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AUDIO

APRIL 1969 60¢

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April 1969 Vol. 52, No. 4

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AUDIO

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Number 67 in a series of discussions by Electro-Voice engineers

BENDING THE BEAM

JOHN R. GILLIOM
Chief Engineer, Loudspeakers

Because paging and PA speakers can't always be placed exactly where needed for best sound distribution, it sometimes seems desirable to alter the polar pattern of the speaker to meet specific requirements. Observation of installations in the field discloses a wide variety of methods employed to achieve asymmetrical sound distribution.

These "accessories" vary from small flaps mounted on the horn to large panels. Even an existing wall or ceiling has been used to modify the polar characteristics. Not all of these devices are completely effective, and a brief discussion of why may aid you in making your own experiments.

When an object is placed in the beam of a speaker, the sound striking this beam may do several things, depending on the size of the object relative to the wavelength of the sound. If the object is large with respect to wavelength (say 5 times as large) sound will reflect, much as light reflects from a similar surface. But if the object is small (perhaps ½ to 1 wavelength in size) sound will diffract around the object.

Now let us consider the case of a typical paging speaker. With a frequency response range of 250 to 13,000 Kz, it will produce wavelengths varying from 4 feet to 1 inch in length. Our deflector must take into account the entire range of wavelengths if we are to affect the polar pattern over more than a small portion of the sound spectrum.

For instance, if we were to place a 6" square panel at an angle in front of the speaker, it would act effectively as a reflector only for the frequencies at or above 2 or 3 kHz (and only if it were squarely in the center of the horn). Below this point, sound would begin to diffract around the panel. At some frequencies, sound intensities might well be higher *behind* the panel than at any other point due to this diffraction effect. At very low frequencies, the panel would have almost no measurable effect on the polar pattern.

The ability of sound to diffract or reflect—depending on the relative size of the surface with respect to wavelength—can be a useful tool in the design of sound equipment. But it can also be a trap for the unwary, leading to unexpected results if not completely understood.

For reprints of other discussions in this series, or technical data on any E-V product, write: ELECTRO-VOICE, INC., Dept. 493A 602 Cecil St., Buchanan, Michigan 49107

Coming in May 1969

Special—Preview of the 36th Audio Engineering Society Convention and Exhibition.

A Recording Engineer Tells It Like It Is—John Woram, RCA Victor recording engineer, takes us into the studio, giving a sound man's view of what happened during a recent recording session.

Transistor Amplifiers' Achilles' Heel: Crossover Distortion — James Bongiorno explodes some popular myths about "crossover" or "notch" distortion that oftentimes causes amplifiers to produce irritating sound. He examines how it occurs, and elaborates on what his investigations on the subject revealed when comparing outputs of different power amplifiers.

Electronic Organs (Conclusion) — Norman Crowhurst concludes his series on electronic organs by discussing tuning methods.

EQUIPMENT PROFILES:

Sony / Superscope TC-770-2 Portable Stereo Tape Recorder, **H. H. Scott** LR-88 Stereo FM/AM Receiver Kit, and more.

PLUS: Record and Tape Reviews, and other regular departments.

ABOUT THE COVER: A music listening and playing room is described by a reader in this month's Sound & Decor Styles, page 62. Amidst stereo hi-fi equipment, which includes a bevy of speakers, are a Schober electronic organ and a piano.

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.

Single Speaker for All Frequencies

Q. We have been hearing for many years about the necessity for more than one speaker to cover the full audio range. Reasons advanced for this necessity include arguments about impedance matching both high and low frequencies to the air mass, doppler distortion, etc. Question: Why do we not hear comparable arguments as to why we need more than one microphone?—William L. Hunter, Katonah, N. Y.

A. A speaker, especially a woofer, is a massive item. It must be designed with a considerable amount of mechanical strength and structural integrity. It must be large. All this is done because the speaker must move large amounts of air. We expect this one piece of paper to move the same amount of air as is disturbed by the performance of a symphony orchestra going "full blast." The amount of motion required is rather great.

Naturally, if the woofer moves a good distance, and if it is expected to produce high frequencies, there will, indeed, be some doppler distortion produced. In an effort to minimize this distortion, we use a separate speaker to reproduce highs. Sometimes we use a separate spaker to reproduce middle-register tones as well.

In addition to the doppler effect and its attendant distortion, there is the problem that the woofer alone, because of its mass, cannot accelerate, decelerate, stop, and then repeat the process in the opposite direction at high speed. Transients will come along and the inertia of the speaker will prevent them from being radiated.

The microphone is a different case altogether. The diaphragm of a microphone is small, sometimes less than a half-inch in diameter. It is obvious that such a diaphragm will respond readily to high frequencies. Obviously, such a small diaphragm cannot be expected to move on the scale possible for a woofer's diaphragm to move. Fortunately, though, this is not necessary. The amount of air vibration which reaches the diaphragm of the microphone is so small that this movement is not visible to the naked eye. Thus, it can produce considerable low-frequency output with no difficulty.

The small size of the microphone's diaphragm will certainly have little effect upon its ability to reproduce transient sound peaks.

Speaker Impedance

Q. When we are told that the impedance of a speaker is 16 ohms, what does that mean? Is this 16 ohms at some specified frequency? Is the voice coil free or blocked?—William L. Hunter, Katonah, N. Y.

A. The impedance of a speaker is taken at some specified frequency. The exact frequency is determined by the function for which the speaker is to serve. The voice coil is not blocked; it is free to move. I don't think that information gained by a blocked voice coil would tell us much because this is not the manner in which the speaker will ever operate.

When the speaker is placed in an enclosure for which it is designed, an impedance curve is often run, showing the speaker's performance over its entire frequency range. The manufacturer strives for the smoothest curve and one which remains relatively close to the actual design impedance of the speaker. If the impedance remains within plus or minus 100 per cent, one would have to say that the speaker is good.

Running such a curve on the speaker when it is outside of its enclosure will not give us as much information as we would learn when the speaker is in its enclosure. This is to be expected when we recall that a speaker is always designed for its enclosure. The impedance curve of real interest, therefore, is that which takes into account the effect of the enclosure in which it is housed.

Speaker Ports & Distortion

Q. My speaker systems are of the ducted-port type. At high volume, the woofer's excursions appear uncontrolled. At times, I have covered the port and the woofer calms drastically, yielding no apparent improvement in sound quality, but certainly not impairing what was not bad to begin with.

If I permanently sealed the port, would I be over-riding a principle that the system was designed to operate upon?

Does a speaker system create intermodulation distortion?—R. H. Harlan, Madison, Fla.

A. I think you will notice a deterioration in bass response when this port is

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closed. Probably the woofer appears to be uncontrolled when the port is open because of some turntable rumble. Closing the port places a greater load on the woofer. It then does not respond so readily to the rumble. This is at least one possible explanation for what you have observed.

Speaker systems produce distortion of all kinds. One such distortion is the doppler type, created simply because the cone must move a considerable distance in order to couple sufficient energy into the air.

Another type is intermodulation distortion. This type is produced in any device where there is nonlinearity. Speakers can be nonlinear in their performance, just as it is possible with amplifiers. A vibrating diaphragm, for example, could, by nonlinear motion, modulate a high-frequency note being produced simultaneously by the cone.

Tape Recorder for Dictation

Q. In the near future I hope to buy an Ampex 860 tape recorder. Because I may some time wish to use the recorder for dictation-copying, I had hoped that it would have had provisions for the attachment of a hand or foot control. Ampex Corporation, however, has told me that the 860 cannot be adapted for use this way.

Because manufacturers are not always inclined to recommend equipment not made by them, I thought that I would check with you whether there is some device, not made by Ampex, which can be attached to the 860 for this purpose.

Would a single switch on the a.c. cord do the trick without damaging the recorder? For your guidance, the tape transport controls on the 860 appear to be mechanical, rather than solenoidal. —Bertram P. Goltz, Jr., Clifton, N. J.

A. I must say that, from your description of the Ampex 860, it is extremely unlikely that this machine can be adapted to work with a foot pedal.

You could connect the foot pedal in series with the motor, but this is not recommended for two reasons.

First, during the time the machine is stopped, the pressure roller would be engaged against the capstan. This would be undesirable. The constant pressure on one spot would cause a flat spot to develop on the face of the rubber roller, thus ruining it.

Second, the use of the foot pedal in this way would be undesirable because of the inertia of the recorder mechanism. When you release the pedal, the motor will coast to a stop, rather than coming to a stop immediately. Thus, it is likely that the tape would continue past the point at which you wish to have the dictating or copying process stopped.

The reverse is true when you wish to begin dictating again. The motor would not come up to speed instantaneously. The combination of these two circumstances would allow some syllables to be missed.

A third drawback in this use of a standard tape recorder is that the foot pedal cannot be used as a means for back spacing, or having a group of words repeated. This provision is essential or else time will be lost in taking one's hands from the typewriter keys and manually rewinding the tape the desired distance.

If you plan doing much in the way of dictation-transcribing, you should obtain a machine which is designed and equipped for this purpose.

If you make a proper choice of dictating equipment, tapes made on standard recorders can be played on the dictating machine. The dictating machine must have a capstan drive, rather than the reel drive sometimes employed on such equipment.

I have given you this advice based on personal experience with hundreds of hours behind dictating equipment.

Tone-Arm Balance Considerations

If we all agree that complete freedom in all planes is necessary for a tone arm, springs used to control tracking force just will not do, for they act a frictional retard.

Let me prove this statement by telling you about an experiment I performed. I took the Grado Laboratory Series and ESL 2000 tone arms, uncoiled the springs which determine stylus force (the arms were then balanced and floating), and then added a mass as a weight to obtain proper stylus force. With the aid of Westrex test records and some instruments, I measured channel separation and frequency response. Comparing these specifications with the results I obtained when using the very same two tone arms with the stylus force determined by springs, I found the channel separation to be at least 4.4 dB greater in the 1-kHz to 15-kHz band. The frequency response was smoother and flatter by 1.1 dB over the range of 30-15,000 Hz. In both portions of the test, I used the same cartridge and the same stylus force. Thus, I reached the following conclusions:

If a tone arm has stylus force which is determined by weight and not by spring tension, it surely will not be in as complete balance as the tone arm controlled by spring force. However, the frequency response is flatter and channel separation is greater when using weights rather than springs.—*Name Withheld.* Æ

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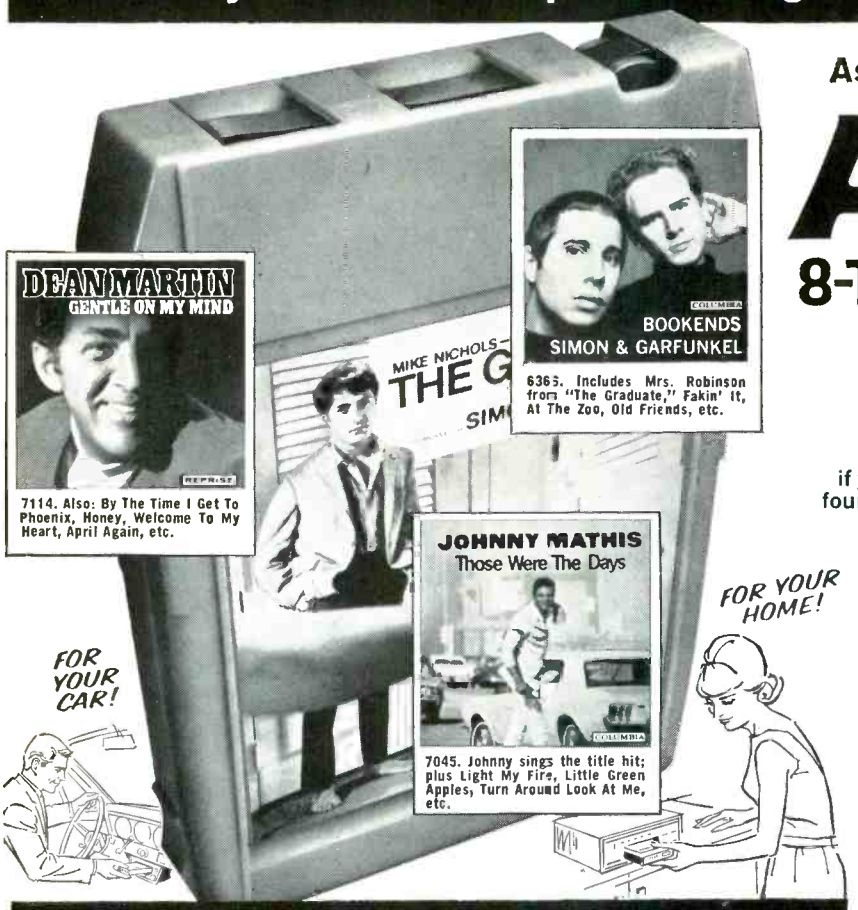

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What's New In Audio

Automatic FM Tuning Indicator Light

H. H. Scott's new Model 342C stereo FM receiver incorporates a number of technical innovations. Outstanding among them is its *Perfectune* automatic tuning device. The name lights up when one is tuned in for best FM reception, in contrast to tuning a meter pointer to a zero-center indication. Other features include: a quartz crystal lattice filter in the i.f. section, an integrated circuit in the unit's multiplex section, printed-circuit modules that snap on to locating pins on the main chassis, an integrated circuit preamplifier, plug-in speaker terminals, and a line-cord antenna that is claimed to eliminate the need for an outside antenna except in areas with poor FM reception.

Also featured are a Field-Effect Transistor front end and an FET tone-control circuit; back-lighted, "three dimensional" dial section; and "full complementary output" circuitry.

The Model 342C's control features are: dual bass and treble, stereo balance, tape monitor, speakers #1 on/off, speakers #2 on/off, power on/off, volume control, volume compensation, muting, noise filter, and mode switch, as well as a signal strength meter, stereo indicator light, and front-panel stereo headphone output, plus the aforementioned automatic tuning indicator.

Specifications include: Power with a four-ohm load, 100 watts (using IHF measurements and a ±1 dB tolerance; IHF standard would therefore be about 75 watts), at 0.8% distortion. FM usable sensitivity, 1.9μV; tuner stereo separation, 40 dB; cross-modulation rejection, 80 dB; capture ratio, 2.5 dB; signal-to-noise ratio, 60 dB. Dimensions of the 342C are 15¾″ L x 5″ H x 11½″ D. Price is $259.95.

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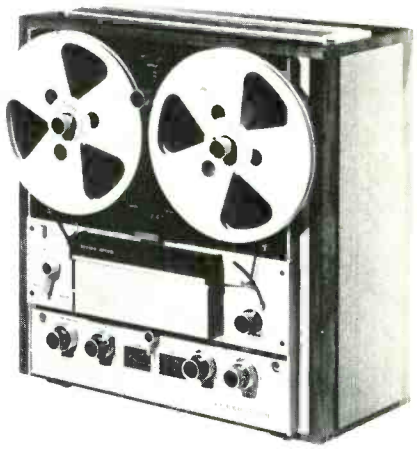
Ferrograph Returns

The British-made Ferrograph tape recorder is now available in the United States through a distribution arrangement with Elpa Marketing Industries. The new "Series Seven" Ferrograph is a fully transistorized unit that incorporates three tape heads and three motors, and is said to employ unusual editing features. Among its many features are: front-panel bias adjustment, brake adjustment, tape tension adjustment, three speeds (including a



15-ips option), an A-B monitor, and 8¼″ reel capacity. Price for the deck is in the upper $500 area. A recorder with solid-state 10-W amplifier is also available.

Check No.10 on Reader Service Card

Tape Recording Aids

A new "VU" meter (basic movement, 500 mA) has been announced by Robins Industries Corp. to eliminate guesswork in recording levels. The meter, model TVU-1, has a two-color scale with modulation range from 0% to 100%, VU of −20 to −3 dB. Impedance is 2700 ohms; 0 VU from 1.2 volts. Dual-impedance inputs allow use with either low- or high-impedance circuits. The meter measure 1 1/16″ x 2″ and has four threaded mounting screws with ¼″ terminals. Lists for $6.95.

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Also announced by Robins is a kit of tape accessories in a "tote-and-store" case. Included in the kit, model SKA-2, which lists for $33.00, are: three 7″ reels with 1200 ft. of 1.5-mil acetate recording tape, a 7″ take-up reel, a tape splicer with splicing tape, a head demagnetizer, 75 tape clips, two oz. of head cleaner and two oz. of head and guide lubricant, 240 self-stick color-coded title labels, four 7″ tape storage boxes, three tape editing and cueing pencils, and a 28-page guide to tape editing and splicing.

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unique: revolutionary Sound Effect Amplifier.

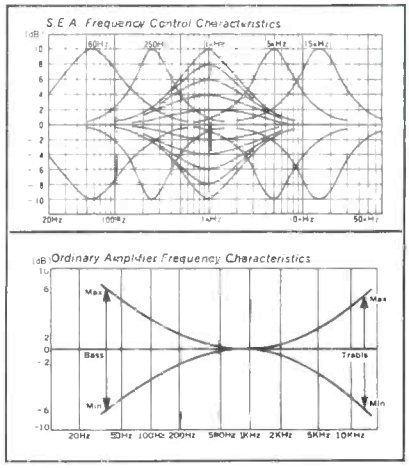
Unique "S.E.A." Sound Effect Amplifier tone control system of models 5001 and 5003 eliminates conventional bass and treble controls. Provides individual control of the five different frequencies that comprise the total tonal spectrum; 60, 250, 1000, 5000 and 15000 Hz.

In introducing the striking all solid state 60 watt 5001 and 140 watt 5003 AM/FM Multiplex Stereo Tuner Amplifiers, JVC brings the stereo fan a new dimension in stereo enjoyment—the complete control of sound effects.

This exciting innovation is made possible through the incorporation of a built-in Sound Effect Amplifier (S.E.A.), a versatile component that divides the audio range into five different frequencies. It enables the 5001 and 5003 to be tailored to the acoustical characteristics of any room, or to match the sound characteristics of any cartridge or speaker system, functions that were once reserved for expensive studio equipment. But even without the built-in S.E.A. system, the 5001 and 5003 would be outstanding values. They offer improved standards in FM sensitivity and selectivity by utilizing the latest FET circuitry with four IF limiters in the frontend of the 5001 and five in the 5003. They both deliver a wide 20 to 20,000Hz power bandwidth while holding distortion down to less than 1%. They feature completely automatic stereo switching with a separation figure of better than 35dB. They allow two speaker systems to be used either independently or simultaneously. Indicative of their unchallenged performance is their refined styling. All controls are arranged for convenient operation. The attractive black window remains black when the power is off, but reveals both dial scales and tuning meter when the power is on. For the creative stereo fan, the JVC 5001 and 5003 are unquestionably the finest medium and high powered receivers available today.

How the SEA System Works

Glance at the two charts appearing on this page. In looking at the ordinary amplifier frequency characteristics where only bass and treble tone controls are provided, you can see how response in all frequency ranges at the low and high levels is clipped off. Compare this chart with the one showing the SEA frequency response characteristics, and the difference is obvious. No clipping occurs in the SEA system. It offers full control of sound in 60, 250, 1,000, 5,000 and 15,000Hz frequency ranges from −10 to +10db. For the first time ever, you have the power to determine the kind of sound you want to hear.



