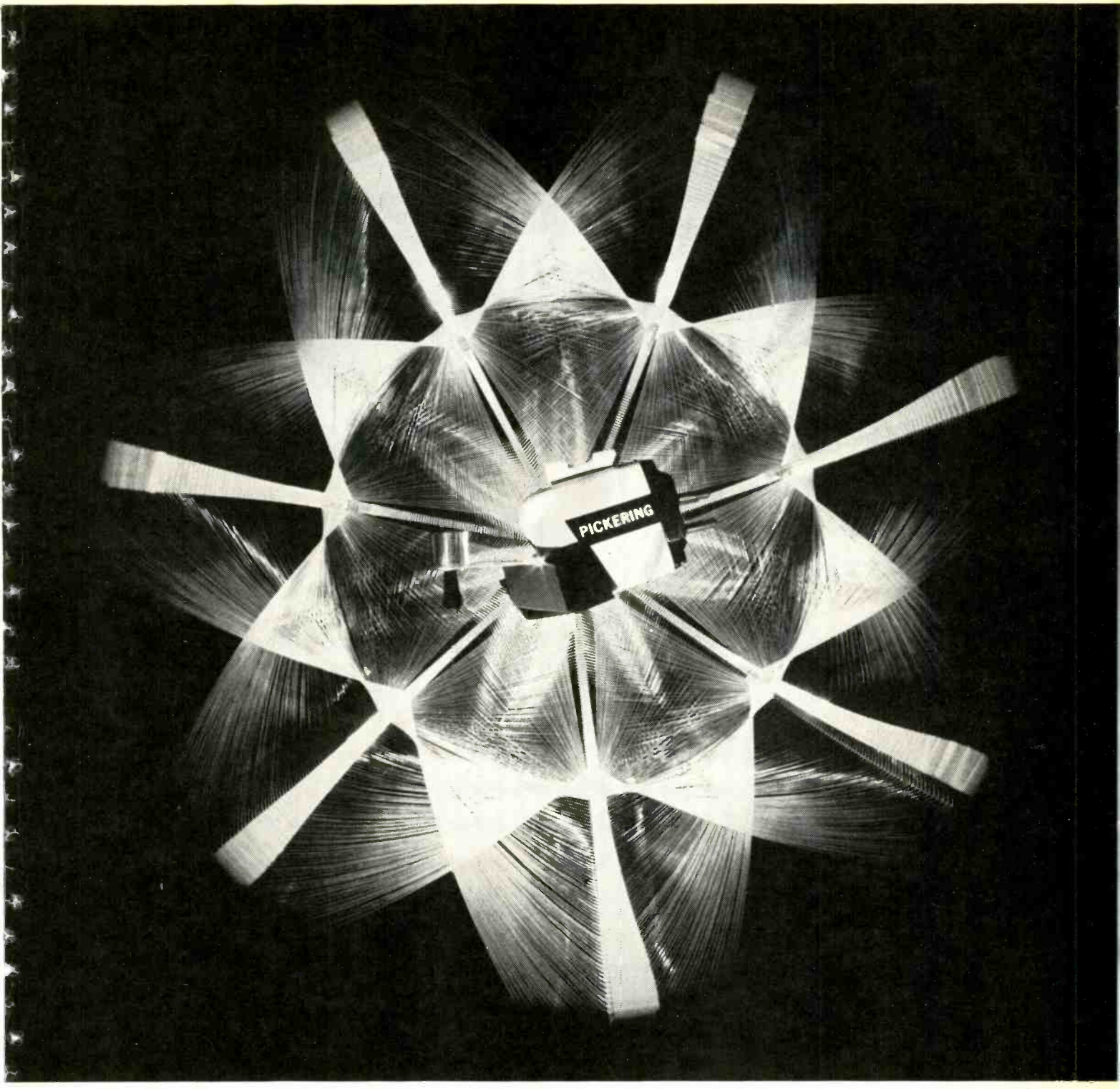
The high fidelity component industry was saddened recently by the loss of three executives who contributed to its growth over the years: Julian Gorski, 54; Edwin C. Cornfield, 56; and Sidney Frey, 47.

Mr. Gorski, who was President of United Audio (Dual automatic turntables) came to the United States in 1938, a victim of Nazi persecution. In later years, he received Austria's highest civilian award, The Gold Medal of Austria, for his charitable work. An accomplished musician, he found himself attracted to the fledgling high-fidelity industry, introducing Dual changers and Wigo speakers to this country. As a graduate engineer, he was able to develop, with the Dual factory, a line of automatic turntables that earned the respect of audio buffs. He leaves this heritage, as well as the memory of him as a sensitive, generous person.

Edwin C. Cornfield, one-time executive secretary of the Institute of High Fidelity, and sales executive for a number of firms in the high-fidelity industry, numbered audio and music as his main interests. The large, genial man played a major role in organizing and running the Institute's hi-fi shows during his tenure in office, attracting and introducing many people to good-quality sound. He will be missed by industry members, many of whom became good friends.

Sidney Frey produced the first stereo records as president of Audio Fidelity, Inc., propelling the industry into stereophonic sound. His "Dukes of Dixieland" and "The Brave Bulls" records, among others, were mainstays of audio enthusiasts about a decade ago. The pioneer's verve in the field of recording will not soon be duplicated.

The X factor in the new Pickering XV-15.



The X in the new Pickering XV-15 stands for the numerical solution for correct "Engineered Application." We call it the Dynamic Coupling Factor (DCF).[SM]

DCF is an index of maximum stylus performance when a cartridge is related to a particular type of playback equipment. This resultant number is derived from a Dimensional Analysis of all the parameters involved.

For an ordinary record changer, the DCF is 100. For a transcription quality tonearm the DCF is 400. Like other complex engineering problems, such as the egg, the end result can be presented quite simply. So can the superior performance of the XV-15 series. Its linear response assures 100% music power at all frequencies.

Lab measurements aside, this means all your favorite records, not just test records, will sound much cleaner and more open than ever before.

All five DCF-rated XV-15 models include the patented V-Guard stylus assembly and the Dustamatic brush.

For free literature, write to Pickering & Co., Plainview, L.I., N.Y.

[SM] Dynamic Coupling Factor and DCF are service marks of Pickering & Co.

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Sherwood

the low-distortion tuner

We are proud that Sherwood FM tuners were selected because of their low distortion by America's foremost heart-transplant pioneers to receive telemetered EKG data in their critical research programs.

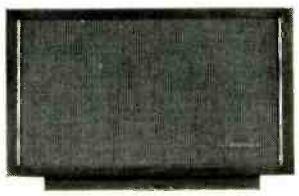
Hirsch-Houck Laboratories evaluates the 0.15% distortion Sherwood tuner shown above as follows: "The tuner has a usable sensitivity of 1.8 microvolts, with an ultimate distortion level of -48 db. This is just about as low as we have ever measured on an FM tuner, . . ."*

The S-3300 features our unique Synchro-Phase FM Limiter and Detector with micro-circuitry, field-effect transistors, a stereo noise filter (which does not affect frequency response), and of course, only 0.15% distortion at 100% modulation. *Less case - $197.50*

* Electronic World, Oct., 1967

Amplifiers and speaker systems

best suited for low-distortion tuners!



Sherwood offers three low-distortion amplifiers precisely suited for your needs–led by the Model S-9000a with 160 watts music power (at 8 ohms). The 140-watt S-9900a and the 80-watt S-9500b feature main and/or remote stereo speaker switching and separate terminals for monophonic center channel or extension speakers. All feature 0.1% distortion at normal listening levels. *Prices from $189.50 to $309.50.*

Our acoustic-suspension loudspeaker systems were designed to reproduce music with minimum distortion and coloration. You can hear the difference low distortion makes. Hear Sherwood's low-distortion Tanglewood, Ravinia, Berkshire, and Newport at your dealer–then take a pair home for a no-obligation trial. *Prices from $84.50 to $219.50.*

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The Truth About
Stereo Amplifier Power Ratings!

RALPH S. HARTZ and FRED S. KAMP*

Why music power ratings of solid-state amplifiers can be false! Component hi-fi vs. packaged equipment power-output ratings.

DIFFERENT MANUFACTURERS' audio power amplifiers may share identical power output ratings, but, in truth, they may have widely different power capabilities.

The Institute of High Fidelity and the Electronic Industries Association have attempted to standardize power-output ratings and methods of measurement of power output. Thus, one might assume that a common reference for comparison and a solid definition of the capability of power amplifiers now exists. In practice, however, the converse is true in ratings designed to indicate amplifier transient power output capabilities, such as the IHF dynamic output rating (IHF-A-201) and the EIA music power output rating (EIA RS-234-A).

The reason for the discrepancy lies in the fact that both standards allow the manufacturer to rate and measure the power output capabilities *using a regulated power supply*. Unlike the power supply furnished with the amplifier, the regulated power supply can deliver all the current the amplifier requires, and the supply voltage does not change. Further, there is no ripple on the regulated supply to add distortion to the output waveform near the clipping level, or to add hum to the input signal.

The EIA standard is primarily used by packaged equipment manufacturers. These are the manufacturers of portable phonographs, packaged stereo hi-fi consoles and packaged home entertainment consoles. The EIA music power output is defined as the power obtained at 5 per cent total harmonic distortion or less, measured after the "sudden application of a signal during a time interval so short that supply voltages have not changed from their no-signal values." The supply voltages are bypassed voltages. These definitions mean that the internal supply may be replaced with a regulated supply equal in voltage to the no-signal voltage of the internal supply. For a stereo amplifier, the music power rating is the sum of both channels, or twice the single channel rating.

The IHF provides two methods to measure dynamic output. One is the constant supply method. This assumes that under music conditions the amplifier supply voltages undergo only insignificant changes. Unlike the EIA method, this measurement is made at a reference distortion. The foregoing method is used by most high fidelity component manufacturers. The reference distortion chosen is normally less than one per cent—considerably lower than the 5 per cent EIA value used by packaged equipment manufacturers.

A second method prescribed is called the "transient distortion" test. This requires a low-distortion modulator with a prescribed output rise time and other equipment, all in a rather complex setup. The modulator output is required to have a rise time of 10 to 20 milli-seconds to simulate the envelope rise time of music and speech. This measurement is done using the internal supply of the amplifier and, consequently, includes distortion caused by voltage decay, power supply transients, and ripple. This tends to be more realistic and to give lower power-output ratings than the constant supply method. Actually, both IHF methods are supposed to be used, with the lowest power rating obtained at reference distortion with both channels operating, both in and out of phase, to be used as the power rating. (There is some question concerning unanimity among high fidelity manufacturers on actually performing *both* IHF tests.)

Since music is not a continuous sine wave, and has average power levels much below peak power levels, one might conclude that the music power or dynamic power ratings are true indications of a power amplifier's ability to reproduce music program material. The problem is that all three methods described here have a common flaw. Even the transient distortion method fails to account for the amplifier's ability to reproduce power peaks while it is already delivering some average power. In the "real world," the amplifier is almost never sitting at zero output when it is called on to deliver a transient. For every transient that comes along after an extremely quiet passage or zero signal, there are hundreds that come along on top of some low but non-zero average power level.

*RCA Electronic Components and Devices, Somerville, N. J.

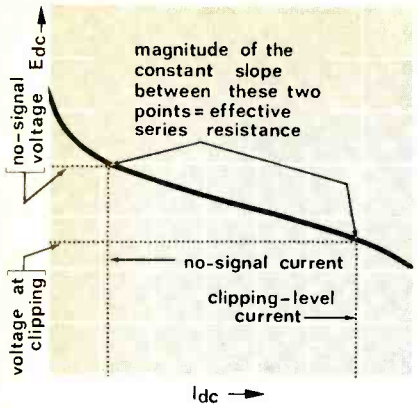


Fig. 1—Regulation curve for capacitive rectifier power supply.

Fig. 2—Typical power supply regulation curve.

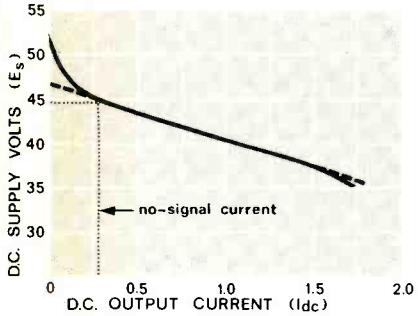


Fig. 3—Equivalent circuit for single-ended capactive input rectifier supply.

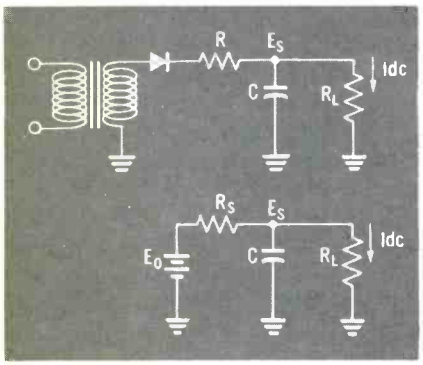
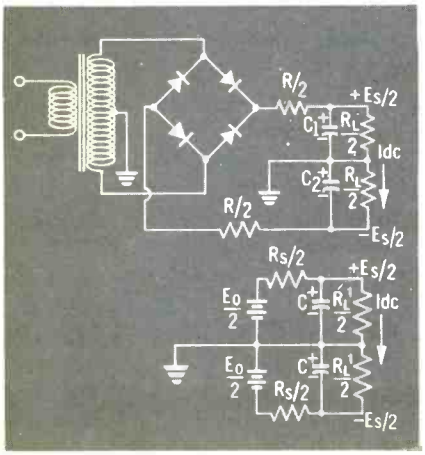


Fig. 4—Equivalent circuit for split capacitor-input rectifier supply.



This can best be clarified by examining the power supply. Many amplifiers have regulated supplies for the front-end or low-level stages, but almost none provides a regulated supply for the power output stages. This is so because regulation requires extra transistors or other devices; it becomes costly, especially at high power levels. The power supply, then, for the output stages of power amplifiers, is commonly a non-regulated rectifier supply having a capacitive input filter. The output voltage of these supplies is a function of the output current and, consequently, of the power output of the amplifier.

Power supply regulation

Power supply regulation is dependent on the amount of effective internal series resistance present. The effective series resistance includes such things as the d.c. resistance of the transformer windings, the amount and type of iron used in the transformer, the amount of surge resistance present, the resistance of the rectifiers, and the amount of filtering. The internal series resistance causes the supply voltage to drop as current is drawn from the supply.

Figure 1 shows a typical regulation curve for a rectifier power supply that has a capacitive input filter. The voltage is a linear function of the average supply current over most of the useful range of the supply. However, notice that a rapid change in slope occurs in the regions of both very small and very large currents. In class B amplifiers, the no-signal supply current normally occurs beyond the low current knee, and the current required for the amplifier at the clipping level occurs before the high current knee. The slope between these points is nearly linear and may be used as an approximation of the equivalent series resistance of the supply.

The amount of power lost depends on the quality of the power supply used in the amplifier. Accordingly, rating an amplifier's power output with a superb *external* power supply (that is, not using the amplifier's own built-in power supply) gives false music power outputs. You can be sure that under actual usage it is lower.

HOW 5.6 WATTS "DISAPPEARED"!

Figures 3 and 4 show equivalent circuits for capacitive-input rectifier supplies. In these circuits, I_{dc} is the average supply current, R_s is the effective equivalent series resistance of the power supply, E_o is the no-signal voltage, and E_s is the steady-state supply voltage. The steady-state voltage, E_s, is related to the no-signal voltage, E_o, as follows:

$$E_s = E_o - R_s I_{dc} \qquad (1)$$

Equation 1 shows that the supply voltage, E_s, is equal to the no-signal supply voltage, E_o, only when there is no current other than the no-signal current being drawn from the supply. As soon as the amplifier begins to deliver some power to the load, the power supply is called upon to deliver some current. A single-ended power supply delivers current on alternate half cycles, and each half of a split supply delivers current on alternate half cycles. Therefore, in each case the supply current, I_{dc}, is related to the peak output current, as follows:

$$I_{dc} = \frac{I_{pk}}{\pi} \qquad (2)$$

The power output is related to the peak output current, as follows:

$$P.O. = \frac{I_{pk}^2}{2} R_L \qquad (3)$$

where R_L is the speaker load resis-

This is explained for those who are mathematically-inclined in the boxed area. For readers who would rather not go into details, simply skip this section. But take our word for it that it proves that an amplifier with a 31.5 watts/channel music power rating could well be, in fact, 28.7 watts/channel, without selecting an exaggerated example.

This 10 per cent decrease in measured transient capability may go up to 20 per cent in some cases. One such case is where the no-signal load is less than that shown in Fig 1. The no-signal load includes the class AB bias current of the output stages and all of the current drawn by the preceding stages and their associated bias networks. This may well be below the 250 mA shown, pushing the no-signal voltage up into the steep portion of the regulation curve. This would cause a

(Continued on page 22)

tance. Consequently, the supply current is related to the power output by:

$$I_{dc} = \left(\frac{2\ P.\ O.}{\pi^2\ R_L}\right)^{1/2} \quad (4)$$

Combining equations 1 and 4

$$E_s = E_o - R_s\left(\frac{2\ P.\ O.}{\pi^2\ R_L}\right)^{1/2} \quad (5)$$

In relating average current and power output, it is assumed that sine-wave signals are included and that no parasitic losses exist.

This can be simplified by assuming R_L to be 8 ohms and by letting $\pi^2 = 10$. Equation 5 then becomes:

$$E_s = E_o - 0.158\ R_s\ (P.\ O.)^{1/2} \quad (6)$$

To illustrate the inability of the no-signal supply voltage to indicate the transient power capability of an amplifier, assume that an amplifier power supply has the regulation characteristics shown in Fig. 2. Using the values for voltage and current from Fig. 2, the music power rating, based on the no-signal voltage (44.8) and an 8-ohm load, is:

$$\frac{E_o^2}{8\ R_L} = 31.5 \text{ watts/channel} \quad (7)$$

(63 stereo Music Power watts)

assuming no parasitic losses.

(The factor, 8, in equation (7) is derived in converting peak-to-peak volts to rms volts.)

The effective series resistance, according to Fig. 2, is approximately 6 ohms. If the amplifier is delivering an average power of 2 watts per channel, or a total of 4 watts, the supply voltage drops from 44.8, according to equation 6:

$$E_s = 44.8 - 0.158\ (6)\ (2) = 42.9$$

$$\frac{E_s^2}{8\ R_L} = 28.7 \text{ watts/channel}$$

(or 57.4 stereo Music Power watts)

The percentage change is $\frac{31.5 - 28.7}{28.7} \times 100$, a 10 per cent decrease over the actual transient power capability.

To examine the effect of R_s on transistor power dissipation, assume a typical complementary-symmetry circuit, such as shown in Fig. 5. Assume a regulated supply under no-signal conditions; the capacitor, "C", is charged to a voltage equal to $E_s/2$ at the clipping level. The maximum peak load current, I_{pk} (max), is given by:

$$I_{pk}\ (max) = E_s/2\ R_L \quad (8)$$

Because the supply delivers current on alternate half-cycles, the average supply current, I_{dc}, is given by

$$I_{dc} = I_{pk}/\pi \quad (9)$$

The power (P_s) delivered by the supply can then be expressed as follows:

$$P_s = (I_{pk}\ E_s)/\pi \quad (10)$$

The power delivered to the load, P. O., is given by

$$P.\ O. = (I_{pk}^2\ R_L)/2 \quad (11)$$

The dissipation, P_T, for each transistor is equal to half the difference between the supply power delivered (P_s) and the power dissipated in the load (P. O.), as follows:

$$P_T = (P_s - P.\ O.)/2$$

$$P_T = \frac{I_{pk}\ E_s}{2\pi} - \frac{I_{pk}^2\ R_L}{4} \quad (12)$$

If equation (12) is differentiated and solved for the peak load current (I_{pk}) at maximum average transistor dissipation, the following expression is obtained:

$$I_{pk} = E_s/(\pi\ R_L) \quad (13)$$

When this value is substituted in equation (12), the ratio of maximum average transistor dissipation, P_T (max), to power delivered to the load at full power output P. O. (max) can be expressed as follows:

$$\frac{P_T\ (max)}{P.\ O.\ (max)} = \frac{2}{\pi 2} \quad (14)$$

Equation (14) indicates that maximum transistor dissipation is approximately 20 per cent of full power output. At the point of maximum dissipation, the power output is given by:

$$P.\ O.\ (max\ diss.) = \frac{E_s^2}{2\pi^2\ R_L} \quad (15)$$

The ratio of the power output at maximum dissipation P. O. (max diss.) to maximum power output P. O. (max) is then given by

$$\frac{P.\ O.\ (max\ diss.)}{P.\ O.\ (max)} = \frac{4}{\pi^2} \quad (16)$$

Fig. 5—Typical complementary-symmetry circuits.

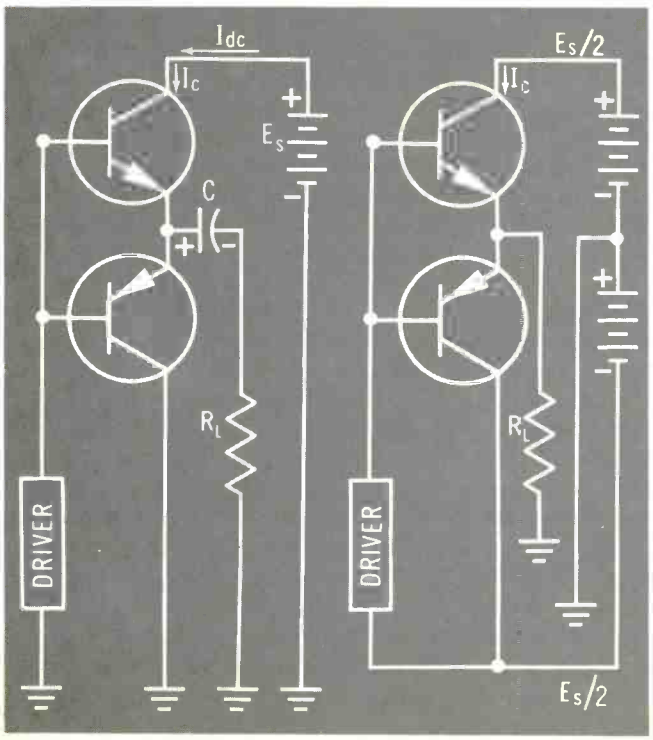
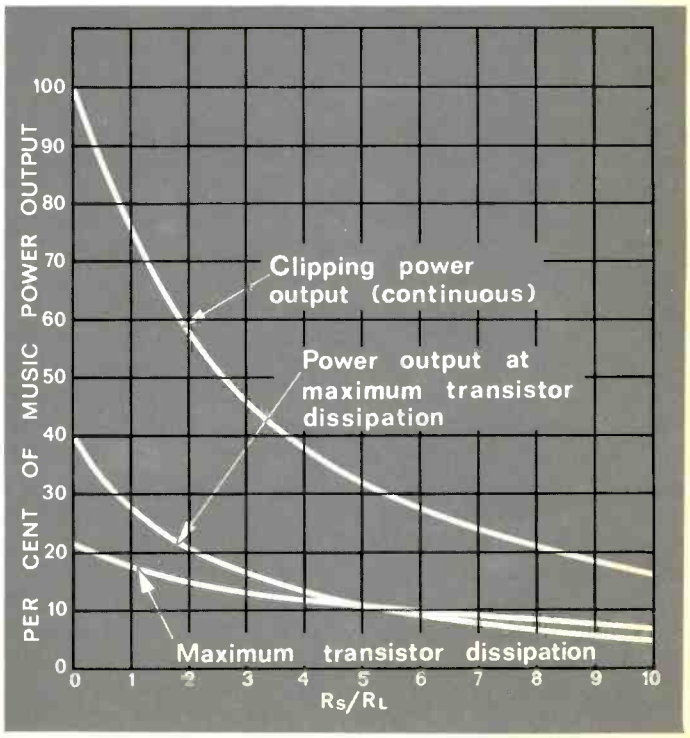


Fig. 6—Power output and dissipation as functions of R_s and R_L.



greater decline in supply voltage when the amplifier was called on to deliver 2 watts or so of average power.

It should be emphasized that, while there is a discrepancy between the actual power available and the power measured under the EIA Music Power Method or the IHF Dynamic Power Methods, these methods are not without merit. The IHF Dynamic Power Rating, in conjunction with the Continuous Power Rating, produces an excellent indication of how the amplifier will perform. The EIA Music Power Rating, since it is measured at 5 per cent THD with a regulated power supply, provides less than an adequate indication of amplifier performance because there is no indication of how the amplifier power supply voltage reacts to power output.

There are some important factors that are considered by packaged equipment manufacturers, the primary users of the EIA Music Power Rating. These considerations are mostly economic in nature and affect many aspects of the amplifier performance. Since there is no continuous power output rating required, two amplifiers may receive the same EIA Music Power Rating but have vastly different continuous power ratings. The ratio of music power to continuous power is, of course, a function of the regulation and effective series resistance of the supply.

One reason for the vast difference in ratings used by the console or packaged equipment manufacturer, compared to ratings used by the hi-fi component manufacturer, is that the latter does not always enjoy the luxury of knowing just what will be required of his amplifier. The console manufacturer always designs his amplifier as part of a system, and consequently knows the speaker impedances and just how much power will be required to drive them to produce an adequate sound output. The console manufacturer may use high-efficiency speakers requiring only a fraction of the power needed to drive many component-type acoustic-sustic suspension systems. The difference may be such that the console may produce the same sound pressure level with an amplifier having one-tenth of the power output. High ratios of music-power to continuous-power capability are common in these consoles. A typical ratio of IHF music power to continuous power may be 1.2 to 1 in component amplifiers, whereas a typical ratio of EIA music power to continuous power in a console system may be 2 to 1. Console manufacturers take advantage of the EIA music power rating with resultant economic advantages, resulting from the reduced regulation requirement of the power supply. A high ratio of music power to continuous power means higher effective series resistance in the power supply. This, in turn, means less continuous dissipation on the output transistors, smaller heat sinks, and a lower-cost power supply.

(More to come in future articles.)

How to be your own Critic of the New Synthesized Music

LEWIS A. HARLOW

WRITERS AND TALKERS about the kind of new music pioneered by the *musique concrète* (music generated from concrete and other objects) group of Frenchmen, now championed by Stockhausen and other contemporary Germans, are fumbling to find a name for this music that will be both accurate and meaningful. The name "electronic music" is accurate to the extent that this kind of music is generally "performed" by electronic tone generators and tape recorders. Composition is often done with the use of computers. The name is not precise, however, because natural sounds are also used; speeded up, slowed down, etc. Thus, "synthesized" music would be a more appropriate name than "electronic" music, since non-electronic sounds are often combined with electronic-generated sounds.

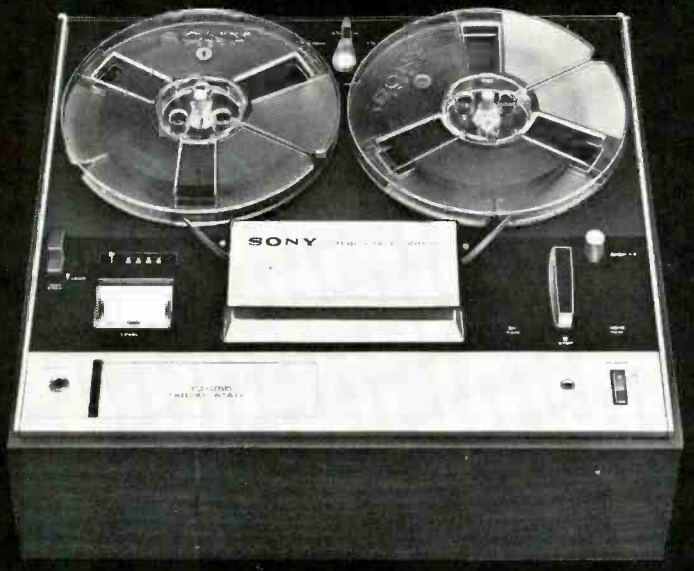
Composers are having their own problems about this. They communicate their messages awkardly with titles like "Poeme for orchestra and tape recorder" or "Concerto grosso electronique." The title offers a clue of what is to come, and knowing this much is better than nothing in your approach to a completely unfamiliar contemporary composer.