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JVC

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BEHIND THE SCENES

BERT WHYTE

On-Location Recording

MOST OF THE pop records made today are products of the recording studio. They could hardly be otherwise, as the ultra-sophisticated multi-track techniques and the embellishments such as reverb would be extremely difficult (if not impossible) to produce on location or "remote" recording sessions. Yet a considerable amount of remote recordings are made of the pop variety, and, of course, most classical recordings are made on location. Naturally this calls for recording equipment that is transportable.

In the minds of many people the term "portable equipment" has the connotation of something inferior. While this is true to a certain degree with some amateur equipment, it usually does not apply to professional equipment. It all depends on what kind of a remote recording is going to be made, and what degree of quality is desired. A tape recorder that would be barely suitable for radio station use, for interviews, local church services, or a remote pick-up from a nightclub, would never do for recording a major symphony orchestra in its concert hall. Actually, almost any type of professional tape recorder and its associated equipment can be "portable" if you are willing to go to a lot of trouble. Engineer Bob Fine, whom we interviewed some months ago in AUDIO, was one of the first people to operate a special recording truck. Years ago, for the classical recordings he made for Mercury Records, his truck was burdened with two Fairchild studio console tape recorders, an Ampex 300 3-channel, half-inch stereo recorder, miles of cable, and microphones, and all sorts of ancillary recording equipment. The truck did not merely transport this equipment — the recorders were operated right in the truck with the input coming from the mikes located in the particular hall. Some years later, when I was recording director of Everest Records, I had a similar truck which contained our 35mm magnetic-film recorders (a huge six-channel unit on one occasion), and all our associated equipment. When I was going to record in London or Paris or Rome, the entire truck and its contents would be lowered into the hold of the *Queen Elizabeth* or the *United States* and, believe it or not, travel with me as "accompanied baggage." On the other hand, when I went to Puerto Rico to record Pablo Casals, we crated up two Ampex 300 three-track stereo console recorders and other crates with mikes, cables, monitor equipment, etc., and the equipment and I made the journey in a slow freighter.

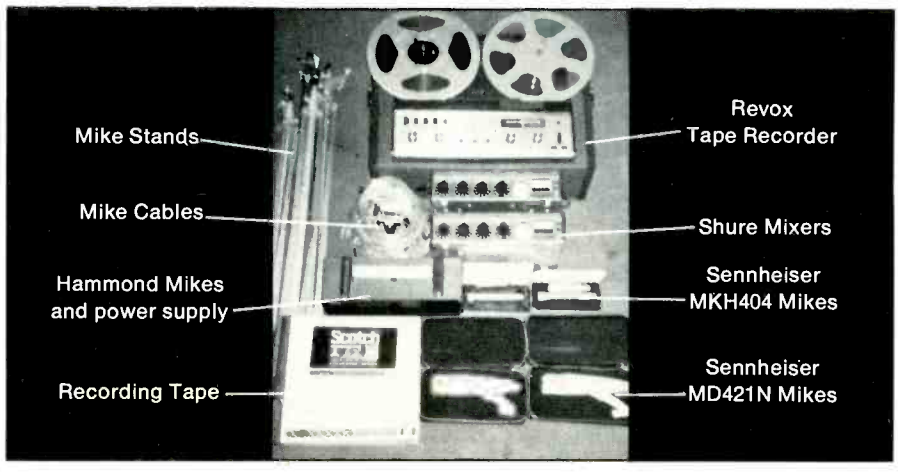
The Bob Fine truck and the Everest truck were extreme examples of "portable equipment." Many other engineers who had to make high-quality location recordings were not so fortunate. They had to use professional recorders in so-called "portable" cases. Rasslin' them in and out of car trunks is an invitation to join the slipped disc club. All other professional recording equipment seems to be built on a similar grandiose scale; mixers, mike stands, booms, and so on. Therefore, if the engineer is conscientious and wants to do a good location recording, he must resign himself to coping with a mountain of heavy equipment.

Sounds very much like a location recordist's lot is not a happy one. This is especially true of the man who runs a small recording company in which 80 per cent or more of his work is on location. Consider, too, the plight of the "serious audiophile" or "semi-professional" who is importuned by the local musical groups to make them a "good recording." A good recording means professional or semi-professional equipment, which, as we have seen, entails lots of weight (and usually means considerable money invested in equipment). Surely in this enlightened age of the transistor, integrated circuits, and light-weight alloys, some aid can be given these poor recordists whose spirit is willing, but whose backs and wallets are weak!

Fortunately for them, help is at hand. As an example, I spent the last few months making professional-quality recordings of pop and classical music with a 34-lb, 15-ips, 10½-in.-reel tape recorder, and associated equipment, that is equal if not superior to the heavy professional machines available not too many years ago. Furthermore, would you believe equipment of this calibre could fit comfortably in the trunk space of a Corvette Sting Ray "fastback"? It does.

This equipment, shown in the photograph here, can handle almost any kind of location recording. It is quickly set up and can be as readily dismantled. It is light enough to be handled by a girl used to lugging suitcases on vacations, yet quite rugged; in the months of hard use I've given the whole rig, I've not encountered any trouble. The recorder is a two-track stereo Revox "Professional Model HS77" which operates at 15 ips (and 7½ ips), and is mounted in a lightweight portable case. The capstan drive of this unit is electronically controlled with a servo system, providing superb tape motion. Even on long-held piano chords, wow and flutter was inaudible. The solenoid-operated controls are positive and smooth in use. And the two reel motors

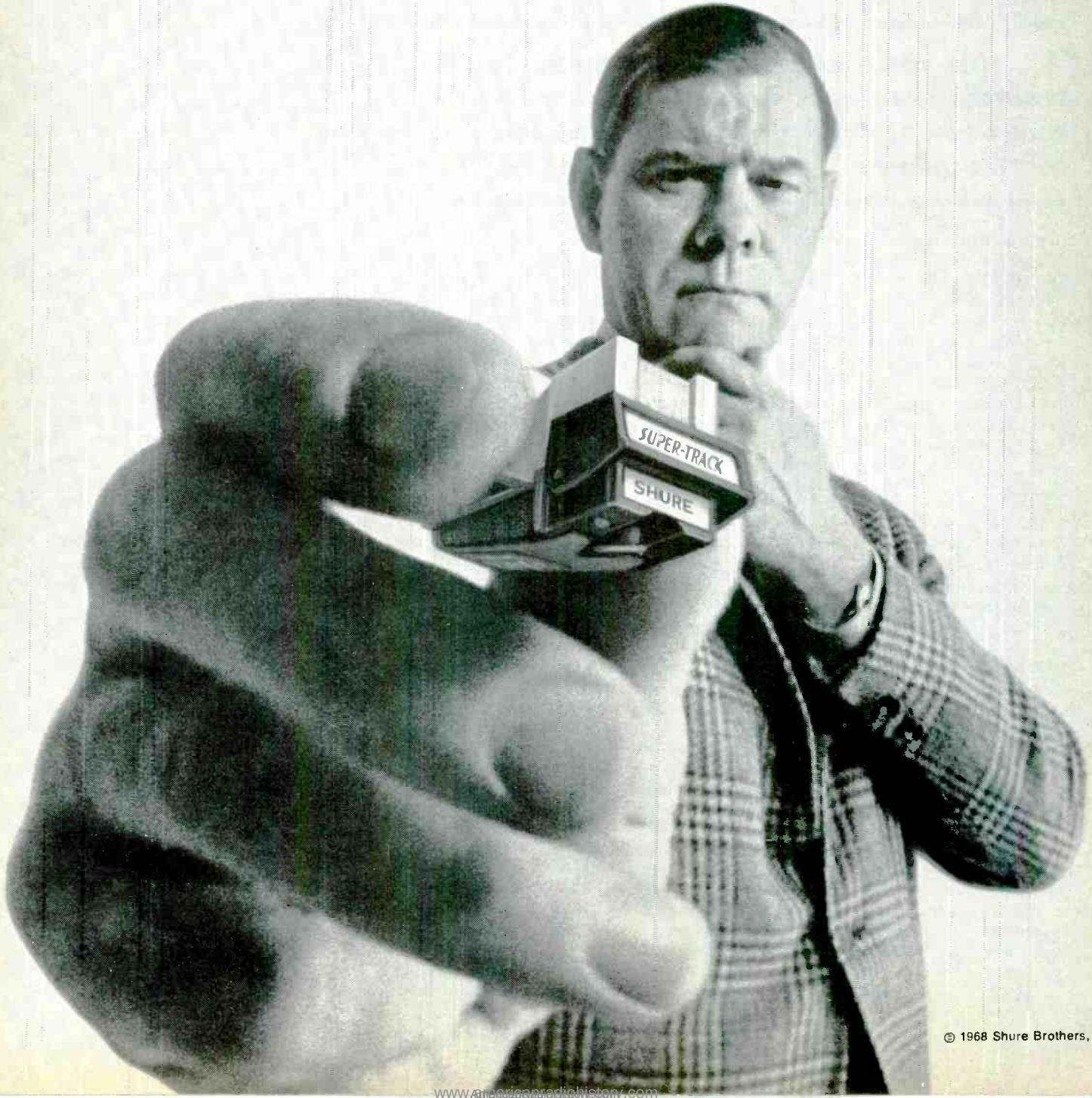
Lightweight, High-Quality, Recording Outfit



The cartridge looms large for a simple reason:

It is the point of contact between the entire hi-fi system and the recording. What happens at the tip of its tiny stylus determines what will happen in all those big and impressive components that are so obvious to the eye and, in the aggregate, so apparent to the pocketbook. Worldwide, experts and critics have hailed the discovery of Trackability as *the* definitive measurement of cartridge performance. When evaluated against this measurement, the superb **Shure V-15 Type II Super Track** stands alone. Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Illinois 60204

The analog-computer-designed Shure V-15 Type II Super-Trackability cartridge maintains contact between the stylus and record groove at tracking forces from ¾ to 1½ grams throughout and beyond the audible spectrum (20-25,000 Hz). Independent critics say it will make all of your records, stereo and mono, sound better and last longer. Tracks 18 cm/sec. and up at 400 Hz; tracks 26 cm/sec. and up at 5,000 Hz; tracks 18 cm/sec. and up at 10,000 Hz. This minimum trackability is well above the theoretical limits of cutting velocities found in quality records. $67.50.



have high torque, affording very fast "rewind" and "fast forward." With Scotch 203 tape for which the machine is biased, the frequency range is very wide, even at 7½ ips. At 15 ips, this two-track unit (which permits editing) has a signal-to-noise ratio of better than 60 dB. My only quibbles concern the threading, which is slightly awkward, and, although the VU meters are thoughtfully calibrated, they are on the smallish side and thus hard to read.

For pop recordings and other occasions when you need a mixer, I used the new Shure M67 units. These tiny, solid-state mixers have inputs for four low-impedance mikes or 3 mikes and a 600-ohm line "in." Each input has its own pot, and a master pot controls all. There is a 600-ohm line "out," as well as such refinements as a built-in oscillator for setting levels, and a good VU meter. Two M67s are needed for stereo (the only shortcoming here is the lack of a common master control). The microphone complement consisted of two Hammond omnidirectional condensers, two Sennheiser MKH404 cardioid condensers, and two Sennheiser MD421N cardioid dynamics. What you use is, of course, dictated by the acoustics of your recording locale. If the hall permits the use of an omnidirectional pattern, these tiny Hammonds do a fine job with their good sensitivity, smooth response, and an excellent bottom end that is especially good for organ recordings. The Sennheiser condensers, with a good cardioid pattern, are great performers, being able to handle many poor acoustical conditions.

I used the latter mikes the most, and they mixed nicely with the Sennheiser dynamics. The power supply of the Sennheiser condensers is a far cry from the bulky units of yesteryear. About the size of a fat *Corona Corona,* the power comes from six mercury batteries which provides about 60 hours of recording. I used the dynamic units mainly for augmentation of the condensers and for some vocals (a switchable filter to control close-up bass heaviness is a feature of these mikes).

Now for the simplest thing and the best news of all for weight-burdened recordists. As they know from bitter experience, one of the real "back breakers" has always been the mike stands and booms. They had to have heavy base plates to support the weight of the heavy mikes. Well, the mikes I have just described are light enough to be able to use collapsible photographic stands. The latter are light in weight themselves, but with good tripod bases they are entirely adequate and reliable. They can put the mikes about ten feet up, which is a good range for most situations. If more height is needed they can be placed on tables. If necessary, and time and circumstances permit, the mikes can be flown as high as you want by using a thin nylon line. The mikes are so light, in fact, that the line sags very little. The mike cables, too, are thin, light and flexible. Although their thinness enables you to carry quite a few feet of mike cable, this is an area where I would add still more mike cable, as well as long a.c. extensions. In many locations, especially in churches where you may be recording organ, you may have long runs from the mikes to where you are permitted to monitor or set up your recorder. A pair of 500-ohm Superex Pro headphones was used for most monitoring. While I was impressed with the smoothness of these phones and the comfortable fit, I thought the outstanding quality was their good low-frequency response, a most helpful attribute with my organ recordings.

With a high-quality remote recording outfit like this, which is so light in weight (relatively speaking) and so easy to set-up, you are encouraged to tackle recording situations that would have been bone-wearying with the blunderbuss outfits of a few years ago. What did I record? You name it: huge pipe organs in reverberant churches, jazz and pop groups up to 15 men in low-ceilinged, incredibly noisy clubs, a prize-winning fife and drum corps in a surprisingly good high-school auditorium, several local symphony orchestras up to 85 men, in one fair and one good hall, innumerable classical instrumental and vocal groups from 2 to 30 musicians in locations from modest living rooms to a small college recital hall. In none of these situations did I have more than minimal trouble obtaining what can be honestly, if immodestly, described as recordings of professional quality. Those participants in these experiments who heard the tapes over my stereo system, were openly amazed that this quality of sound could be obtained from such a modest quantity of equipment.

". . . this ultra-portable two-channel stereo recording outfit . . . would have served to make commercial masters as good as much equipment used some years ago."

I will say this: if I were recording some commercial symphonic masters today, I would like to avail myself of such things as 4-channel one-inch recorders and the Dolby system, but to reiterate, this ultra-portable two-channel stereo recording outfit I have described would have served to make commercial masters as good as much equipment used some years ago. As to cost, this whole system would be slightly over 2100 dollars—less than the cost of the old heavyweight recorders alone.

Naturally, one can substitute other present-day equipment for the aforementioned group in order to gain some important features. But there's a trade-off in cost and weight (both higher) in the case of recorders that feature 15-ips speed, 10½-in. reels, and two tracks. Below the $1000 mark, only the 34-lb. Revox HS-77 (15-ips option) and the 57-lb. TEAC A-7030 come to mind. From here you'd have to jump to the more expensive and heavier Crown or Telex Magnecord models. Forsaking 10½-in. reels for 7-in. ones, losing half of the continuous recording time, is the Ampex AG-500, the lightest a.c.-power-only unit at 28 lbs. Dropping the 15-ips requirement for 7½ ips and the 10½-in. reels for 7-in. reels opens up some other high-quality two-track machines. More importantly, battery-powered types can be chosen: Sony Superscope's new Model TC-770-2, which also operates on a.c., weighs in at 25 lbs. and offers a slew of dream features for serious recordists. And for those who like to jog while recording, there are 5-in.-reel mighty mites Tandberg 11-2 (9½ lbs.) and the Uher 4000L (7 lbs.). (Seven-in. reels can be used with the former when the case top is opened.) Only Nagra, among battery-powered models, has a 15-ips speed, though this 15-lb. recorder is about 2.5 times the price of the foregoing lightweights. Each of these incorporates servo systems to maintain accurate speed in face of weakening batteries.

Clearly, on-location recordists never had it so good. Æ

Our competition builds some pretty good stereo receivers.

(We just happen to build a great one.)

Let's not kid around. At 700 bucks plus tax, a Marantz Model 18 Stereophonic FM Receiver isn't for everyone.

But, if you'd like to own the best solid-state stereophonic receiver made anywhere in the world, this is it. Here are just a few of the reasons why.

The Marantz Model 18 is the only receiver in the world that contains its own built-in oscilloscope. That means you can tell a lot more about the signal a station is putting out besides its strength or whether or not it's stereo. Like if they're trying to put one over on you by broadcasting a monaural recording in stereo. Or causing distortion by overmodulating. (It's nice to know *it's their fault.*)

The Marantz Model 18 is the only stereo receiver in the world with a Butterworth filter. Let alone four of them.

The result: Marantz IF stages *never need realigning.* Marantz station selectivity is superior so strong stations don't crowd out adjacent weaker stations. And stereo separation is so outstanding that for the first time you can enjoy true concert-hall realism at home. Moreover, distortion is virtually non-existent.

But there is much more that goes into making a Marantz a Marantz. That's why your local franchised Marantz dealer will be pleased to furnish you with complete details together with a demonstration. Then let your ears make up your mind.

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Letter from Reader

• Ever since your [Bert Whyte] articles about tape began appearing in AUDIO, I have read them and enjoyed them and ruminated over them, but with respect to off-the-air recording [Behind the Scenes, January 1969 AUDIO], it also includes some disagreement.

On record companies destroying themselves, you say they have abetted their own downfall by giving away free recordings to the stations and that they are wrong in thinking they must have radio exposure for their products in order to insure sales.

Well, the first Steppenwolf album did nothing in markets where it did not receive air play. Here in Cincinnati, where we played it pretty hard, it sold 15,000 copies (so we are told).

If you are taken in by the tears of Mr. Racusin about the dwindling profits of record companies, Scully and Ampex can't begin to keep up with their orders for new multi-channel tape machines. New labels spring up at the rate of about 25 per week. Supposedly astute record men put out as high as $200,000 front money for unknown rock groups. Do you think that all these things happen in a business where everyone is losing money?

Of course there is justification for maintaining that a record company or a copyright holder or an artist should be given some protection against unauthorized copying of his works. It would seem that the easiest way to do this would be to follow the example of Europe, where, as I understand it, a decent-quality tape machine is looked upon as a device intended to infringe copyright and is cleared for sale on the market place only after a sort of tax has been paid to the European equivalents of ASCAP, etc. Probably the way to work that out in this country is to hold that a blank cassette or reel should carry some kind of "tax" for the benefit of the record companies. But if the record companies try to lay this on the radio stations, you can forget all about contemporary music, which might not be a bad idea at that!

Incidentally, I have been very pleased with the frank way in which you have discussed the qualitative shortcomings of 8-track cartridges and of cassettes. This shows a lot of courage.

FRANK WOOD
Cincinnati, Ohio

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Also three peerless component speakers. Our spectacular 12" high-compliance woofer, with an 8-lb. magnetic structure and 2" voice coil for flawless bass down to 25Hz. A 4½" midrange direct radiator, for purely transparent sound between 450 and 5000 Hz. A 1" ultrasonic domed tweeter for highs up to 20k Hz.

Even the power-handling capacity that's made Empire famous: a full 90 watts for distortion-proof, burnout-proof performance no matter how hard you drive it.

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Tape Guide

HERMAN BURSTEIN

Track Disposition

Q. Enclosed are three "pictures" I have developed of recordings made on three different tape recorders. You will note the disparity in the track arrangements. Can you tell me which one is considered to be the correct pattern for a four-track recorder? It would seem to me that the four tracks should be equally separated, but I find that it is not possible to accomplish this with the Criterion 1000. In order to decrease the space in the middle and increase the space between tracks 1 and 2, I would have to raise the tape head; but if I do this, tracks 1 and 4 will be partly off the tape. In other words, the gap in the recording head for track 1 is already at the very top of the tape. The Uher 8000 produces an even wider space in the middle. The Lafayette 650 has a reverse pattern. It has a narrow space in the middle and wide spaces between tracks 1 and 2, and between tracks 3 and 4. Is this disparity not likely to produce the following results: (1) incomplete erasure of a recording made on a machine different from the one being used; (2) crosstalk; (3) partial erasure of track 2 or 4 when recording on tracks 1 and 3? Has this matter been standardized in the industry?—Robert Starrett, Hollywood, Calif.