"Electronic music" is really an imprecise term, as noted earlier. "Synthesized music" and "synthesized sound" seem to be the best available so far. You should make precise use of both of these titles, since they should not be considered interchangeable.

You are listening to "synthesized music" when the piece seems to qualify in some way as in an art form. Does it seem to hold together? Does it seem to have form—or purpose—or meaning? Does it stimulate thought—about itself or about something else? Is there anything about it that you would be likely to remember? These are very loose criteria of music as an art form, but they are enough to justify the name "synthesized music."

You are listening to "synthesized sound" when not one of the above messages gets through to you. For instance, you may experience the same reaction from an "electronic" piece that you do from Dupont's sample card of Lucite color chips—ahead of the decision on what color to paint your garage. This is synthesized sound, a random sampling of the existing tone colors and, hopefully, the discovery of a few new ones. From these tone colors, music can be composed, but you are not hearing anything yet that classifies as composition. Many composers of synthesized music go through this preliminary stage of experimentation. The composer you are evaluating may be very inexperienced at his job, or he may never progress with

There's Music in the Air



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his abstract tone colors beyond the status of technician. This is your decision to make, and it will help you toward the decision if you know how long he has been experimenting.

The discovery of synthesized sound should be credited to some nameless experimenter of years ago who first noted the effect of a running-down spring-powered phonograph—and then wondered what would be the new sound at consistantly higher or lower speed than standard. And what about reverse play? With the advent of the tape recorder, all such experimenting became easy. Synthesized sound was first offered to mass America in the mid-1950s by Jim Fassett as an intermission diversion on the New York Philharmonic broadcasts. Interest was enough to justify the release of Columbia MI4938, a collection of Jim's experiments under the title "Strange To Your Ears."

Obviously, the technique has broadened with the passage of time. Anything goes now, just so long as it is mechanico-electronic manipulation of the original sound as accepted by the microphone. The electronic organ has contributed effects, especially in the controlled degeneration of tone which is available in its "percussion" stops. The guitar amplifier offers adjustable reverberation, vibrato and other "distortion." Composers with soldering irons design band-pass filters and gating circuits. Other composers with access to computers put in tired old sounds and take out fresh new ones.

The oldest synthesized music to have survived its test on people dates from 1949. The actual creation was *musique concrète* (Ducretet-Thomson 20001), and its composers were Pierre Schaeffer, Pierre Henry and Michel Philippot. Some of *concrete* is synthesized sound, admittedly experimental abstractions, but some of it is true music in the philosophical definition of the term. Pierre Henry's *Veil of Orpheus* includes electronically-distorted voices from "Hell" that will stand your hair on end.

The ground rules

You no doubt have heard the new medium, but probably have never attempted to get orderly and objective in your thinking about it. Synthesized sound (?) music (?) can be very frustrating because there is rarely anything comfortable to use as a launching pad for your analysis. If the work is titled and presented to you in a music environment like the concert hall or your hi-fi system, let's assume that the intent is synthesized music rather than abstraction in sound.

This music isn't Popular, or Classical, or Baroque, or Romantic, or identified by any other of the familiar labels. Like any critic in a medium foreign to familiar traditions, you must fumble at the start. And good fumbling material can always be found in the non-artistic limitations within which the composer proposes to do his creating. Here are some of the ground rules which may govern this game. You will probably discover others, and certainly you should be looking for them.

1. Before being changed electronically, were the source sounds in this piece made by traditional musical instruments and/or the human voice? The composer may choose to limit himself by this tie with the past. Here again you are to use your best possible judgment. You may be deceived; some of the distortions are extremely difficult to identify with the original.

Are all of the sounds the new kind, or is this a combination of the new and the old? Do you occasionally hear something familiar, maybe out of Chopin? This decision is easy, and it is another kind of limitation within which the composer may be holding himself.

2. If the piece is exclusively electronic, are you taking it as a self-contained package from a tape or a disc? Or might there be performers on stage with microphones and amplifiers? If it is the self-contained package, it is strictly for the ears; opportunity for concomitant visual entertainment does not exist. Most synthesized music falls in this category at present, and the absence of the visual (or at least the imagination of what the visual might be) is a rather serious handicap to the total entertainment value of the offering. Just as the Hollywood or TV personality must make an occasional guest tour or do an occasional Broadway show, today's composer of electronic synthesis must make an occasional concert hall appearance to prove that his music is still man-made, not the product of machine alone.

For instance, there is a recent composition by Milton Babbitt for "live soprano, recorded soprano and recorded instruments." The live and the recorded sopranos are the same girl, but in her live incarnation she provides the element of visual entertainment, justifies a concert-hall presentation, and proves that music is still a human offering. (This total effort can never, of course, be recorded without complete loss of its purpose. It would then be just another work for two recorded sopranos.)

3. If the work proposes to combine live music and synthesized music in concert performance, how compatible are its two elements? Otto Luening and Vladimir Ussachevsky composed *Rhapsodic Variations for tape recorder and orchestra.* Who is master of this and who is slave?

4. Does the recorder dominate and dehumanize the performance? Must the conductor, usually the final word on tempi and taste, relinquish his traditional authority? In combinations of the live and the synthesized, this is another decision of yours, and you should credit the composer with especially inspired creation when the conductor seems to come out on top.

So much for the ground rules. Here are some telltale signs to watch for. The presence of all or any of them may suggest that you are listening to synthesized music.

► Does this piece seem to have form? You need not know the traditional music forms. For instance, the form of a good novel; exposition, development, climax, conclusion. Or even the form of a good prize-fight—with a slow start and a fast ending.

► Does it have rhythm, something predictably repetitive like a good old-fashioned "beat" to hold it together? Melody, in the popular definition of the word, is almost sure to be wanting from electronically distorted sources of sound. A good beat, though, will tend to hold the composition within the category of music.

► Does it arouse an emotion like

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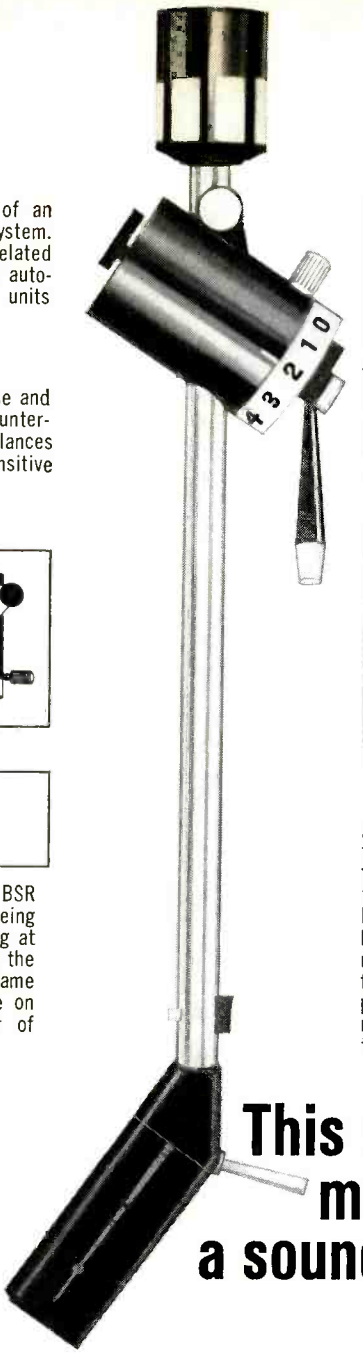
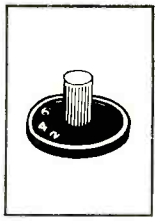
Micrometer Stylus Pressure Adjustment permits ⅓ gram settings all the way from 0 to 6 grams. This important part of the tone arm assures perfect stylus pressure in accordance with cartridge specifications.

A much appreciated feature built into all BSR McDonald automatic turntables is the Cueing and Pause Control Lever. It permits pausing at any listening point and then gently permits the tone arm to be lowered into the very same groove. Positioning of the stylus anywhere on the record is accomplished without fear of damaging the record or the cartridge.

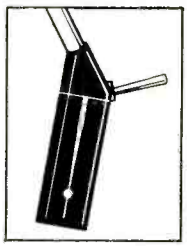


To achieve the ultimate in performance, BSR McDonald has brought to perfection the Anti-Skate Control. This adjustable dynamic control applies a continuously corrected degree of compensation as required for all groove diameters. It neutralizes inward skating force and eliminates distortion caused by unequal side wall pressure on the stylus. All of the BSR McDonald automatic turntables incorporate anti-skate.



After the last record has played on any of the three BSR McDonald automatic turntables, the tone arm automatically returns to the Locking Rest. In conjunction with this action, the On-Off-Reject lever automatically shifts into the Off position which securely locks the tone arm in its cradle to protect it from accidental drops and resulting stylus damage.

All BSR McDonald automatic turntables have a Clip-In Cartridge Head. This lightweight tone arm head, with finger lift and clip-in cartridge holder, provides universal mounting and quick change facility. It can accommodate practically every contemporary cartridge currently on the market.



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humor, fear, intense pleasure or displeasure? Or any other emotion?

► Does it hold your interest—perhaps by starting a chain of thought about something seemingly unrelated? This is not to be confused with boredom.

► Does it seem to have "rememberability"? Do you feel that you would recognize it if you heard it again?

Any evidences of the above are in its favor, and probably remembrance is the most important. It is not necessary that you like the piece. You may dislike it intensely, in which case it will have succeeded in its probable purpose and qualify as music. Beware, though, if it bores you. Here you are justified in calling it synthesized sound.

Synthesized music is an immature art, and it is still difficult for the critic to identify a composer by a taped or disked hearing of his newest work. Every composer aspires to this kind of identification. Relatively few realize it, even in traditional music. Except perhaps for Gershwin, Wagner, Richard Strauss, Prokofieff and Stravinsky, the trained musicologist will often guess wrong on a short segment of an unrecognized work.

The lazy way for a composer of synthesized music to attain originality is by the creation of new sounds. The manner of creating them is frequently guarded as trade secret. Sometimes, as previously mentioned, he becomes preoccupied with the trade and forgets the art aspects of the end product.

Fig. 1—Robert A. Moog stands in front of his company's electronic music composition-performance equipment.

Some of these new sounds and new techniques are already in the public domain. Here are a few clues to help you to recognize them as common property—and to withhold credit from the first composer that you hear use them.

The human voice, distorted or otherwise, has been used by most of the synthesists. It is an extremely effective and dramatic sound, especially after a long episode of "instrumentalism," which tends to get monotonous because of the unfamiliarity of *all* of the instrumental sounds.

Fragmentation and silence is a clue to the combined output of a particular group of composers. If the unfamiliar composition is explosive and fragmented, and if this is interspersed with long periods of silence which are an integral part of the music rather than conventional pauses between sections or pieces, you're probably right if you attribute this music to one of a group of far-out young Americans, mostly disciples of Webern. These composers have been writing this way for undistorted voices and instruments, and it is logical that their recent creations in the medium of synthesis will show the same symptoms.

Acceptance in the older medium is a clue to be explored by research rather than by listening, and for this one you must first know the composer's name. Do you find this name in the *Schwann Catalog* or on concert programs as a composer of non-electronic music? If so, you have a hint of the kind of background experience that includes exposure to the good and bad of music that has gone before. It not, your composer may have come up by way of the slide rule and the soldering iron. This clue must never be the sole basis of your judgment, but if you are confused in making a decision between music and sound, it is fair to use the clue in weighing this decision.

The French School produced *musique concrète*, but since that auspicious start, the output of the French School has not attained the international reputation of the Germans and the Americans. The French influence in music is too subtle to be apparent to the amateur critic, though the pro can identify a French orchestra, a French conductor or a French composer with reasonable ease. One clue is the saucy competence of French percussion, and percussion in general is a kind of natural bridge between the traditional and the synthesized.

The German School is another matter. Here there are two very conspicuous clues. One is great length. The other is rules; rules to compose by and rules to listen by. Mahler wrote two-hour symphonies. Wagner wrote five-hour operas and voluminous prose about how you should listen to these operas.

Too often, the great length is out of step with the listening habits of the 1960s, and it may also seem somewhat conceited for any composer to assume that he operates at the level of genius that will justify this much listening.

Karlheinz Stockhausen is the most widely heard of the contemporary Germans. Already some of his compositions in synthesized music crowding an hour of performance time, and he is working on another that is to last an entire evening. Still another, Stockhausen's non-synthesized *Zyklus* of 1955, is circular in form; its single performer starts anywhere around the circle and quits when he gets back to his starting point. This piece confounds the whole evolution of music since the days of the Fifteenth Century German academicians; today you find the likes of it only in the continuous-loop tape cartridges.

The name of Pierre Boulez, the "Great White Father" of the *musique concrète* group, should be added to the very few names previously mentioned. Other names could easily be dropped, but this would be unfair to names overlooked who may already have contributed something that will endure in the literature of music. If you are to be the critic, your responsibility is to everyone who has something sincere to say in this new art form.

There's a lot more to the art of synthesized music today than meets the ear. Timbres and rhythm patterns are beyond the scope of conventional musical instruments and human capabilities. Just as teenagers have their "way out music, serious music listeners now have *their* radically different musical form in synthesized music. And as evidence of its growth, *Schwann's Catalogs* added 11 new "electronic" music listings last year. Æ

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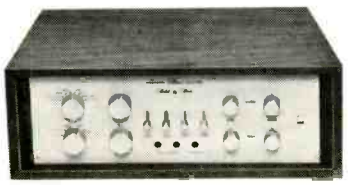

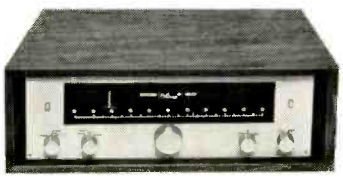

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Rossini vs. Rossini

EDWARD TATNALL CANBY

FROM THE VERY beginning of "classical" recording, collectors of discs have recognized one of the prime advantages of the recorded medium, virtually never previously possible in history — the direct, "AB" comparison of two or more different performances. It is in truth a miraculous kind of a situation and we would marvel every day if we weren't so utterly used to it.

Alas, the mass sale of LP records, sight unheard, has made things far more difficult than they were in the old 78 days, when every record store had a couple of air-tight listening booths in which, so long as you could sustain life without oxygen, you were privileged to make all the comparisons you wished, straight out of stock. Can't tell you how many hours I stifled away in that fashion as a college student, ploughing through huge piles of heavyweights, staggering home blue in the face with maybe a half-dozen winnowed out for purchase!

Now, it is the record critic who decides in advance, or you after the fact. You buy your two versions and go home to find out which *you* like best. No wonder there are crowds at the discount houses.

To take a splendid instance, perhaps you will have read my review [in this issue] of a superb new recording of well-known Rossini overtures (Everest 3186, with the Orchestra of the Accademia di Santa Cecilia under Fernando Previtali), the finest I had ever hoped to hear.

Well, just after I had written that, I caught up with another simultaneous release, same month, on the RCA Victrola label. Rossini overtures! Only one disc, to Everest's two, but some of the very same music. Better still, both conductors are pure-bred Italian, and right in the tradition. Two minutes of listening will tell you this, even if you don't know both names; but you will know the second conductor, all right. Arturo Toscanini.

Which is best? Ha ha, I'm not going to say. Because my point is that the AB comparison itself is so marvelously revealing, in the over-all and in detail. Frankly, I was quite astonished at what came out for the ear in this comparison, but I leave this astonishment for you to discover for yourself, at your pleasure.

I will only note a few attendant circumstances, for which you must make some allowance, and which do, indeed, affect the total score or rating which you may want to apply to each recording.

Toscanini's NBC disc is, of course, of many years ago and a broadcast at that (I think), with all the problems of age in the technology and no "re-takes" for editing. But these are relatively late recordings, and the sound is remarkably good; Carnegie Hall provides the acoustics, rather than the sterile Studio 8H. So you will not have trouble on this score, though the modern stereo on Everest is a superior sound.

The Everest orchestra is virtually unknown hereabouts, and the more remarkable is its performance, as per my review. But it is, note well, *Italian*—and in Italy. Toscanini, Italian to his own core, conducts an American orchestra—which means an American-based outfit with members from just about everywhere you can imagine as to background and origin, yet amalgamated in the School of New York City. I, for one, could hear a distinct difference between these two orchestras, that is surely in part due to this difference in musical background.

So get out your fat wallet and whiz down to the record mart. Everest 3186, containing two discs. RCA Victrola VIC 1274, one disc. See what you think. *You* may be surprised. Æ

P.S. Ho ho. Turn around once and there's another one!

Rossini Overtures—and now it's still another Italian conductor, a first rate man; this time we have a crack *British* orchestra in a recent-vintage reissue in stereo. Carlo Maria Giulini with the Philharmonia Orchestra, Seraphim S 60058. Make it an ABC comparison? Cheap at the price.

(Of course if you really want to be exhaustive, and exhausted, you'll first want to look for a new alphabet. ABCDEFGHIJK . . . . to the nth. Even before the above recordings appeared there were *over thirty* records of Rossini overtures listed in Schwann.) Æ

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ROBERT C. EHLE

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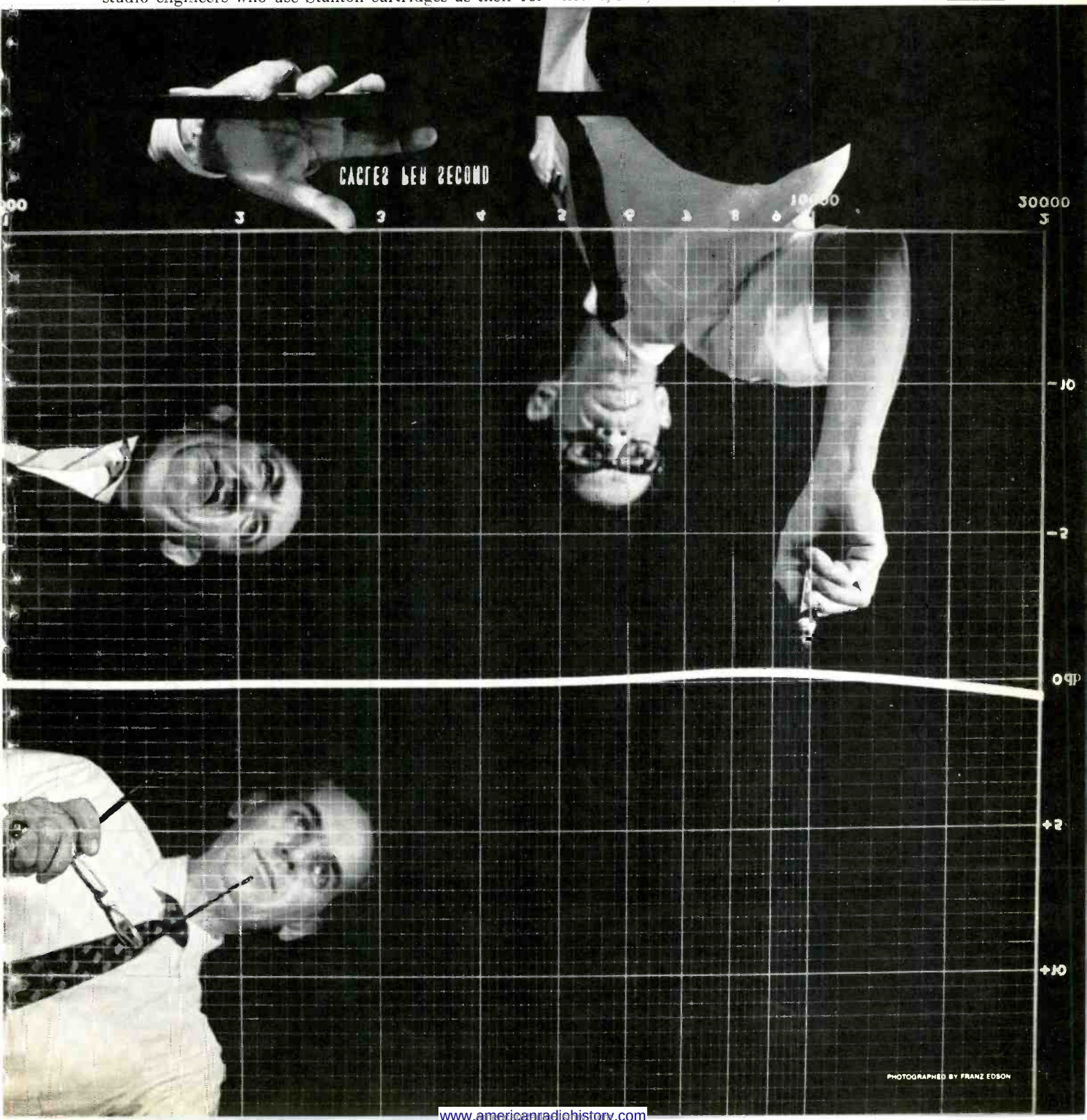


PARTS LIST

1. **Lumber:** seven boards, 2″x4″x3′; two boards, 2″x4″x6′; one board 2″x4″x 1½′. Total: 34½ running feet.
2. **Metal:** one sheet of No. 26 spring steel; 5′10″x2′6″. One-half in. holes drilled two in from both ends with centers at 2½″, 5″, 5″, 5″, 5″, 5″ (see drawing)
3. **Glue:** one bottle "Elmers" glue (large size).
4. **Nails:** fifty 2½″ nails; fifty 1½″ nails.
5. **Insulation:** 30′ fiberglass insulation.
6. **Wire:** 30′ rubber-covered twin conductor; 30′ single conductor, shielded phono.
7. **Tape:** Plastic, insul., one roll No. 33 Scotch or equiv.
8. **Plugs:** 4 male, 4 female phone plugs,
9. **Plugs:** two male, 110V wall plugs.
10. **Ceramic phono cartridge:** or equivalent, must be modified.
11. **Preamp for ceramic phono cartridge.**
12. **Loudspeaker motor:** may be speaker with cone and basket removed.
13. **Driver amplifier:** five to twenty watts.
14. **Equalizers:** for driver amplifier to provide selectivity of reverb. frequency, optional.

Notes:

A. Rubber grommets may be made from pieces of inner tube, tape, etc., if not available.

B. The loudspeaker motor is easiest to obtain by removing the cone and basket from a complete loudspeaker. The cone must be cut away while preserving the spider intact with the voice coil. Some brands of speakers bolt the basket to the magnet, making disassembly easier.

C. The cartridge is to be mounted at right angles to the steel. A stiff wire is inserted in the stylus shank and soldered to the plate.

Fig. 1—Construction plans of the sheet-metal reverberator. The finished unit should be fastened to the floor or walls of a small room or closet which can be acoustically treated to prevent unwanted sound from escaping.

Fig. 2 – Block diagram of recommended hookup. Note: two channels and reverberators are required for sterec

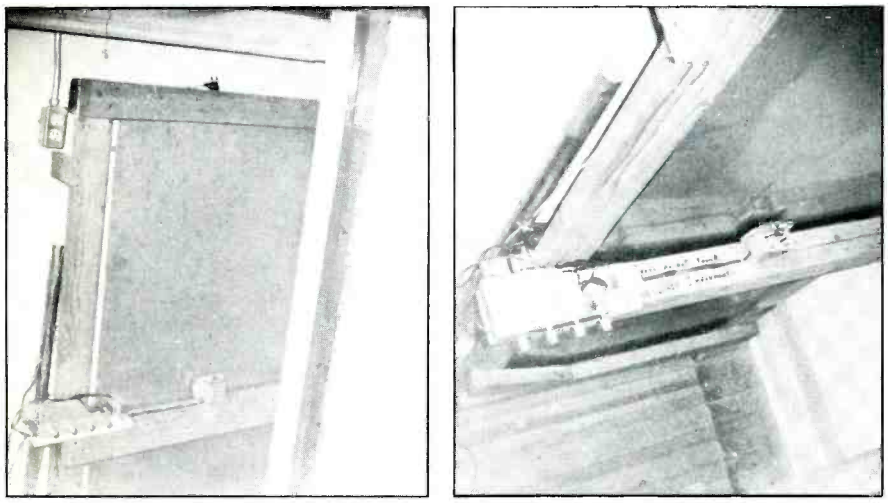


Fig. 3—Two views of the completed sheet-metal reverberator. The white area on the right of the above photo is fiberglass which is glued to the closet door for sound proofing. A five-watt transistorized unit is used to drive the loudspeaker motor.

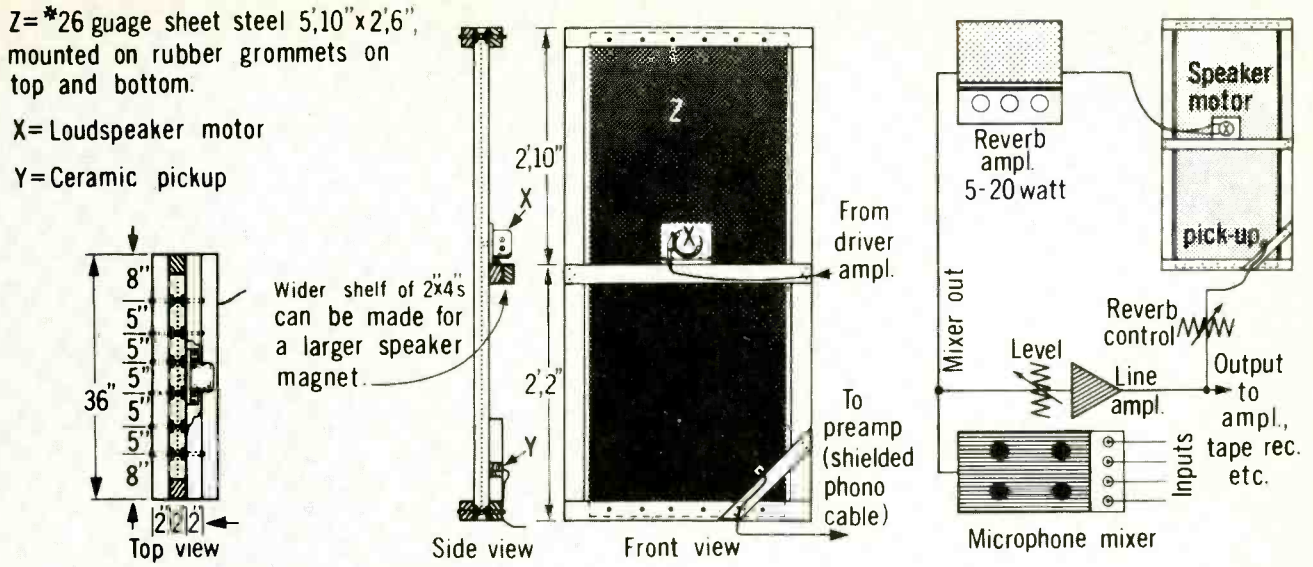
exaggerated effects are the tools of surrealistic music and are, in some ways, similar to the paintings of Dali and other surrealistic painters.