Criterion 1000

Lafayette 650

Uher 8000

A. The 1965 NAB standard and the 1965 RIAA standard both specify that the four tracks "shall be equally disposed across the tape." Hence the islands between tracks should all be of equal width, as you have observed. And all your other observations also appear correct, namely those concerning incomplete erasure, crosstalk, etc.

In the case of the Criterion 1000 and Uher 8000, if the outer tracks are already at the edge of the tape, this indicates that the heads are faultily constructed, either as to separation between the two sections of the head, or as to vertical span of each section, or both. The only thing one could do, as you suggest, is to raise the tape slightly above the tape head (or lower the head). But this is undesirable, partly because you then lose signal (causing signal-to-noise ratio to deteriorate) and partly because the tape (whose edge now runs below the top of the upper head section) will tend to cut a groove into the head gap.

In the case of the Lafayette 650, the head is not necessarily of faulty construction. The NAB and RIAA standards permit the outer edges of the outer tracks to be slightly inside the tape edges. If the tape is of rated 246-mil width, the margin between gap edge and tape edge can be a maximum of 3 mils (per the RIAA standard) or of 1 mil (per the NAB standard). I cannot visually determine from the "pictures" you sent me whether lowering the head by the amount that the standards permit will result in islands of equal width. Also keep in mind the possibility that maximum tape width is 248 mils; if your tape is of this width, you can add another mil to the margin between gap edge and tape edge, permitting further lowering of the head with respect to the tape.

Matching Microphone Impedance

*Q. I recently purchased a *** tape recorder. It has output jacks marked* MIC, AUX, EXT. SP. *My question concerns the impedance of my microphone jack. The operating manual states that the microphone jack has an impedance of 4.7K ohms. However, the microphone which came with the recorder has an impedance of 200 ohms. Isn't 4.7K ohms considered high impedance, while 200 ohms is considered low impedance? Would this be enough of a mismatch to cause loss of high frequencies? I plan to purchase another microphone in the near future. Would it be best for me to purchase a 600-ohm microphone, a 200-ohm microphone, or a 5K-ohm microphone.*—Ronald W. Hebard, Tulsa, Okla.

A. The jack marked MIC is an *input* jack. The load impedance of 4.7K ohms at this jack is about "medium." The 200-ohm impedance of the microphone is low. Inasmuch as the mismatch between microphone and load is upward —200 ohms feeding into 4.7K ohms— there sholud be no significant deleterious effects. Such mismatches, as you call them, are common; for example, a high-impedance microphone rated at 25K ohms will typically feed into a load of 500K ohms. This follows the rule that the load should be at least 10 times as great as the source impedance to prevent the load having significantly adverse effects upon operation of the source of the signal voltage.

For your particular tape recorder, I doubt that you should get a microphone with a rated impedance appreciably higher than 200 ohms. You don't want to match the microphone impedance to the load impedance because you are concerned with transferring signal voltage rather than power.

Head-Gap Effect on Frequency Response

Q. I am planning to design a tape recorder circuit. Please help me decide whether to use a 400 mH, 100-micro-inch-gap head with 1.8 mV. output at 1 kHz; or a 500 mH, 50-micro-inch-gap head with 1.8 mV. output at 1 kHz. The speeds to be used are 3.75 and 7.5 ips.—S. Nashiro, Ft. Sill, Okla.

A. If you plan to operate at a speed no lower than 3.75 ips, a 100-micro-inch head should give you treble response not significantly different (worse) than a 50-micro-inch head. To put this positively, either head will adequately cover the audio range before appreciable high-frequency losses arise due to gap width. If you are planning to use the same head for recording as well as for playback, a tape head with appreciable inductance may present problems in recording. That is, the head may present excessive impedance to the amount of audio recording and bias current which it is necessary to drive through the head. Record-playback heads usually have inductances not much above 500 mH. If you are planning to use the head for playback only, then a head of higher inductance is desirable for increased output and increased signal-to-noise ratio.

Eliminating Noise Pickup

Q. What would you suggest in the way of a microphone or filter to eliminate unwanted noises when recording out of doors, such as bird and animal calls?—Kenneth F. Peabody, Sunnyside, Wash.

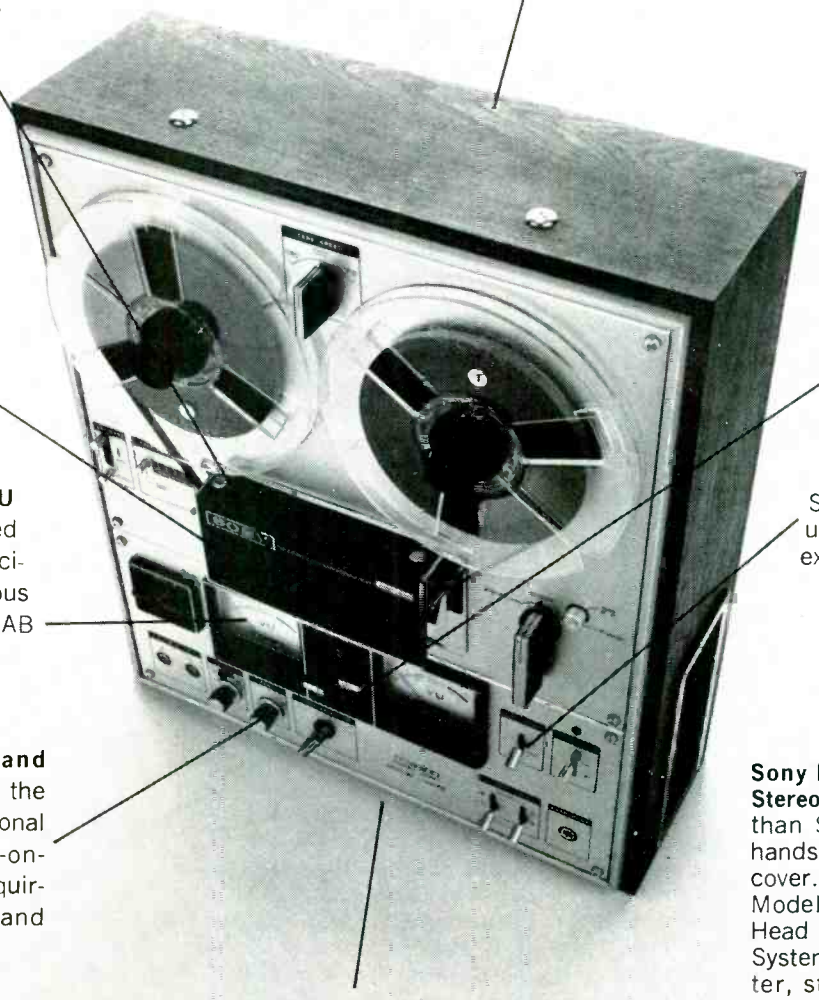
A. To eliminate unwanted noises, one wants to focus keenly on the source of the desired sound. Therefore, one uses a highly directional microphone, such as a cardioid or supercardioid, and aims it directly at the desired sound. Sounds to the side and rear of such a microphone are considerably attenuated relative to sounds to the front. You can get further information, including price, from your audio dealer or from microphone manufacturers. Æ

Music lovers, take control!

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

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

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



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

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

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

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

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

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

SONY SUPERSCOPE

You never heard it so good.

MUSICAL GLASSES

Edward Tatnall Canby

THE GLASS HARMONICA is back again, via Vox's Candide label and the indefatigible Bruno Hoffman, world's only virtuoso in the strange musical medium. Many of us will welcome the chance to hear more glass music even if not much on this new recording is of more than pleasing musical value. The unearthly, arresting tonal quality of the vibrating glass saucers still fascinates our ears, as it did those of the late years of the 18th century and the first decades of the 19th when important composers—Beethoven and Mozart—were attracted to the point of writing glass music.

Most children with musical ears discover the musical properties of glassware at an early age. I remember covering my mother's dining room table with family heirlooms, varyingly filled with water to tune them to a drunken musical scale that meandered irregularly through wine glasses, tumblers, jelly glasses, cordial sippers, and anything else that would emit a ringing tone when tapped. One played tunes on them with a pencil, and with care there could be a bit of harmony in two parts—until one or another of the glasses spilt or tipped over. But few of us discovered the further principle of glass *rubbing,* for the unearthly continuing glass "howl" that is the basis of the so-called glass harmonica.

Rub your fingers around the rim of a glass—not too coarse or thick, and definitely not plastic—and once in twenty times you'll be lucky enough to set up a piercing tone. It requires a scrupulous cleanliness and a total lack of grease. Even after a detergent bath most glasses merely emit an unpleasant squeal, like chalk on a blackboard. But once the pure, evanescent, piercing true glass tone has emerged, you are likely to be fascinated into testing a kitchenful of glassware and spraying most of the room with water in the process.

To play a tune in this crude fashion is almost inconceivably difficult when more than a few notes are involved—and even then, the agonized effort to make each glass "speak" destroys all sense of continuity and rhythm. It is therefore the more astonishing, even miraculous, to hear Bruno Hoffman's fluent, many-voiced performances in full harmony and at a relatively nimble pace. It is even more interesting to realize that the notes he plays were in fact composed for a similar performing virtuosity almost two centuries back! The persistence of man, faced with a problem to solve, is ever amazing.

The original glass harmonica was Ben Franklin's scientific invention, a characteristically practical job of good mechanics. In 1761 he got hipped on musical glasses, and like an early Edison proceeded to work out a way to make them play more easily. He mounted thin glass saucers close together on a turning lathe, against which the wet fingers could delicately be held, producing the ethereal tones in whole chords. Assorted refinements did not greatly change the instrument, which was taken on tour by two well-known lady musicians, both named Marianne; if I am right it was Marianne Kirchgessner who brought the instrument to Mozart's attention, resulting in the profound but not very playable Adagio and Rondo K. 617, composed near the end of his life.

As R. D. Darrell points out in lively notes for the Candide recording, there was a characteristic fascination at the end of the 18th century over ingenious inventions that combined mechanical wizardry, then in high repute, with musical expression. Somehow, the "harnessing" of nature by man to express nature's deepest beauties in the form of music appealed profoundly to great minds of the age. Hence we find the marvelous mechanical organs, orchestras, musical clocks, and other music boxes of the period, exquisitely constructed and ornamented, playing delicate music of an ethereal nature without a player—almost unbelievable.

The glass harmonica and its "music of the spheres" fitted into this category, though it was not mechanically played. It was a clumsy machine at best, and to write music for it required an ingenuity not all of its composers could produce. But two minutes of the glass sound will explain its remarkable impact—it is almost drug-like, hypnotic in its intensity, a weird, softly shattering sound with a touch of nightmare to it, like the feeling we sometimes get on a night of full moon. It is as though tiny shards of glass were piercing the ear.

Odd—there is a hand-played modern counterpart of the glass harmonica, the theremin, a pioneer electronic instrument that caused a considerable sensation in the years between the wars. (It produces a heterodyne tone via a fixed supersonic oscillator and another that is variable by capacitance between a hand, moving in air, and a metal rod.) There was a theremin-playing lady, too, who gave recitals far and wide; I heard her. As I remember, her problem was that she couldn't play in tune. Nevertheless, the theremin's weird, unearthly moan, like an insane cello at one moment, a shrieking factory whistle the next, attracted composers of the 1930s exactly as had the glass harmonica 150 years before. Now, this clumsy instrument has found a place in our continuing solid-state age.

Bruno Hoffman's glass harp is his own special refinement on the Ben Franklin design, and evidently an improvement in that as many as four tones can be played together and their quality varied via hand motions. But the wet-finger technique is still the basis, and one must grant that even today it is amazing to hear how much music can be drawn from such a very damp device. Particularly when it is music so redolent of a bygone period whose minor music we seldom hear, the earliest years of budding Romanticism. Nice!

(Note that there are two earlier Vox recordings and one Archive by Bruno Hoffman, with some overlap of material.)

Music for Glass Harmonica. Bruno Hoffman, with assisting instrumentalists. **Vox Candide CE 31007 stereo.**

More Music Reviews on Page 66

press comment *on the*

AR-3a

the AMERICAN **record guide** *(Larry Zide)*

"In choral works and other music of relatively 'heavy' content, the AR-3a simply eliminates any mid-range lack of clarity . . . I find myself repeating what I said in 1959 [about the AR-3]. The AR-3a . . . easily succeeds its prototype as a speaker that I consider 'as close to musical realism in the home . . . as the present state of the art permits.' In a word, it's superb."

HIGH FIDELITY *(Norman Eisenberg)*

"Our reaction on first hearing the AR-3a was [an] . . . enthusiastic one which has not diminished after weeks of listening . . . in normal use, predominantly fundamental bass is evident to about 30 Hz . . . Tones in the 13 to 14 kHz region can be heard clearly at least 60 degrees off axis . . . at [high] levels, the speakers sounded magnificent . . . On any material we fed to them, our pair of AR-3a's responded neutrally, lending no coloration of their own to the sound."

Hi Fi/Stereo Review *(Hirsch-Houck Laboratories)*

". . . the best speaker frequency response curve we have ever measured using our present test set-up . . . virtually perfect dispersion at all frequencies — perhaps the most non-directional forward-facing speaker we have ever tested . . . AR speakers set new standards for low-distortion, low-frequency reproduction, and in our view have never been surpassed in this respect."

CHICAGO DAILY NEWS *(Bernard Jacobson)*

". . . I have heard many stereo setups, both professional and non-professional, in my time, but this is the most unobtrusive . . . the most faithful, record reproduction I've ever heard."

The AR-3a is priced from $225 to $250, depending on cabinet finish. Literature is available for the asking.

ACOUSTIC RESEARCH, INC., **24 Thorndike Street,** **Cambridge, Mass. 02141**

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EDITOR'S REVIEW

Mozart By A Mile

Mozart compositions on LP records captured the honor of "most recordings in 1968," based on listings in *Schwann Catalogs*. No one came close to the number of Mozart recordings, 193 listings. And should you think that only Mozart's prolificacy made this possible, think again—the most-recorded classical piece of music in 1968 was Mozart's Symphony No. 35, with seven recordings (tied by Debussy: Prelude a l'Apres-Midi d'un Faune).

The year 1968 was also a very good one for Tchaikovsky, Chopin, Debussy, and Mahler recordings. Interestingly, fewer recordings of Beethoven, Bach, Haydn, Brahms, Schubert, Schumann, Wagner, and Ravel were made in 1968 as compared with 1967. Here are the "top 15" most-recorded composers in 1968, compared to standings in 1967:

1968	*1967*	*Composers*	*1968 Listings*	*Vs. 1967*
1.	1.	Mozart	193	+19
2.	2.	Beethoven	99	−27
3.	3.	Bach	84	−33
4.	7.	Tchaikovsky	63	+15
5.	4.	Haydn	55	−32
6.	5.	Brahms	52	−15
7.	6.	Schubert	45	−17
8.	—	Chopin	43	+11
9.	—	Verdi	43	−00
10.	8.	Debussy	36	+11
11.	11.	Schumann	36	− 5
12.	12.	Wagner	35	− 3
13.	13.	Ravel	33	− 4
14.	—	Mahler	30	+ 8
15.	—	Liszt	29	−00

In addition to the Mozart and Debussy recordings noted above as the most-recorded classical pieces of music in 1968, with seven each, here are other leaders: With six recordings—Tchaikovsky: Nutcracker Suite; Ravel: Pavane pour une Infante Defune. With five recordings each: Beethoven: Piano Concerto No. 5; Beethoven: Piano Sonata No. 14; Berlioz: Symphonie Fantastique; Brahms: Piano Concerto No. 2; Schubert: Symphony No. 8; Tchaikovsky: Marche Slave, 1812 Overture, Symphonies 5 and 6.

The twelve monthly 1968 *Schwann Catalogs* listed 2199 classical LPs and 245 classical collections. Nineteen new electronic music records were added in 1968, one of which became a best seller, The *Switched-On Bach* LP with the Moog Synthesizer.

Hi-Fi & Audio Shows

The Washington, D. C. High Fidelity Music Show last February packed 'em in (averaged 958 visitors an hour to over 80 exhibit rooms, according to Show sponsors). And it was SRO at the Show's five seminars, called "hear ins." Attendees also had a first-hand opportunity to hear the Moog Electronic Music Synthesizer do its thing, and to listen to music while sitting in The Lee Chair, a fibreglass-shell chair with hidden 8-in. drivers. The Almo Radio Hi-Fi Show in Philadelphia, Pa., held the same month, was also well attended, though it was a smaller show, with fewer exhibitors. Sponsored by an audio components dealer, it held the lure of being able to purchase a component right at the show. (Admission was not charged.)

Philadelphia's Mayor James H. J. Tate proclaimed January 28 through February 1, 1969 as "High Fidelity Week." Activities during the week —audio clinics, equipment demonstrations, contests and prizes—were sponsored by the newly formed High Fidelity Dealers Association of Delaware Valley.

* * * *

The 36th Audio Engineering Society Convention and Exhibition will be held at the Hollywood Roosevelt Hotel, Los Angeles, Calif., April 28 to May 1. *A.P.S.*

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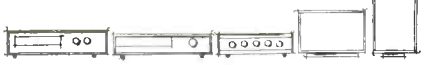

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How to Build a

15-Watt Amplifier on Your Loudspeaker Basket

C. G. McPROUD

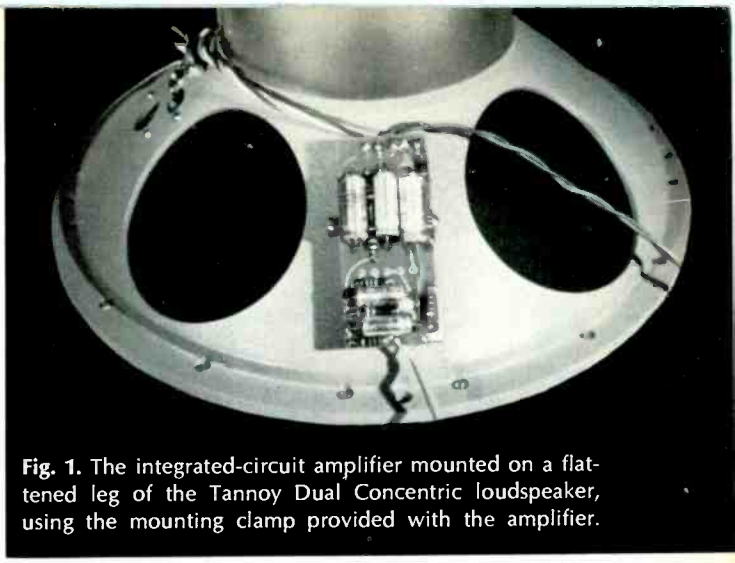


Fig. 1. The integrated-circuit amplifier mounted on a flattened leg of the Tannoy Dual Concentric loudspeaker, using the mounting clamp provided with the amplifier.