To the experimenter who wishes to experiment with reverberation in an amateur sound studio situation, two techniques usually are available. These are tape recorder reverberation and the spring reverberation made famous by the Hammond organ company. A third, less common, technique is to use a coiled tube with a transducer at each end. Of the three, the coiled spring is probably capable of the most natural reverberation. The tape recorder reverberator has a major drawback: The quality of the sound produced by the tape reverberator is too precise, nonresonant and uncolored for some purposes. While this is useful, it leaves the field open for a mechanical, resonant reverberator with a strong signal and a long delay time (longer and stronger than the spring reverberator). Such a reverberation device is the large sheet-metal reverberator which has found great acceptance in the professional recording and broadcasting field under the name EMT-140. [Gotham Audio Corporation, New York City, has distributed more than 800 such units in this country and there is as yet no other device of this kind available. The EMT-140, incidentally, is protected by U. S. Patent No. 2,923,369 and is made of specially controlled steel not available generally. It costs just under $3000. It must be pointed out, therefore, that the similar device which this article describes is not in the performance class with the EMT-140 and may not be manufactured in violation of the above patent.]

The sheet metal reverberation device described here was actually built by the author for the electronic music laboratory at North Texas State University. In use for about two years, it has proved to be capable of a variety of strong reverberation effects and is more subtle than the tape recorder reverberator.

Construction

The accompanying drawing, Fig. 1, illustrates the construction as it was carried out, with the exception that the corner supports for the sheet of steel were eliminated, reducing the damping effect caused by six rods and rubber grommets. The reverberation device was mounted in



a closet that was acoustically treated with fibreglass to prevent sound leakage (the reverberator does emit some sound).

The sheet is simply a sheet of stainless steel purchased at a metal and roofing dealer (for about six dollars). The gauge of the steel is No. 26, although other thicknesses would probably work as well so long as the sheet is stiff enough to support itself without sagging or bending under its own weight.

The pickup employed in this instance was the ceramic type of contact microphone commonly sold for attachment to electric guitars. In this type of device, the mounting bracket is isolated from the case and attached to the ceramic element so that sound is transmitted through the bracket into the pickup. The quality of the sound picked up can be improved if the case is mounted securely to the frame without putting undue pressure on the element.

Although not everyone wants a wide frequency response from a reverberator, this one could be improved in the high end by using a pickup with less mass in the coupling between the steel-sheet diaphragm and the ceramic element. Certain types of phonograph cartridges with removable styli could be used here simply by replacing the stylus with a piece of wire and soldering the other end to the steel diaphragm.

A critical part of the design is the modified loudspeaker motor. It is possible to use any speaker here, although some types are better than others. Ideally, one should have a 10- or 12-in. speaker with a fairly large magnet (six to sixteen ounces) and a bolt-on basket assembly. The speaker employed by the writer was a TV replacement type, 12-in. in diameter, with a rivited basket. Thus, it took considerable patience and care to remove the speaker basket from the magnet assombly; however, it can be done.

If the spider is attached to the magnet assembly, as most are, no problems arise here. If the spider should happen to be attached to the basket, it would have to be moved to a new location. The builder would, therefore, be wise to avoid the latter type of speaker.

Before removing the basket assembly, cut the cone down to where about 2-in. of paper is left from the apex to rim. This small cone area can be glued directly to the sheet-metal diaphragm after the speaker motor is bolted to the support structure in the center of the steel sheet. Be careful to have the motor properly positioned before glueing.

Concerning the method of driving the reverberator and feeding the output into the sound system, several things may be said. In the first place, feedback from the output to the input must be rigorously avoided (unlike the tape recorder reverberator) as the system will howl just the same as a sound system in an auditorium might. It is necessary to take the output from a sound system before an amplifier stage and to mix the reverberation signal back in after the stage in order to provide isolation. Signal ground loops must be carefully avoided, as these can cause enough feedback to force the system to oscillate. Remember, several watts of audio are driving the sheet and only a few milliwatts are needed from the pickup. Figure 2 shows a block diagram for driving and mixing.

To sum up, the reverberator is capable of a very large, long reverberation effect of a sort not usually obtainable from more common reverberators. Small recording studio operators should find it to be an attractive device for generating bigger sounds, and electronic music experimenters may want to build one for the subtle sound it offers and for an effect greater than that from commercially available devices (excepting a very costly European-built unit which uses principles similar to the unit discussed here). In spite of the attractiveness of the device (from an application viewpoint) it can be built for under fifty dollars. All you need is a place large enough to accommodate it. Æ

ABZ's of FM

LEONARD FELDMAN

FM Broadcasting

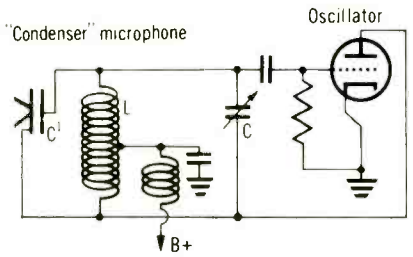
HAVING EXAMINED THE noise-free, high fidelity characteristics of FM transmission, we shall now devote some time to a study of how an FM signal is created electronically and how it is radiated for ultimate reception by an FM receiver.

There are two general methods used for the generation of an FM signal. The first is sometimes called "direct FM." This involves varying the frequency of the main oscillator of the transmitter in accordance with the modulation to be impressed. In the second method, frequency modulation is achieved by varying the *phase* of a signal obtained from a stable, crystal oscillator.

Direct FM

The most obvious and direct way to obtain a frequency-modulated wave is through variation of one of the frequency-determining elements of an ordinary, high-frequency oscillator. A crude method of doing this is illustrated in Fig. 1. Here, a "condenser" microphone is connected in parallel with the frequency-determining L and C of a familiar Hartley oscillator. As long as no sound is fed to the microphone, the resonant frequency will be determined by the sum of the capacitances of the microphone and C in parallel with the coil, L. This frequency represents the resting, or carrier frequency, translated to FM terminology. As sound waves hit the microphone capacitor plate, it vibrates closer to, and further away from the fixed plate. Thus, its capacitance (and hence the total capacitance in the circuit) is altered. The instantaneous frequency is therefore caused to shift above and below the central resting frequency, and a frequency-modulated signal is developed.

Fig. 1—Simple, direct FM, produced by varying total capacitance in oscillator "tank" circuit (L, C, and C^1)



In actual practice, a reactance tube (or transistor) acts as a variable inductance (L) or capacitance (C) across a predetermined resonant circuit, as shown in Fig. 2. Audio information applied to the grid of V1 effectively changes the apparent "L" of the output circuit which, in turn, varies the oscillator frequency. In practice, the oscillator frequency is kept at around 5 MHz, and the reactance modulator is able to shift that frequency by only about ± 5 kHz. Frequency multipliers, such as doublers and triplers, are then used to boost the center frequency up to the 88-108 MHz band required for FM broadcasting. In so doing, the modulation swing is correspondingly increased. As an example, if the 5 MHz basic oscillator frequency is multiplied by 18 (say, by doubling once, and tripling twice), the resulting frequency will be 90 MHz. Since the modulation (or change of frequency) undergoes the same multiplying factor, a total modulation of 4 kHz x 18, or 72 kHz, will result; just about right for the usual maximum of ±75 kHz required in standard FM broadcasting. A block diagram of a transmitter using the reactance tube approach is shown in Fig. 3.

Since the basic oscillator used in reactance modulation transmitters is not crystal controlled (a crystal-controlled oscillator could not be "forced" to shift frequency, since the crystal determines the resonant point), if no further steps were taken to stabilize the transmitter, its frequency might be expected to drift considerably. The FCC requires that center frequency be maintained within ±2 kHz. In the example cited, this would represent a stability of approximately ±111 Hz at the 5 MHz master oscillator level. To insure such extreme stability, a crystal oscillator is used as a reference to produce a correcting voltage (very much like the familiar AFC voltage used in receivers to help keep stations tuned in), as shown in Fig. 4.

Phase modulation

When a carrier wave shifts back and forth in phase while maintaining a constant frequency, this shifting causes the same effect as if the frequency itself were being instantaneously varied. This variation represents a moderate amount of frequency modulation and is the basis of all phase-modulation schemes for producing an FM signal. The indirect FM produced will depend

Fig. 2—Reactance tube appears as variable capacitive reactance across the master oscillator tank circuit (L, C).

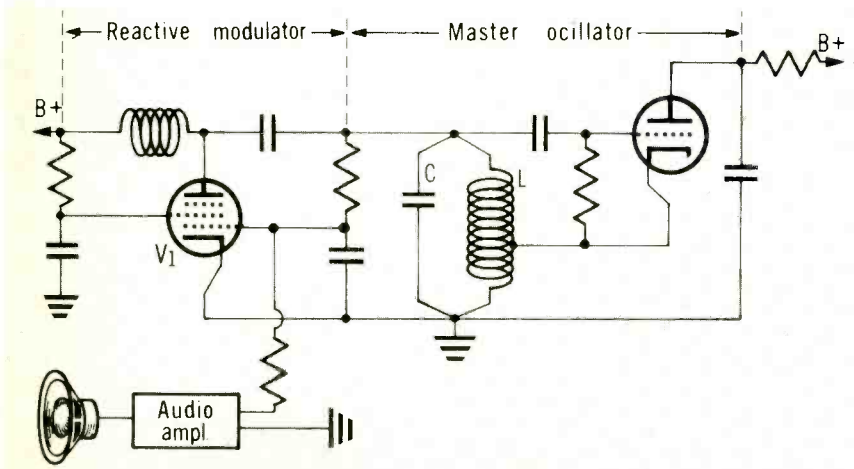
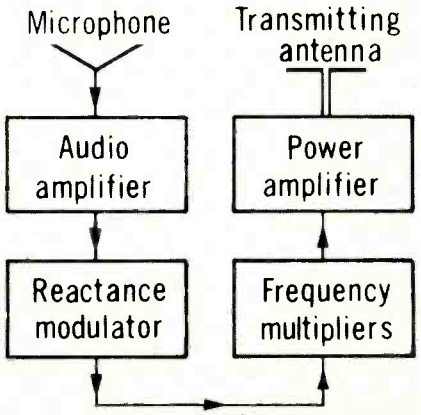


Fig. 3—Block diagram of FM transmitter using "direct" FM approach



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upon the maximum angle that the carrier wave is shifted, and on the frequency at which the shift takes place.

In one variation of the phase-modulation approach, the maximum practical phase angle that can be produced in the phase modulator is 30 deg. (approximately half a radian). Since the FM produced equals the product of modulating frequency and phase angle, for a 15 kHz modulating frequency, we could expect the resulting FM to be 15 kHz x 0.5 (radians), or ±7.5 kHz. Offhand, you might expect that, starting with a 10 MHz crystal-controlled oscillator (the chief advantage of all the Phase Modulation approaches is that a crystal-controlled oscillator can be used as the master oscillator), one would only have to multiply the frequency 10 times to come up with a 100 MHz carrier frequency and a ±75 kHz modulation capacity.

Examination of the mathematical relationships just stated discloses that this would only be true for a 15 kHz modulating tone. At 50 Hz (the lower end of the audio spectrum desired in FM transmission) we would get FM amounting to only 50 Hz x 0.5 (radians) = 25 Hz! In phase modulation, therefore, something must be done so that regardless of modulating freqency, the net amount of FM will be the same, notwithstanding the audio modulating frequency. An R-C corrective network, such as shown in Fig. 6), must be interposed between the audio source and the phase modulator, so that the higher frequencies will be attenuated relative to the lowest audio modulating frequency (in this case, 50 Hz). Therefore, *all* audio frequencies concerned will produce only a mimimal 25 Hz of indirect FM when the phase angle is 0.5 radians.

If we divide 75,000 Hz (the desired total deviation at carrier frequency) by 25 Hz, it becomes apparent that doublers and triplers would have to be arranged to multiply the starting frequency by some 3000 times. Put another way, if we wished to have a carrier frequency of 90 MHz, we would have to start with a crystal master oscillator having a frequency of 90,000,000/3000, or 30,000 Hz. While crystals of such low resonant frequency can be made, a more practical approach is to use a crystal having a freqeuncy of around 200 kHz. After several doublers and triplers, we achieve a frequency of 32.4 MHz, as shown in Fig. 5. At this point, a second crystal oscillator output, at 27.4 MHz, is heterodyned with the 32.4-MHz signal to produce a 5-MHz output. This signal is then tripled and doubled in much the same way as was shown in Fig. 3, resulting in a final output of 90 MHz having a maximum deviation of ±72.9 kHz, as required.

Several variations of phase modulation have been developed over the years, many of which are in current use in practical transmitter installations. One, known as the Armstrong system, simplifies the method used to obtain substantial phase modulation. Another, known as a Serrasoid Modulator, secures a relatively large amount of initial phase modulation, reducing the amount of frequency multiplication required to achieve a carrier frequency at the assigned FM frequency.

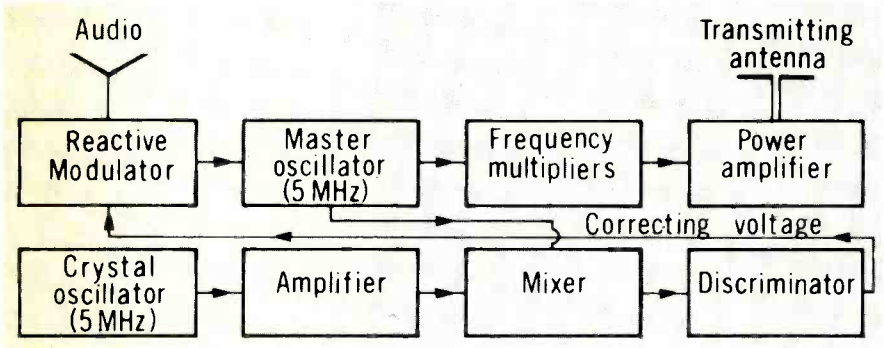
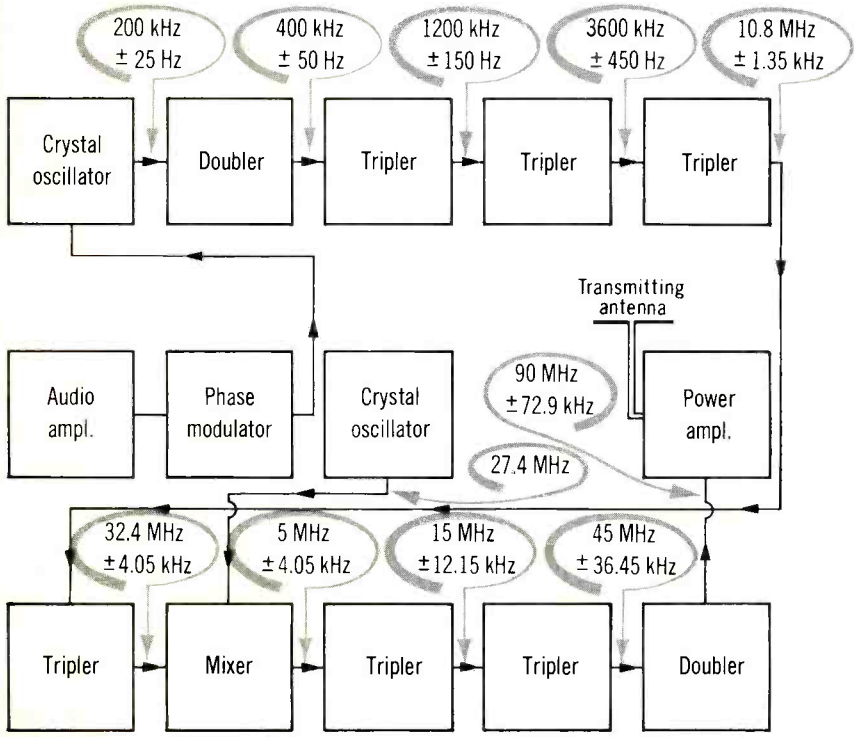


Fig. 4—Accuracy of master oscillator frequency is maintained by a crystal-controlled reference which provides a corrective voltage.

Fig. 5—Starting with a 200 kHz ±25 Hz signal, using a second crystal oscillator makes practical the generation of a 90 MHz ±72.9 kHz FM signal.



Transmitter power & range

The Federal Communications Commission has set up rules governing assignment of FM frequencies, maximum permitted radiated power, frequency separation between stations and allowable signal interference ratios. The various classes of station in service are shown here.

TABLE I

Class of Station	Class of Channel	Permissible Power (kW)
I-A	"Clear"	50 (to 100 in certain cases)
I-B	"Clear"	10-50
II	"Clear"	0.25-50
III-A	Regional	1-5
III-B	Regional	0.5-1 (night) to 5 (day)
IV	Local	0.1-0.25

Power will be determined by elevation of antenna, since the higher the elevation of antenna, the greater the coverage or range of transmission and reception. Bear in mind that since FM

(Continued on page 75)

This suggestion is made only to those who have top-flight integrated amplifiers with an electrically separate preamp and power amplifier, or individual preamp and power amplifier components. It involves your present equipment and three Sony components: the TA-4300 electronic crossover and two TA-3120 stereo power amplifiers. It's for those venturesome enough to break away from conventional approaches to sound reproduction. If we've described you, then these Sony components can bring you just that one iota closer to realism in home music.

Here's why.

The electronic crossover goes between the preamplifier and the power-amplifier portions of your present stereo amplifier. It divides the audio-frequency spectrum into three ranges, and sends each range to a separate amplifier: your existing power amplifier, plus the two Sony TA-3120's. Each amplifier feeds a speaker expressly designed to handle that particular part of the audio spectrum. By not forcing a single amplifier to handle the full range of frequencies, IM distortion is reduced. By eliminating the inductor-capacitor-resistor crossover networks built into ordinary speaker systems, speaker damping is not distrubed. The speakers' motions are always fully controlled by the amplifiers. Speaker impedance variations have less effect on the amplifiers.

Also, you can select crossover frequencies to suit the speakers of your choice, or experiment to discover the audible effects of varying crossover points. The points provided are 150, 250, 400 or 600 Hz between woofer and mid-range, and 3, 4, 5, or 6.5 kHz between mid-range and tweeter. A bass turnover control fits the system's response to the characteristics of the woofer, and a bass-boost control lets you experiment with extending the woofer's bass response.

The Sony TA-4300 solid-state electronic crossover costs $199.50; the two TA-3120 solid-state amplifiers $249.50 each. Sound extravagant? Maybe just a bit. But so are the results. Interested? Write for literature on how to upgrade your system. Sony Corporation of America, 47-47 Van Dam St., Long Island City, N.Y. 11101.

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AUDIO INVITES YOU TO SEND IN PHOTOS AND DETAILS ON YOUR HI-FI SYSTEM. PAYMENT WILL BE MADE FOR ALL PUBLISHED MATERIAL.

Vertical-Style Hi-Fi Installations

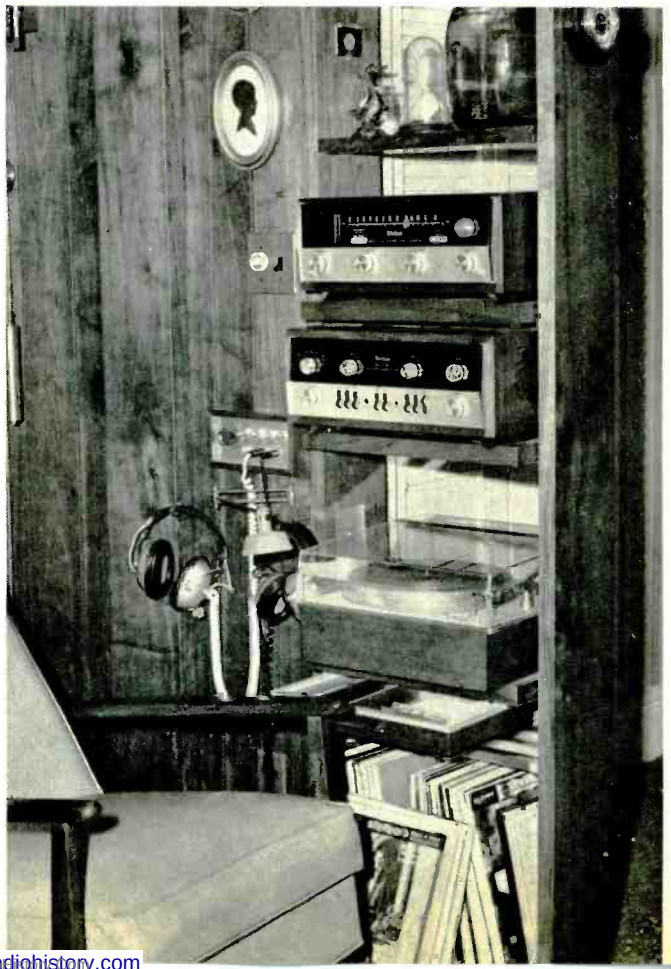
INSTALLATION No. 1—

Gene F. O'Conner, San Rafael, Calif. The cabinet housing stereo equipment here was designed by the owner to take up a minimum of floor space (it's located in a den that has limited wall space). Made of walnut, stained in fruitwood tones to match other furniture and to blend handsomely with ribbon mahogany walls, it was constructed as two separate units. The base portion serves as storage space for magnetic tapes and records. The top unit contains all the stereo hi-fi components: A Scott FM stereo receiver and an Ampex tape deck are concealed by a single tambour door that slides up and down; a Miracord 10H automatic turntable is mounted on a sliding drawer which can also be concealed by tambour doors. A fluorescent lamp at the top of the section throws light on the tape deck and, aided by the recessed and slanted front, also lights the receiver and the turntable (when the latter is extended).

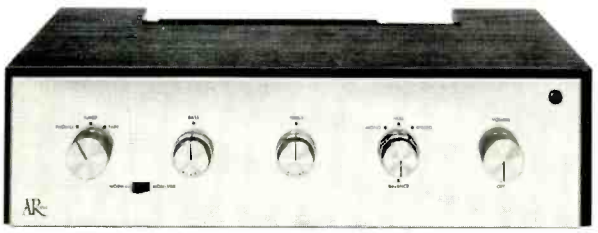
The top section of the cabinet creates a shadow-box effect. It is indirectly lighted, and the antique gold-leaf back of this part produces a nice decorative effect. The uppermost portion also contains a single Jensen speaker system with its own volume control; this is connected to the center channel of the receiver. A speaker switch at the side of the receiver controls a pair of AR speaker systems in the living room, a pair of Electro-Voice "Wolverine" speaker systems in a family room, and a University outdoor speaker in the patio area (the outdoor speaker also operates from the receiver's center channel).

INSTALLATION No. 2—

Joseph Malta, Bayonne, N. J. Compactness and chair-side control mark this stereo hi-fi setup. Equipment, from top to bottom, includes a McIntosh MR71 stereo FM tuner, McIntosh MA5100 control amplifier, "Rondine" Rek-O-Kut manual turntable with an Ortofon cartridge, and Koss Pro-4 and Pro-4a stereo headphones. To the left of the equipment is a control box which controls a high-intensity lamp's illumination. Beneath the control is a switch for the turntable, a second switch for a third-channel amplifier and two additional headphone jacks. To the left of the tuner is a master switch that shuts off the complete system. At the opposite end of the room (not shown) are two Empire "Royal Grenadier" speaker systems.



the AR INC. *amplifier*



The AR amplifier delivers 60 watts per channel continuous output at less than 0.5% harmonic distortion, 20 to 20,000 Hz, both channels operating simultaneously into 4 ohms; 50 watts per channel into 8 ohms.

One of the most important specifications of an amplifier is its power output. In view of this, consumers might expect this measurement to be presented clearly and accurately in amplifier advertising. This has not been the case. In recent years, a variety of vague or irrelevant terms has been used by manufacturers to describe power output: music power, solid-state power, stereo power, audio power, transient power, transistor power, IHF power and others. The list includes terms invented by manufacturers and applied to their products alone, as well as standards of measurement known only to advertising copy writers.

Acoustic Research uses the definition of a watt given in physics texts: work done at the rate of 0.7375 ft.-lb./second. We know of no "transient watt" or "music watt" which science recognizes. AR amplifiers are rated exactly as we measure them, with both channels continuously delivering at least the rated power without exceeding our harmonic distortion limit of 0.5%, or the I.M. distortion limit of 0.25%. The laws of physics and the nature of music require that power measurements, if they are to be meaningful, be made with a steady, uninterrupted tone, similar to the purest sound of a pipe organ. AR amplifiers must deliver their rated power at all frequencies to which the ear responds, not just at 1,000 Hz, where most amplifiers can deliver much more power than at the extremes of the range of hearing. Distortion measurements are made through the AR amplifier's phonograph input because music must go through the amplifier this way—even though performance might be better without the preamplifier in the circuit.

It is for these reasons that the power output rating of the AR amplifier is true for any kind of musical tone, not just those easy for an amplifier to reproduce.

The AR amplifier is covered by a guarantee unmatched in the industry. If an AR amplifier fails to operate as advertised within 2 years of its purchase date, AR provides parts, labor, freight to and from the factory or nearest authorized service station, and a carton if necessary—all with no charge for factory defects.

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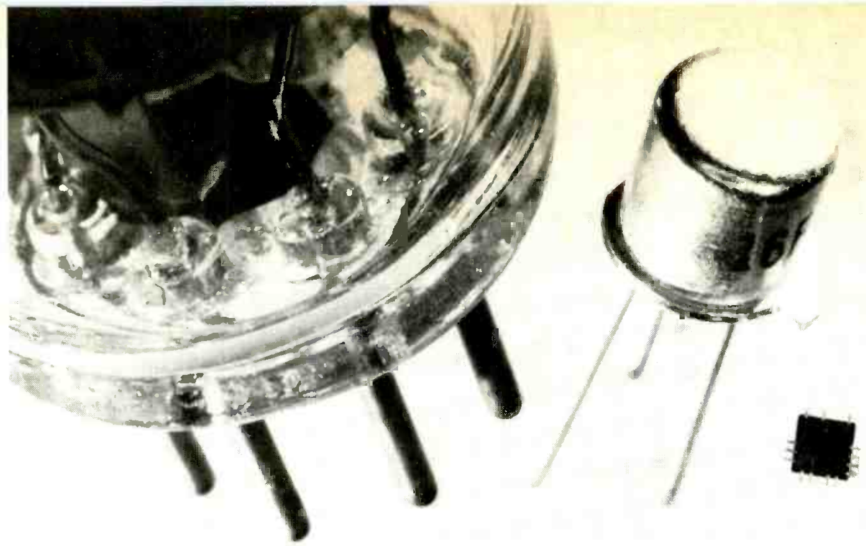
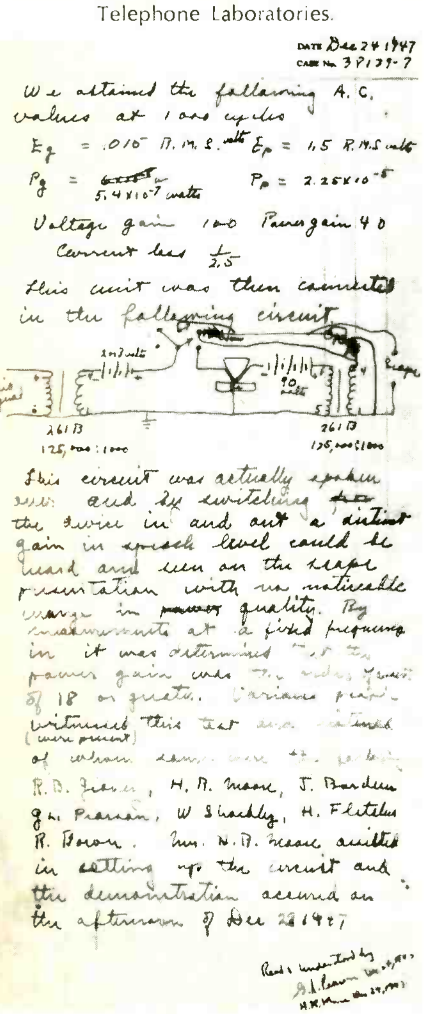
Transistors: 20 Years Old



Evolution of amplifying devices from vacuum tubes to transistors to integrated circuits.

IT WAS HARDLY more than twenty years ago when Bell Lab Scientists showed that a small piece of the element germanium could be made to amplify a speech signal about forty times. Shock waves of this revolutionary discovery are felt up to the present day, with variations on the solid-state theme taking place constantly.



DATE Dec 24 1947
CASE No. 38139-7

We obtained the following A.C. values at 1000 cycles

E_g = .015 R.M.S. volts E_p = 1.5 R.M.S. volts

P_g = 5.4×10⁻⁷ watts P_p = 2.25×10⁻⁵

Voltage gain 100 Power gain 40
Current loss 1/2.5

This unit was then connected in the following circuit

This circuit was actually spoken over and by switching the device in and out a distinct gain in speech level could be heard and seen on the scope presentation with no noticeable change in quality. By measurements at a fixed frequency in it was determined that the power gain was [illegible] of 18 or greater. Various people witnessed this test [illegible] (were present) of whom some were the following
R. B. Gibney, H. R. Moore, J. Bardeen
G. L. Pearson, W. Shockley, H. Fletcher
R. Bown. Mr. H. R. Moore assisted in setting up the circuit and the demonstration occurred on the afternoon of Dec 23 1947

Read & understood by
G. L. Pearson Dec 24, 1947
H. R. Moore Dec 24, 1947

Laboratory notebook entry recording discovery of the transistor effect at Bell Telephone Laboratories.

Transistors brought smaller equipment size, less heat production, instant "on," lower power requirements, longer component life, near-permanent operating characteristics (compared to tubes) and, in many instances, improved performance to hi-fi equipment. With the advent of stereo, which requires two of practically everything in amplifier and tape electronics, and the addition of multiplex circuitry for FM, transistors arrived on the scene just in the nick of time.

How it works

Current flowing across the layer-like structure of a transistor can be controlled by an electrical signal applied to one of the layers. The flow of electricity between these layers can be changed. Changes in conductivity are produced by temporary changes in the way electrons are distributed among the atoms in the transistor layers.

To turn pure semiconductor materials [that is, material in between good conductors of electricity (metal) and poor conductors (rubber)] into transistors, scientists add very small amounts of the right kind of "impurities." Some of these impurities are atoms of material that interact with silicon or germanium crystal lattices in such a way that electrons (negative charges) detach themselves and become free to move.

Other impurity atoms create deficiencies of electrons, or "holes." These holes are, in effect, positive charges. The holes, as well as the electrons, are able to move through the material.

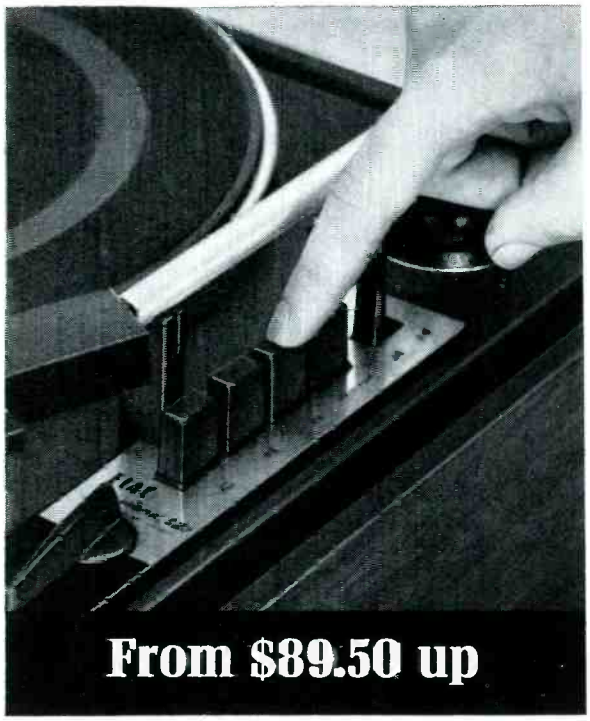
When the semiconductor crystals are grown, they are purposely "doped" with minute amounts of impurities. After the crystals are sliced into wafers they are further altered locally by precise processes to produce sandwiches of materials that contain alternating layers with either free electrons or free holes.

Where the two types of material meet—at each junction—the loose electrons and holes face each other. Being of opposite electric charge they are attracted to each other and a few drift across the junction. The impurity atoms have charges of their own and these charges are fixed in position in a solid. The net result is that an electric field is formed which prevents the motion of additional free electrons and holes.

Each three-layered sandwich becomes a transistor when an electrical contact is attached to each of the layers. The current flowing between two of the contacts can be controlled by applying an electrical signal to the third. The signal in this way can be amplified—made 50 to 40,000 times more powerful. Further, this large current keeps step with the incoming signal so that the outgoing signal is an enlarged image of the original signal.

Outgrowths of the development of transistors abound, of course. Junction and MOS Field-Effect Transistors (which, unlike conventional transistors described above, are unipolar rather than bipolar devices) have been developed. Integrated circuits which include transistors have replaced discrete transistors in many areas. But it all started only 20 years ago by a trio of scientists who were awarded the Nobel Prize for their discovery in 1956. Æ

Miracord gave its great new automatics the light touch



From $89.50 up

There are two new Elac/Miracord automatic turntables: the 620 and 630, both born of the same aristocratic lineage that bred the magnificent 50H. But they cost less.

Naturally, they don't offer everything the 50H does. But they do share many of its deluxe characteristics: its gentle way with records; its exclusive light-touch push-button controls; its cueing facilities; its effective anti-skate compensation; its simple selection of manual vs. automatic play; its ability to track with cartridges designed for low stylus force operation; its low wow and flutter and rumble content and, of course, its smooth, quiet performance.

Each operates at the 4 standard speeds, each has a powerful four-pole induction motor, dynamically balanced tonearm with calibrated stylus-force dial, continuously adjustable anti-skate compensation and cueing.

Both, like the 50H, play single records, manually or automatically, either once-through-and-stop, or repeating until instructed to stop. Or they can play stacks of up to 10 records, in automatic sequence. Even without the famous 50H hysteresis motor, you'll love everything else about the 620 or 630.

The 630 has a lathe-turned, dynamically balanced turntable, cast from non-ferrous metal. It has the Miracord exclusive leadscrew adjustment and indicator which lets you adjust stylus over hang precisely.

The 620 has a pressure-formed non-ferrous turntable, balanced for minimum wow and rumble. Like the 50H and 630, its stylus force can be set from 0 to 7 grams to accommodate any cartridge.

We think you will be happy with any Miracord turntable. They're *all* pretty amazing! And as for prices, the 630 is $119.50; the 620, $89.50, both less base and cartridge.

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the light touch

PALACE... where the new RE15 was born!

The biggest names in show business play the Hollywood Palace on ABC-TV. They demand the finest sound possible. And they get it from the new Electro-Voice RE15. It's no accident, and here's why: ABC-TV sound engineers worked with us for almost two years perfecting the RE15. Their demands reflected the problems that make TV variety programs one of the toughest assignments for any sound engineer.

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They asked for a small, light microphone. The RE15 is shorter than a pencil, with a body no thicker than a Cannon XL connector. And it weighs just 8 ounces. Perfect for a fast-moving boom or for hand-held applications.

Flat Off-Axis Response

ABC engineers requested the same response curve off axis as on axis. With a big band in the same studio, some band pickup from the back of the solo microphone would be inevitable. It wasn't easy to make this "off mike" pickup as smooth, flat and wide range as the on-axis response, but that's exactly what the RE15 has to offer at every angle.

Super-Cardioid Pattern

But the next request almost stumped us. They asked for wide front pickup, so that a boom operator could easily "work" two or more performers, yet they wanted the RE15 dead at the rear for longer "reach". In short, a polar pattern similar to a ball sliced neatly in half! And that's almost what they got.

The RE15 is down only 3 db at 80° off axis (in any plane) and just 8 db at 90°. But at 120° and 180° the level drops over 19 db, and at 150° the RE15 response is almost 26 db below the on-axis level. This super-cardioid pattern (with a small lobe at the back, 15 db down) proved much more useful than a classic cardioid. With the microphone tipped 30° (a typical boom or stand operating position) the area of greatest cancellation is oriented directly at the sources of unwanted sound—the audience and the sound reinforcement speakers.

L. to R.: Robert Crawford, Chief Utility; Eric Reid, Chief Boom Operator; Eugene Lukowski, Technical Director; John Neal, Audio Engineer, for ABC's Hollywood Palace.

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ABC-TV also demanded plenty of output. They got it. A crisp -55db. And they got the reliability and ruggedness typical of all E-V professional dynamic microphones, as well. Famous E-V Acoustalloy® diaphragm plus multiple dust and magnetic filters assured unchanging response and sensitivity. Plus a "bass tilt" switch to cure boomy acoustical problems.

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More About Negative Feedback

NORMAN H. CROWHURST

Part 3

IN PREVIOUS ARTICLES the subject was examined in block diagram form, where the amplifier and the feedback are both boxes, functionally connected by lines. But what is an amplifier, and what is fed back? Is it voltage or current? To both of these questions there are two answers. Let's illustrate.

The amplifier

If the amplifier uses a tube input, the voltage signal applied to the grid controls ultimate output. Varying the impedance in the input circuit will vary the current associated with this input voltage, but the voltage is the important quality that directly controls the ultimate output.

If the amplifier uses a grounded emitter transistor input, current is the important quantity. Although adjustment of circuit values can vary the voltage required to drive this signal current into the input, the output of the amplifier is directly related to input current.

If the amplifier uses an FET (Field Effect Transistor) for input, we have a device like a tube, and voltage is the important parameter about input. Now let's look at outputs.

If the output tube is a triode, probably transformer coupled, the most meaningful way to view the output is as a voltage source, with an internal resistance that is lower than the design value of load impedance.

If the output tube is a pentode, or a transistor, the most meaningful way to view the output is as a current source, with an admittance that is lower than the design load, regarded as admittance rather than impedance (which would be higher than the design load).

In some circumstances it may be more convenient to view transistor or pentode outputs as voltage sources, with source resistances higher than design load values, but usually they behave more like current sources. The distinction between output circuits is no black and white one, definitely a function of either voltage or current, as it is with input circuits, where one or the other definitely controls the signal amplified.

An ultra-linear circuit, regarded as entity—the tubes with the output transformer that provides the screen taps, all acting as an ideal unit—is part-way between these extremes. It may be regarded as either a voltage source with a source impedance approximately equal to design load, or as a current source with a source admittance approximately equal to the design load.

Figure 1 shows the variety of amplifier ins and outs, before feedback is applied. But from here on, we'll not complicate the issue with in-betweens, but assume either voltage or current inputs and outputs. On the overall picture then, we have two kinds of input and two kinds of output, according to whether the important parameter is voltage or current at each end.

So in all we have four basic kinds of amplifier (Fig. 2). Where both input and output are either voltage or current, the amplifier may be regarded as a voltage or current amplifier. It merely amplifies the same parameter.

Where input is one and output is the other, we have a transadmittance or a transimpedance amplifier. In effect, with one the amplifier increases the current delivered to the load by a given input voltage, while in the other the amplifier increases the voltage developed across the output load by a given input current.

The feedback

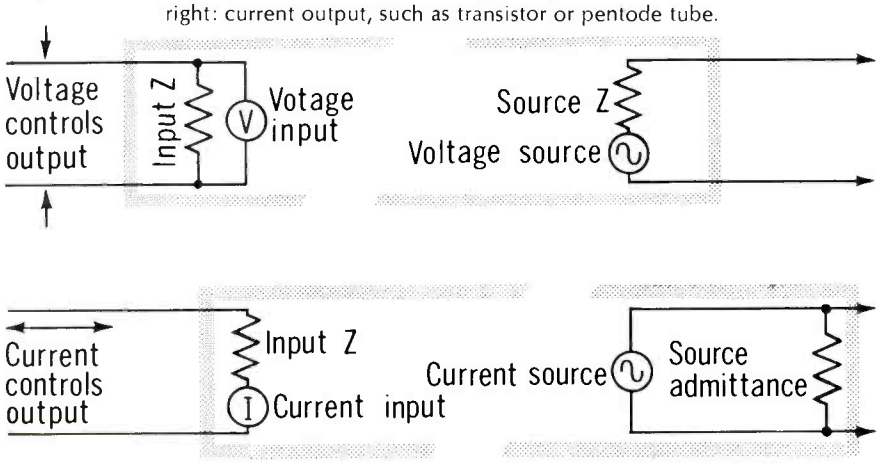
Now with four possible kinds of amplifier, each of which uses an input and an output impedance possessing both voltage and current parameters, we can apply the feedback in a variety of ways.

At the output end, to derive a signal to feed back, we can use either voltage or current. The feedback signal can be made proportional to either the voltage or the current output (Fig. 3).

When the feedback signal gets back to the input, it can be injected in series or in shunt with the external input (Fig. 4). This is sometimes referred to as voltage or current combination at the input. Series injection combines voltages; shunt injection combines currents.

Now put the whole thing together, and we have four kinds of amplifier, to each of which four kinds of feedback can be applied. Thus there are 16 basic, simple kinds of feedback (Fig. 5) before we get into combinations using multiple feedback, or cases where the output isn't simply voltage or current dependent, but

Fig. 1. Schematic representation of the two basic kinds of input and output encountered in amplifiers. Top left: voltage input, such as tube or FET; bottom left: current input, such as grounded emitter transistor; top right: voltage output, such as triode tube; bottom right: current output, such as transistor or pentode tube.



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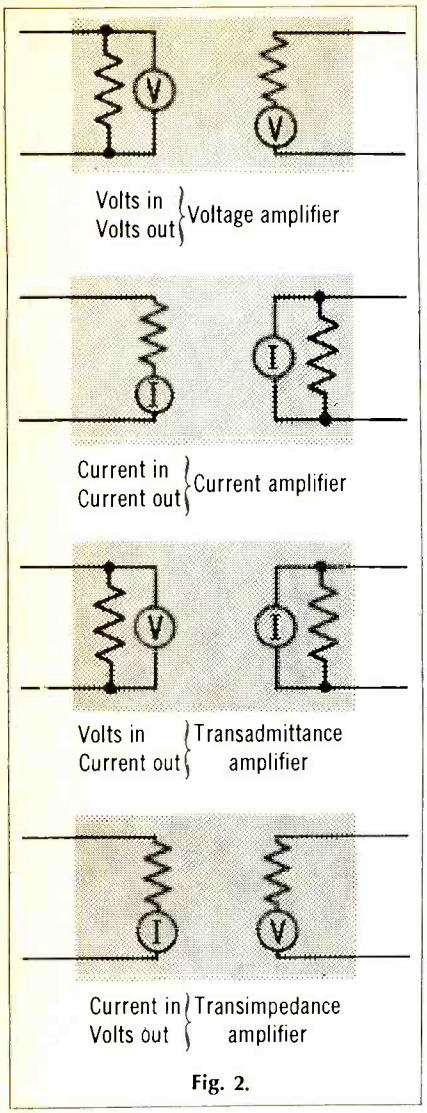


Fig. 2.

Fig. 2. The four basic amplifier configurations, using different combinations of input and output from Fig. 1.

Fig. 3. Different derivations for feedback, shown here in the same circuit.

Fig. 4. Different ways of injecting the feedback at the input end.

somewhere between the two, or some of the other things the theory overlooks.

Reasons for feedback

What do we apply all these kinds of feedback for? A variety of reasons, but let's answer the question first by what feedback does:

1. *It changes gain.* Negative feedback reduces gain.
2. *It changes input impedance.* According to the way it is applied, it can either increase or reduce input impedance. Negative feedback using shunt injection reduces input impedance, while using series injection increases it.
3. *It changes output impedance.* Negative feedback using current-derived feedback increases output impedance, while using voltage-derived feedback reduces it.
4. *It reduces internally generated distortion,* with certain limitations.
5. *It stabilizes gain,* reducing the amount by which gain fluctuates due to various causes.

Each feedback loop changes all these properties by the same factor. For example, 20 dB feedback, voltage-derived from the output and shunt injected at the input, will reduce gain by 20 dB, divide both the input and output impedance by 10, reduce distortion to one tenth, and stabilize gain so that a fluctuation of 1 dB without feedback will be reduced to 0.1 dB with it.

Or if the same feedback is series injected at the input, the input impedance will be multiplied by 10, the other effects remaining the same. The reader can have fun figuring the various angles on simple feedback loops.

What impedances?

Now we start running into unexpected complications. When I referred to input and output impedance changes, I was deliberately vague concerning the impedances meant. For example, when we speak of modifying output impedance, do we mean the source impedance seen by the load connected? Feedback

Fig. 3.

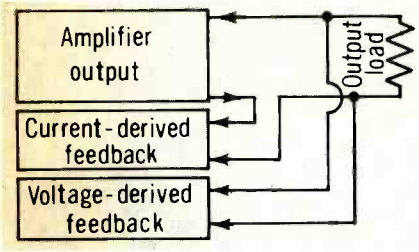


Fig. 4.

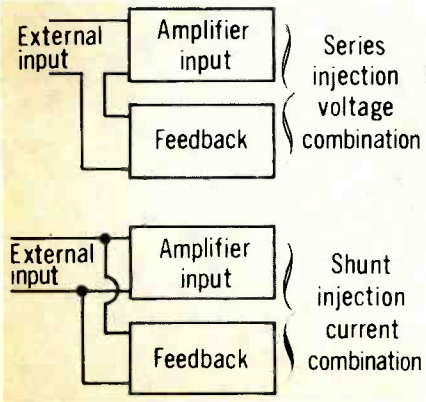
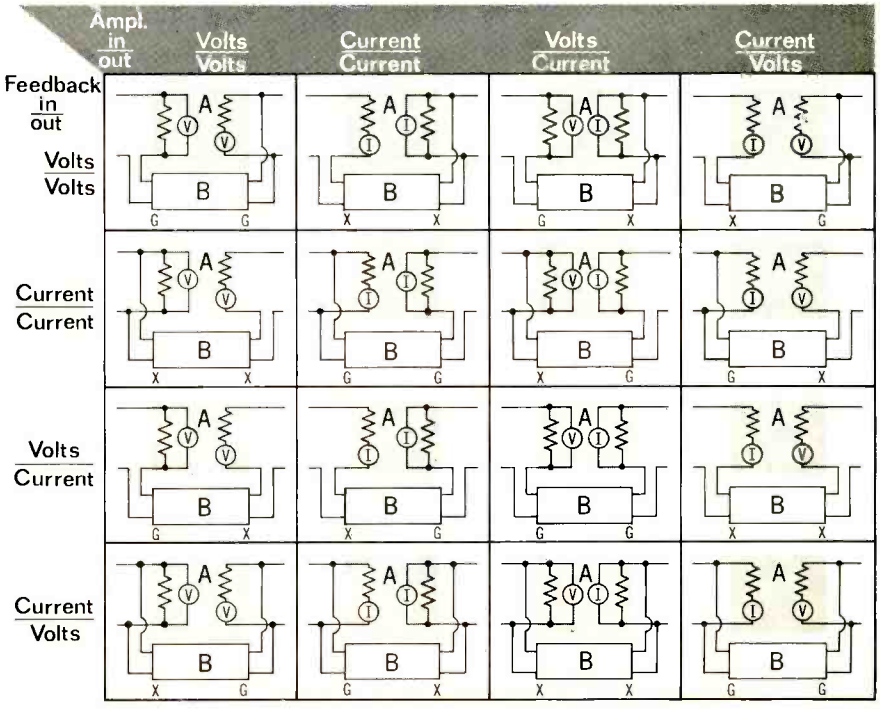


Fig. 5. Combining the possibilities of amplifiers and feedback networks, we have 16 overall possible combinations, shown here. The letters under input and output in each have the following significance: G indicates that feedback is not materially affected by the value of external impedance, within normal range of likely values; X indicates that feedback is critically dependent on external impedance. This is not necessarily bad, as it may be the purpose for which the feedback is applied.



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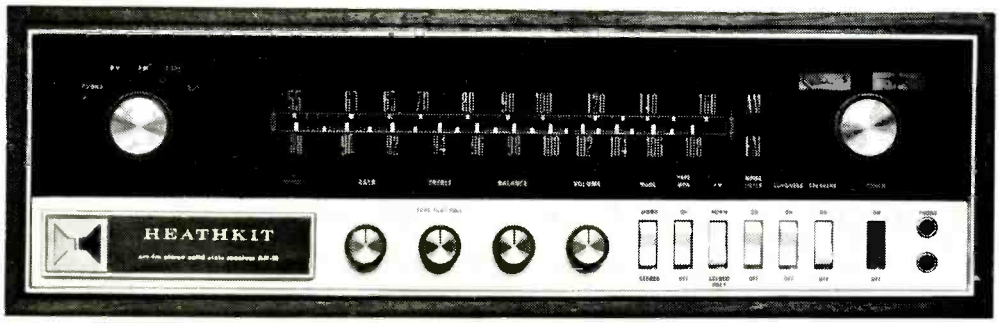

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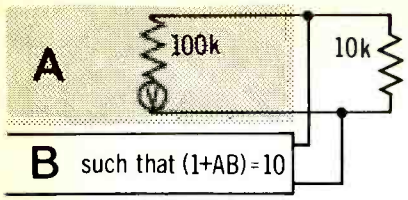


Fig. 6. The question of what output impedance is meant, discussed in the text, refers to these impedances.

can't modify the actual external load impedance connected, can it?

The only way to clarify this is to take an example. Suppose we have an output stage using pentode tubes or transistors in which the source resistance, without feedback, is ten times the design load value. Just to put in some figures, suppose the design load impedance is 10K and the source resistance is 100K (Fig. 6).

Now we apply 20 dB voltage-derived feedback to this amplifier, reducing its gain by a factor of 10. What is the output impedance changed to?

First we must ask what gain is reduced by a factor of 10? In other words, under what condition is the feedback 20 dB? We'll presume the factor intended in this statement is the gain with the load connected. Without feedback, removing the load would cause the output voltage to rise about eleven times (assuming the input level is low enough so that the amplifier does run into serious distortion when the load is removed).

Looking at the output impedance as a parallel combination of the 100K source and the 10K load, which is how the feedback connection "sees" it, the value is about 9K. Feedback at 20 dB will reduce this effective value to one tenth, or 900 ohms.

But the external load of 10K has not changed. This means the internal (source) resistance must have changed to a value that will make the parallel combination of the two come to 900 ohms. To do this, the source resistance must have a value of 1K.

Viewed this way, then, the 20 dB feedback has reduced the source resistance from which the 10K load works from 100K to 1K. It begins to look as if we have made a liar out of our formula. Feedback of 20 dB should change impedance by 10:1, not 100:1. Actually, we're talking about different feedback values.

To think of source resistance apart from load impedance, which we do when we regard the load impedance as external to the amplifier, we should consider the gain without the load resistance connected, ideally. This may not be practical, for a reason we shall mention soon. But for the moment, consider the gain change without the load connected. Removing the load will cause the output voltage to rise about 11 times; connecting the feedback will now reduce the gain by 100 times, because 11 times as much gets fed back as there was when the load was connected, relative to the output.

Previously, the feedback was 9 times input, to make (1 + AB) = 10, so now feedback is 9 × 11 = 99 times input, to make (1 + AB) = 100. So source resistance is reduced by a factor of 100, which was the value calculated by the other method.

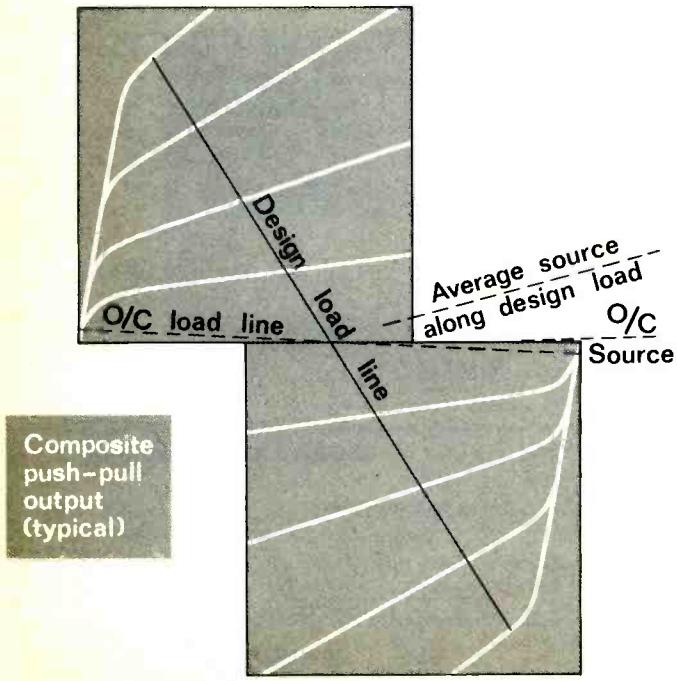
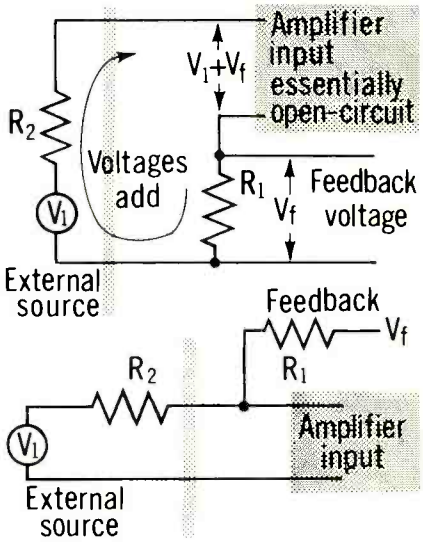


Fig. 7. Composite curves for a push-pull output shows how source resistance changes with loading (dashed lines).

Fig. 8. Different feedback methods applied to voltage type input: (a) series injection is sensibly independent of external source impedance; (b) shunt injection is critically dependent on the ratio of R_1 and R_2, where R_2 is the internal resistance of the external source.



The reason this method may not be practical is that effective source resistance is actually dependent on the load value connected. When the load is disconnected, the output may not rise by precisely the factor calculated from the source resistance. It invariably changes when the amplifier is operating open-circuit because a different load line is applied to the output tube or transistor (Fig. 7). We discussed some aspects of this variation of source resistance in a previous article in this series.

That's an example of ambiguity in definition of feedback, as related to the output end. The input end also presents problems in defining the precise condition. With tube or FET circuits using series injection, we have little problem. The voltage delivered to the grid of the tube or the control electrode of the FET is substantially the sum of the external input voltage and the feedback voltage (Fig. 8).

(Continued on page 69)

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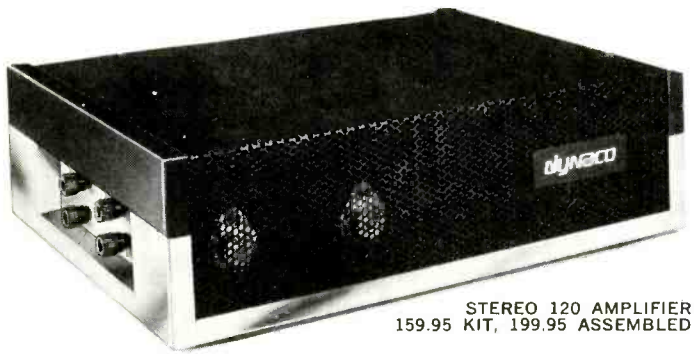

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Equipment Profiles

This Month:

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AR Stereo Integrated Amplifier
Garrard SL-95 Automatic Turntable

Crown Model CX822 2-track Stereo Tape Recorder

MANUFACTURER'S SPECIFICATIONS— Tape Speeds: Three, equalized; 15, 7½, 3¾ ips. Timing: 99.8% or 1.8 sec. in 15 min. and adjustable to ±0.05% short term. Wow and Flutter: 15 ips, 0.06%; 7½ ips, 0.09%; 3¾ ips, 0.18%. (Guar. max. for record, playback.) Record/Play Frequency Response: 15 ips, ±2 dB 30 to 30 kHz; 7½ ips, ±2 dB 30 to 20 kHz; 3¾ ips, ±2 dB 30 to 10 kHz. Signal-to-Noise Ratio: −57 dB @ 15 ips; −56 dB @ 7½ ips, −50 dB @ 3¾ ips. Stop Time: One-half in. @ 3¾ ips; 1-in. @ 7½ ips; 3 sec. from full rewind on 10½-in. reel. Start Time: Under 0.1 sec. Wind and Rewind: 1200 ft. in 45 sec.; 2400 ft on 10½-in. reel in 58 sec. Reel Size: 10½-in. (NAB) max.; 5-in. min. Distortion: Approaches threshold of measurability. Inputs: 2 per channel; high-Z mic. or line level. Opt. input transformers for low-Z mic. Tone Controls: Bass, 15 dB atten. or boost at 30 Hz; treble, 15 dB atten. or boost at 15 kHz. Outputs: Two per channel, 600-ohm unbal. One low-Z output (stereo phone jack) on front panel. Motors: Three. Drive, 1 Hysteresis synch. drive motor; Reel, 2 capacitor-run torque motors. VU Meters: Two 5-in. professional types with edge lighting. Bias Freq.: 100 kHz. Monitoring: Front-panel switch for ea. channel. Dimensions: 17½-in. high, 19-in. wide, 9-in. deep. Price (basic machine): $1790.00.