New Integrated-Circuit Amplifier is applied here by Author

A GOOD LOOK at a loudspeaker frame — or basket, as it is called in the trade — makes one wonder why all that metal is going to waste when it could just as well be used as a heat sink. Having gone this far, the next step was to try it out, but early experiments with the conventional transistor circuits yielded results which were less than ideal. An announcement from Bendix of an integrated 15-W amplifier whetted the desire again, so Bendix was prevailed on to send one for experimentation.

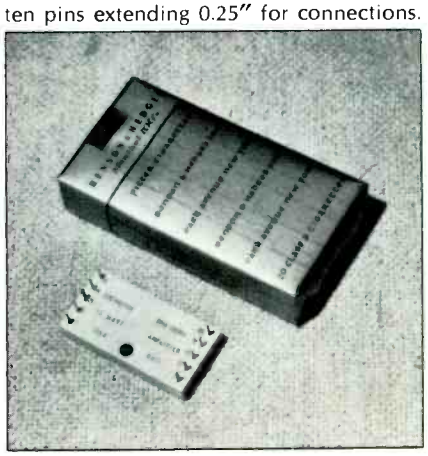
This amplifier, the BHA-0002, is shown in Fig. 2 for size relationship. It is a five-transistor quasi-complementary circuit packaged in a plastic case with a ceramic substrate bottom which is the heat-conducting surface. Its schematic is shown in Fig. 3. Access to its internal circuitry is by means of ten pins which extend upward from the plastic case.

Designed for 3.2-ohm loads, it is capable of 15 watts output at a distortion figure of 0.3 per cent, but with 8-ohm loads, its output drops considerably. The addition of an external input stage would permit using more feedback with improved results into 8-ohm loads, and the circuit of Fig. 4 was developed. Consultation with Bendix engineers indicated that with an 8-ohm load, a supply of 40 volts could be used, provided no more than about 800 mA was allowed to flow.

The specifications of the BHA-0002 seemed sufficiently attractive for the application so a 12-in. Tannoy Dual Concentric speaker was obtained on which the amplifier would be mounted. This model was selected because it is efficient—and therefore could be driven easily by a 15-watt amplifier—and because it has a cast aluminum basket of sufficient mass to be a good heat sink. In addition, it is a recognized good performer, capable of showing up any deficiencies if the amplifier had any.

The circuit of Fig. 4 was first tried out in breadboard form to determine the values for best performance. Then it was reduced to a printed circuit form, as shown in Fig. 5. This printed circuit allows for the mounting of capacitors C_4 and C_5, required for the operation of the amplifier, as well as for the additional input stage and all its components. It is designed to slip over the ten terminals of the Bendix amplifier and to solder directly to them. Since these ten pins are only 0.25 in. high, the components had to be mounted on the foil side of the printed circuit board, since it would be difficult if not impossible to solder the amplifier pins to the foil if it were on the bottom, adjacent to the amplifier itself. Extensions were provided for the external connections — supply voltage, output, feedback, and the input cable.

Fig. 2. Bendix BHA-0002 amplifier compared in size to a package of 100-mm cigarettes. Overall dimensions are 1.05″ wide, 2.05″ long, and 0.31″ deep, with ten pins extending 0.25″ for connections.



The printed circuit board was made in the usual fashion, using Kepro sensitized laminate and a negative made from the layout of Fig. 5. Exposure of the laminate was made with a Sylvania Sun Lamp at a distance of 18 in. for three minutes. The laminate was then developed according to directions, allowed to dry, and then etched. While the laminate can be cut with a hacksaw, it is much easier to heat it in an oven to about 250 deg. and then cut it with a tinner's shears. If it is cut in this manner while it is cold, it will chip on the underside, but when hot it can be cut with shears as easily as though it were a piece of cardboard, and it will not chip.

The mounting holes were next drilled, using a #55 drill. The input ground hole should be drilled with a #52 drill, since it has to accommodate the twisted shield wires from the input cable. The components were next mounted on the foil side, with about 1/16 in. being bent over on the underside to retain the parts without resorting to the adherence of the foil alone. Since the parts are mounted close together, the order of mounting is important. The transistor should be soldered in place first, then all the resistors, and finally the capacitors. Figure 1 shows the completed circuit board with all the components mounted. While R_7 is listed as 270 ohms, which was determined as the value required to

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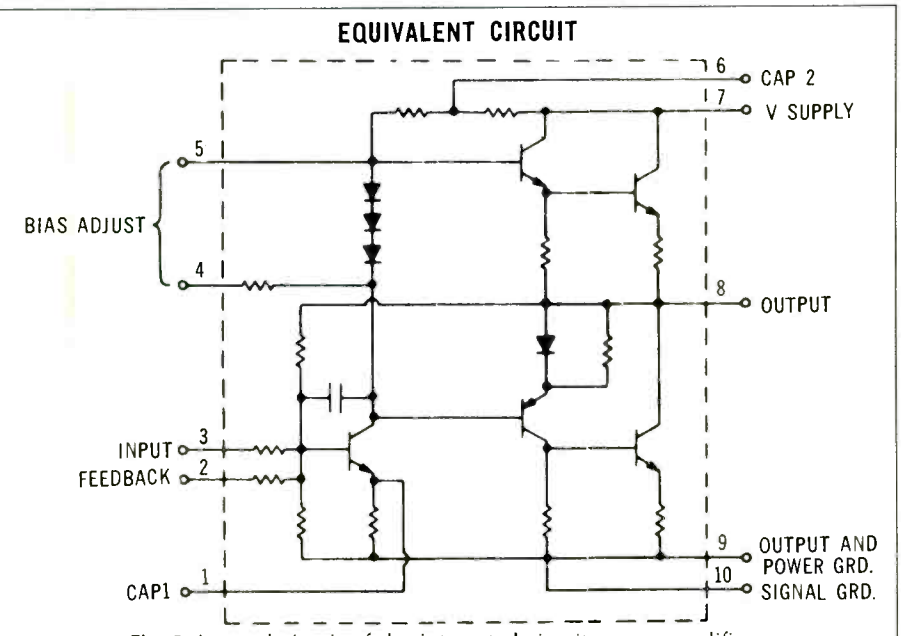


Fig. 3. Internal circuit of the integrated-circuit power amplifier.

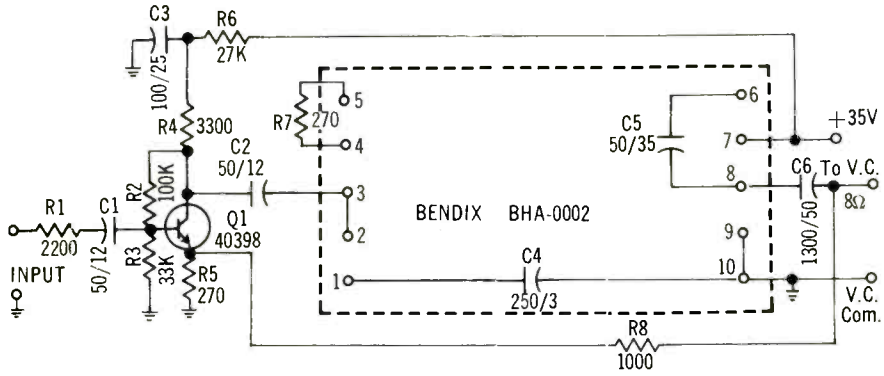


Fig. 4. Schematic of the completed unit with an additional stage to provide for more feedback to increase output into an 8-ohm load. The integrated-circuit amplifier is shown inside the dotted lines.

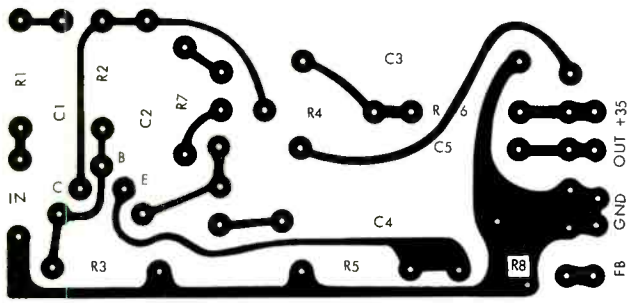


Fig. 5. Layout for the printed circuit board shown full size. This drawing may be copied exact size to make your own printed circuit board.

PARTS LIST

C_1, C_2	50 μF, 12 V electrolytic capacitor, Sprague TE-1133	R_2	100 K ohms, 1/2-watt resistor
C_3	100 μF, 25 V electrolytic, Sprague TE-1211	R_3	33 K ohms, 1/2-watt resistor
C_4	250 μF, 3 V electrolytic, Sprague TE-1065	R_4	3300 ohms, 1/2-watt resistor
C_5	50 μF, 35 V electrolytic, Sprague TE 1306	R_5	270 ohms, 1/2-watt resistor
C_6	1300 μF, 50 V electrolytic, Sprague 132G050AA	R_6	27 K ohms, 1/2-watt resistor
R_1	2200 ohms, 1/2-watt resistor	R_7	270 ohms, 1/2-watt resistor
		R_8	1000 ohms, 1/2-watt resistor
		Q_1	40398 transistor
			1 Universal capacitor mounting clip, 1 3/8-1 7/16 in.
			1 Bendix BHA-0002 15-watt amplifier

produce the idling current of 7 mA with the units that were tested, it is possible that a different value might be required on other samples of the amplifier. 270 was right for three of the four units available; the fourth required 330 ohms.

The amplifier is clamped to the speaker basket as shown in Fig. 1, using the bracket provided with the amplifier. In the case of the Tannoy Dual Concentric, the basket was rounded slightly, so it was necessary to file it flat enough to make a suitable contact with the amplifier substrate. To ensure good heat sinking, the bottom of the amplifier was covered with a silicone compound before mounting. Two holes were drilled with a #43 drill, and tapped for 4-40 screws, spaced to accommodate the mounting clamp. The amplifier was then mounted on the basket with the screws provided, making sure to use the springs under the screw heads. The logical mounting for the amplifier is with the end having terminals 6 to 10 nearest the magnet assembly, since the output leads are at that end, and that is where the input connections to the speaker are most likely to be. The output coupling capacitor, C_6, is mounted in a capacitor clamp on the opposite leg of the basket. For the Tannoy, which has an input cable that feeds the dividing network rather than a simple pair of terminals on the speaker itself, it was necessary to mount a two-terminal strip on the basket. If the speaker used has input terminals on it, this strip will not be necessary.

The circuit board is next slipped over the ten terminal pins of the amplifier and soldered in place. Depending on the space around the circuit board, it may be desirable to attach the leads to the board before soldering it to the amplifier. The "output" lead is connected to the positive terminal of C_6, and the negative terminal of the capacitor and the "ground" terminal of the circuit board feed the speaker input. An additional lead from the negative lug of the capacitor connects back to the feedback terminal, marked "FB" on the circuit board. The supply is connected to the "+35" and "GND" terminals of the circuit board, and the input leads connect to the "IN" terminals.

Performance

With the additional input stage, the amplifier was capable of putting out 13 watts into an 8-ohm load at a distortion of only 0.2 per cent. Frequency response was within 1 dB from 12 to 22,000 Hz, dropping off thereafter to half-power points at 9 and 37,000 Hz. Distortion at a 1-watt output was less than 0.1 per cent.

At the suggestion of Bendix engineers, a supply of 40 volts was applied for testing, using a regulated power supply which could be set to interrupt at a specific output current —in this case, 800 mA. This increased supply voltage provided a comfortable 15 watts output at the same 0.2 per cent distortion. However, with an unregulated supply, it was considered safer to work with 35 volts to avoid exceeding the maximum in case of line-voltage variations in the upward direction.

Listening quality of the mono amplifier was comparable to that of most amplifiers in the average-quality range. It did not compare with that from a number of really top-quality units, but from the standpoint of size and simplicity of assembly, it was judged to be an excellent unit. If it were to be used with an enclosed speaker system, the amplifier should be mounted on a piece of 6 in. square, ⅛-in. thick aluminum. This type of heat sink could well be mounted on the back of a speaker cabinet with ½-in. spacers to provide for free circulation of air. The amplifier should not be used to drive low-efficiency speaker systems, however, since many of these require as much as 30 watts for satisfactory operation. It is suitable for use with any of the high-efficiency models, and is easily capable of putting out around 10 volts into an 8-ohm load, which is about its limit.

At the price of $9.40 each in lots of 1 to 24, the Bendix BHA-0002 is economical to use. If you can use 25 or more, the price goes down to $7.50, and for 100 or more, the price is $6.50—just in case you are planning on a large installation. The amplifier is available from Bendix Semiconductor Division, South St., Holmdel, N. J. 07733, and likely from their stocking distributors throughout the country. Æ

How to Add Electrostatic Tweeters

ROBERT C. EHLE

THE ELECTROSTATIC TWEETER has had considerable popularity for several years. This is probably due to the fact that the electrostatic tweeter has a relatively smooth and musical frequency-response curve, and that several inexpensive electrostatic tweeter units have been placed on the market. These were manufactured by various companies and included some imports from Germany, marketed at very low prices (about $1.50 each) by various American parts houses.

The electrostatic tweeter, as is well known, requires a polarizing voltage from 300 volts up to thousands of volts. Due to its extremely high internal impedance, however, no current is drawn, thus simplifying power-supply design considerably. In the days when vacuum-tube amplifiers were standard, it was a simple matter to use the amplifier's power supply to polarize the loudspeaker as well. The circuit is simple, requiring only two extra capacitors and two resistors to decouple the high voltage from the audio.

A second advantage of using electrostatic speakers with vacuum-tube amplifiers is the natural impedance match between these two types of devices. The vacuum tube and the electrostatic tweeter are both high-impedance devices and, thus, the vacuum-tube amplifier may be made to drive the electrostatic loudspeaker in an output-transformer-less (OTL) mode just as a transistor amplifier will drive the dynamic loudspeaker directly (both devices being low impedance).

The connection of electrostatic tweeters to vacuum-tube amplifiers is made direct to the plates of the output tubes (through suitable capacitors) to the electrostatic tweeter, as shown in Fig. 1.

Today, with the increasing popularity of transistor amplifiers, the situation is different. It is no longer a simple matter to connect electrostatic tweeters to transistor amplifiers because there is no power supply having a sufficiently high voltage to polarize the speaker and there is no audio output of sufficiently high impedance to drive the electrostatic tweeter directly. Both a power supply and an impedance converter are required for electrostatic tweeters to work.

This article describes a simple power supply and impedance converting system applicable to simple tweeters of the unipolar type (the type having one fixed and one moving electrode) which is the type generally used as tweeters. The bi-polar type has somewhat less harmonic distortion but, at frequencies above 5000 Hz, even the second harmonic (being twice the fundamental frequency) is close to the limit of audibility while others are inaudible. Thus, the electrostatic tweeter makes a particularly effective and inexpensive method for extending the range of medium-priced dynamic woofers. With the circuit described here they are also adaptable to transistor amplifiers with the same results.

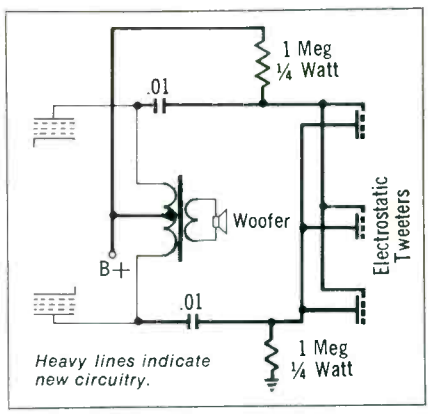


Fig. 1—Connections for driving electrostatic tweeters from vacuum-tube amplifiers.

Figure 2 is a schematic of the circuit developed by the author and described in this article. It consists of two parts: a three-hundred-volt power supply, and an impedance matching and decoupling circuit. The power supply is a type of voltage doubler. The transformer (T1) is a very small 150-volt secondary (peak-to-peak) power transformer. The two diode rectifiers are epoxy-breakdown voltage. The power supencapsulated units with 600-volt

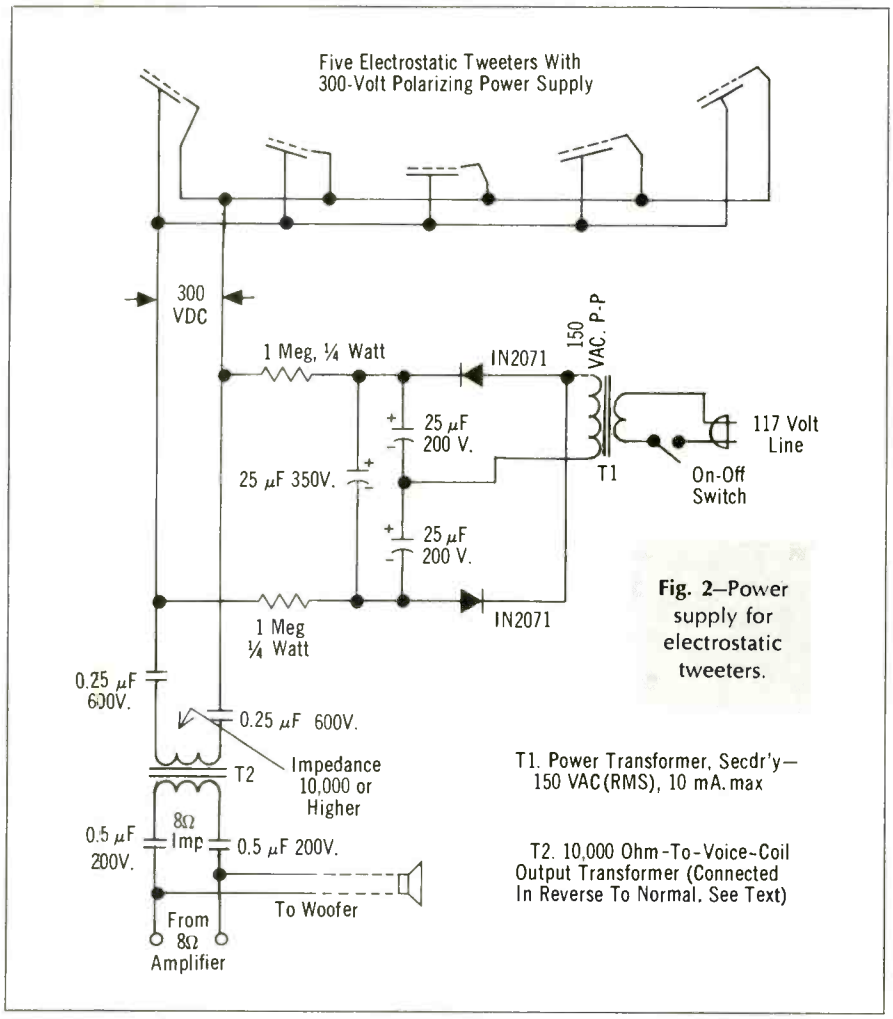


Fig. 2—Power supply for electrostatic tweeters.