The Crown CX822 pictured here is probably the finest tape recorder that has been reviewed in these pages. In addition to delivering phenomenal performance, it incorporates numerous features and refinements that place this machine in a class by itself.

The Elkhart, Indiana manufacturer has, for example, introduced a computer-type logic system to prevent destructive operations; electronics is substituted for mechanical mechanisms in many instances; tape handling has been made more gentle and faster than ever before, while tape tensions have been drastically reduced; editing has been greatly simplified; construction appears to be rugged enough to withstand parachute drops; and Old-World craftsmanship is apparent at a glance, quickly substantiated by handling the well-engineered recorder.

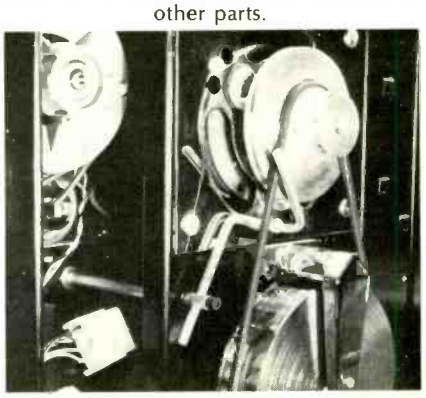
The Crown Model CX822 recorder is the latest model in the 800 series of recorders from Crown International. It consists of two detachable parts: the tape transport and the electronics assembly. Since the tape heads are part of the tape transport, all adjustments to the electronics affecting the combined performance of the transport and electronics are performed when the two are mated. So for descriptive purposes, let us consider the CX822 as one unit, breaking it down functionally, rather than physically.

To begin with, the CX822 is a two-track machine which works at three speeds. This means that the necessary speed changes (see Fig. 2) and selectable equalizations are built-in. (Crown's Model CX824 is a four-track unit, with high speed at 7½ ips and low at 1⅞ ips.) The machine accepts standard, plastic, EIA reels directly (see Fig. 3) onto the turntable or 10½-in. NAB reels with adaptors, which are furnished with the machine (Figs. 4 and 5). Each turntable is driven by a 1250 rpm capacitor-run torque motor with self-aligning bearings. Turntable braking is accomplished by electric means, whereby the motors are slowed by applying d.c. voltage to them. This contrasts with the solenoid-actuated mechanical braking system of most comparable machines. The type of differential electro-dynamo braking used here is a patented feature of Crown transports, whose brakes did not grab, jerk or need adjusting during our extensive tests, and work extremely well in bringing the tape to a smooth, gentle, rapid stop. A positive temperature coefficient resistance is used to provide the braking differential.

We tried to make the deck misbehave by stopping a roll of super-thin ½-mil tape at high speed by rocking the tape back and forth, and by other tortuous combinations. Not only did we fail to foil the machine, but once motionless, the tape at the gate was limp (not under tension) and no stretch marks were to be found anywhere on the tape. All this despite its breakneck wind and rewind speed. It took exactly one minute to smoothly wind 1800 feet of 1-mil Mylar tape between 7-in. reels. The only apparent problem with this kind of braking would occur if there was a loss of electrical power during rewind, say. But the mechanical simplicity, reduction of maintenance and potential reliability of the CX822 far outweigh such an unlikely occurence as a power failure at the precise moment of rewind.

The stainless steel capstan shaft is centerless ground, hardened and highly polished. Its tip is of non-magnetic, chrome-plated stainless steel, and it is concentrically aligned with a four-pound flywheel of nickel-plated steel. The assembly is mounted in a ⅜-in. thick aluminum "tunnel" casting, five in. long, with self-aligning Oilite bronze bearings. The flywheel is driven by a centerless ground-neoprene drive belt

Fig. 2—Drive pulley and capstan flywheel system shown in 7½ ips position. The flywheel, driven by a seamless neoprene belt, is mounted on rear of capstan. Note flywheel bearing support. Belt can be switched from 7½ to 3¾ ips from front-panel push rod. The 15 ips speed change is done manually by stretching the band over the largest pulley. The belt can be replaced in seconds, without removal of other parts.



The SM60 cannot be stereotyped—is equally at home in the studio or in the field—stand-mounted or hand-held—in uses as diverse as outdoor sporting events and elaborate variety shows. Small wonder that audio engineers have called it one of the most versatile omnidirectional dynamics they've ever encountered, for the SM60 is a unique combination of good-looks, strength, performance and economy.

The smooth, wide-range response provides cleanest, natural reproduction of both speech and music. A very effective built-in wind and "pop" filter protects against undesirable effects of close-talking.

Lustrous, non-glare metallic finish and tailored-to-the-hand dimensions provide striking on-camera appearance and superior handability. Specially reinforced machined-steel case front is designed to take abuse that would ruin other microphones—you can drop it on its nose without damage to the internal structure! Efficient windscreen and front end are *quickly* and *easily* removable for cleaning.

Best of all, it is priced competitively with conventional "workhorse" microphones. Why not check out an SM60 now? See your Shure Professional Products Distributor, or contact Mr. Robert Carr, Manager of Professional Products Division, Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. 60204—Phone 312 - 328-9000.

SHURE SM60

VERSATILE OMNIDIRECTIONAL DYNAMIC MICROPHONE

THE LAST WORD IN WEARABLE LAVALIER MICROPHONES . . . BY SHURE

Specifically designed for radio, TV, motion pictures . . . matches well in sound with stand or desk mounted units. Smoothly-contoured, machined-steel case and recessed grille for minimum clothing noise. Exclusive snap-in mounting of microphone for greater convenience, security. "Positive Lock" lavalier goes on in an instant—provides simple, noiseless position adjustment. Extra-flexible, kink-free rubber cable is easily replaceable.

MODEL SM51 DYNAMIC LAVALIER

Fig. 3

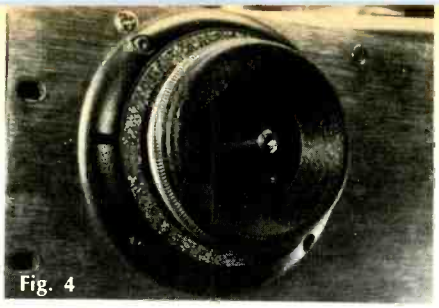


Fig. 4

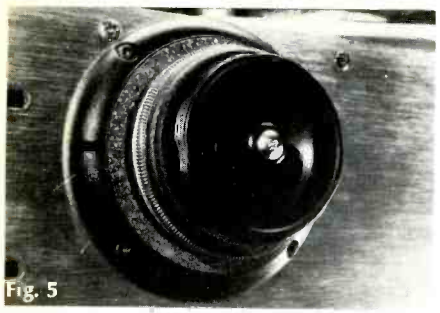


Fig. 5

Fig. 3–Turntable set to accept 7-in. EIA tape reel.

Fig. 4–Turntable with NAB reel adaptor in place.

Fig. 5–Locking tape-reel holder is screwed on for use with all reels. Tightening holder compresses adaptor, causing adaptor spring to spread, and thereby applying tension to inside of NAB hub to hold it tight.

which slips over the flywheel and one of the three motor-drive pulleys. The capstan motor is a huge hysteresis synchronous device, permanently lubricated, ball-bearing drive motor. Ducted forced air flows over the drive motor, forced by its fan, and is forced out the side of the transport. An appropriate cutout is made in the case for this. The pressure roller that engages the capstan to pinch the tape and move it is made of neoprene, with a full Oilite bearing supporting the roller. The neoprene itself is ground to ±0.001-in. concentricity. Glass rod lifters lift the tape onto the heads in the play and record mode, releasing (thereby removing tape from the heads) during FAST FORWARD, REWIND, and STOP modes. See Fig. 6. A plug-in solenoid, designed for continuous duty, closes the gate, raising the tape lifters and pressure roller. See Fig. 7. Once the solenoid is seated, over 20 pounds of force applied to the pressure roller is required to unseat it. The extent to which Crown has gone to assure a friction-free, concentric, noiseless tape drive and guiding system apparently paid off because even at 3¾ ips, its lowest speed, the deck had 0.1% flutter and wow at most. At 7½ ips it was 0.07%; at 15 ips, 0.05%—a remarkable achievement, living up to the manufacturer's claims.

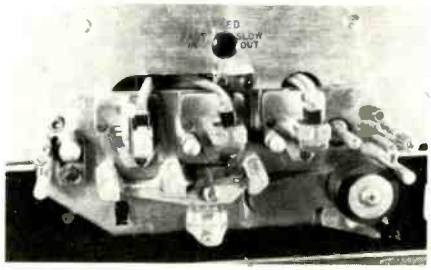
One of the unique features of the deck is its tape motion system, which is controlled by either the built-in, illuminated pushbuttons (four) or via remote control. Five leads are required for external control of FAST FORWARD, REWIND, STOP and PLAY/RECORD modes. Either momentary closure of a 4-V line at 40 mA or an external supply of 1.55 V as 5 mA will operate all four modes. But getting back to local control, the trick is in the built-in integrated-circuit "computer" system that stores the pushbutton commands, its memory retaining only the last command given it. It compares the last command with the present state of the deck—that is, the direction in which the tape is going and how fast—and executes that command in the safest way. The tape motion and direction sensor is shown in Fig. 8. For example, if the machine is going FAST FORWARD and the green PLAY button is pressed, the tape will come to a complete stop, the red STOP button is automatically illuminated (we didn't press it, remember) followed by the gate closing and the tape going into play motion as the green PLAY button lights up. All this without hands. Any command or combination of commands can be safely given at any time. If multiple commands are given to the machine, it will obey the following priority rules. (1st) REWIND or FAST FORWARD (except when in RECORD mode); (2nd) PLAY; (3rd) STOP. We found the tape motion command system to be as foolproof as Crown says it is, and could not beat the computer by design or by accident.

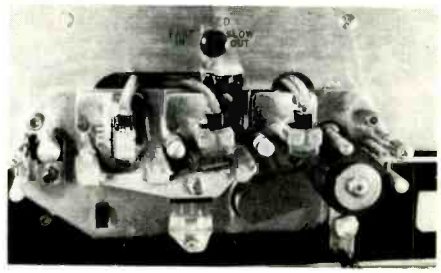
An automatic tape sensor is provided in the form of a photocell and lamp on the left end of the head assembly. This gives a continuous stop command whenever tape runs out or a transparent "window" in the tape is sensed. Because of the priority command setup, the STOP command may be overridden by holding down any other command. As was mentioned earlier, the control system performed flawlessly. In professional recording and editing application, the Crown's computer system acts as a time saver, which simplifies operation.

Every part of the deck is easily accessible. Part of the back swings out on hinges; the rest comes off with removal of a few screws. All motors are easily removable, as is the head assembly and printed-circuit cards. Relays are unplugged. Controls as well as connectors can be replaced with easy access (Fig. 11) everywhere. Surely, the CX822 is a serviceman's dream, considering the unit's inherent complexity.

The CX electronics, Fig. 12, is a solid-state, modular record/playback amplifier. Its purpose is to accept and condition input signals to properly drive tape recording heads and to provide playback facilities and proper equalization. The input circuit accommodates two inputs per channel, which are individually mixed on the front panel. Either or both can be high- impedance microphone or line level. A low-impedance option converts the high impedance mike inputs to low impedance and adds a balanced, low impedance +12 dBm 600-ohm output level which can be adjusted internally between −20 dBm and +18 dBm. The standard output level is +12 dBm unbalanced. The preamplifier response is essentially flat over the 10 Hz to 100 kHz range, exclusive of the required equalization and bias traps.

Figs. 6 and 7–(Left) Tape head assembly, gate open. (Right) Tape head assembly, gate closed (pinch roller up against capstan). Note elaborate guiding system of glass rods and chrome plated, hardened steel guides. Lever at lower right is used to manually close the gate for editing. Slide switch, at lower left, removes take-up reel torque for easier editing. Note easy access to heads from all angles. Azimuth and tracking are independently adjustable and are factory set and sealed. Molded cables connect to head and the entire head assembly. The assembly is removable and head covers snap off easily. The leaf-spring loaded pressure pad applies just a slight amount of tension to the tape against the record head. This might be used as an added flutter filter or to insure perfect contact at low speeds.





The bias oscillator consists of a pair of push-pull connected power transistors operating into a ferrite cup-core assembly. The circuit produces a clean 100 kHz signal for bias and erase. Bias current is adjustable from the front panel, using the VU meters as relative indicators. Erase was highly effective, producing a level better than 61 dB down from 0 VU. The 5-in. illuminated and accurately calibrated VU meters indicate any of four selector-switched modes of operation. They can show input level, output level of the tape, output level leaving the machine after the output level controls, or a combined source and tape level which is used for echo effects .They also show bias voltage, which is proportional to bias current, and calibrated to correspond to 0 VU. Output level of the machine is controllable at the front panel and the same controls are used to regulate monitor headphone levels during recording.

Front panel electronic controls include: selector switches for output and meter, separate treble and bass controls for each channel that are usable for recording and playback, four input level controls; separate output level controls, a play-record switch that has a press-to-move-button safety interlock and separate positions for reading bias voltage with the VU meters, and bias adjustments. All these controls operate separately and independently on each channel and are sensibly laid out across the front face. The 3-speed equalization switch is common to both channels. The versatile control setup, coupled with a high signal-to-noise ratio, makes this machine useful for such applications as "sound on sound" recording where tone shaping is required, for example.

Since the record function is interlocked mechanically, electrically and visually, it's almost impossible to record or erase or ruin a recording by accident. For example, the deck won't go into REWIND while recording, though it will go into REWIND from PLAY. Such awkward intentions are common even in professional use, when confusion and hurry conspire to overide common-sense rule, and it seems that tape machines can never be too goof-proof.

A regulated 30V power supply is employed to make the CX electronics nearly independent of line voltage variations, and to insure stable operation in all modes when the load changes suddenly. The supply is built-up on a printed circuit card. Additional filtering and de-coupling of the power supply lines is used within the various circuits, where needed.

Performance

The Crown CX822 easily met its specifications. Its frequency response was flat and balanced, with no evidence of peaks. The measured playback response at 7½ ips, shown in Fig. 10, comes out to 50 to 15,000 ±1.2 dB, at 60 dB signal-to-noise ratio. At 3¾ ips the playback signal-to-noise ratio measured 57 dB. The measured record/play frequency response, using Scotch 203 tape, is shown in Fig. 10. It can be summed up as: 30 to 28,000 Hz ±2 dB at 15 ips, 20 to 20,000 Hz ±2 dB at 7½ ips, and 20 to 10,000 Hz ±2 dB at 3¾ ips. The measured frequency response closely matched the individual factory-run curves which accompanied the sample machine.

Harmonic distortion of the record electronics was less than 0.2% at 10 kHz. A 10 kHz signal recorded at −10 VU yielded a record/play distortion of less than 1%, measured while recording. It was even less in the other parts of its frequency range, as well as when playing back (not recording simultaneously). This is outstanding. IM distortion of the record electronics was better than 0.1%. Off the tape, while recording, it was 1.5% on left channel and 1.3% on right channel, which is also especially fine. The record/playback signal-to-noise ratios were measured at 15 ips, yielding −55 dB left, −57 dB right; 7½ ips, produced −56 dB left, −58 dB right; 3¾ ips, −54 dB left, −56.5 dB right. Crosstalk at 1 kHz was down a phenomenal −63 dB, which is really negligible since it is below the noise level.

The minimum input required for 0 VU was 0.1 mV through the low-level high-impedance mike input and 0.5 V through the high-level line input. Thus, this is a highly sensitive machine, suitable for every conceivable type of input. The VU meters, which are driven by their own drive circuit, respond the same regardless in which sensitivity range the main amplifier is operating. There is also plenty of level for monitoring stereophones—no matter how inefficient a pair is chosen. A standard 0 VU recorded tape produced 2.5 V out.

To truly appreciate this machine, you must *use* it, of course. At the outset, tape threading is delightfully simple and, therefore, accomplished quickly. There are no tensed compliance arms around which the tape must go. Just shove the tape into the slit formed by the head covers and you're in business. Editing facilities are great, too. There's a newly designed editing tape (cue) lifter, for example, and under the head cover is a slide switch to shut power of the takeup reel motor,

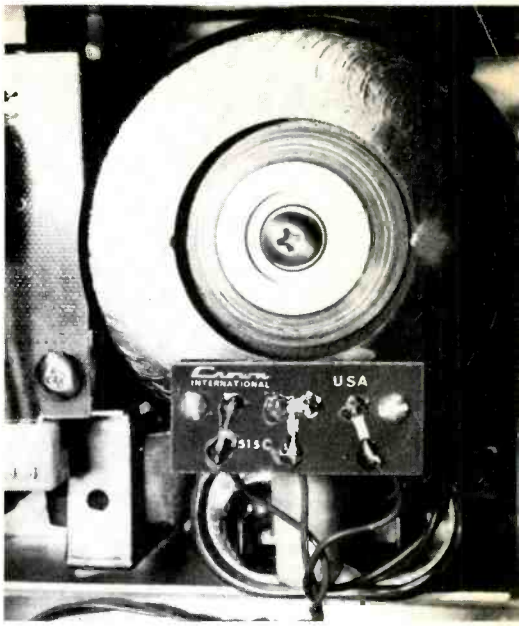
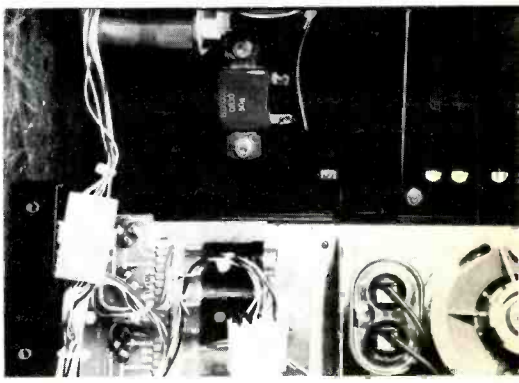


Fig. 8—The tape motion and direction sensor is installed on rear of the supply motor, as shown above. When the supply reel moves the slightest amount, it causes the shiny disc at center to move from its rest position in the same direction as the motor turns. After about 5 deg. of rotation, the disc reaches its stop and halts. During its journey, however, its slits (not seen) interrupt an appropriate light beam created by the lamp whose base is visible below the motor. The light (or absense thereof) triggers a photocell which energizes a relay through gates. When the disc begins to turn in the opposite direction, it activates a different photocircuit, which then energizes a second relay. The information gleaned by the motor and direction sense circuit is used by the computer to come up with proper commands to control tape motion.

Fig. 9—Tape control pushbuttons are attached to the rear of a printed circuit card (bottom-left). Take-up reel motor is at top, with ballast resistor and capacitor on swing-away panel at left.



thus simplifying editing jobs. You can "rock" between fast forward and fast rewind to your heart's content as a result of the CX822's fool-proof control system. Tape tension limits are set by a switch for small-size reels or for the larger type.

Playing back first-generation transfers from original masters, the sound produced through the Crown CX822 was peerless. When recording and playing back from records and FM broadcasts, there was absolutely no aural difference between the original and the copy at 15 ips. The same held true at 7½ ips, though, theory says, there should have been.

The machine was taken to a night club, where it was pushed, kicked (in its case), and, in general, treated rather callously to simulate what might be expected under normal conditions. The rugged unit, with its 50% thicker panel and added structural members (as compared with previous models), continued to operate like the professional-quality unit it is. Recordings made of piano music and a Regina music box were entirely faithful to the original, thanks to the CX822's low order of wow and flutter, among other highly prized characteristics. We had to use good condenser mikes to fully appreciate the quality of sound that this machine is capable of recording. Using a pair of calibrated ribbon types in our possession, the Regina music box exhibited better "highs" than evident in playback, for example. But the difference was already apparent before going onto the tape, as monitored via headphones. Switching mikes produced a recording almost indistinguishable from the real thing.

Is the 15 ips speed worthwhile? For master tapes, undoubtedly yes. Insofar as our ears are concerned, though, the "extra" sound quality achieved over 7½ ips is only a wee bit better in high-

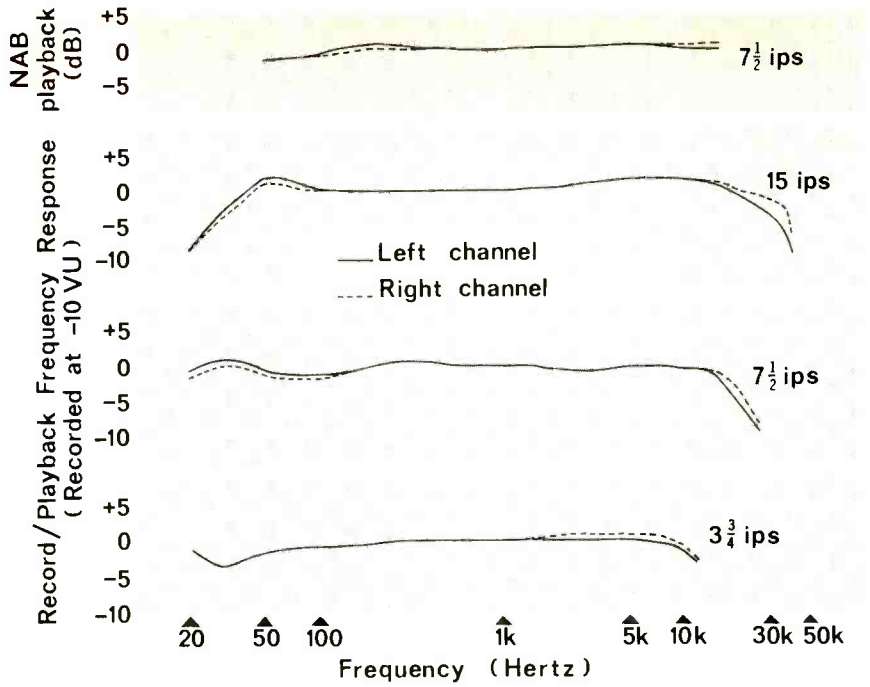


Fig. 10—Record/playback response of Crown CX822 stereo tape recorder.

frequency response, and then on music which has high-energy content here (say, above 16 kHz). The truth is, that the performance of this machine at 7½ ips is so good that, except to meet a professional recording need or for playing back 15 ips tapes, the 7½ ips speed would serve equally well (as offered in the model CX824).

Aside from large size and heavy weight, which cannot be avoided, the only area where the bull's eye of perfection went very slightly astray was the NAB reel adaptors. The problem here, shared by most other machines which offer them, is that when you screw on the cap to spread the spring which holds the hub, the spreading does not take place evenly. This causes very small eccentricities, which, at high speed, results in the tape not being wound as smoothly as it could. [*Crown will have a new NAB reel adaptor available in the near future which overcomes this minor deficiency. The center hub will be larger, and it will include three "feet" so that it can't twist due to spring tension—Ed.*] But this aside, the new Crown CX822 is capable of providing the most faithful reproduction of sound through the magnetic recording medium that we have observed to date. And it does it in as foolproof and as easy a way as we've seen. It is the machine for the tape enthusiast who wants and can afford the best.

(Accessories supplied with test sample were four CX2 playback amplifiers, $180; a 2CX6 output amplifier, $50; 4/X low-impedance balanced mike inputs and outputs, $100; model X carrying case, with complete access to front and rear of the recorder, $59.)

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Fig. 11—Underside of electronics chassis.

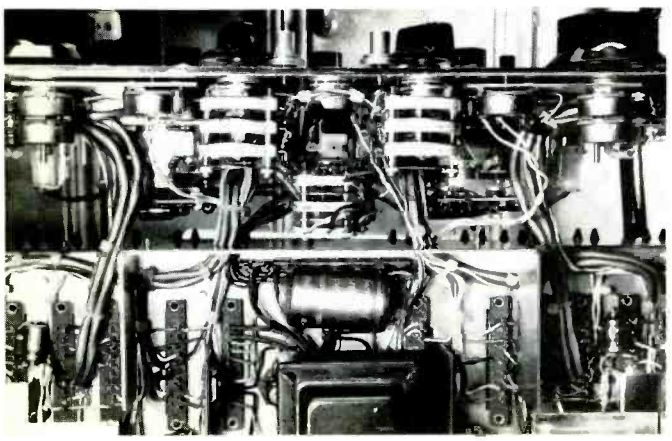
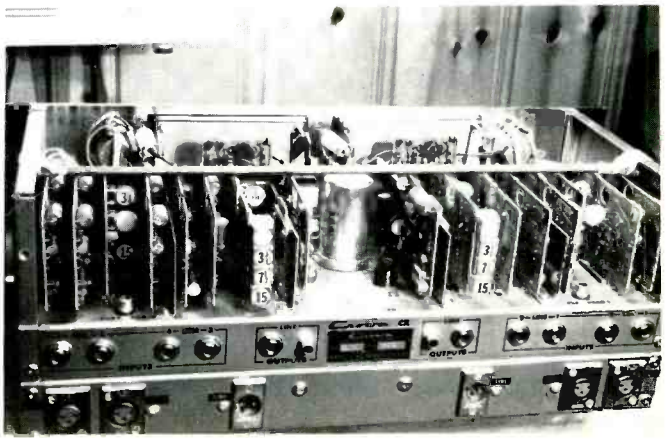
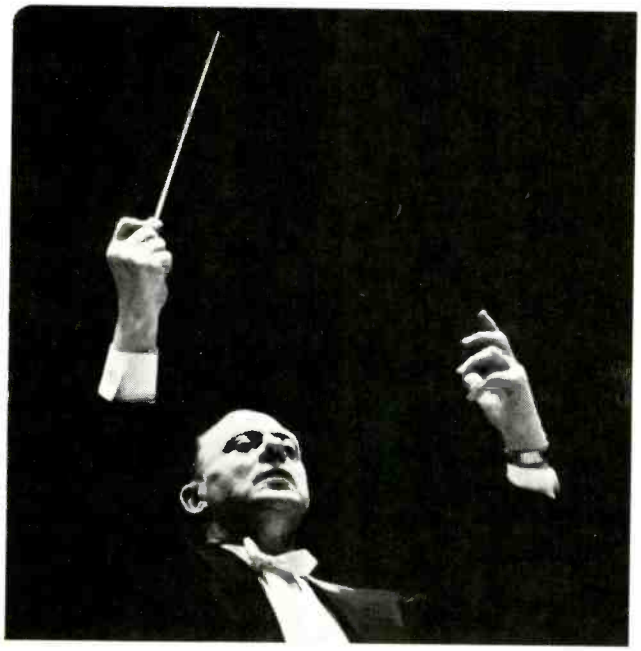


Fig. 12—Back view of complete electronics chassis.