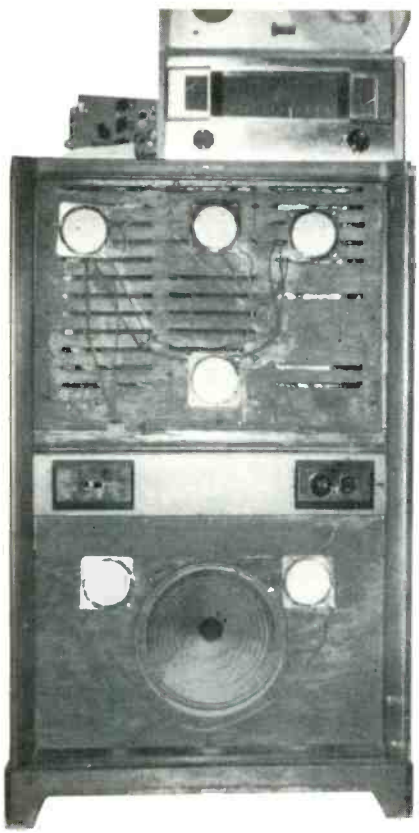
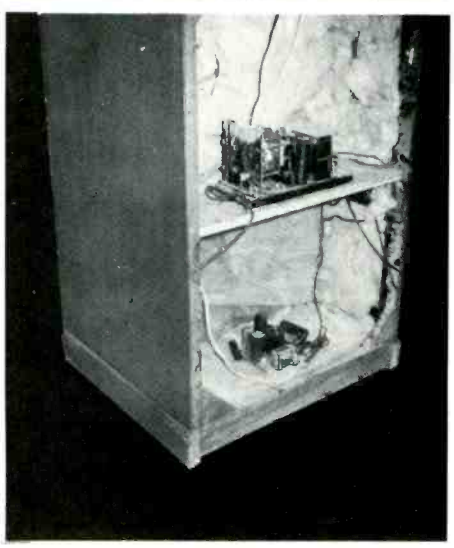


Fig. 3—Author's loudspeaker system with grille cloth removed to show electrostatic speakers. At bottom is rear of the enclosure. The upper unit is a transistor amplifier; the lower unit is the power supply for electrostatic speakers.



ply is capable of supplying 300-plus volts into a high-impedance circuit but it cannot supply much current. If one attempts to measure the voltage with a 20,000 ohm-per-volt meter the voltage falls off and finally stabilizes at approximately 280 volts d.c. The two resistors provide protection for the diodes in case of short circuits and also serve to decouple the audio from the power supply.

The audio circuit consists of an impedance-matching transformer which is, in fact, a conventional audio output transfromer connected in reverse. That is, the input impedance is about eight ohms and the output impedance approximately 10,000 ohms. It serves to step up the low output impedance from transistor amplifiers to match electrostatic tweeters. The capacitors serve two purposes. First, they decouple the high polarizing voltage from the audio input and, second, they serve as high-pass networks to prevent low-frequency power from entering the tweeter circuits. Thus, no additional crossover networks are needed since most dynamic woofers roll off naturally in the frequency range where electrostatic tweeters are ideally used.

The schematic shown in Fig. 2 includes five electrostatic tweeters and illustrates a situation where any number of tweeters may actually be used. In fact, even with the impedance step-up transformer, the impedance to the tweeters will only be 10 to 20 thousand ohms from most standard output transformers. The impedance of the tweeters is many megohms. Therefore, any number of them may be connected in parallel without sacrificing output from each individual speaker. Thus, the efficiency of the loudspeaker system will be directly related to the radiating area (that is, the number of speakers used). An additional advantage to multiple speakers is the possibility of mounting them in a curve to increase the effective radiating angle. This type of situation can make an effective high-frequency loudspeaker system if several inexpensive speakers are obtained. The cost can be equal to or less than more conventional tweeters and can offer special advantages unique to the electrostatic tweeter. Æ

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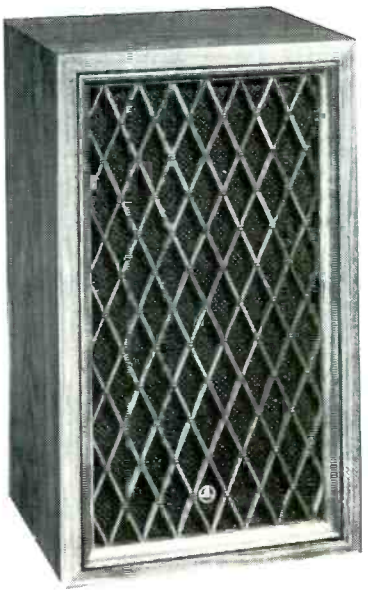

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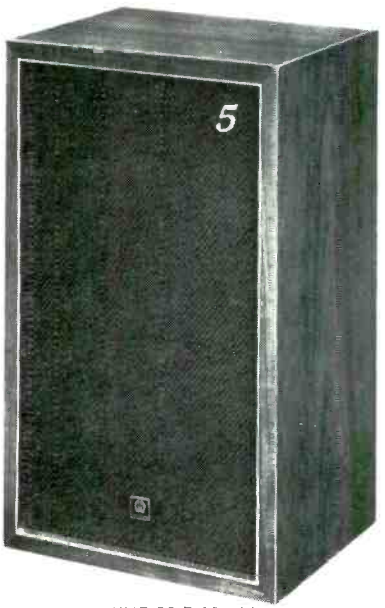

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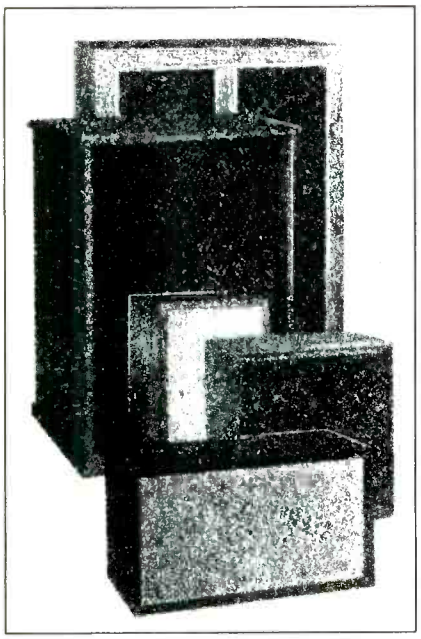
1969 Speaker System Buying Guide



Of over 130 speaker systems listed on the following pages, about one-half utilize acoustic suspension systems, while the other half opted for other designs—bass reflex, infinite baffle, horn loaded, etc.—as a means of achieving good bass response. The same dissimilar design approach holds true for tweeters, which include cone types, dome types, horns, electrostatic radiators, and so on. Each group has its advocates.

Specifications (supplied by respective manufacturers) constitute the heart of the speaker system buying guide. From it, readers can garner considerable comparative data to make a buying decision easier. We cannot stress strongly enough, however, that *performance* specifications are, at best, only a rough gauge of a speaker system's merits. Manufacturers, unfortunately, do not use the same test conditions. In our judgment, however, it is better to have a broad concept of how a speaker is claimed to perform than to have no idea whatsoever.

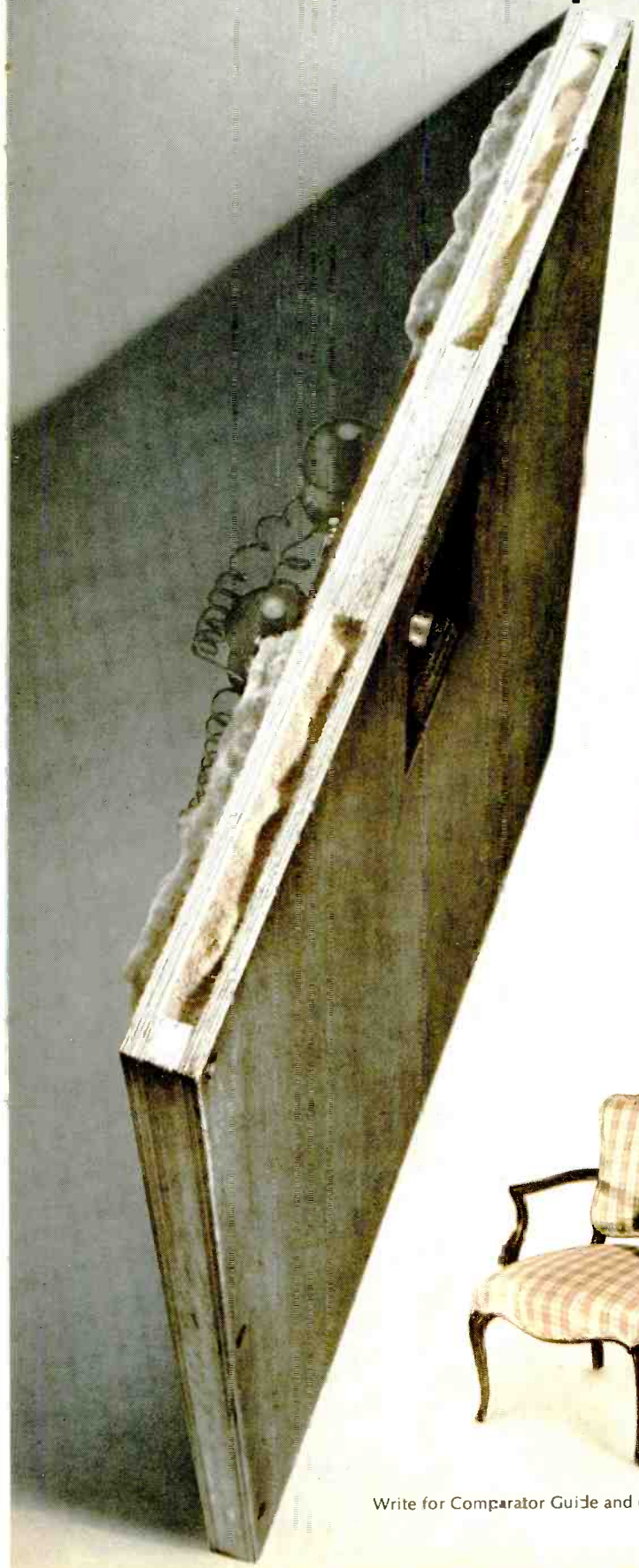
Some manufacturers omitted certain categories because they either did not have the information at hand, or objected to a listing because of the absence of qualifications. The categories "woofer resonance," "overall frequency response," and "power-handling capacity" were very much in dispute, for example. One manufacturer pointed out that they measure woofer resonance as used in the system, while others give woofer resonance outside the enclosure. Another manufacturer observed that power-handling capacity depends on the wave shape and fundamental frequency of the signal, and that handling continuous power is a very different story. Some manufacturers declined to list frequency response since industry-wide standards governing such test procedures have not been established. Others listed frequency response without a tolerance, which is, frankly, meaningless.

After pinpointing a speaker system(s) selection you might be interested in buying, based on specifications, dimensions, price, et al, be sure to listen to them, preferably in an A-B situation. Keep in mind, too, that speaker systems sound differently in other environments. As an example, a bright-sounding speaker in a dealer's well-damped listening room might be too bright for you if your room does not have absorbent furnishings.

The same tabular format used by AUDIO in the past is employed in the Speaker System Buying Guide (overleaf page). A circled number under a manufacturer's name directs you to the page on which his advertisement appears.

(Turn page for speaker system directory)

Does WHARFEDALE still use sand in its speaker systems?



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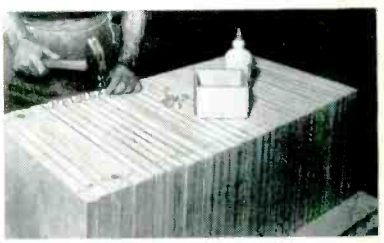
2. Panels are stacked on specially designed vibrating machine. Note small, round openings on top edges, for fine-grain, cleansed white sand.

3. Sand is poured on, filtering slowly through small openings into panel cavities. Vibration machine eliminates air pockets, insures maximum compression.



4. Feed holes are sealed with wood plugs. Panel becomes totally inert to the back waves of sound which will be projected against it in the speaker enclosure.

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Wharfedale

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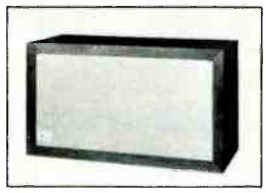
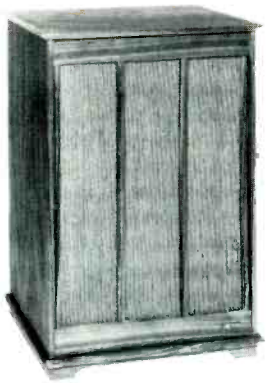
Write for Comparator Guide and dealer list to: Wharfedale Div., British Industries Corp., Dept. HF-2, Westbury, N.Y. 11590.

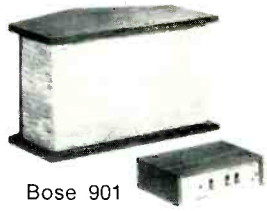
AUDIO's 1969 Speaker System Buying Guide



AR-3a



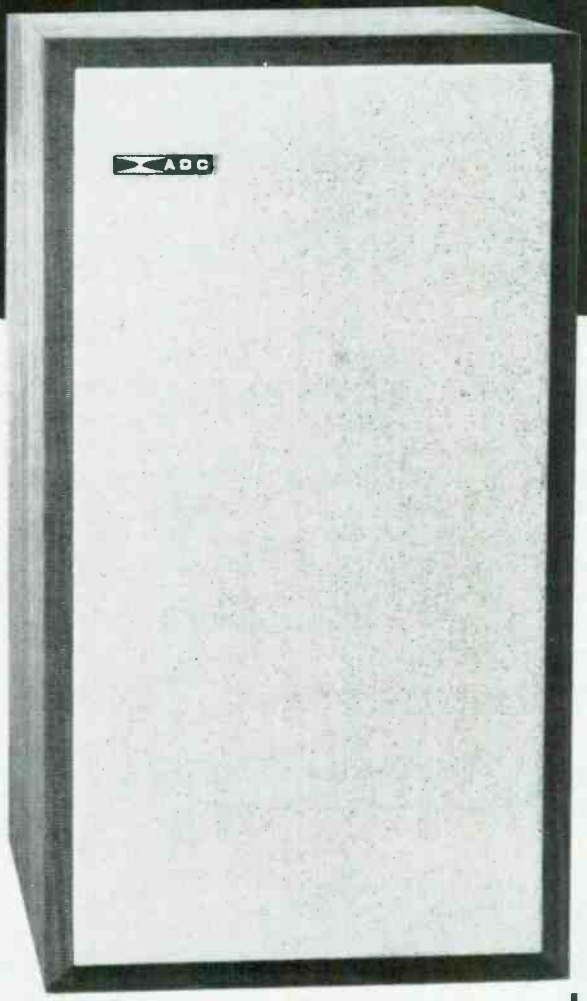
ADC 18A



Bose 901

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance, Hz.	WOOFER Enclosure Type	MID-RANGE Diameter, In.	MID-RANGE Type	TWEETER Diameter, In.	TWEETER Type	Overall Freq. Response, Hz. ±dB	Min. Amplifier Power Req'd, W.	Power Handling Capacity, W. (rms)	Crossover Frequencies, Hz.	Impedance, Ohms	Enclosure Dimensions, In. W x D x H	Wood Finish	Grille Material & Color	Weight, Lbs.	Price	SPECIAL FEATURES
ACOUSTECH	X			All Electrostatic System					30-30k	–	–	1300	–	30 x 4 x 72	Wal	Cloth Beige	175	1690.00	Incls. 4 ampls. 500-w. music pwr. Electronic crossover.
ACOUSTIC RESEARCH	AR-3a	12	44*	Acoustic Susp.	1½	Dome	¾	Dome		25		575 5000	4	25 x 11⅜ x 14	Oil Wal. & 6 Others	Burlap Beige	53	250.00	*Special Note: Woofer resonances for AR are given as used in the system.
	AR-5	10	56*	Acoustic Susp.	1½	Dome	¾	Dome		20		600 5000	8	24 x 11½ x 13½	Oil Wal. & 6 Others	Burlap Beige	39	175.00	
(17)	AR-2a[X]	10	56*	Acoustic Susp.	3	Cone	1⅜	Dome		20		1750 7500	8	24 x 11½ x 13½	Oil Wal. & 6 Others	Burlap Beige	36½	128.00	
	AR-2[X]	10	56*	Acoustic Susp.	–	–	3½	Cone		20		1200	8	24 x 11½ x 13½	Oil Wal. & 6 Others	Burlap Beige	33	102.00	
	AR-4[X]	8	68*	Acoustic Susp.	–	–	2½	Cone		15		1200	8	19 x 9 x 10	Oil Wal. Unf.	Burlap Beige	18½	57.00	
ALLIED	2380	15	16	Duct Loaded	Horn	Horn	1½	Dome	20 ▷ Aud.	10	50	2000, 10,000	8	20½ x 14 x 30	Oil Wal.	Cane Straw	52	149.95	Midrange and treble controls.
	2300C 2300CK	12	28	Air Susp.	Horn	Horn	Horn	Horn	25-20k	20	30	1000, 5000	8	25 x 13½ x 14	Oil Wal.	Cloth Brown	47	99.95 79.95k	H.F. Level Control.
	3030B 3030BK	12	65	Duct Loaded	6	Cone	3½	Cone	35-17k	10	30	400 5000	8	24 x 9 x 14½	Veneer Wal.	Cane Straw	26	64.95 49.95K	H.F. level control.
ALTEC LANSING	A7-500 W-II	15	25	L.F. Horn + Reflex	10 x 23	Horn multicel			30-22k	10	30	500	8-16	32 x 25 x 44	Wal.	Fretwork	170	537.00	"Voice of the Theatre" components, Fretwork grille.
	846A	15	25	Reflex	8 x 18	Horn	Covered by horn		35-22k	10	50	800	8-16	28 x 19 x 30	Wal.	Fretwork	100	333.00	Same as above.
	847A	12	32	Reflex				Horn	40-22k	10	35	3000	8	19 x 14 x 26	Wal.	Fretwork	60	246.00	Multicellular horn.
(31) (65)	890C	10	28	Free susp. phase inv.			Compression type		40-22k	20	35	3000	8	26 x 12 x 15	Wal.	Cloth Beige Snap-on	30	179.50	10" phase inverter.
	892A	10	28	Inf. Baffle			Compression horn		45-18k	20	50	2500	8	24 x 12 x 13	Wal.	Cloth Snap-on Type	44	149.50	Snap-on grille.
	893A	10	30	Inf. Baffle			3" HF speaker		50-18k	20	40	2500	8	22 x 10 x 13	Wal.	Cloth Snap-on	22	89.75	Snap-on grille.
AMPEX	715	(2)6	68	Air susp.			3½	wide dispersion air damped	50-20k	6	30	1200	8	19 x 13 x 9¼	Oil Wal.	Cloth dk. brn.	45 pr.	129.00 pr.	New dual woofer.
	415	–	–	–	4" wide range Dynamic		–	–	100-15k	8	21	–	8	6 x 6 x 6	Oil Wal.	Cloth Beige	5 pr.	39.90 pr.	
ADC	ADC 18A	15	20	Acoustic Susp.	5¼	Cone	(2) 1½	Dome	20-20k ±3	6	–	400 2500 7000	8	26½ x 17 x 39½	Oil Wal.	Cloth Brown		300.00	Removable frame, intchg. grille cloth. HF and mid controls.
(29)	ADC 400	10	30	Acoustic Susp.	5¼	Cone	1½	Dome	30-20k ±3	10	–	1000 7000	8	14½ x 11⅞ x 25	Oil Wal.	Cloth Brown		159.50	Same as above.
	ADC 303AX	10	30	Acoustic Susp.	–	–	1½	Dome	33-20k ±3	6	60	1500	8	13 x 11¾ x 22¾	Oil Wal.	Cloth dk. Brown		99.95	H.F. and mid level controls.
	ADC 404	6	35	Acoustic Susp.	–	–	1½	Dome	45-20k ±3	6	50	2500	8	7⅜ x 8¼ x 11⅞	Oil Wal.	Cloth Light		56.00	
BOGEN	LS-30	10	15	Acoustic Susp.	6	Comp. Cone	3	Cone	35-20k ±5	5	40	600, 5000	8	22 x 14 x 11	Oil. Wal.	Cloth blue-green tweed	40	99.95	Hi-frequency, mid controls.
	LS-20	8	25	Acoustic Susp.			3	Cone	50-20k ±5	5	32	1100	8	19 x 10 x 9	Oil. Wal.	Cloth blue-green tweed	22	59.95	Hi-Frequency control.
BOSE (33)	901	(9) full-range, high-compliance long-throw spkrs. in each encl.								20	270 rms	none	8	20 5/16 x 12 7/8 x 12¾	Oil Wal.	Belgian linen Beige	33	238.00	89% reflected, 11% direct sound. Active equalizer w. 20 sep. contours.
BOWERS & WILKINS	F2 HEA	9 x 12	25	friction-loaded reflex	3 x 5	Alum. Cone	2 x 8	Ionic Cloud	30-40k ±5	10	25	3500	8	16½ x 15 x 50	Teak	Cloth Gray	110	450.00	Cal. curve supplied.

When you hear the sound of this new ADC 210 you'll gladly pay $100. But don't.



$100 quality... inside and out.

- Book shelf or free standing totally enclosed 2-way system. 22¾" x 13" x 10¾".
- High flux long throw 8" woofer with 4 layer aluminum voice coil.
- Frequency response 35 to 18,000 Hz ± 4db.
- Impedance 8 Ohms. 6 to 60 watt maximum.
- 2½" wide dispersion Mylar dome tweeter.
- 3 position treble control.
- Non-ported fully loaded walnut cabinet ¾" and 1" solid stock, oil finished.
- Removable grill for customizing to any decor.

We challenged our engineers to create a $100 speaker that would outperform any other competitive speaker selling in this price range. Then to make it an even more difficult assignment, we told them this speaker had to be sold for less than the others. For $74.50. And they did it!

Actually it wasn't surprising, because after all ADC is the expert in the speaker business and has been for many years. If you're in the market for a most superb speaker at an almost absurd price . . . ask to see the ADC 210.

$74.50 Suggested retail

- Quality magnetic cartridges
- Home entertainment electronics
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ADC

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Please send free detailed brochure on your new ADC 210 and your complete line of speakers. Also name of my nearest dealer.

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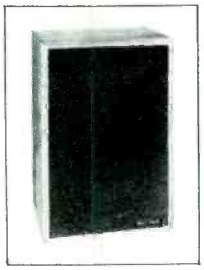
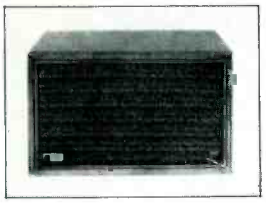
Speaker Systems (continued)

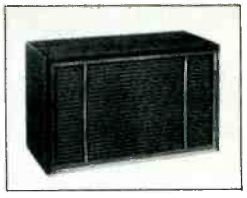


Fairfax FX-100



Fisher XP-7

Harman-Kardon HK-50



Heathkit AS-38

JBL Sovereign II

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance, Hz.	WOOFER Enclosure Type	MID-RANGE Diameter, In.	MID-RANGE Type	TWEETER Diameter, In.	TWEETER Type	Overall Frequency Response, Hz. ± dB	Min. Amplifier Power Req't., W.	Power Handling Capacity, W. (rms)	Crossover Frequencies, Hz.	Impedance, Ohms	Enclosure Dimensions, In. W x D x H	Wood Finish	Grille Material and Color	Weight, Lbs.	Price	SPECIAL FEATURES
FAIRFAX (69)	FHC-Studio			Folded Horn					20-20k		60	900 4000	8	28¾ x 20 x 12	Oil Wal.			259.50	
	FH-C			Folded Horn	3½	Cone		Dome	25-20k		40		8	28¾ x 20 x 12				169.50	Var. h.f. and Mid Cont.
	FX-100	8		Reflex	–	–	3½	Cone	30-20k			5500	8		Oil Wal.			89.50	Var. h.f. and Mid Cont.
	C-150	8		Single Extended-Range Speaker					45-18k		30	–	8	12 x 12 x 12	Var.	Var.		59.50	"Color Cubes"
FISHER	XP-18	18	14	Air Susp.	8 5¾	Cone	(2)2	Dome	30-22k	10	50 Music	150. 1500 3000	8	30½ x 16½ x 29½	Oil Wal.	Cloth Wal.	105	329.95	4-way sys. high compl. woofer, sep. conts: Lo-mid, hi-mid, tweeter.
	XP-15B	15	15	Air Susp.	8	Cone	1½	Dome	28-20k	10	50 Music	400 2500	8	27 x 14⅜ x 27	Oil Wal.	Cloth Green	80	269.95	High comp. woofer; 12-lb. mag. Sep. controls 3-way sys.
	XP-12	12	25	Air Susp.	8	Cone	1½	Dome	30-20k	10	50 Music	400 2500	8	22½ x 24 x 13¾	Oil Wal.	Cloth Brown	60	199.95	
	XP-60	10	30	Air Susp.	–	–	2½	Cone	35-20k	10	40 Music	1000	8	23 x 13 x 10½	Oil Wal.	Cloth Brown	30	79.95	
	XP-55B	8	38	Air Susp.	–	–	3	Cone	37-20k			1500	8	20 x 7½ x 10	Wal. (Vinyl)	Cloth Green	18	49.95	Compact 2-way system high-compl. woofer.
GOODMANS (75)	MAGNUM-K	12	20	Air Susp.	4	Cone	3½	Cone	30-20k	10 rms	25 rms	1500 6000	4-8	15 x 11 x 24	Wal.	Cloth Black	47	189.00	Separate mid-and high freq. controls.
	MEZZO-II	12	35	Air Susp.	–	–	4	Cone	40-20k	10 rms	15 rms	2000	8	12 x 9 x 19½	Wal.	Cloth Black	20	139.00	Flush High-freq. control.
	ELEGANZIA II	12	35	Air Susp.	–	–	4	Cone	35-15k	10 rms	15 rms	900	16	27 x 20 x 6¼	Wal.	Cloth Brown	35	99.95	Extremely thin.
	MAXIM	4	35	Air Susp.	–	–	3½	Cone	40-20k	6 rms	12 rms	2200	16	10½ x 7¼ x 5½	Wal.	Cloth Brown	8	59.95	Extremely small.
HARMAN-KARDON	HK-50	8	28	Air Susp.	–	–	2¼	Paper	30-20 khz	5	40	2500	8	10¾ x 10¾ x 18	Oil Wal.	Char Brown	24	110.00	Hi-Freq. control. Omni dir. dispersion.
	HK-10	6	40	Air Susp.	–	–	–	–	40-18 khz	2	20	–	8	9 x 7½ x 14	Oil Wal.	Char-Brown	10½	45.00	
HARTLEY	VI a	24	13	Semi-inf.	10	Cone	7	Cone	16-25k ± 3	15	60	300 3000	16	29 x 18 x 40½	Oil Wal.	Cloth Bk.-Gof.	125	760.00	All cones of same material.
	Capri	10	28	Inf. Full-range Co-ax.			3	Cone	40-25k ± 4	15	40	1500	8	24 x 12 x 12	Oil Wal.	Cloth Brown	35	180.00	Mag. Susp.
HEATH (37)	AS-48	14	30	Ducted Port	–	–	2	Cone	40-20k	4	50	2000	8	23½ x 12 x 14	Pecan	Cloth Brown	43	169.95K	New Model.
	AS-38	12	32	Ducted Port	–	–	2	Cone	45-20k	4	40	2500	8	23½ x 11⅜ x 14	Oil Wal.	Cloth Brown	37	149.95K	New Model.
	AS-10	10	58	Air Susp.	–	–	(2)3½	Cone	30-15k	10	40	2250	16	13½ x 11½ x 24	Unf. Wal.	Cloth Brown	43	59.95K 64.95K	Acous. Susp.
	AS-37	8	70	Ducted Port	–	–	2 x 6	Horn	50-12k	3	25	1600	8	23 x 11⅛ x 11½	Wal. Vinyl	Cloth Brown	29	39.95K	New Model.
	AS-18	6	40	Air Susp.	–	–	2½	Cone	60-20k	4	25	3000	8	15⅛ x 6½ x 8¼	Wal.	Cloth Brown	16	32.95K	New Model.
JBL	Olympus S7R	15	20	Passive Radiator	–	–	Horn	Acoustic Lens	Full Range	10	60	500	4,8,16	40 x 20 x 26½	Oil Wal.	Wal. Fretwk.	165	678.00	JBL Passive radiator, Slant-plate treble lens.
	Sovereign II S7	15	20	Closed, Ported Enclosure	–	–	Horn	Acoustic Lens	Full Range	10	50	500	4,8,16	26½ x 20 x 26½	Golden or Country Oak	Special Pleated Fabric	100	657.00	Avail. with JBL energizer and matching equalizer board.
	Alpha I	12	28	Passive Radiator	5	Cone	1.7	Paper Cone	Full Range	10	50	1200 7000	4,8,16	26½ x 35 x 17⅝	Russet Oak	Cloth Brown	230	324.00	Augmented two-way system, matching equip. cab. avail.
	88 Nova	12	28	Ported	–	–	1.7	Paper Cone	Full Range	10	40	2000	4,8,16	23½ x 11⅜ x 14¼	Oil Wal.	Cloth Brown	46	180.00	Hi-freq. cont. Also avail. as Cortina.
	Lancer 77	10	20	Passive Radiator	–	–	1.7	Paper Cone	Full Range	10	40	2500	4,8,16	22½ x 11¾ x 14	Oil Wal.	Ok. Brown Cloth	42	162.00	JBL Passive radiator. 14-element H.F. lens.
JVC NIVICO	5340	12	30	Air Susp.	–	Cellular Horn	3½ 2	Cone Horn	20-20k ± 6	25	40	1000 7000 10,000	8	16½ x 15¼ x 28½	Wal.	Cloth Dark Brown	47	229.95	Multi-channel-input terminals. 2 level controls. Removable front panel.
	5303	(4)5	35	Air Susp.	–	–	(4)2	Horn	20-20k ± 6	25	80	5000	8	Spherical 13½ dia.		Metal Black	26.5	199.95	Spherical Shape. Omni-directional Radiation.
	5304	12	45	Air Susp.	6½	Cone	3½ 2	Cone Horn	30-20k ± 6	20	40	1500 7000 10,000	8	15⅝ x 13⅜ x 24⅜	Wal.	Cloth Dark Brown	35	169.95	Multi-channel-input terminals, 2 level controls. Removable front panel.
	5320	8	45	Air Susp.	3½	Cone	2	Cone	35-20k ± 6	20	30	5000 10,000	8	13 x 9⅜ x 21½	Wal.	Cloth Dark Brown	20	89.95	Hi-freq. Cont. Removable front panel.
	5305	8	65	Bass Reflex	–	–	3½	Cone	40-20k ± 6	10	18	5000	8	13 x 9⅜ x 21½	Wal.	Cloth Black	20.5	69.95	

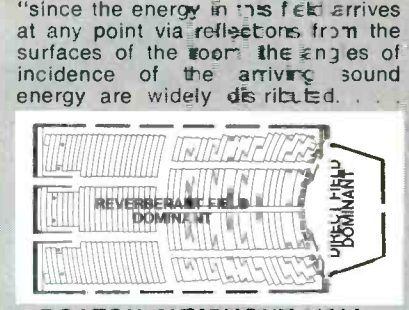
BOSE puts you in the REVERBERANT FIELD

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

We've mentioned previously that the "spatial property of the sound incident on a listener is a parameter ranking in importance with the frequency spectrum of the incident energy for the subjective appreciation of music."* By 'spatial property', we mean the directions from which the sound arrives at the listener — not the directions in which the sound leaves the speaker.

Yet though it is as important as frequency response, spatial property has played little part in the design of speakers prior to the 901. Measurements of a speaker, on-axis in an anechoic environment, deliberately avoid spatial property ('room effects') because in order to measure spatial characteristics, the speaker and the room must be considered as a system. No way was previously known to distinguish the contribution of the speaker from that of the room.

In a room, "the Sound Pressure Level drops off as the distance from the source increases until the direct field becomes smaller than the reverberant field. Beyond this point the intensity is independent of distance and its variation with room position is a function only of the standing wave pattern in the room. This becomes significant for loudspeaker design "when we examine the sound field in concert halls and find that for virtually all seats, the reverberant field is dominant. Even for a large hall such as Symphony Hall in Boston, the reverberant field equals the direct field at about 75 feet from the source." In the reverberant field, "since the energy in this field arrives at any point via reflections from the surfaces of the room the angles of incidence of the arriving sound energy are widely distributed. . . .



BOSTON SYMPHONY HALL
FLOOR PLAN

Conventional speaker design however results in the dominance of the direct field from the loudspeakers with the consequent localization of stereo sound in two points and the noticeable lack of fullness or openness of the reproduced sound."*

How The 901 Incorporates These Findings

The use of the Direct/Reflecting technique in the 901, with only 11% direct sound, is designed to simulate the concert hall experience by placing the listening area in the reverberant field rather than the direct field. The stereophonic experience of the listener is uniform throughout the room. The speakers vanish as point sources — even to a listener directly in front of one speaker. Instead, they project the image of the musical performance across the entire wall behind the speakers.

These spatial characteristics are combined with three other essential advances to produce the full range of benefits offered by the 901. They will be the subjects of other issues. Meanwhile, if you'd like to hear what spatial property means, ask your franchised ECSE dealer for an A–B comparison of the 901 with the best conventional speakers he carries, regardless of size or price.

You can hear the difference now.

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

THE BOSE CORP.
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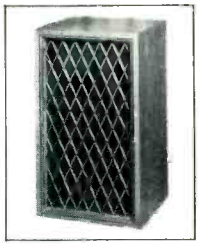
Speaker Systems (continued)

Neshaminy JansZen Z-960



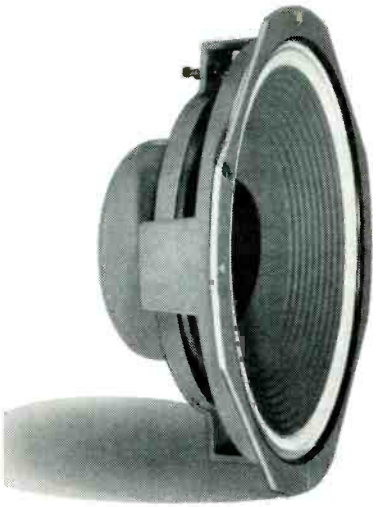
Pioneer CS-88

Rectilinear VI

Scott S-12

Sony SS-3100

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, In.	WOOFER Resonance, Hz.	WOOFER Enclosure Type	MID-RANGE Diameter, In.	MID-RANGE Type	TWEETER Diameter, In.	TWEETER Type	Overall Freq. Response, Hz. ± dB	Min. Amplifier Power Rec'd, W.	Power Handling Capacity, W. (rms)	Crossover Frequencies, Hz.	Impedance, Ohms	Enclosure Dimensions, In. W x D x H	Wood Finish	Grille Material & Color	Weight, Lbs.	Price	SPECIAL FEATURES
NESHAMINY	Z-960	(2)11	42	Inf. Baffle	3 Electrostatic Elements				30-30	20	100	800 2000	8	26¾ x 27½ x 14½	Oil Wal.	Cloth Beige	67	259.95	High-frequency switch.
PIONEER	CS-63	15	15	Air Susp.	6.5	Cone	2.5 + 2.5× 3.5	Cone & Horn	25-20k	10	60	800 3000 10,000	8	19 x 13 x 26¼	Oil Wal.	Cloth Gold & Brown	60	245.00	4-way 15-in. Bookshelf. Mid & Hi level controls.
	CS-88	12	15	Air Susp.	5	Cone	(2)2.5 + 2 Horn	Cone + Horn	25-20k	15	60	750 3500	8	14⁵⁄₁₆ x 13 24¹³⁄₁₆	Oil Wal.	Lat. Gr. Brown	48	175.00	3-way, 5 speakers.
(25)	CS-44	8	25	Air Susp.			2.5	Cone	35-20k	10	25	2500	8	9⅝ x 11 x 19	Oil Wal.	Lat. Gr. Brown	18	67.50	
	CS-5	8	25	Air Susp.			2.5	Cone	35-20k	10	25	2500	8	9⅝ x 11 x 19	Oil Wal.	Black	15	59.00	
	CS-52T	6.5	45	Bass Reflex			2.5	Cone	45-20k	10	20	3500	4	8½ x 8⅝ x 13⅜	Oil Wal.	Brown	11	45.00	
RECTILINEAR RESEARCH	III	12	22	Ducted Port	5	Cone	(2)2½ (2)2	Cone Cone	22-18.5k ± 4	20	100	250 3000 11,000	8	35 x 18 x 12	Oil Wal.	Fiberglass and Polyester White	70	279.00	Hi-freq. cont. light moving mass.
	VI	10	26	Ducted Port	5	Cone	(2)2½ (2)2	Cone Cone	26-18.5k ± 4	16	80	250 3000 11,000	8	14 x 11 x 25	Oil Wal.		50	239.00	
(41)	Mini-III	8	35	Air Susp.	5	Cone	2	Cone	50-18.5k ± 4	20	70	250 3000 11,000	4	12 x 9¼ x 19	Oil Wal.		25	79.50	3-way sys. Midrange and tweeter conts.
ROLA CELESTION	Ditton 25A	12	20	Aux. Bass Radiator	2	Pressure	¾	Dome	25-20k ± 4	10	25	1700 12,000	8	14 x 11 x 32	Teak. Wal.	Cloth Brown	48	275.00	BBC pressure units. Resp. beyond aud.
	Ditton 15A	8	25	Aux. Bass Radiator			2	Pressure	30-15k ± 5	10	20	2500	8	9½ x 9¼ x 21	Wal.	Cloth Brown	20	110.00	
SANSUI	SP-200	12		Cone	(2)5	Cone	(2)2	Horn	35-20k	–	40	1500 5000	8	14 x 12 x 25	Oil Wal.	Fretwk. Wal.	40.6	179.95	Hand-carved grille. 3-pos level control.
	SP-100	10		Cone	5	Cone	2	Horn	45-20k	–	25	1500 5000	8	14 x 11 x 24	Oil Wal.	Fretwk. Wal.	34.8	139.95	As above.
	SP-30	6½		Cone	–	–	2	Horn	50-20k	–	20	7000	8	10 x 7 x 16	Oil Wal.	Fretwk. Wal.	10	199.95 pr.	Hand-carved grille.
	SP-50	8		Cone	–	–	2	Horn	50-20k	–	25	7000	8	12 x 9 x 19	Oil Wal.	Fretwk. Wal.	19.8	79.95	Hand-carved grille.
SCOTT	S-12	15	20	Air Susp.	5¼	Cone	3	Cone	30-20k	12	60	750 3500	8	27 x 21 x 16	Wal.	Cloth Tan	68	274.95	Controlled z; 3-pos. switch; high comp. woofer.
	S-11B	12	22	Air Susp.	4¼	Cone	3	Cone	35-20k	10	55	750-3500	8	24 x 14 x 11⅛	Wal.	Cloth Brown	36	149.95	As above.
	S-20	10	26	Air Susp.			3½	Cone	35-18k	7	50	1200	8	22⅜ x 11⅜ x 11	Antique Pecan	Cloth Red	32½	129.95	As above. Incls. base and interchangeable dec. cloth grille.
	S-15	10	26	Air Susp.	4¼	Cone	3	Cone	35-20k	10	50	750 3800	8	23½ x 11⅜ x 9	Wal.	Cloth Brown	24½	119.95	As above. Binding post – Connectrs. and standard spkr. plug.
	S-10	10	26	Air Susp.			3½	Cone	35-18k	7	50	1200	8	23½ x 11⅜ x 9	Wal.	Cloth Tan	21	89.95	As above.
	S-14V	6	36	Air Susp.			3	Cone	50-20k	6	25	2500	8	16 x 10 x 6½	Wal.	Cloth dk. Brown	13½	49.95	As above.
	S-17	8	34	Air Susp.			3	Cone	40-20k	7	35	2000	8	18 x 10½ x 8½	Wal.	Cloth Brown	16	59.95	As above.
SHERWOOD	SR-4 Tanglewood	(2)10	19	Acoustic Susp.	8 5	Cone Cone	3½	Inv. Cone	22-22k	12	75	200 600 3500	8	24 x 31½ x 13	Oil Wal.	Plas. cane nat.	73	219.50	H.f. cont.
(20)	SR-6 Ravinia II	15	19	Acoustic Susp.	5	Cone	3½	Inv. Cone	24-22k	10	70	600 5000	8	25 x 17 x 11½	Oil Wal.	Dark Wal.	53	159.50	H.F. cont.
	SR-5 Berkshire II	12	21	Acoustic Susp.	5	Cone	3½	Inv. Cone	28-22k	8	60	600 5000	8	24 x 14 x 9	Oil Wal.	Dark Wal.	40	119.50	H.f. cont. Snap-on grille.
	SR-1 Newport	10	23	Acoustic Susp.			4	Inv. Cone	35-22k	10	45	1800	8	24 x 13 x 9½	Oil Wal.	Plas. cane nat.	30	84.50	H.f. cont.
SONY	SS-3300	12	25		6½	Cone	2	Cone	30-20k			500 3000	16	22⅞ x 14⅝ x 31½	Wal.	Cloth blk.	90	349.50	Sep. sw. for multi-channel use.
	SS-3100	12	25		6½	Cone	2	Cone	30-20k			400 5000	8	15¼ x 11¹³⁄₁₆ x 26¾	Wal.	Cloth blk.	55	229.50	As above.
	SS-2800	10	30		6½	Cone	2	Cone	40-20k			600 6000	16	13⅜ x 9¼ 23⅛	Wal.	Cloth blk.	35	124.50	