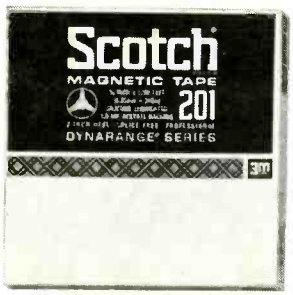


Build a world of your own on "Scotch" Brand Dynarange® Tape.



Great moments in music . . . happy times at home and away—capture whatever sound you want to save on "Scotch" Brand "Dynarange" Recording Tape. "Dynarange" delivers true, clear, faithful reproduction across the entire sound range. Makes all music come clearer . . . cuts background noise . . . gives you fidelity you didn't know your recorder had.

And "Dynarange" saves you money, too! Delivers the same full fidelity at a slow 3¾ speed that you ordinarily expect only at 7½ ips. The result: You record twice the music per foot . . . use half as much tape . . . save 25% or more in tape costs! Lifetime silicone lubrication protects against head wear, assures smooth tape travel and extends tape life. Isn't it time you built your own private world of sound on "Scotch" Brand "Dynarange" Recording Tape?



Magnetic Products Division 3M COMPANY

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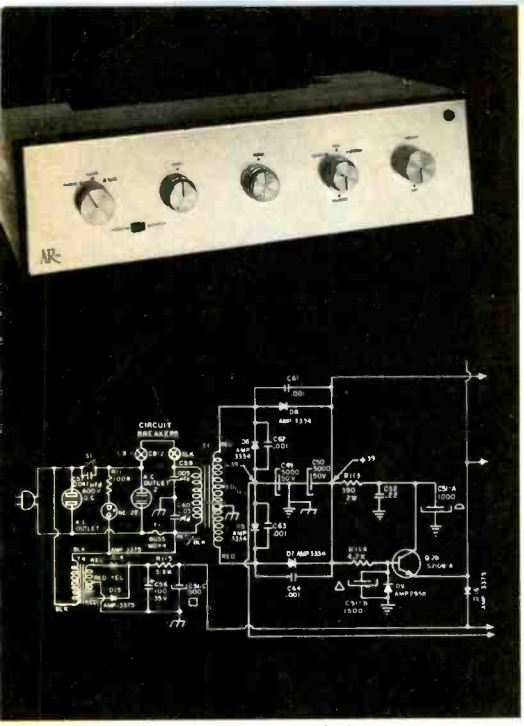


Fig. 1—Front panel of the new AR integrated amplifier is shown above. Below it is the AR's power supply, which features a standby power supply to eliminate "thumps" when turning the unit on.

AR Stereo Preamplifier-Amplifier

MANUFACTURER'S SPECIFICATIONS—

Power Output per channel (both channels driven): 60 watts rms at 4 ohms; 50 watts rms at 8 ohms; 30 watts rms at 16 ohms. IM Distortion at any power level to rated output: less than 0.25%. Total Harmonic Distortion at any power level to rated: less than 0.5% at any frequency from 20 Hz to 20 kHz. Frequency response: ±1 dB, 20 Hz to 20 kHz. Signal to noise ratio: phono, 57 dB, ASA "C" (flat) weighting; tape and tuner, 75 dB, "C" weighting. Input sensitivity (for full output): phono, 2 mV to 5 mV, adjustable at 1 kHz; tape and tuner, 0.2 volts. Outputs: tape recorder and 4-16 ohm speakers. Damping factor: 20 for 4-ohm speakers, 40 for 8-ohm speakers, 80 for 16-ohm speakers, at any frequency above 75 Hz. Dimensions (with optional wood enclosure): 15¾ in. wide by 4½ in. high by 10 in. deep. Price: $225.00. Opt. oiled-walnut enclosure, $15.00.

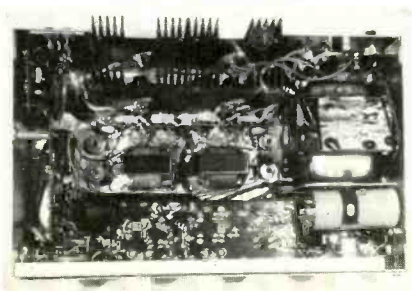
IT COMES AS no great surprise that Acoustic Research's first entry in the control/amplifier field should be a real "powerhouse" of a unit. Long noted for its excellent acoustic suspension speaker designs (which generally require more amplifier power for successful operation than more efficient types), AR would hardly be expected to offer an amplifier that didn't fill the bill for its own speaker line.

The specifications listed above are some of the most conservative ever noted. Although the industry has agreed to use "music power" ratings, no doubt because they result in somewhat higher power capability figures, AR chooses bravely to hold to the more conservative "rms" power figures.

The front panel of the AR amplifier is so startlingly simple in arrangement that it belies the sophisticated circuitry behind it. It is, as shall be pointed out later, perhaps a bit too simple for a control amplifier in this category, omitting certain features which have come to be expected nowadays (though many are not used by owners). Scanning from left to right one encounters a selector switch with only three positions: "phono," "tuner" and "tape." Next are the dual concentric pairs of "bass" and "treble" controls, clutch operated for individual adjustment of left and right channel tonal compensation. These are followed by a concentric pair of controls, the inner of which is the usual channel balance control. The outer knob of this pair is a mode switch whose positions include "mono," "null" and stereo." At the extreme right is the volume control, which also turns off the instrument in its extreme counter-clockwise position. The only other items we could find on the front panel were a tape-monitor slide switch and a bright red indicator light at the extreme upper right of the panel. Figure 1 illustrates the Spartan simplicity of this layout. Knobs, of the heavy turned-metal type, are gold colored, as is the entire dress panel.

As for the rear panel, it contains the usual pair of speaker terminal strips (color coded for ease of connection, and adequately separated to prevent accidental shorting), three pairs of input jacks (also color coded to correspond with AR's interconnecting cables supplied on its turntable), a pair of tape output jacks, concentric phono input level controls (adjusted to match the phono cartridge at installation), two convenience power outlets for auxiliary equipment (one switched, one non-switched), two speaker line fuses as well as an overall line fuse, and a very convenient "external ground" post. A view of the rear connection panel is shown in Fig. 2.

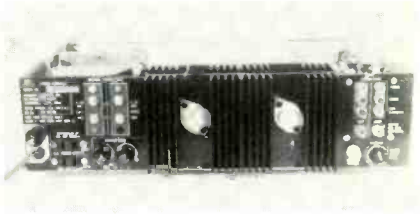
Fig 3—Internal layout reveals PC boards, heavy heat sinks, large power supply and driver transformers.



The entire amplifier is enclosed in a well-ventilated, black anodized, aluminum cover. The package is attractive enough for shelf installation even if you omit the optional wooden enclosure.

It was when we removed the cover of the amplifier that we began to appreciate the ruggedness of this design. The power transformer is massive, reminiscent of the old vacuum tube days. This accounts for the fact that power output is almost the same whether one or both channels are driven to full output—the power supply just never "quits." Speaking of power supplies, a novel innovation here involves the use of two complete power supplies. The first, or standby supply, actually energizes the earlier stages of the amplifier even when the amplifier is turned *off!* Consuming only a mere trickle of power, this feature eliminates the loud thump usually associated with the turning on of a high-powered solid state amplifier.

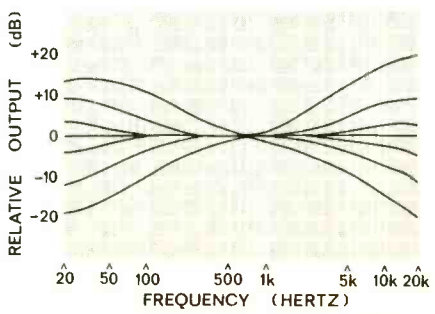
Fig. 2—Rear panel shows heat-sink arrangement for output transistors.



Each phono preamplifier consists of two NPN transistors which utilize feedback to accomplish the very accurate (within 0.5 dB from 30 to 20,000 Hz) RIAA equalization. Gain of each preamp is externally adjustable to suit cartridge outputs from 2 to 5 millivolts, and for insuring identical gain of the preamp channels. Both preamps are mounted on the first of three independant printed-circuit modules.

The second P.C. module contains six NPN transistors to accomplish the necessary voltage gain and tone control compensation. The tone controls are of the familiar feedback variety which vary both the degree of bass and

Fig. 4—Tone control range with settings for ⅓, ⅔ and full rotation in either direction from center.



Nothing is sacred anymore.

Fisher has just come out with a stereo receiver that sells for less than $200.

Thirty years ago, Fisher built high-cost, high-quality music systems for a small, closely knit group of music lovers and engineers.

And although the group has grown in number through the years, it has remained basically the same: a group of music lovers who demand the finest audio equipment available, regardless of price.

But times have changed. Practically everyone drives a car. Most people have telephones. Why shouldn't everyone own a Fisher?

So, though we realize that a few diehard Fisher owners from the old days will view it with alarm, we're introducing the Fisher 160-T, priced at $199.95.

The 160-T FM-stereo receiver, though slightly less powerful and a bit smaller than other Fisher receivers (it measures 15¼" x 3⅛" x 11¼" deep), is every inch a Fisher.

Its amplifier section has 36 watts music power (IHF)—enough to drive a pair of good bookshelf speaker systems at full volume without distortion. Harmonic distortion is very low: 0.5%. And the power bandwidth is broad: 25-25,000 Hz.

The tuner section is just as good as its counterpart in higher-priced Fisher receivers. It has 2.2 microvolts sensitivity, while signal-to-noise ratio is 60 dB or better. Like all Fisher receivers, the 160-T will pull in weak, distant signals and make them sound like strong, local stations.

Stereo stations are signalled by Fisher's patented Stereo Beacon* which automatically switches between stereo and mono. And FM-stereo separation is all anyone could want (35 dB or greater).

As you might expect from a Fisher receiver, the 160-T employs silicon transistors, including 2 FET's and 3 IC's. And Fisher's exclusive Transist-O-Gard™ circuit protects the output transistors from ever overloading.

The new Fisher receiver has a versatile control panel, with Baxandall tone controls (normally found only in more costly equipment), a 3-way speaker selector (main-off-remote) and a loudness contour switch that boosts bass and treble automatically at low listening levels.

The 160-T, with most of the exclusives found on Fisher's more expensive models, has some unique features of its own. Like Tune-O-Matic pushbutton tuning, which allows you to pretune your five favorite stations and switch to them instantly, at the touch of a button. This switching is accomplished electronically, and bears no relation to inaccurate mechanical pushbutton tuning. (Normal tuning across the FM dial is, of course, also provided.)

And, as we've said, the most unusual feature of all is the price, $199.95.

There may be some raised eyebrows among the more conservative Fisher owners, on account of the low price of our new receiver.

But think of the thousands of happy new Fisher owners.

The Fisher 160-T

Mail this coupon for your free copy of The Fisher Handbook 1968. This 80-page reference guide to hi-fi and stereo also includes detailed information on all Fisher components.

Fisher Radio Corporation
11-35 45th Road
Long Island City, N.Y. 11101

Name_____

Address_____

City_____ State_____ Zip_____

0304681

Overseas and Canadian residents please write to Fisher Radio International, Inc., Long Island City, N.Y. 11101.

*U.S. Patent Number 3290443.

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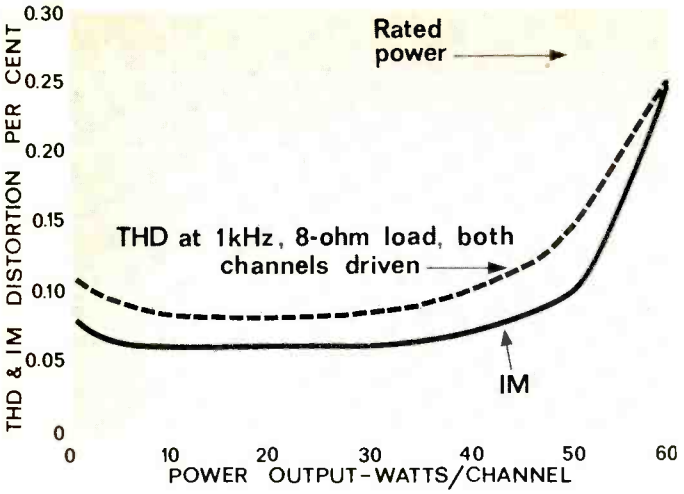


Fig. 5—IM and THD measurements. (Note that this is an expanded scale, with the graph's distortion percentage ranging from 0 to 0.3.)

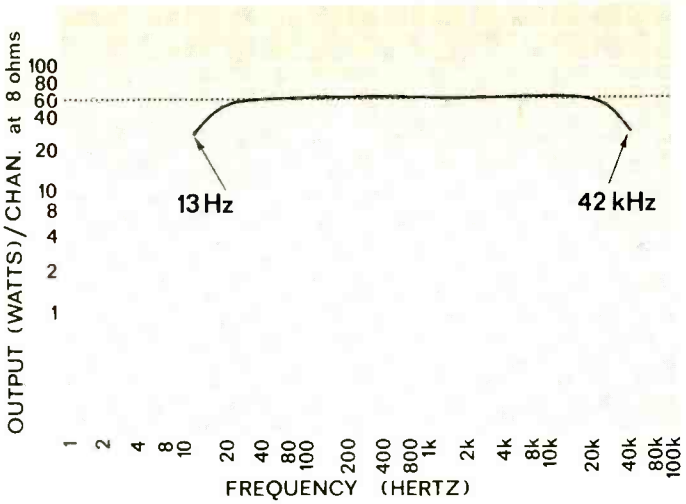
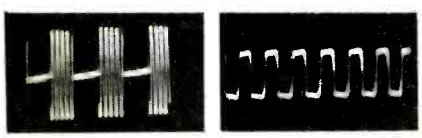


Fig. 6—Power bandwidth for 0.5% THD, referenced to 60 watts/channel (10 watts higher than the manufacturer's rating).

treble boost and attenuation, as well as the crossover frequency. Typical tonal response curves at intermediate and extreme settings are shown in Fig. 3.

The third P.C. board contains four transistors per channel and delivers the necessary amplification and power to the driver transformers (which are larger than some output transformers we have known). A pair of RCA AMP-2947 transistors (themselves used in low-power output amplifiers) are used to drive a pair of AMP-2919 output devices, mounted to individual, massive finned heat sinks for each channel. Two other transistors are found in the amplifier, for a total of 28 transistors. One of these is used as a regulator in the power supply, while the other acts as a phase inverter in the nulling circuit.

Fig 7 (left photo)—Tone-burst response of AR amplifier at 1 kHz, 50% duty cycle. **Fig. 8** (right photo)—Square-wave response at 15 kHz.



Each speaker line is fused with a 3-ampere fuse. In addition, thermostatic circuit breakers, mounted to the output transistors, open the power line circuit in case of overheating. The circuit breakers are self-resetting, once the heat is dissipated. A view of the "insides" is shown in Fig. 4.

"Nulling"

While the controls enumerated earlier are generally self-explanatory, there is one setting of the "mode" switch, called "NULL," that requires a word of explanation. We saw this feature on an early brand of stereo amplifier about eight years ago—thought it was a good idea then, and wondered why it wasn't picked up by other manufacturers. The NULL position of the mode switch is used in conjunction with the balance control to achieve electrical balance of signal input sources. In the NULL position, one input channel is reversed in phase, with unity gain; it is then mixed with the other channel, and the combination is fed to the amplifier outputs. A sharp null or cancellation is obtained when the balance control is then properly adjusted.

Though AR doesn't mention it, even the tone control settings can be equalized (one channel with respect to the other) by means of this feature, thus insuring exact equality of gain and frequency response for both channels. Of course, the feature is useless if non-identical loudspeakers are used in your system, but it will still allow you to balance all signal input sources quickly and precisely.

As mentioned earlier, the front panel trades some flexibility for simple operation. We could liken the AR amplifier to a sport's car, as compared to a family car. For example, a loudness compensation control is omitted. True, AR does mention the need for loudness compensation at lower-than-live listening levels in its manual, and advises the user to accomplish this compensation by means of the accurately calibrated tone controls. But it is certainly easier to depress a loudness "on"-"off" switch.

The most serious omission, in our view, is the absence of the very popular headphone jack. It's not as if AR's engineers forgot about it. They take the trouble to include a full-page brochure explaining how to hook up a set of stereo headphones. They even give a diagram on how to wire up an adapter so that one can switch from headphones to speaker and back again. But with stereo headphones being so popular today, why inconvenience users who choose to use them? Some minor omissions include absence of high and low frequency cut filters, and a power on-off switch divorced from volume controls.

Performance

We actually checked our calibrated resistors and meters before accepting the power readings of this amplifier. With an 8-ohm load, and with both channels driven, the output had to be cranked up to 60½ watts rms *per channel* (bettering by far the 50 claimed) before we reached the 0.5% total harmonic distortion (THD) figure. Amazingly, with a 4-ohm load, power output actually reached 90 watts rms per channel for 0.5% THD. The curves of Figs. 5 (IM and harmonic distortion) and 6 (power bandwidth) tell the full, incredible story of conservatism in power ratings. Frequency response, too, is better than claimed, measuring ± 1 dB from 15 Hz to 40 kHz. In short, every single measurement (including signal-to-noise, which was 62 dB and 78 dB for phono and high level inputs, respectively) exceeded published specifications, often by a *very* wide margin.

Listening Tests

Connecting high-quality, "acoustic suspension," low-efficiency speakers to the AR amplifier, FM, prerecorded tapes and discs were played. At no setting of the volume control could the slightest trace of distortion be detected, excepting, of course, when speaker cones began to travel beyond limits for which they were designed. A scope connected across the output terminals of

one channel and calibrated to read peak watts disclosed that the absolutely clean sound filling the room reached electrical outputs of 75 watts.

Performance quality was limited only by components external to the amplifier: loudspeaker systems and signal sources. The amplifier imparted no muddiness whatsoever. Attack time was minimal and precise (see tone bursts, Fig. 7, and square-wave response, Fig. 8). No amount of loud listening could induce the least bit of "fatigue"—a subtle measure of an amplifier's distortionless qualities. This will doubtlessly induce owners to play music "loud," thus obviating the need for tonal adjustments to compensate for the Fletcher-Munson effect at low listening levels.

In summary, let the prospective purchaser beware! If you plan to purchase the AR amplifier, you had best look to your loudspeaker systems and signal sources such as tuner, cartridge, turntable, and tape machine. The AR stereo amplifier will reveal many deficiencies in allied equipment that are hidden by lesser-quality amplifiers. For example, what was thought to be some form of low-frequency instability during quiet musical passages turned out to be a fair amount of low-frequency rumble (doubled and tripled by the loudspeakers, making it audible) emanating from our highly respected turntable. To combat this deficiency in auxiliary equipment, an "outboard" rumble filter with a cut-off frequency of about 30 Hz was installed. From that point on, nothing marred flawless reproduction. The variable cross-over tone controls enabled us to properly equalize some older recordings (pre-RIAA) which we prize for their dynamic range and recording quality.

In our estimation, the AR stereo integrated amplifier has no peer in its price category insofar as performance is concerned. And it outperforms most units of its type that cost much more than it does. The only area where it falls down is in providing operating frills such as a stereo headphone jack, a rumble filter, and a loudness control, among others. The need for these can be circumvented, of course, but it would be a minor nuisance to do so. This is an insignificant deterrent to one who wishes to own a magnificant piece of equipment, however. For where else can you get an integrated amplifier at $225 that could flaunt 150 watts of music power (if AR wanted to use music power ratings instead of rms power ratings) with such immaculate amplifying ability? At this writing, AR has wrapped up this class for themselves.

Check Reader Service No. 54

Garrard Synchro-Lab 95 Automatic Turntable

The Garrard line of automatic turntables over the past few years has employed the Volkswagen philosophy of incorporating advances into its machines without changing physical appearances (or model numbers, in this instance). However, there comes a time when the improvements—and the requirements—outgrow the earlier models, and a new unit is born.

Such is the case with the SL-95, the current Garrard "top-of-the-line" unit. Mounted in the usual fashion on a stamped steel base plate measuring 12⅜ x 14 in. and supported on four damped spring mounts, the unit is literally full of innovations.

To begin with, a new "Synchro-Lab" motor is used to maintain a constant speed over a wide range of line voltages, and yet still have sufficient power to insure a fast start when first turned on. The motor is a combination of an induction motor—such as are used in most turntables—and a synchronous section. While a *large* synchronous motor can serve satisfactorily for both starting and running, this is an uneconomical solution, since the synchronous motor is expensive to build, and if it is to have sufficient power, it becomes relatively heavy. By combining the two sections, sufficient starting torque is provided, and in addition the advantages of the synchronous motor are retained. These advantages are quite well known, but to the novice, there is no harm in restating them. This type of motor has the advantage of running at a speed which is entirely dependent on the *frequency* of the line power rather than on the *voltage* of the supply. In many localities there is likely to be a variation in the line voltage during the day, yet all—or nearly all—domestic electric power is maintained at an exact *frequency* of 60 Hz/sec so that electric clocks, which use small synchronous motors, will keep exact time.

Fig. 1—Garrard's top-of-the-line SL-95. "automatic transcription turntable"

Old timers will remember the Crocker-Wheeler motor which was used in early motion picture theatres in the Western Electric 208A Non-Synchronous Reproducer Sets to provide sound during intermissions or whenever sound was being presented to the audience without originating on the sound track of the film itself or from a synchronized Vitaphone record. These Reproducer Sets consisted of a heavy—35-pound—turntable/motor which used an induction disc section to bring the turntable up to speed and a synchronous section to hold the speed to the desider 78.26 rpm. These motors were superb for their purpose, and many an early hi-fi buff secured one of them for his record playing facility. They did have one disadvantage for those days—they had a strong hum field which practically ruled out magnetic pickups.

Garrard has adopted a similar arrangement for the SL-95 motor (which is also used on the SL-75, SL-65, and SL-55) and it performs just as well as claimed. Over a voltage range from our available 140 down to 35, the turntable speed remained constant, and while playing a piano record, we varied the line voltage from maximum down to 35 volts with nary a wow. This is an important consideration in the choice of a turntable.

The drive method consists of a stepped motor pulley and an idler.

Another feature is the tone arm and its miscellaneous advantages. In the

Fig. 2—Closeup of tone arm shows adjustable sliding counterweight (rear of tone arm), calibrated stylus-force gauge (circular dial underneath tone arm) and anti-skating control (foreground).

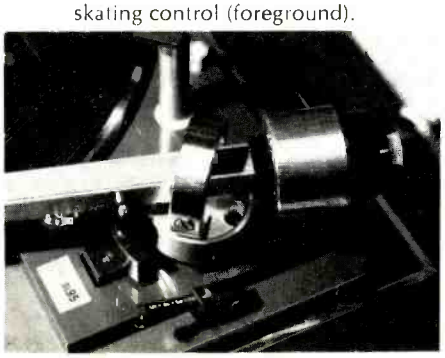


Fig. 3—Garrard's record platform rises into position for automatic play when the button next to it is pressed. The platform is retracted out of the way for convenient manual use.

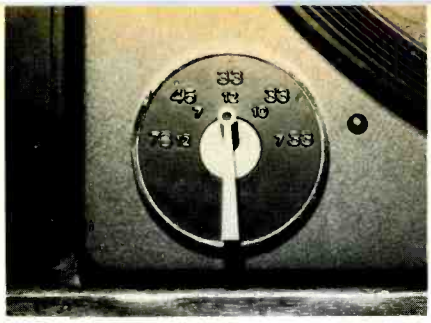


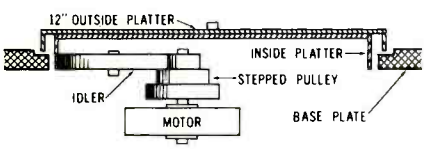
Fig. 4—Combined speed and record-size selector. (The SL-95 has 33⅓ rpm, 45 rpm and 78 rpm speeds.)

Fig. 5—Combined manual-cueing-pause control is shown at left; automatic control lever at right.

first place, it is constructed of a combination of a low-resonance wood—afrormosia, they call it—and an aluminum frame. It is light, and without apparent resonance in the audible spectrum. The head is integral with the arm, and the cartridge is mounted on a slide which slips into the head readily. The counterbalance permits the use of cartridges ranging in weight from 0 to 22 grams — yes, the arm *will* balance with no cartridge installed—which covers the entire current range of cartridge weights which extends from 1.5 to 18.5 grams. The stylus force is adjustable by a small dial on the underside of the arm from 0 to 5½ grams. (See Fig. 2). This dial is calibrated in ½-gram divisions, and further provided with ¼-gram click stops. At the left of the arm pivot is a record platform which is used for automatic playing. The platform can be depressed for manual playing simply by pressing down on its top; it rises by depressing a white button adjacent to the base of the platform.

Anti-skating correction is provided by a small arm which carries a sliding weight over a calibrated scale. The arm

Fig. 6—Dual platter construction is illustrated, with a 12-in. aluminum turntable platter and a 10¼-in. drive section. The entire platter assembly weighs 3¼ lbs.



rises as the arm moves toward the center of the record, thus compensating for the lesser amount of correction needed toward the center of the disc. This type of anti-skating compensation maintains a fairly correct force because of the reduction of the length of the lever arm as the arm moves across the record. At the outside where the most correction is needed, the lever arm is longest. At the center, it is shortest, as it should be to reduce the amount of corrective force applied.

The SL-95 operates at three speeds, and the speed and record diameter are set by a single selector lever. This lever is set at one of five positions—12-in. 78, 7-in. 45, and 12-, 10-, and 7-in. 33⅓. Thus it will not intermix 12- and 10-in. records, but this is of little importance since the 10-in. record is now a rarity, and the absence of the interchangeable automatic play should be missed only by the rare individual who has a large collection which contains many records of both diameters. It will also be noted that the SL-95 does not operate at 16⅔ rpm, but few users have them anyhow.

The operating controls are centered at the right front of the base plate, and consist of two selector levers similar in appearance to the speed/diameter selector. One lever is for automatic operation, and starts, rejects, and stops the automatic operation. The other lever is for manual operation, and has three positions—PLAY, LIFT, and STOP. When the lever is thrown to LIFT, the arm rises and remains up until the lever is returned to the PLAY position, when the arm lowers to a position about four grooves ahead of where it lifted, thus replaying a few seconds of the record. The STOP position returns the arm to its rest and stops the motor, with the idler retracted from the motor pulley. A small lever at the base of the arm rest serves to lock the arm to the post. The usual locking screws are provided to hold the unit solidly against the motor board while the turntable is being transported.

The turntable mat is provided with grooves at the three set-down positions so that in case the arm is lowered to the turntable when no record is there, the stylus simply rides in the grooves, rather then being thrown off the platter and possibly damaging the stylus.

The turntable platter is of stamped aluminum, and is relatively "dead" so as to transmit no resonances to the stylus. It is composed of two separate sections, with the inner one serving as the driven surface which is contacted by the idler.

The platter consists of two "pans" which are attached to a die-cast center section which contains the actuating pinion gear. The outside diameter is 12 in., and the inner driven pan is 10¼" in diameter. This is the rim which is driven by the idler wheel making simultaneous contact between the motor pulley and the rim of the inner "pan." The entire platter assembly weighs 3¼ lbs. The reason for the double-pan construction is that the visible portion is outside the base plate, whereas the deeper section of the driven pan provides for the up and down movement of the idler wheel.

A base is available as an accessory when the unit is to be used on a table or shelf. This base is a molded plastic simulating ebony and walnut, with silver trim. Another similar unit is available with a lighted rocker switch mounted on the front apron to permit "Power-Matic" operation so as to turn off the entire system when the last record is finished. Both bases are also available with molded accessory trays which accommodate both long and short spindles and the 45 adapter. The cover keeps the accessories dust-free, yet immediately accessible.