A 14″ Woofer In A Bookshelf System Gives Floor Speaker Sound In Less Space At Lower Cost

New Heathkit® AS-48...Only $169.95

• Two custom-designed JBL® speakers • 14″ woofer for clear, solid bass response • 2″ direct radiator tweeter delivers clean, transparent highs • Extended 40-20,000 Hz frequency response • Handles up to 50 watts program material • High efficiency permits use with lower power amplifiers • High frequency level control • Rich pecan finish cabinet • Vertical or horizontal installation • Easy, one evening assembly

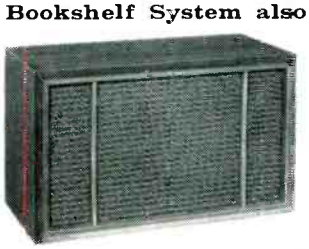
Until now, if you wanted a speaker system that performed like a floor system, you bought a floor system . . . and paid the price — in money and less living space. You don't have to anymore . . . we've taken the performance of an expensive, space-consuming floor system and put it on the bookshelf — the new Heathkit AS-48.

Two Custom-Designed Speakers . . . built by famous JBL to Heath's exacting specifications. A 14″ woofer is extremely rare in a bookshelf system, but the AS-48 has one — and it really delivers. A massive 11½ pound magnet assembly and a 4″ edgewound copper ribbon voice coil combine with a special inert, self-damping cone material to produce clean, crisp bass down to 40 Hz . . . without doubling or annoying distortion from overload. An RLC-type crossover network sends all frequencies above 2000 Hz to the 2″ direct radiator tweeter. The combination of a 1¼ pound magnet structure and rigid cone produce natural, uncolored highs up to 20,000 Hz. The total result is a sound no other bookshelf system can match, at any price.

Engineered For Discriminating Audiophiles. Heath engineers didn't stop with just an excellent choice of speakers for the AS-48. They included a precision, three-position high frequency level control that lets you balance the highs to compensate for room acoustics or speaker placement. A switch is used in place of the usual continuously variable control to insure exact balance between each system. The AS-48 will handle up to 50 watts of program material, making it the ideal system for use with the higher power amplifiers and receivers popular today. It also boasts very high efficiency, and will deliver creditable results when driven with as little as 8 watts. The one-piece ducted port cabinet is another example of total engineering . . . it results in an enclosure that is always "tuned" — air leakage through the back panel is eliminated. Assembly is also made easier . . . all components mount from the front of the rich pecan finish cabinet, and the AS-48 goes together in an evening. Measures only 14″ high x 23½″ wide x 12″ deep . . . installs either vertically or horizontally. Put the superb performance of a floor system on your bookshelf now . . . with the new Heathkit AS-48.

Kit AS-48, 57 lbs.....**$169.95***

The New Heathkit AS-38 Bookshelf System also has JBL speakers...a 12″ woofer and 2″ tweeter. 45-20 kHz response... handles up to 40 watts program...handsome walnut finish.



Kit AS-38, 49 lbs.....**$144.95***

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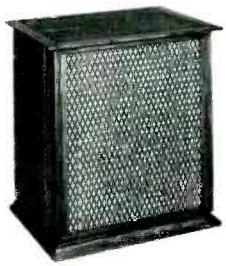
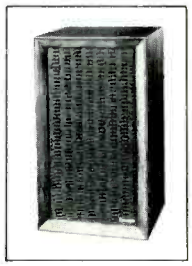
Speaker Systems (continued)



Tannoy Stuart



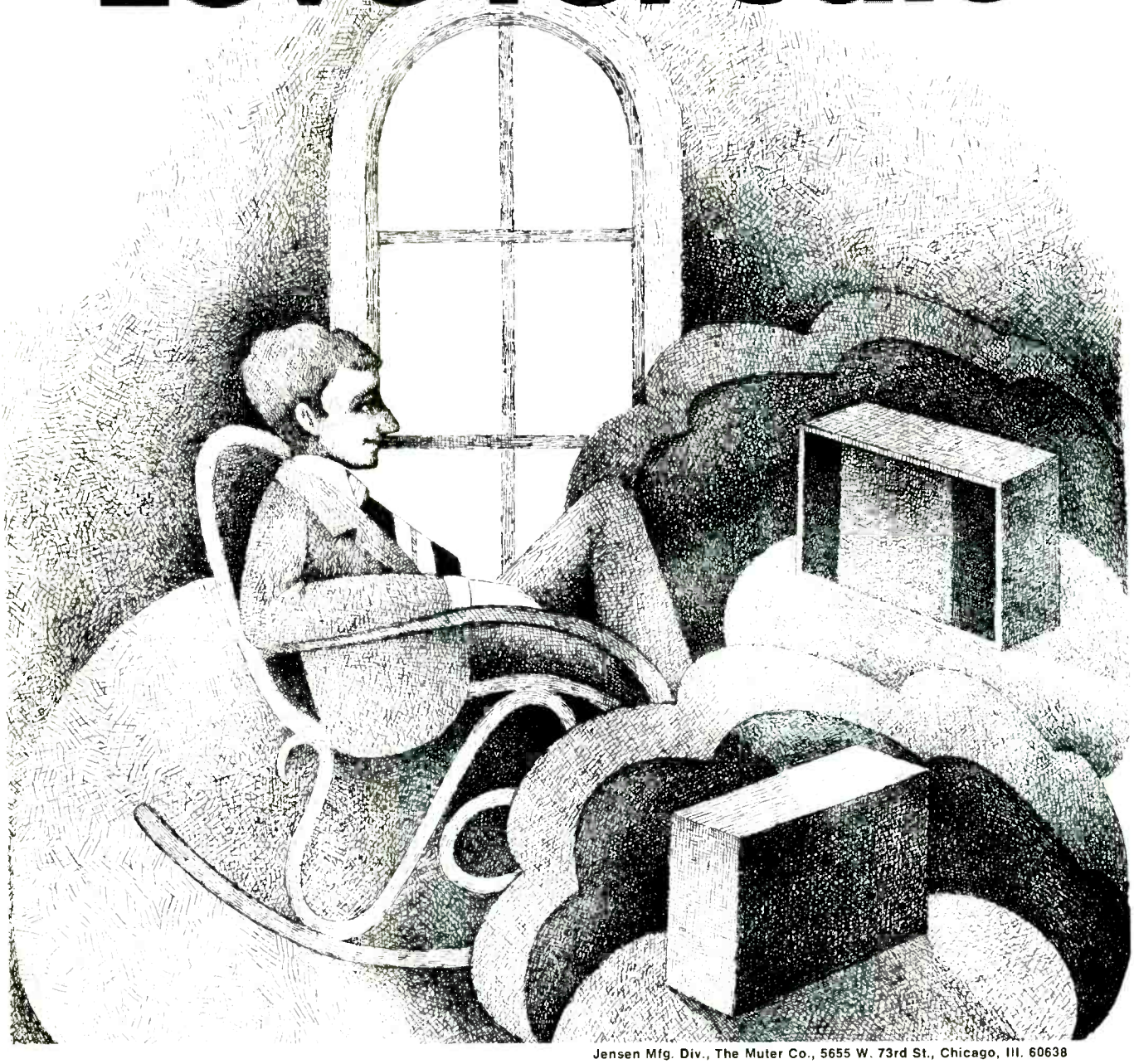
University Estoril

Utah AS-8

Wharfedale W90D (on B67 base)

MANUFACTURER (Circled number indicates ad page)	Model	WOOFER Diameter, in.	WOOFER Resonance, Hz.	WOOFER Enclosure Type	MID-RANGE Diameter, in.	MID-RANGE Type	TWEETER Diameter, in.	TWEETER Type	Overall Freq. Response, Hz. ± dB	Min. Amplifier Power Req'd., W.	Power Handling Capacity, W. (rms)	Crossover Frequencies, Hz.	Impedance, Ohms	Enclosure Dimensions, In. W x D x H	Wood Finish	Grille Material & Color	Weight, Lbs.	Price	SPECIAL FEATURES
TANDBERG	114 116-8	10			–	–	2½	Cone	45-16k					27½ x 10 x 10¼	Teak*	Teak		106.50	*or Rosewood
TANNOY	GRF Windsor	15	26	Rear horn loaded	–	–	2	exp. horn	35-20k ± 4	10	50	1000	8	23¾ x 17 x 42	Oil Wal.	Dec. wood wht. cloth	120	440.00	H.f. cont.; non-dec. model (GRF) $393.00
	Belvedere	15	26	Reflex	–	–	2	exp. horn	35-20k ± 5	15	40	1000	8	23¾ x 16 x 33½	Oil Wal.	Dec. wood wht. cloth	80	290.00	H.F. cont.; dec. model (Lancaster) $345.00.
	Stuart	12	28	Reflex	–	–	2	exp. horn	35-20k ± 4	15	30	1000	8	24⅛ x 16⅞ x 25½	Oil Wal.	Dec. wood wht. cloth	50	272.00	H.F. cont.; non-dec. model (Dalton) $232.00
	Cadet	10	30	Inf. baffle	–	–	2	exp. horn	40-20k ± 5	15	20	1200	8	13¼ x 11 x 23¾	Oil Wal.	Dec. wood wht. cloth	40	172.00	As above.
TELEX	4400	8	80	Acoustic Susp.	–	–	3½	Cone	20-20k			2500	8	16 x 5 x 14	Oil Wal.	Cloth brn. cane	25*	120.00*	*System-2 encls. w/built in pwr. amp., conts.
UTC	7	12	26		3½	Cone	Horn	Comp.	25-35k			1000, 8000	8	24 x 14 x 12	Oil Wal.	Cloth Seran	58	189.00	Conts. beh. Velcro rem. grilles.
(75)	5	12	28		6	Cone	Lens	Comp.	35-18k			1000, 5000	8	24 x 14 x 12	Oil Wal.	Cloth Seran	52	129.00	As above.
	55	12	32		6	Cone			30-20k			2000 5000	5	24 x 14 x 12	Oil Wal.	Cloth Seran	39	99.50	As above.
	33	8	32		–	–	3	Cone	35-18k			2000	8	18 x 11 x 9	Oil Wal.	Cloth Seran	25	56.00	As above.
UNIVERSITY	Classic Alhambra III	15	20	Rad. res. loading	8	Cone	Dome	Sphericon	20-40k	20	60	500 3000 5000	8	35 x 27¼ x 17½	Oil Wal. w/matte Bl. Trim	Cloth Brown	105	379.50	3-way conts.
	Mediterranean	12	20	Rad. res. loading	8	Cone	–	Horn	20-?aud	20	50	800 5000	8	24⅜ dia. x 22½	Butternut	Cloth Beige	74	269.50	End table commode, 3-way conts.
	Estoril	12	25	Aero-dynamic bass energized	Diffusicone			Dome	Sphericon	25-40k	10	40	1000* 3000	8	12 x 12 x 26½	Oil Wal.	Cloth Brn.	40	164.50	*Mech. xover.
(71)	Senior III	12	23	Rad. res. loading	8	Cone	Dome	Sphericon	23-40k	10	40	600 4000	8-16	23½ x 12⅛ x 15¾	Oil Wal.	Cloth Bei., Br.	40	145.00	Appl. grille cloth; bril & pres. conts.
	Laredo	12	35	Rad. res. loading	8	Cone	Dome	Sphericon	35-40k	10	40	600 1500* 3000	8	15 x 12 x 24	Oil Wal.	Cloth Brown	38	109.50	*Mech. xover in mid range cone.
	Project M	11	18	Acoustic Susp.	–	–	2½	Cone	30-?aud	30	60	1000	8	23½ x 12¾ x 11⅞	Oil Wal.	Cloth Beige	30	99.50	
	Ultra D	10	25	Acoustic Susp.	4	Cone	3½	Cone	30-?aud	10	32	1000 5000	8-16	23¹³⁄₁₆ x 9¾ x 11⅞	Oil Wal.	Cloth Eggshell	24	76.90	Brit and pres. controls.
	UR-4A	8	35	Rad. res. loading	–	–	2½	Cone	35-?aud	10	30	2000	8	19 x 10½ x 9	Oil Wal.	Cloth Beige	14	58.95	6 db/octave high-pass network.
UTAH	AS-8	12	25	Acoustic Susp.	4 x 10	Comp. Horn	1¾	Comp. Horn	35-20k	20	30	2200, 5000	8	30 x 12¾ x 25½	Wal.	Cloth Brown	60	189.00	Credenza; mid and h.f. conts.
	AS-6	12	25	Acoustic Susp.	4 x 10	Comp. Horn	1¾	Comp. Horn	35-20k	20	30	2200, 5000	8	25 x 13½ x 14	Oil Wal.	Cloth Gold	49	120.00	Mid and h.f. conts.
(73)	HS-4	12	45	Ducted port	4 x 10	Comp. Horn	3½	Cone	30-18.5k	10	20	800, 4000	8	25¾ x 14 x 15	Oil Wal.	Cloth Gold	46	94.50	H.F. Cont.
	AS-1	10	25	Acoustic Susp.	–	–	3½	Cone	32-18.5k	20	20	3500	8	24 x 12 x 12	Oil Wal.	Cloth Gold	41	79.95	H.F. cont.
	AS-12	8	25	Acoustic Susp.	–	–	3½	Cone	40-18k	20	20	3500	8	10 x 9 x 11	Oil Wal.	Cloth Gold	22	49.95	H.F. cont.
WHARFEDALE	W 90 D 4-way	12½ 12½	20 22	Acoustic Susp.	(2)5	Cone	(2)3	Dome	20-aud	10	50	100, 1000, 4000	4-8	30 x 13½ x 23¾	Oil Wal.	Cloth Brown	100	317.60	2 woofer types, ea. w/9½-lb magnet. Sand-filled panels.
	W 70 D 4-way	12½	22	Acoustic Susp.	8 5	Cone Cone	3	Dome	25-20k	10	40	175, 1250, 3500	4-8	22⅜ x 13⅝ x 24	Oil Wal.	Cloth Brown	73	199.95	Divided mid-range – 8" & 5" cones, sand filled panels.
(27)	W 60 D 3-way	12½	22	Acoustic Susp.	5	Cone	3	Dome	30-20k	8	40	1000, 3500	4-8	24 x 13 x 14⅛	Oil Wal.	Cloth Brown	56	147.00	9½-lb woofer mag. omnidir, tweeter; sand-filled panels.
	W 40 D 3-way	10	30	Acoustic Susp.	5	Cone	3	Dome	35-20k	8	35	1250, 3500	4-8	23½ x 10⅜ x 12⅛	Oil Wal.	Cloth Brown	37	105.85	Long-throw woofer, omnidir. tweeter.
	W 30 D 2-way	8	30	Acoustic Susp.	–	–	3	Dome	40-18.5k	10	35	2000	4-8	10 x 9¼ x 19	Oil Wal.	Cloth Brown	22	64.65	As above; tweeter level control.
	W 20 D 2-way	8	35	Acoustic Susp.	–	–	3	Dome	45-18k	10	35	1600	4-8	14 x 8½ x 9⅜	Oil Wal.	Cloth Brown	14	52.95	As above.

Love for sale



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Like a lot of guys, you're probably having a passionate affair with your pet stereo album. And some groovy 45's. Right.

You keep them in top shape. No dust. No static. Not one little scratch. And they sound great. That's beautiful.

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That's where we come in. We've built two completely new speakers. The TF-25. And the smaller TF-15.

We put a ten-inch FLEXAIR® woofer plus a horn-loaded tweeter in the TF-25. And in the TF-15, we put a special eight-inch woofer and a dynamic cone tweeter.

We built them to sound like a million bucks. And they do.

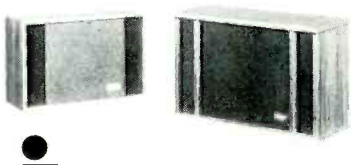
No distortion. No break-up. No coloration. The brass sounds like brass. And the strings like strings. True fidelity. That's beautiful.

This weekend. Take your favorite side to anyone of our dealers. Listen to it through the TF-25. Or the TF-15. You'll hear exactly what we mean.

There's something else that's beautiful about our two new speakers. The price.

The TF-25 sells for only 89.50. And the smaller TF-15 for 44.40. That's beautiful. Right.

Who knows. This could be the start of another love affair.



jensen

for people concerned about the way life sounds.