The automatic spindle permits handling six records automatically, with gentle changing. The single-play spindle is in two parts—the upper section rotates with the record.

Performance

Measured cycling time for the SL-95 shows that set-down occurs 10 sec. after actuating the start lever, and that record changing takes only 14 sec. from the last note on one record to the first note on the next. This is relatively fast for 33⅓ records, but is exceeded at 45 by only three seconds, and by five at 78 rpm. At this higher speed, the arm action is rather abrupt, and the stylus is apt to bounce once or twice on set-down.

Tone arm resonance is below 10 Hz. Tracking error does not exceed 1.5% at maximum and minimum diameters.

Changing is initiated by the run-in groove, and is effective down to stylus forces as low as ½ gram. Suitable operation is obtained with stylus forces of as low as 1 gram (using a Shure V-15 cartridge) although for optimum performance, a force of 1½ gms. is recommended.

Rumble was measured at 32 dB below 3.54 cm/sec on stereo, and 36 dB below on mono, with the principal energy content in the vicinity of 3 Hz, which corresponds to the rotational speed of the idler, which is approximately 170 rpm. Wow and flutter were between 0.20 and 0.25 per cent, all occurring in the frequency range from 0.5 to 6 Hz, since the range from 6 to 500 Hz showed practically no flutter at all. In all, the performance is quite acceptable for any but truly professional studio equipment. The SL-95 is priced at $129.95, and the co-ordinated base at $5.95. The Power-Matic base is $15.95 with the accessory tray, $14.95 without. A dust cover of clear styrene is available at $5.95.

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AUDIO ENGINEERING SOCIETY

34th Convention

Place: Hollywood Roosevelt Hotel, Los Angeles, Calif.

Date: April 29 (Monday) through May 2 (Thursday)

Technical Sessions: 9:30 a.m., 1:30 p.m., 7:30 p.m.
(no 7:30 p.m. session on May 1)

Equipment Exhibition: April 20-April 30: 1:00 p.m.—9:00 p.m.
May 1: 1:00 p.m.—5:00 p.m. May 2: 1:00 p.m.—5:00 p.m.

Awards Banquet: May 1, 7:30 p.m.

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Motorola Semiconductor

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John C. Sinclair, Zenith Radio Corp.

A Self-Contained Condenser Microphone Using a Solid-Electrolyte Battery for Permanent Polarization
Alan Dauger and Charles F. Swisher, Vega Electronics Corporation

The "BI-FET" and Its Circuit Application.
David R. Pryce, Amperex Electronics Corp.

The Audio Behavior of Integrated MOS Devices.
James F. Kane, Motorola, Inc.

AMPLIFIERS, GENERAL

Chairman: Jim Noble
Altec Lansing

Frequency Controlled AGC in Small-signal Audio Amplifiers
Wm. Greenbaum and Iraj Gharib, Zenith Radio, Hearing Aid Div.

New Solid-State Amplifier for the Recording Industry
Vern Bushway, RCA West Coast Operations

Modular Transistorized Volume-limiting Amplifier
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TRANSDUCERS SESSION

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James B. Lansing Sound, Inc.

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James S. Arnold and Vincent Salmon, Stanford Research Institute.

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G. M. Sessler and J. E. West, Bell Telephone Laboratories

Electret Condenser Microphones of High Quality and Reliability
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Capitol Records

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Edward R. Hansen, North American Philips Co., Inc.

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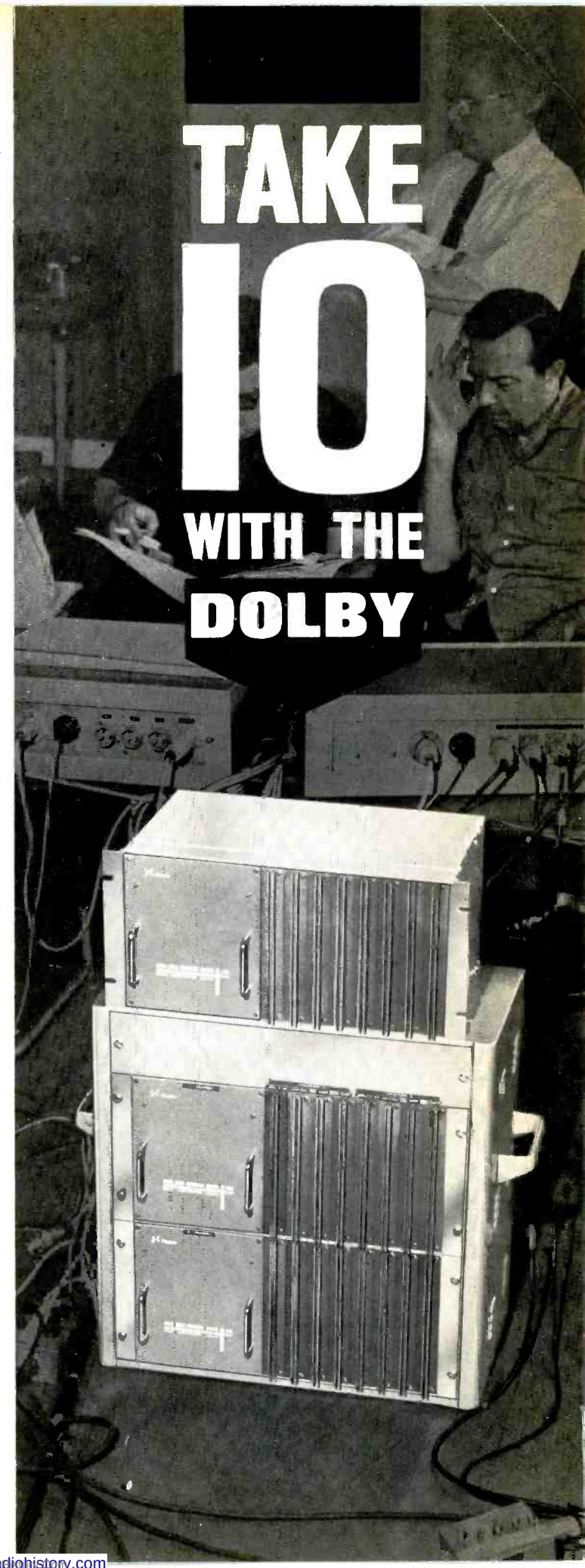
PLUS generally cleaner, more transparent recordings—with unaltered frequency response and signal dynamics.

Recording engineers and musical directors are so enthusiastic about the Dolby S/N Stretcher system that the network of users is growing at an astonishing rate—on an international scale. Master tapes made with the system now fly regularly between the major recording centers of the world, such as New York, London, Rome, and Vienna.

The basic principle of the system is simple. Low-level signals are amplified in four independent frequency bands during recording and attenuated in a complementary way during playback—recording noises being reduced in the process. High-level signals are unaffected by this procedure (no distortion or overshooting), and the symmetrical design of the circuitry ensures that the signal is restored *exactly* in all details—high-level *and* low-level, amplitudes *and* phases. The result is a noise reduction system with ideal characteristics—perfect signal handling capability which can pass any line-in, line-out A-B test, and a genuine 10dB noise reduction.

In short, the Dolby system offers an entirely new area of sound for the recording engineer. Get to know more about it fast by writing directly to Dolby Laboratories or contacting your nearest agent.



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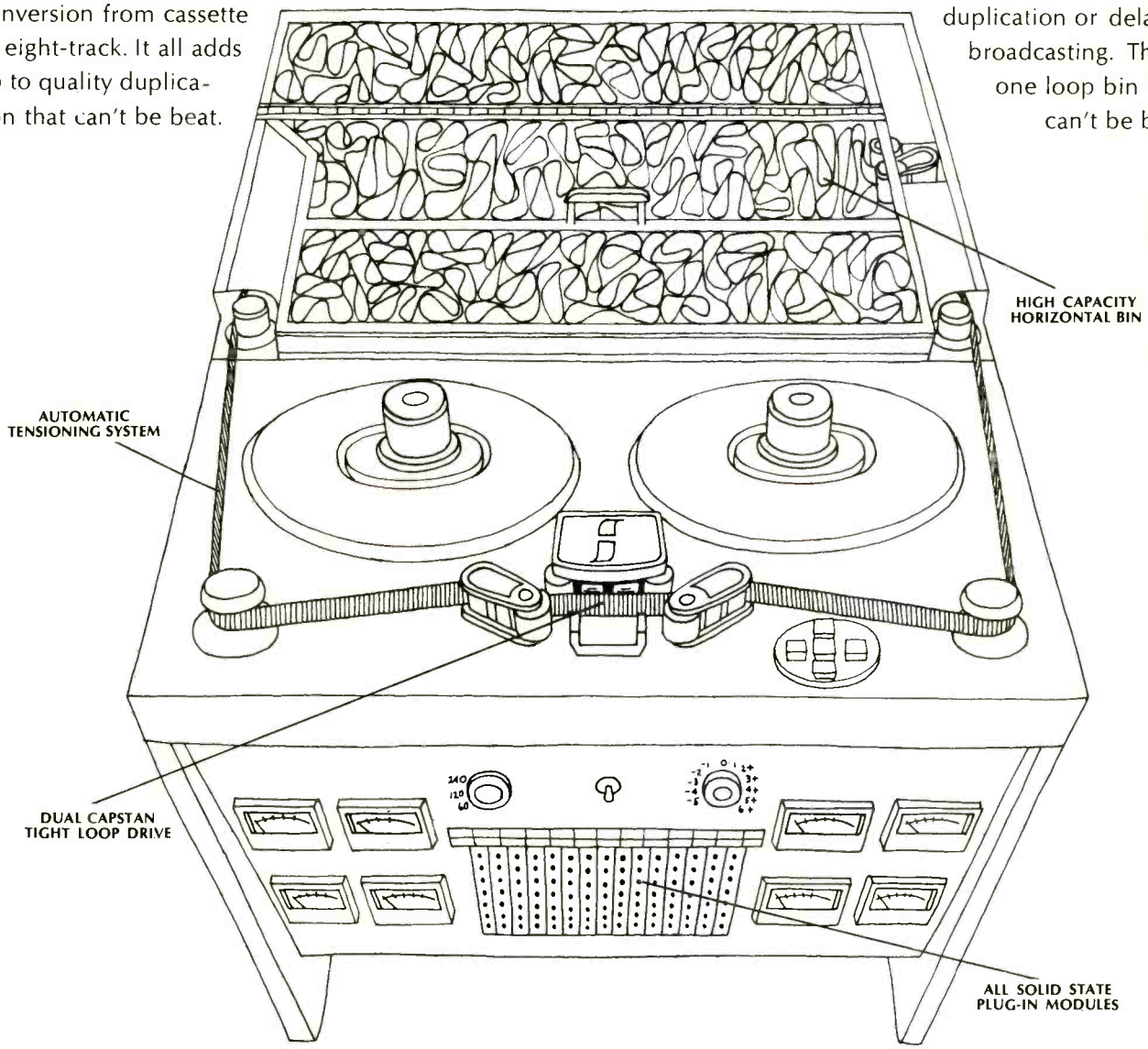

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Classical Record Reviews

EDWARD TATNALL CANBY

A Stravinsky Harvest

Stravinsky: Firebird Suite. Tchaikowsky: Marche Slave; Mussorgsky: Night on a Bald Mountain. London Symphony Orchestra, Stokowski.
London SPC 21026 stereo

Got to keep our eyes on these Stokowski *Phase 4* spectaculars. In a sense they're corny, and the music is hardly chosen for the highbrow taste. (Not as of 1968, anyhow, though some of this music was very far out in its early days.) But we can almost always expect something special from the old Maestro, who has been jolting musical listeners out of a million-odd seats ever since 1912.

In this collection of chestnuts the radioactive item is "Night on a Bald Mountain," as revised by none other than Leopold Stokowski. In true modern style he says that, in Russia, soon after the Revolution, "the authorities permitted me to photograph the original score, which I have in my library." ("This after he has just told us there were four different unfinished versions.) Aha, the old musicologist! But no. "The version we have performed is based on the Original of Moussorgsky with certain changes and additions of Rimsky-Korsakov." Then he adds, casually, "I have re-orchestrated the whole composition because of passages which were out of balance and therefore unclear." Some musicology!

If you think you know the "Night," then you'd better try here. Stokowski's version of it is a terrific spectacular and, indeed, it does seem to bring out a great deal of the chiller-diller horror that has been missing at least since those four original uncompleted versions. A *tour de force* for every hi-fi set, and a musical revaluation, too.

Nor is the tired old "Marche Slave" tired here. I haven't ever enjoyed it as much before. Instead of the usual heavy, ponderous doom-like sound, this performance breezes along with the freshness of a Sousa march, or perhaps a ballet of very lively elephants. Lovely.

Only the "Firebird" Suite seems somewhat tired. It has been a Stokowski set piece for too many years, I guess. His version still, somehow, manages to make it into a ripe old Romantic piece, where many later conductors stress its modern overtones.

Phase 4 is spectacular but not, in these days, unusual. Rather beefed-up bass, I would say, at least via our RIAA playback. Probably intentional.

Performances: A— to B— *Sound:* B

Stravinsky Conducts Four Great Ballets (Apollo, The Fairy's Kiss, Pulcinella, Orpheus). Columbia, Chicago Symphony Orchestras, vocal soloists.
Columbia D3S 761 (3) stereo

Time was when we knew only the early Stravinsky ballet scores—"Fire Bird," "Petrouchka." These middle and late scores are now easy on almost any ear, no longer sounding very "modern"—and they are composer-authentic performances out of Columbia's vast collection, helpfully assembled in this big album.

All the recordings date from recent years, done in stereo of Columbia's moderately elaborate sort. Most of us will find it highly satisfactory for this music, with more of a close-up stage sound than a so-called concert-hall effect. Why not? It isn't concert music, after all. Music for the ballet theatre, which is something else again.

Occasional vocal soloists appear in these complete versions; Stravinsky has often used them in his stage-type works.

Performance: A— *Sound:* B+

Stravinsky Conducts Symphony in E Flat, Op. 1. Columbia Symphony Orch.
Columbia MS 6989 stereo

A superb parlor-game record here. Try it on your musically simple-minded friends! They'll think it is Tchaikowsky or Rimsky-K., or any one of a dozen others of that period. It is one of the composer's very earliest extant works and lots of fun to hear today. It's done here with just enough wit and indulgence, by the old man himself, to point up both the youthful bombast of the music and the undeniable genius of the very young composer who wrote it—1905-07.

The Columbia styling of the long-continued Stravinsky - by - Stravinsky series is remarkably consistent in sound and engineering; though dates range over quite a spell, the time factor is not unduly important, beyond the major breaks occasioned by LP, then stereo. This would seem to be a relatively brand-new tape.

Performance: A— *Sound:* B+

Stravinsky: L'Histoire du Soldat. Complete, in French and English versions. Madeleine Milhaud, Jean-Pierre Aumont, Martial Singher; Instr. Ens. conducted by Stokowski.
Vanguard VSD 711/6 (2) stereo

This album brought a number of interesting innovations, both artistically and technically. It is, first, a high-level-type performance with major imported stars for the speaking parts and the direction. And it is done twice—a version in the original French (spoken, against the music) and in a translation into English. In addition, this was one of the first major "Dolby-ized" releases in the U. S. and it shows, in ultra-smooth, quiet-background sound.

Presumably, simple tape work put the two languages, each on its own LP, against an identical musical performance. The speakers are, of course, French in their native language and that version is decidedly the best. Aesthetic uniformity and consistency made it reasonable to do the English with the same speakers; but their accents are very decided, though the English is perfectly intelligible. And on its own the English version is best as a sort of audible translation of the French. Not a bad idea, come to think of it.

Performance: A— *Sound:* A—

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Classical Record Reviews (continued)

Mozart Festival

Mozart In London (The Odyssey of the Young Mozart–Vol. I). Frankfurt Ch. Orch., Koppenburg; Karl Engel, pf.
Odyssey 32 16 0164 stereo

The start of an interesting series on Columbia's budget label, musically outlining the famous virtuoso journeys of the child prodigy Mozart, beginning here at the age of eight, with the composer's only trip to London.

What music—at eight? Plenty. The most profound influence on the small child was J. S. Bach's youngest son, Johann Christian, often called "the London Bach" (and at this point, in 1764, already well into middle age). The small-boy Mozart worshipped him, and met him as a musical equal, too. On this record we have first a typical J. C. Bach work, a Sinfonia in B flat—all airy fluff and expert musical "business." Then a parallel piece, a Sinfonia by Mozart! At eight, he wrote it in London to keep himself busy when Papa, being sick, wouldn't let him practice out loud at the keyboard. Astonishing.

Side 2 gives us two of the often-mentioned but rarely-heard early "Mozart" piano concerti, which were, at age 15, Mozart's very ingeniously contrived arrangements, for his own use, of a number of keyboard sonatas by his friend and mentor, Bach. They are strictly portable concerti, set for the absolute minimum force of musicians likely to be available in small provincial towns (three—with Mozart at the keyboard).

Of course, given larger available forces, they could be nicely filled out, as they are in this performance.

Odyssey's European orchestra is sincere and musical, if not always very precise. Karl Engel's piano is rather too large and too close for this music, notably in the first little concerto on Side 2. Unaccountably, it sounds better in the second concerto.

Performance: B *Sound:* B

Mozart: Don Giovanni. Nilsson, Arroyo, Grist, Fischer-Dieskau, Plagello, Talvela, Schreier, Mariotti, Czech Choir of Prague, Czech Nat. Theatre Orch., Bohm.
Deutsche Grammophon 139260/63 (4) stereo

What a sound! I had not got around to a big Mozart opera on records for some time when I got to this one, and what D-G has done here in stereo terms is enough to make your hair stand on end.

I would say that the sheer sound on these eight sides, in terms of stereo spread and space, of clarity and brilliance, immediacy and, above all, in dynamic range, beats any sound I have yet heard—though I assume D-G has the same on tap for many another recording.

Especially, the dynamic range is astonishing. You'll notice it the instant you put down the stylus for the commanding tones of the overture—the velvet silence that accompanies the soft passages (which, of course, you will turn up higher, without thinking), then the sudden, unbelievable impact of the loud tones, so much louder than you expect. Quite fantastic, Dolby or no Dolby.

D-G, unlike some other producers of opera in stereo, does not feel inclined to place its voices back aways, in the orchestra, as per actual stage opera. (In some recordings they almost disappear at times.) Here, they are very much up front and *very* potent. Impressive sounds, all right, and never a trace of distortion, no matter how huge the vocal power. But in a way this becomes frustrating—for the orchestral sound is so splendid that you want to hear it loud too; and when you turn it up, the voices blow you out of your seat. Can't have both. So you settle for the right vocal volume and let the orchestra find its place as a proper accompaniment. (In the end, this is musically right, in spite of all temptations to higher wattage.)

The international-type performance, recorded in Prague where the opera was first heard 180 years ago, is first rate, but I'd say not quite tops. There are wonderful voices here, every one of them musical and accurate. But they are very big. To an extent, the singing is uneconomical for such a taut, sophisticated drama, with so many subtle overtones of tragedy, cynicism and humor. Too much gorgeous singing, not quite enough musical acting for the proper lightning-fast contrasts and rapid-fire action.

Surprise! The famed Wagnerian singer Birgit Nilsson is the best of them all here as the much-wronged Donna Anna. Wouldn't have believed it. The others are good, but not ideal. Even Dietrich Fischer-Dieskau, finest baritone around today, isn't really the type for the devilishly amoral Don. Too serious, too sincere. (If you want to see what I mean, try the all-time top recording, the pre-war Glyndebourne production with John Brownlee.) But even so, it is a pleasure just to listen to these superb vocal instruments, in so fine a recording.

Performance: B *Sound:* A

Mozart: Serenade for 13 Wind Instruments, K. 361. Musica Aeterna Wind Ensemble, Waldman.
Decca DL 710150 stereo

I'll stick my neck out. This is one of the finest records, in its category, to come out of New York city in many years, in an all-around sense—both musically and technically.

In the international music market, New York is relatively provincial. We think we're pretty good, of course; but who else does? In most musical areas, New York either benefits from visiting firemen, the great performers of other places, or puts on second-best versions on its own steam. This—of course—referring to "classical" music; other sorts thrive beautifully in NYC.

And so a man like Frederic Waldman, possessing all the sophistication of a central European heritage, yet able to lead those tough babies, the typical New York professionals out of Local 802, able to inspire them straight out of their habitual cynicism, is really somebody. Frederic Waldman is such a conductor.

The Mozart Serenade on this record has often been played and recorded: this is just about the best version I ever hope to hear—and out of New York! It is intense, dedicated, marvelously well rehearsed and utterly expressive. The spirit of the piece—a wind Serenade for *thirteen* instruments (not the normal four or five) and, under its stylishly light exterior, a profoundly serious work is perfectly understood.

Moreover, the combined woodwind sound (with two of those rare and interesting bass clarinets, the basset horn) is recorded with absolutely superb quality. The ensemble is full and round and impressive. Each of the winds instruments seems positively to breathe its own special woodwind quality, as well. An extraordinarily *musical* hi-fi sound.

Performance: A *Sound:* A

Mozart: Wind Serenade in E Flat, K. 375 (original version). J. Myslivecek: Two Octets. Musica Viva Ensemble, Bolle.
Monitor MCS(C) 2126 stereo

Here is the relatively familiar Mozart wind Serenade in E Flat in its original form as a wind sextet, a first recording. The usual version, revised, is an octet with two added oboes, a much richer texture for the music; but the sextet version has interest on its own, with the two clarinets doing double the work, minus the oboes.

Here also, on Side 2, is a new "unknown" composer and a remarkably fluent musician as well as friend of the Mozart family. Josef Mysliveck was, alas, saddled with an unpronounceable Czech name, and he was a professional miller, as well. But musical instincts prevailed and he wrote some of the most lucidly expressive music of the time—short of Mozart himself and a very few others. The two wind Octets played here require much more virtuosity, in all the parts, than the Mozart work, but the writing is so skillful (and the playing) that the whole seems quite effortless.

Monitor's excellent home-based Collector's Series still plugs "compatible" stereo, a slightly dead issue now that everybody says his stereo is playable on mono equipment. No matter — this stereo sounds as good as any, compatible or no. The tapes are by the well-versed David Hancock, New York musician and solo recording engineer.

Performance: A *Sound:* B+

Mozart: Symphonies No. 39 in E Flat, No. 41 in C ("Jupiter"). Japan Philharmonic, Peter Magg.
Crossroads 22 16 0126 stereo

Two of the great last three symphonies of Mozart (straddling the well-known G Minor, No. 40) in a curious performance, Japanese but led by an authentic Westerner. The styling is thus outwardly correct, in a middle-European tradition; warm, somewhat heavy and a lot less intense than comparable U. S. performances, which tend to "high voltage." But the Japanese—at least to my ear—do not hear many important subtleties in the music. They play accurately but, so to speak, musically deadpan. OK unless your ear is better than theirs.

Crossroads began as an all-Czech operation, via Epic and out of CBS but sourced exclusively from the Czech Supraphon label. But evidently Supraphon itself sometimes gets out of Prague. Or was the Japanese orchestra visiting there on tour? In these times, anything can happen — at least on records.

The recorded sound is a bit bottom-heavy and seems very slightly distorted in the louder parts. Equalization of foreign-made tape is still a serious problem for us. It's only too easy to follow the rules—and yet come out with a wrong sound.

Performance: B— *Sound:* B—

Interesting Miscellany

Borodin: Symphony No. 2 in B Minor; On the Steppes of Central Asia.
Tchaikowsky: Romeo and Juliet. Saxon State Orch., Sanderling.
Heliodor HS 25061 stereo

This ought to be a real bargain—excellent sound, out of Deutsche Grammophon, and a brace of typical and well known Russian works of the late Romantic era. Alas, it isn't a bargain, even at the low Heliodor price.

Why? The music, technically played with accuracy, plods along didactically, unimaginatively, without a spark. Just notes—lots of them. The Borodin symphony, which is an absurd old war horse at best, nevertheless can be impressive if done with the right swashbuckling drama. Here, it is unbeatably dull. Dreadful *Romeo and Juliet* is somewhat better but only because the music is intrinsically more meaningful. It's not a good version, considering the manifold competition available.

Performance: C *Sound:* B—

Brahms: Serenade No. 1 in D, Op. 11. The Chamber Symphony of Philadelphia, Brusilow.
RCA Victor LSC 2976 stereo

This attractive recording of the ever-lovely Brahms Serenade (one of two, his first informal works for orchestra) seems to have been a herald of things to come; shortly after its release the official announcement burst upon us that the Philadelphia Orchestra was returning from Columbia to RCA Victor. Connections between the members of the big orchestra and this group are not specified but, shall we say, are likely.

The only problems at all with this recording are minor. The work, being fairly new to the players (it isn't performed too often), is in spots a tiny trace ragged in the ensemble. Not much. And the RCA recording, also perhaps newly arrived in Philadelphia, seems a bit distant and not well filled out acoustically. *Very* minor problems in view of the fresh, natural quality of the playing. The few recent recordings of the work have been musically inferior. This is a piece that all who enjoy Brahms should know well—it has been

a favorite of mine since I bought part of it on an ancient 78 rpm disc as a very youthful collector.

Performance: B+ *Sound:* B

Charles Ives Orchestral Works. (Robert Browning Overture, Circus Band March, Set for Theatre Orchestra, The Unanswered Question.) Royal Philharmonic Orchestra, Farberman.
Vanguard Cardinal VCS 10013 stereo

Charles Ives, America's rugged musical pioneer of the early part of this century, is at his most piquant for most modern ears in these orchestral works. (The vocal music and the piano and chamber works are more difficult, decidedly.) They remain outrageous in sound, provocative, howlingly dissonant, and yet old fashioned and highly American in a smalltown way—you can't help liking them. For beneath the deliberate shock, the clashings of three or four harmonies all at once, are gentle old hymn tunes, Fourth-of-July-style band music, unassuming stuff that is the essence of non-highbrow art.

The famed British orchestra would perhaps make its former chief operator, Sir Thomas Beecham, turn purple with astonishment, playing this music—but the orchestra plays it very well, with both accuracy and an appropriate reverence. Papa Ives, at last, is internationally recognized.

Vanguard's Cardinal recordings, like the Nonesuch Elektra series called Checkmate, are new original recordings, not reissues, and are priced a dollar above the low-priced level, still well below the "standard" expensive labels. Let's hope Vanguard is able to prosper in this venture; it is of a sort that fills a needed gap, between high-priced originals and low-priced reissues.

Performance: B+ *Sound:* B+

Liszt: Hungarian Portraits, Nos. 1-7; Valses Oubliées, Nos. 1-4; Polonaises Nos. 1-2. Edith Farnadi, piano.
Westminster WST 17127 stereo

Liszt's piano music is definitely coming back. Because, increasingly, we now can hear its extra-ordinarily experimental, progressive semi-atonal harmonies, where earlier generations merely noted the frilly frosting, the elaborate and difficult fingerwork, and called it musical tinsel. Tinsel—yes. But on a very solid tree.

There are unusual late Liszt works here, the gloomy and powerful Hungarian Portraits (of heroes out of the revolutions of 1848) and the strange little "Lost Waltzes." Only the Polonaises are of earlier and more conventional sound, though lovely enough on their own.

Edith Fernadi is one of those determined and hard-working pianists who do us immeasurable good simply by performing music that ought to be played. But there is a somewhat chilly impact in her otherwise impeccable finger work. Somehow, she does not feel the inner depths, only the outer. Not bad—just not tops in musical communication. She plays the notes with a great deal of power, which is enough to get their sense over to any ear.

Performance: B— *Sound:* B

Prokofieff: Symphony No. 4, Op. 47/112 (revised version). Moscow Radio Symphony Orch., Rozhdestvensky.
Melodiya-Angel SR 40040 stereo

The original Fourth was composed for the 50th anniversary of the Boston Symphony, back in 1930, in part out of themes from a ballet score, *The Prodigal Son.* It wasn't a success—too harsh and outspoken for those days; but it remained the composer's favorite and shortly after World War II he went back to do a rewrite, the present work.

It's good Prokofieff, combining the lean, strong ideas of his early period with the gentler, more harmonious orchestral style of his later days. It should please no end, if you know other Prokofieff, for this version is perhaps his definitive and best symphony; more solid of texture, if less "popular" in idiom, than the familiar Fifth. The new Russian performance does it proud. Recorded sound is excellent, the stereo full and alive though the hall sound is somewhat drier than we are accustomed to in the West.

Performance: A— *Sound:* B+

Rossini: The Complete Overtures. Orch. of the Accademia di Santa Cecilia, Previtali.
Everest 3186/2 (2) stereo

Gotta keep an eye on this Everest label and its dozens (so it seems) of associated labels. You never know what's coming next. This time it's a winner. The eleven overtures, familiar and unfamiliar (including all the usual ones—"Lone Ranger" theme and all) are played with an absolutely hair-raising accuracy and intensity, sheer Italian at its best. Every note is precise and perfect; every change of mood is etched like spring steel. Listen to the drum rolls of *La gazza ladra,* beginning side 4! One is so machine-gun loud that you'll jump a foot, the next so faint, so dramatic, that you'll instinctively crouch down, expecting the worst. . . . Such flashing-eyed intensity! Now, you can see where Toscanini got his style.

A fully modern recording, this, as is implied by the use of the senior (and most expensive) Everest label. List price, that is.

Just what is meant by "complete" I do not know, since Rossini composed almost 40 operas and we have eleven overtures. Do none of the others have them? I'm not going to investigate. More likely, the word just looks good on a record album cover. Or maybe it's the complete "famous" overtures? Who cares. It's a splendid album.

Performance: A— *Sound:* A—

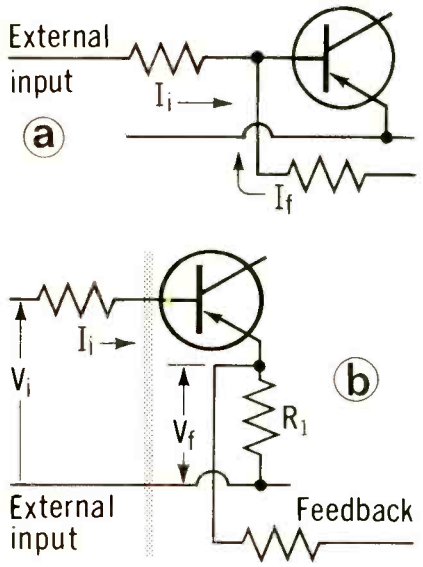
NEGATIVE FEEDBACK

(Continued from page 46)

But with the same kind of input circuit and shunt injection, the voltage received due to feedback depends quite critically on the external impedance connected. If this is a pure voltage source (with zero resistance) it will short-circuit the feedback (there will be none). The source resistance is, in effect, part of the feedback network under these circumstances.

With an input where the controlling parameter is current, such as a transistor, the situation changes a little (Fig. 9). Parallel combination is as simple as series combination is with the voltage-input variety. But

Fig. 9. Comparison of methods of input connection with a current input circuit, such as grounded emitter transistor: (a) shunt connection sums currents independent of external input impedance; (b) series connection makes the result dependent on both voltage and current from the external input (its internal impedence).



series injection, by developing a voltage across the emitter resistor, for example, modifies input current in a manner dependent on external source impedance.

We could labor through all the combinations of amplifier types and varieties of feedback connection, to cover all sixteen possibilities. But there are some other basic causes of complication that we want to show, to get a complete picture of the problem in analyzing what feedback really is and does.

(Continued next month)

Light Listening

STUART TRIFF
ROBERT SHERMAN

Theatre

How Now, Dow Jones—Marlyn Mason, Anthony Roberts, Brenda Vaccaro, Hiram Sherman and other members of the Broadway cast; Peter Howard, cond.
RCA Victor LOC/LSO-1142 ($5.79)

Elmer Bernstein, an admirable musician, and composer of several dozen film scores, including the memorable "The Man With the Golden Arm," comes a cropper with his first Broadway show, "How Now, Dow Jones." Max Shulman's musical, about the world of Wall Street, stars Marlyn Mason (a newcomer with an attractive singing voice) as a girl whose job it is to announce the latest Dow Jones averages over a loud-speaker system, and Brenda Vaccaro, as a tour guide of the financial district. Anthony Roberts and the veteran, Hiram Sherman, head the cast's male contingent.

With the exception of Miss Mason, the show is weak on singers, and weaker still on good songs. The best tunes in a rather dreary lot are a ballad called "Walk Away," "Gawk, Tousle and Shucks"—which despite its dreadful title, is a catchy number in pseudo-ragtime rhythm, and a march, "Step To the Rear." Helping not at all are Carolyn Leigh's lyrics, which work overtime trying to be chic and clever.

This ticket-tape tragedy notwithstanding, we need composers of Elmer Bernstein's talent and expertise in the Broadway theatre, and I hope we'll be hearing from him soon again. RCA Victor's sound is bright, vivid, and spacious, with good stereo effects. S.T.

Performance: B *Sound:* A

Sound Track

Camelot (motion-picture soundtrack)—Richard Harris, Vanessa Redgrave, and Franco Nero; chorus and orch./Alfred Newman.
Warner Bros. B/BS-1712 ($5.79)

I have not seen the film version of "Camelot" and am therefore unable to evaluate its cinematic achievements; but judging from the soundtrack recording, it is musically at least, a major disappointment. Frederick Loewe's score for the 1960 Broadway musical, based on T. H. White's "The Once and Future King," is his finest and most unappreciated achievement. In spite of a libretto which often lacked focus and direction, this sumptuously-mounted, beautifully-scored show deserved a longer run.

"Camelot," on screen was afforded the chance for a new lease-on-life . . . a second opportunity, unrealized, because of performers who cannot meet the vocal requirements of the songs they are asked to sing. Richard Harris' mannered, self-conscious performance runs the emotional gamut from whispering to shouting, as he blusters his way through the songs, without one iota of the understanding and poignancy Richard Burton, without much more voice, brought to them.

Vanessa Redgrave, as Guenevere, is off-pitch most of the time—assuming it *is* she. (I can't imagine hiring a vocal stand-in to sing so badly.) The songs, "C'est Moi" and "If Ever I Would Leave You" are competently, if not too expressively delivered by Franco Nero (or his singing counterpart?) as Lancelot.

Four numbers from the original score are omitted, including "Parade" —a charming, Prokofiev-like instrumental march. Alfred Newman, conducting a large orchestra, does his usual musicianly job. The recorded sound is good, if somewhat dry. Columbia has re-packaged their wonderful original-cast recording with Richard Burton, Julie Andrews and Robert Goulet, to coincide with the movie's release; but they needn't have bothered —there's no competition here! S.T.

Performance: C *Sound:* B

Beatle Magic

The Beatles: "Magical Mystery Tour."
Capitol (S) MAL-2835 ($5.79)

"Away in the sky, beyond the clouds, live 4 or 5 Magicians. By casting wonderful spells they turn the most ordinary coach trip into a MAGICAL MYSTERY TOUR. If you let yourself go, the Magicians will take you away to marvelous places." . . . so runs the written preamble introducing the latest Beatles L.P. And so, we are whisked off to a world of electronic gimmickry and outlandish stereo effects, which might be sub-titled "Alice In Beatle Land."

The six numbers that comprise the first side of this record were written for a television color film called "Magical Mystery Tour." The songs are the work of John Lennon and Paul McCartney, except for "Blue Jay Way" which was written by George Harrison; and "Flying," an instrumental credited to the quartet. The only tune I found appealing was "Your Mother Should Know," though the words are pure nonsense. Another song, "I Am a Walrus," is much more than nonsense—it's downright obnoxious, and ends with the effect of a radio receiving multiple signals.

The disc is filled out with five other L & M collaborations, all equally undistinguished. The last song, "All You Need Is Love," ends with what is probably the longest fade-out ever recorded; symbolic, perhaps, of the Beatles' reluctance to say farewell. I wish I could say the feeling was mutual.

The album contains a bound-in, 24-page booklet of photographs, mostly in color, along with the story of the "Magical Mystery Tour." The text is illustrated with drawings by Bob Gibson that are hilarious, and by far the most entertaining part of this pretentious enterprise. S.T.

Performance: B *Sound:* B

Instrumental Beatles Themes from Sgt. Pepper's Lonely Hearts Club Band—arranged and conducted by Peter Knight.
Mercury MG-21132/SR-61132 ($4.79)

These orchestral versions of the tunes from The Beatles' "Sgt. Pepper" album make very entertaining listening. Peter Knight, a British arranger and conductor, not usually associated with this type of material, turns out to be a very versatile musician indeed, as he leads a swinging orchestra of moderate size through these imaginatively-scored Lennon & McCartney inventions.

All but four of the songs were orchestrated by Knight, and I especially enjoyed his renditions of "With a Little Help From My Friends," "Lucy In the Sky with Diamonds," and "She's Leaving Home," with some beautiful passages for strings.

Stand-outs on the flip side, are Bob Leaper's arrangements of "When I'm Sixty-Four" . . . a charming piece of razz-ma-tazz, and "A Day In the Life" . . . the best track for demo purposes. The sound overall is excellent, with a clean and spacious stereo quality. S.T.

Performance: B+ *Sound:* B+

Encore: More of the Concert Sound of Henry Mancini
RCA Victor stereo LSP 3887 $4.79

Mancini is generally recognized as one of the more imaginative composers and arrangers in Hollywood, and his latest album gives further evidence of his prowess in both fields. Occasionally he gets a bit too cute for comfort (as when he intermixes the opening of Beethoven's Fifth with the intro to the Beatles' *A Hard Day's Night*), but the rest of the time his settings provide lush, relaxed listening, with just enough of a modern tang to keep things from getting maudlin. The arrangements are for large orchestra, with the strings carrying most of the freight, but solo stints by piano, flute, trumpets and saxophone adding plentiful dashes of instrumental color.

Most of the program is given over to movie music, compiled in three extended medleys, but Mancini starts out with what he calls a "Portrait of the Beatles." Whatever doubts might still be lingering that Lennon and McCartney have written some genuinely beautiful tunes, is removed by this fantasy, which includes *Michelle, Yesterday* and *This Bird Has Flown,* among others. "Foreign Film Festival" also has a lyric focus, with such attractive entries as the love songs from *Moulin Rouge, Black Orpheus* and *The Umbrellas of Cherbourg,* after which a Hollywood roundup takes a turn for the dramatic, with *Exodus, Man with the Golden Arm,* etc. In the final group, "Three by Mancini," the composer makes his recording debut as a pianist, playing *Charade, Days of Wine and Roses* and the inevitable *Moon River* with a smooth, fluid touch, if not a distinctively personal style. The stereo sound is spacious, clean and well-defined. R. S.

Performance: B+ *Sound:* A

Bob Dylan

Bob Dylan: "John Wesley Harding" and eleven other ballads. Bob Dylan (vocal, guitar, harmonica and piano); with Charles McCoy, bass and Kenny Buttrey, drums.
Columbia CL-2804/CS-9604 ($4.79)

Bob Dylan is a talented tunesmith, but as a singer, his appeal has always eluded me. On this much-ballyhooed, new disc of Dylan originals, the singing is more subdued than usual, with less hand-wringing torment and torture. The songs seem to straddle the fence, somewhere between Folk and Country & Western. The ballad of "John Wesley Harding," from which the album derives its title, is about a reputed friend of the poor, who travelled with a gun in each hand and never hurt an honest man. "The Ballad of Frankie Lee and Judas Priest" is a sagging saga that takes 5 minutes and 30 seconds to unfold and would try the patience of all but the staunchest Dylanites.

The obscure lyrics of all these songs are hardly made more intelligible by the singer's slurring, monochromatic delivery. Well, I suppose you either get the Dylan "message" or you don't . . . and those of us who don't, are more than likely to feel that the man is putting us on. Columbia's stereo effects are predictable with guitar and bass on the left, drums on the right, and Dylan, front and center. S.T.

Performance: B *Sound:* B

JAZZ & BLUES

BERTRAM STANLEIGH

DOCUMENTING FOLK MUSIC with actual field recordings has been going on for very nearly as long as the gramophone has been extant. Bartok and Kodaly made early documents of this type in Hungary, and Percy Grainger carried out similar field recording projects in the British Isles. In the United States, important work was done in the Thirties and Forties by the Lomaxes and in the Fifties by Frederic Ramsey, Jr. and several others. But until the development of the first professional, lightweight portable tape recorders in the late Fifties, quality of sound was rather grim and highly variable.

When the Nagra, a compact tape unit whose specifications compared favorably with studio recorders, came on the scene, there was reason to hope that the situation would change. This machine not only operated from a battery pack, it also provided the necessary current for a condenser microphone. With it, the field recordist could collect performances in remote regions lacking power lines, and the results, as demonstrated by some pioneering location recordings made by Emory Cook in 1956 or 1957, could be every bit as fine as what could be done in a studio. It gave one reason to hope that the folklorist would soon be turning out platters that could be enjoyed rather than studied. But a sampling of some of the recent releases of field recordings makes it clear that there is not much technical improvement between work being done today and that accomplished on old Library of Congress discs.

Not all of the blame can be placed on the failure of field recordists to utilize the fine equipment available to them today. Professional sound recording equipment is not likely to deliver truly professional results unless it is handled by knowledgeable sound engineers. And the men who comb our southland for new songs and singers are hardly trained recordists. There are a host of problems, even when skilled engineers do the recording. Acoustics are either too dead or too reverberant, background noise cannot be eliminated, and often the performers are so unused to recording that they do not know how to work in front of a microphone.

The best way around all of the problems is simply to transport the performers to the recording studio, and this is the general approach of BluesWay, one of the newer labels devoting its attention to folk blues. Its recent recording of Jimmy Reed (*Soulin'*, BluesWay Stereo BLS-6009 [$4.79]) is a perfect example of how splendid a blues recording can be when a fine singer gets together with a group of experienced musicians under the controlled conditions in a good studio. The Reed guitar, harmonica, and voice are all heard in proper balance as this vigorous performer delivers his message.

T-Bone Walker, the Texas blues singer, is heard on another studio recorded set (*Stormy Monday Blues*, BluesWay Stereo BLS-6008 [$4.79]). It features the same high-quality engineering as the Jimmy Reed platter, and a nine-man combo well matched to Walker's exhuberant style.

Blues recordings made in the field are offered by Arhoolie and Blues Classic, two small Berkeley, California firms run by Blues scholar-collector, Chris Strachwitz. They offer indifferent sound, but three recent releases are of particular interest both for their high musical quality and the light they focus on areas that have been only partially documented to date. *Blind James Campbell and his Nashville Street Band* (Arhoolie Mono F1015 [$4.98]) features a type of group that is rarely encountered in the South today, the blind street singer accompanied by a fiddle, guitar, and occasional bits of trumpet and tuba. The group's style combines jazz, blues, country fiddle, and gospel. In spite of its mediocre sound, this disc has moments that swing, surge, and explode.

Texas Blues, the Early '50s, (Blues Classic Mono 16 [$4.98]) offers thirteen songs sung by nine singers, among them Frankie Lee Sims, John Hogg, Texas Alexander, and Lightning Hopkins. Another collection, *Memphis and the Delta—1950s*, (Blues Classics Mono 15 [$4.98]) offers no less than 14 different singers in as many songs. Quality on this set ranges from fair to miserable, but the singers, who include Roosevelt Sykes and James Cotton, provide an interesting contrast in styles, and, in the one-man band of Joe Hill Louis, some real excitement. Æ

Reissues

Jimmy Rushing: Listen to the Blues
Vanguard Everyman Mono SRV 3007 ($2.50)

A welcome reissue on this low-price series of a fine blues disc that brought Rushing together with Pete Johnson, Lawrence Brown, and several of his old Benny Moten, Count Basie collaborators. For its age, the sound is fine.

Performance: A *Sound:* B

Esquire's All-American Hot Jazz
RCA Victor Mono LPV-544

A Vintage reissue of the special recordings made in 1946 of the winners of the Esquire Magazine poll, together with some Coleman Hawkins and Lucky Thomson waxings of the same period. Armstrong, Elligton, Hodges, Don Byas, Billy Strayhorn, Chubby Jackson, and many others are heard in waxings that included the Hodges, Byas, Strayhorn, Palmieri *Gone With the Wind.*

Performance: A to C *Sound:* B

Jelly Roll Morton: Mr. Jelly Lord
RCA Victor Mono LPV-546 ($4.79)

Sixteen Vintage series reissues, dating from 1926 to 1930, of group recordings that included such musicians as Johnny and Baby Dodds, Ward Pinkett, Bubber Miley, Johnny Hodges, Alber Nicholas, Omer Simeon, George Baquet, and Wilbur DeParis. The swagger and intensity of Morton's happiness permeates every groove of this skillfully transferred set.

Performance: A+ *Sound:* B

Jazz Veterans Score

Pee Wee Russell & Henry Red Allen: The College Concert
Impulse Stereo AS-9137 ($5.98)

Pairing veterans Pee Wee Russell and the late Henry Red Allen with three young contemporary jazzmen: Steve Kuhn, piano; Charlie Haden, bass; and Marty Morell, drums, has resulted in a fresh-sounding disc that demonstrates better than any other record the breadth of expressive imagination of Allen. His *Body and Soul* vocal is a fascinating commentary on his instrumental style.

Performance: A *Sound:* B

Latin Touch

Charlie Byrd: More Brazilian Byrd
Columbia Stereo CS 2692 ($4.79)

Swinging freely against the background of an orchestra under Tom Newsom, Charlie Boyd devotes most of his album to a new Brazilian rhythm with a 5/4 beat. Called the *Jequibau* (pronounced Zhak-ee-bough), it sounds like an ideal bit of exotica for either dancing or background.

Performance: A *Sound:* B

Willie Bobo: Juicy
Verve Stereo V6-8685 ($5.98)

The special flashy swagger that Willie Bobo imparts to his Latin percussion jazz-making is again in evidence as this drummer, composer, arranger steers his group through a dozen tunes that are well suited to the bouncy Bobo style. Included are *Knock on Wood, Mating Call, Mercy, Mercy, Mercy, Felicidad, Juicy, Ain't Too Proud to Beg, Music to Watch Girls By, Dreams, Dis-Advantages, Roots, Shing-A-Ling,* and Bobo's own *La Descarga del Bobo.* There's just a mite less of the jazz freedom in this group of performances than in his last couple of releases. Before heading out on his own, Bobo worked first as a Latin percussionist with Tito Puente and Mongo Santamaria, later he played jazz percussion with Cal Tjader. Whether this release indicates a trend toward a more popular performance style it's too soon to tell. It is clear that some form of evolution is in process, and that Willie will continue to bear watching.

Performance: A *Sound:* A

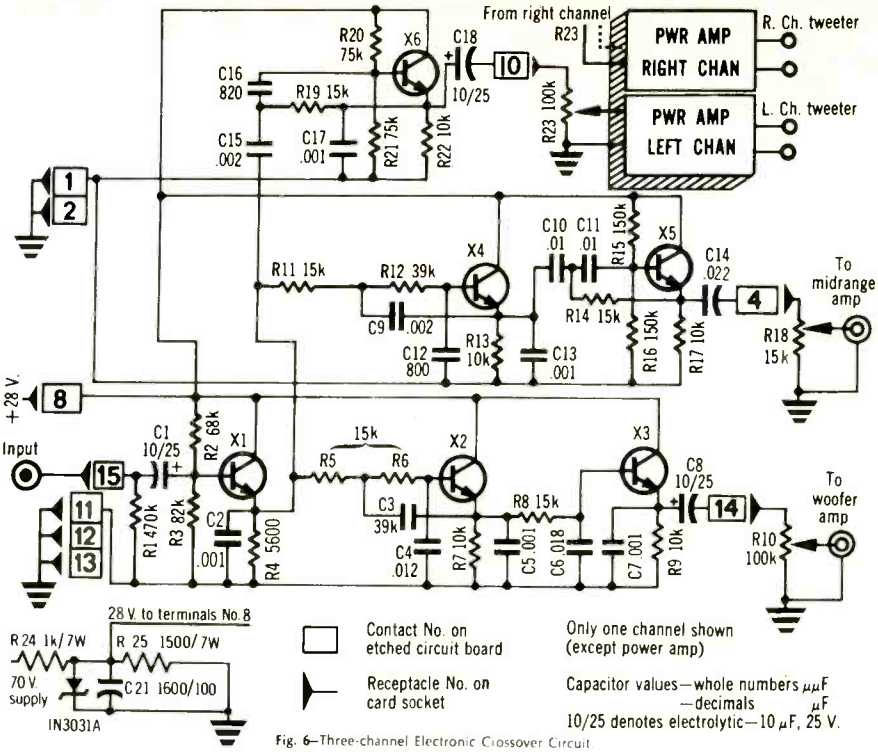


Fig. 6—Three-channel Electronic Crossover Circuit

Schematic of three-channel electronic crossover network (**Audio,** February 1968) incorporating corrections (see letters).

LETTERS

(Continued from page 10)

• Among a number of mistakes in the schematic, there is another in the calculations for the voltage divider. R24 and R25 cannot produce 28 volts if the two crossover circuits together draw 16 ma. *(We omitted the 30-V. Zener diode across C21 which is used in the original Acoustech XI with the PM preamp. With this in place, there is 28-V. across R25, although there is too much current through the Zener. R24 should be 1000 ohms.—Ed.)*

Please continue construction articles for those of us who still have, and plan to keep, separate tuners, preamps, and power amps.

GERALD BUCK
Madison, Wisconsin

• I have just read your article on the electronic crossover, and I have one suggestion: warn your readers that horn-loaded mid- and high-frequency units can be ruined when connected directly to power amplifiers, even when properly designed low-level crossover circuitry is used. Low-frequency transients generated by the power amplifier during turn-on and turn-off (especially transistorized units) may well be enough to damage a delicate diaphragm assembly.

The solution is to use a simple high-pass filter between the driver and the power amplifier. This can be designed so that it comes into effect at a lower frequency than the low-level crossover, and thus doesn't change the overall characteristics of the system. For example, if the low-level crossover is set at 500 Hz, a capacitor can be inserted in series with the high-frequency driver to attenuate the signal below 250-300 Hz.

G. L. AUGSPURGER
James B. Lansing Sound, Inc.
Los Angeles, Calif.

(The last suggestion covers a question we have often heard—but not yet experienced—about damaging tweeters and midrange drivers. We did introduce a 6-μF capacitor in the output circuit of the tweeter amplifier, it will be remembered. For a 500-Hz crossover, a 40-μF motor-starting capacitor would be ideal for a 16-ohm mid-frequency driver. The new schematic will answer most of our readers questions, and we hope that everyone who read the article will also see these comments and corrections.—Ed.)

• I am more excited about your electronic crossover project in the February issue of "Audio" than any other construction project you have printed in years.

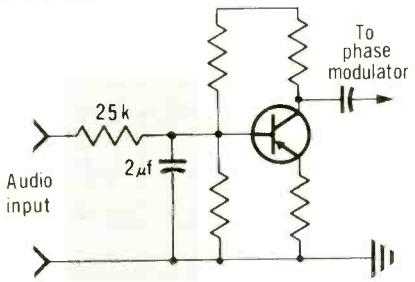
MARK A. SHARCK
Mechanicsburg, Pa.

ABZ's of FM

(Continued from page 34)

is basically a "line-of-sight" form of transmission, the higher the location of the antenna above sea level, the further the distance to the visible horizon. As an example, a transmitter having a power of 20 kW will be received with a signal strength of 1000 microvolts per meter at a distance of 32 miles if its transmitting antenna is 500 feet above sea level. Raising the antenna to an elevation of 1000 feet above sea level

Fig. 6—Corrective network attenuates high frequencies so that FM at output of the phase modulator is no longer a function of the audio modulating frequency.



would result in a signal strength of 1000 microvolts at a distance of about 43 miles from the transmitter site. At this elevation, reducing the power of the transmitter to 5 kW would reduce the 1000 microvolt "contour" to only about 35 miles.

Channel separation & interference

While the FCC generally assigns frequencies at least 800 kHz apart in the same city, objectionable interference is not considered to exist when the channel separation is 400 kHz or greater. Therefore, FM stations in the same general are often assigned to 400 kHz apart. Of course, the receiver's ability to separate stations only 400 kHz apart is extremely important, and recalls earlier discussions in this series concerning adjacent channel interference, capture ratio, and associated measurement which describe a receiver's ability to discriminate between one station and the next.

The FCC considers the necessary signal strength for satisfactory service in city areas to be 1000 microvolts/meter. In rural areas, far removed from highways (and associated noise produced by automotive ignition), 50 microvolts/meter of signal strngth is deemed adequate.

Signal *strength* in an area and signal *intensity* actually reaching your receiver may be two entirely different numbers unless you pay careful attention to antenna requirements.

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AKG D-24E Microphone, $145. Factory-overhauled 10/67. T. J. Immel, 1524D Spartan Village, E. Lansing, Mich. 48823. 517-355-3115.

DISC RECORDING EQUIPMENT: Cutterheads, Recording Amplifiers, and Lathes. New and used. From Rek-O-Kut to Scully. Send requirements. Wiegand Audio Labs, 221 Carton, Neptune, N. J. 07753.

SHACKMAN ELECTROSTATIC SPEAKERS. British. 180° dispersion. This mid-range treble can be used with any woofer. Brochure, reports, and prices sent on it and full-range systems manufactured in Canada. Olson's Audio House. Box 1075. Wetaskiwin, Alberta, Canada.

SCULLY Professional Tape Recorders, from 1 to 12 tracks, complete recording studios available in prewired console cabinets starting at $8,000.00. 70% financing. WIEGAND AUDIO LABORATORIES, 221 Carton, Neptune, N. J. 07753.

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REK-O-KUT Rondine Transcription table with Shure SME Arm—one or both—make offer. Harold Kuever, 1401 S. Boyle, St. Louis, Mo. 63110.

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CITATION "A" good condition. See AUDIO Profiles 10/62 and 4/63 $175.00 w/cabinet. Robert E. Raymond, 730 West Washington Ave., South Bend, Ind. 46601.

FREE! Send for money saving stereo catalog AM and lowest quotations on your individual component, tape recorder, or system requirements. Electronic Values, Inc., 200 West 20th St., New York, N. Y. 10011.

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CITATION "A," $100; "B," $125. HK F1000T Tuner, $90; 2—AR3s, $90 each. Albert Peloquin, 505 S. Birney, Bay City, Mich.

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CITATION "A", "II", IIIx, Pre-Amp, Amplifier, Tuner. Good cond. $325.00. Gary Kohnke, 3070 S. 54th St., Milwaukee, Wis. 53219.

TWO SYNCRON S-10 Condenser Microphones with wind screens. One year old, $210 each. Don Sherrill, 14598 Lorain Ave., Cleveland, Ohio.

AMPEX (300-2C, 300C, 354P, PR10-2, 601-2, MX10, 2-2010's) Rek-O-Kut disk cutter, Concertone 505, EV 665, Syncron, AU7a's, Altec 21D, Box 15058, Phoenix, Arizona.

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WANTED: used EMT echo chambers mono or stereo. Vanguard Records, 71 W. 23rd St., N. Y. C. 10010—212-255-7732 Ext. 34.

CONCERTONE 20/20 Recorder-Amplifier TWA-1. Eiskamp, 1185 Woodside, Eugene, Oregon 97401.

ALTEC LANSING Drivers (806A or 802D) and horn. State price & cond. J. Geyer, 2431 W. Hazelwood, Phoenix, Ariz.

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