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Names and Addresses of Speaker System Manufacturers

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Acoustic Research, Inc.
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100 N. Western Ave.
Chicago, Ill. 60680
Altec Lansing Corp.
1515 S. Manchester Ave.
Anaheim, Calif. 92803
Ampex Corporation
2201 Estes Ave.
Elk Grove Village, Ill. 60007
Audio Dynamics Corp.
Pickett District Rd.
New Milford, Conn. 06776
Benjamin Electronic Sound Corp.
40 Smith St.
Farmingdale, N. Y. 11735
Bogen Communications Div.
Lear Siegler, Inc.
Paramus, N. J. 07652
The Bose Corp.
East Natick Industrial Park
Natick, Mass. 01760
Bowers & Wilkins (see IMF Products)
Bozak Mfg. Co.
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Darien, Conn. 06821
British Industries Corp.
Westbury, N. Y. 11590
Dynaco, Inc.
3060 Jefferson St.
Philadelphia, Pa. 19121
Electro-Voice, Inc.
602 Cecil St.
Buchanan, Mich. 49107
Elite Electronics, Inc.
195 Central Ave.
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Garden City, N. Y. 11530
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Houston, Texas 77036
Ercona Corp.
2121 Bellmore Ave.
Bellmore, N. Y. 11710
Fairfax Industries, Inc.
165 Ward St.
Paterson, N. J. 07505
Fisher Radio Corp.
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Long Island City, N. Y. 11101
Goodmans (see Elite Electronics, Inc.)
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Heath Company
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JVC America, Inc.
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Klipsch and Associates
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Furling & Edison Rds.
Furlong, Pa. 18925
Pioneer Electronic (USA) Corp.
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Rola-Celestion, Ltd.
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Woodside, N. Y. 11377
Scott, H. H., Inc.
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Maynard, Mass. 01754
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Long Island City, N. Y. 11101
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809 Stewart Ave.
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Utah Electronics
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Wharfedale (see British Industries)

Don't Let Speaker Phasing Faze You!

AL FANNING

Of all the many controls and switches present on some stereo control amplifiers, perhaps the least understood is the so-called phasing switch. Often, this switch, if present on your amplifier, is a two-position affair labeled "normal" and "reverse." The user tends to leave this fearsome switch in "normal" out of sheer timidity. The braver experimenter will experiment with the "reverse" position, listen quizzically, often hear no difference (particularly in listening to stereo material) and quickly restore it to its "normal" position. Due to this, most manufacturers have eliminated this somewhat puzzling control altogether.

Yet, the fact is that a pair of stereo speaker systems operating out-of-phase really degrades stereo listening to a very substsantial degree. Consider, for a moment, just what a speaker cone does in reproducing sound. The cone moves back and forth as directed by the amplifier's accurate electrical impulses and, in so doing, pushes wavefronts of air periodically spaced in accordance with the tone and magnitude of the desired sound.

Now, suppose that two loudspeakers are operating simultaneously (as would be the case in a stereo system) and that while one cone is compressing the air in front of it, or moving forward, the other cone is moving backward, causing decreased air pressure in front of it. The net result of this simultaneous compression and rarefaction will tend to cancel or actually reduce the sound heard to next to nothing (under ideal non-reverberatory conditions). Of course, if the program material coming from one speaker is not identical to that coming from its companion speaker, cancellation will not take place, but there will still be a distortion of the subtle "time" or "phase" relationships in the original music. This is just what happens when stereo is heard through an out-of-phase pair of speaker systems. When the program material is heavy in bass passages, the bass seems to be deficient. In light, treble passages cancellation is less of a problem, but there seems to exist a subtle lack of realism which ruins even the best stereo program. What's worse, unless you can quickly "switch phase," you may not even realize that your speakers are out of phase. That's the purpose of the phasing switch mentioned earlier. Unfortunately, more often than not, the phasing switch located on the amplifier prevents you from actually testing its positions while standing directly between (and close to) your speaker systems. Then, too, room acoustics play a confusing part in these tests and even if you stand where you should and switch back and forth quickly, you may not always be absolutely certain which of the two positions represents "correct" phasing.

You might argue that after extended listening and trial and error you will establish correct phasing and eventually let it go at that. Unfortunately, correct phasing means correct polarizing of the signal all the way back to the record groove or the microphone. There are actually older stereo records on the market that were made before phasing was standardized. Too, if you make your own stereo tape recordings and use dissimilar microphones for the left and right channels, it is actually possible that your microphone set-up is producing recordings that are out of phase with respect to your "recording standardized" speaker hook-up. Of course, to reverse the phase of your speakers you need only reverse the leads to one (not both) of your loudspeaker systems. Knowing whether to do this for sure sometimes takes considerable experimentation. And even then there may be some doubts.

A sure-fire way to check phase is to emulate methods used by some manufacturers on production lines: Use "phasing meters." This technique provides meter indications of in-phase and out-of-phase conditions. Consequently, aural judgments, so often wrong, are bypassed. Some commercial phase meters, reasonably priced, are available from many audio dealers. Æ

When this little eighty-dollar speaker speaks, the Establishment trembles.

Our new **Mini-III** speaker system has nothing to do with revolutionary politics. But, among loudspeakers, it's shaking up the established hierarchy quite radically.

Everybody who cares about speakers knows the Establishment. It consists of the top systems of perhaps half a dozen major manufacturers, mostly of the larger bookshelf size but a few of them floor models, nearly all with acoustic-suspension woofers plus one to four other drivers, and ranging in price anywhere from $134 to $330. It's a strong and distinguished ruling class, capable of a far more natural sound than the giant horn-type systems and other dinosaurs it originally succeeded (and which, incidentally, are still being sold to reactionaries at prices up to $2250).

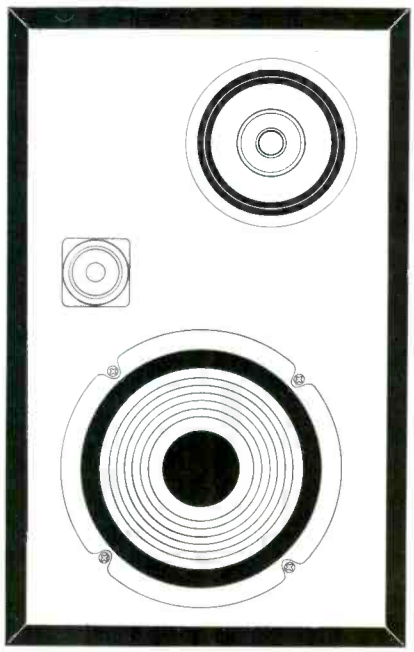
Now, into this exclusive group steps an upstart, measuring a puny 19" by 12" by 9½" and with a ridiculous $79.50 price tag, and has the temerity to sound better than the whole lot of them. (Not just *different*, like certain interesting novelty speakers you may have heard lately, but *better* in the Establishment sense: smoother, clearer, lower in distortion, more natural.)

Of course, just because a manufacturer claims his product is better, you don't necessarily have to believe him. However, we feel quite secure against the skeptics because the superiority we're talking about isn't so subtle. Music lovers will hear it all right.

For one thing, the Rectilinear **Mini-III** is the first box-type speaker system that doesn't sound like one. It has none of the boxy coloration you can hear, either a little or a lot, in the output of all other completely enclosed systems. In this respect, it's comparable to the large and murderously expensive full-range electrostatic speakers.

Also, the sweet-sounding top end of the **Mini-III** isn't the kind that comes from rolling off the high-frequency response. The highest highs are all there, just about flat. But they're nice and peak-free, so the result is realism instead of spitty "crispness."

Finally, bass distortion in the **Mini-III** is so low that the bass is much more natural and impressive than the typical Establishment speaker's, whose larger woofer may go a few (just a few) cycles lower.



These easily audible differences are the result of some strictly non-Establishment engineering.

Wide-eyed audio enthusiasts are generally unaware that the typical hi-fi manufacturer can't attract the same caliber of engineers as, say, Boeing or NASA. We at Rectilinear try to be an exception to the rule. So far we've been able to provide the kind of unorthodox engineering environment that keeps a few music-loving NASA-type brains happy. When they make three cone speakers in a one-cubic-foot box sound better than some of the world's most elaborate systems, they feel as creative as the space capsule boys.

But now they're beginning to worry. What if their little avant-garde loudspeaker becomes the new Establishment?

(For further information, see your audio dealer or write directly to Rectilinear Research Corporation, 30 Main St., Brooklyn, N.Y. 11201.)

MINI-III
by Rectilinear

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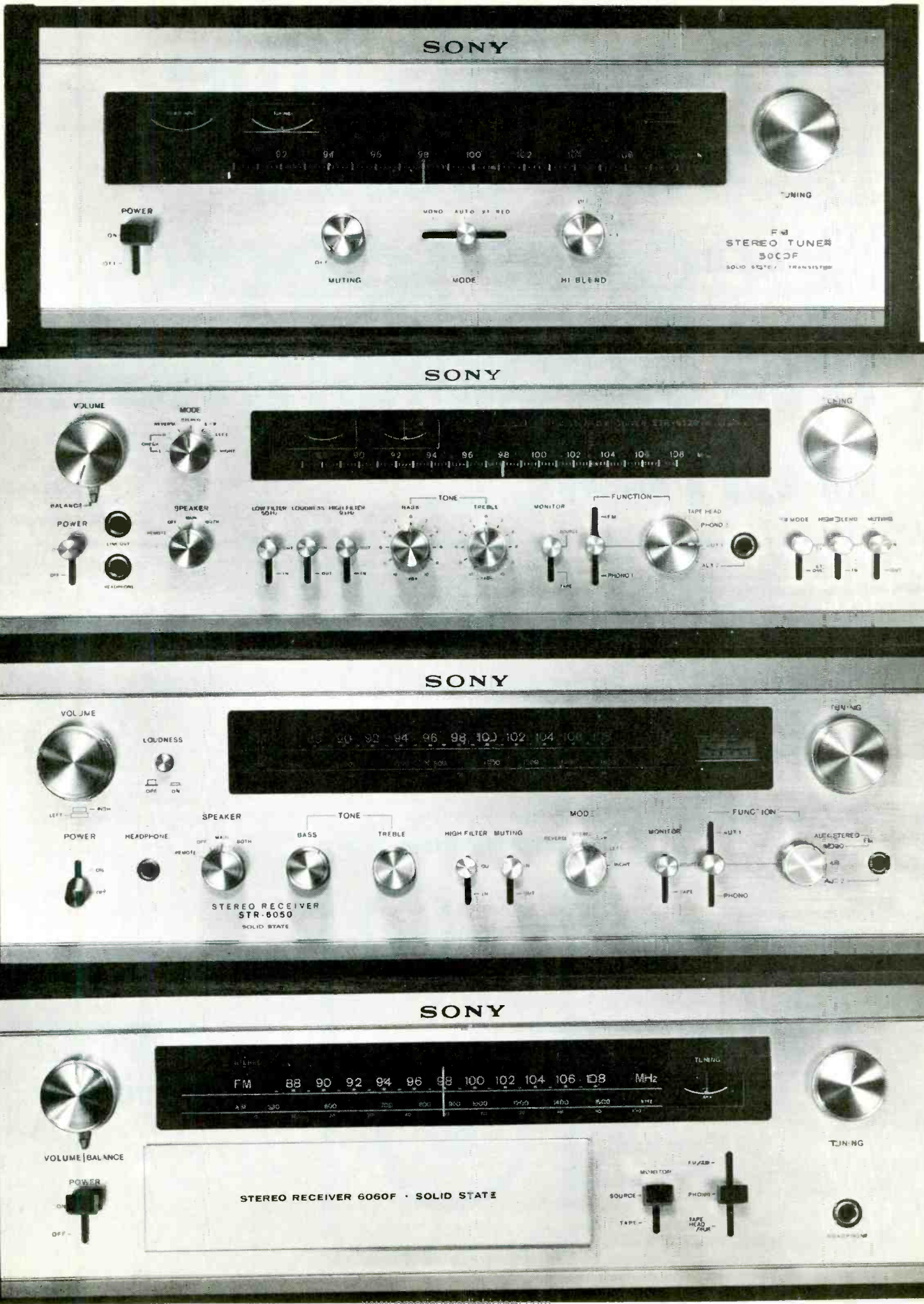
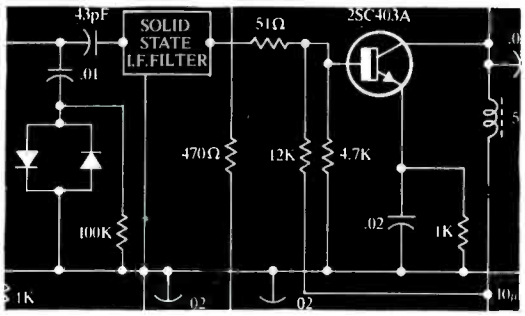


We'll never, ever, change our tune.



Not all receivers (and FM tuners) are created equal, and they get even more unequal as they grow older. Not Sony receivers and tuners. They sound great when you first hear them. When you bring them home. And years later, they give you the same brilliant performance you heard on the first day. The reason: a Sony engineering innovation, the new solid-state i.f. filter — the "forever filter."

The "forever filter" replaces the conventional transformers used in most receivers and tuners. And that eliminates one of the major causes of performance slowly deteriorating over the years. Transformers are limited in selectivity by their winding resistance. What's more, they can easily go out of alignment due to heat, cold or mechanical shock.

Sony solid-state i.f. filters permit the design of an FM section with an excellent capture ratio, superb stereo separation, razor-sharp selectivity and a minimum of distortion. To begin with, Sony solid-state filters mean better performance. To end with, the "forever filter" preserves this high standard of performance for almost ever, because it cannot go out of alignment.

Sony uses their exclusive solid-state i.f. filters in the new deluxe 6120 FM stereo receiver ($699.50). In the new FM stereo/FM-AM receivers, the Sony 6060 ($399.50) and Sony 6050 ($279.50) and in the highly acclaimed Sony ST-5000FW FM stereo tuner ($449.50). They sound great first time you hear them and they just never change their tune in later years.

Visit your Sony stereo component dealer today. Sony Corporation of America, 47-47 Van Dam Street, Long Island City, **SONY**® New York, 11101. All prices suggested list.

ABZs of FM

LEONARD FELDMAN

FM Receiver Alignment

THERE ARE THREE general methods currently used to align the FM circuitry of either an FM tuner or the FM portion of a complete receiver. The first involves the use of relatively inexpensive test equipment, such as an AM r.f. generator and a vacuum tube voltmeter. The second involves the use of more sophisticated equipment such as a frequency modulated r.f. generator and an oscilloscope. The final method will be mentioned once, and then quickly forgotten, we trust. This method involves the "ear-to-the-loudspeaker-screwdriver-to-the-alignment-points" approach which we have, regrettably, observed from time to time. A really experienced service technician can sometimes get away with this approach in aligning a simple AM transistor radio—using known stations as a signal source. Even then, the final alignment job will not equal that attainable with the use of proper instruments. In the case of FM receiving equipment, this "hit-or-miss" approach will lead to a "miss" 99 times out of 100—so don't even try it!

Before proceeding to the actual job of alignment, some generalizations can be made as to the order of the various alignment steps. Most manufacturers will advise that the detector (be it a discriminator or a ratio-detector) be aligned first. This is usually followed by a complete i.f. alignment. Finally, the r.f. or "front end" section is aligned. Often, the i.f. section and detector are aligned in a single procedure, depending upon circuitry, available test points, and the individual preferences of the manufacturer. The owner of a fine tuner or receiver would do well to equip himself with the manufacturer's service manual. If this valuable booklet is not included with the operating instruction manual, it is usually available at a slight cost directly from the manufacturer. Having this manual available when it is needed is well worth the slight expense. A good many manufacturers include the necessary alignment information at no charge along with the operating instruction booklet. We shall examine a typical "manufacturer's alignment instructions" after we've generalized the procedure.

I.F. and Detector Alignment

Figure 1 is a very generalized block diagram of an FM tuner. The receiver in question may be either of solid-state or tube construction. The detector in this diagram takes the form of a ratio detector, though later we shall repeat that part of the alignment which involves the detector stage using a discriminator and detailing the differences in procedure required.

To align the i.f.-detector portion of the receiver using just an *AM* r.f. generator and a VTVM, the generator is set to a frequency of 10.7 MHz. The output of the generator is coupled to point "A" of Fig. 1 through an isolating capacitor (generally .01 μF or even smaller), so that the d.c. voltages at the input to the first i.f. stage will not be upset or altered. The VTVM is set to a low-voltage d.c. scale (5 volts or even 1.5 volts full-scale) and connected to point "B" (one side of the charging or "storage" capacitor of the ratio detector circuit).

It will be assumed that this tuner has conventional i.f. transformers (as opposed to the newer crystal or ceramic filters), each of which has a tuning adjustment in the primary and secondary circuits. The signal generator should be adjusted to provide just enough r.f. output at 10.7 MHz to cause the VTVM to indicate part way up the scale. As adjustments are made in each i.f. interstage transformer, the output of the generator should be reduced each time a higher reading is obtained on the meter. Each transformer is adjusted to obtain a maximum indication. Normally, it is usual to adjust the earlier i.f. transformers first, going right down the line toward the detector in the same way that the signal itself proceeds through successive i.f. stages. It is extremely important to keep reducing the signal generator output as each stage is adjusted for maximum gain at 10.7 MHz. If this is not done, the i.f. system will soon be well into "full limiting" and it becomes difficult to discern well-defined maxima as the adjustments proceed.

It is good practice, after all the i.f.. transformers have been "peaked," to repeat the process, trimming up each transformer primary and secondary to achieve the absolute maximum indication on the VTVM. Only the *primary* of the ratio detector transformer is adjusted at this time. The AM generator used in this procedure should be capable of being attenuated down to only a few microvolts output and this part of the alignment is done with no modulation applied.

Once you are certain that the i.f. transformers have been optimally peaked, move the VTVM probe to point "C" (audio) in Fig. 1. If your VTVM has facilities for moving the pointer to center scale electronically, do so, still keeping the range setting on the lowest, most sensitive scale. Adjust the *secondary* of the ratio detector transformer so that precisely "zero volts" is read on the meter. Do not make the mistake of de-tuning the secondary so far as to be completely "out-

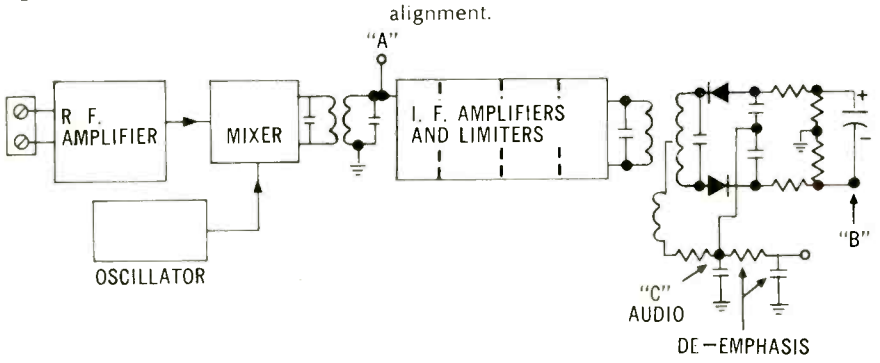


Fig. 1—Test and signal application points for intermediate-frequency (i.f.) and detector alignment.

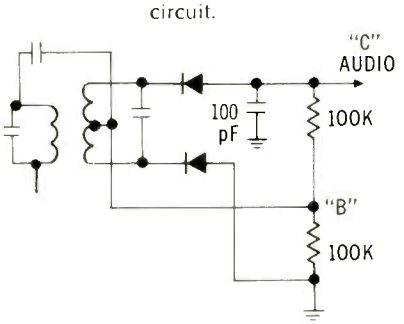
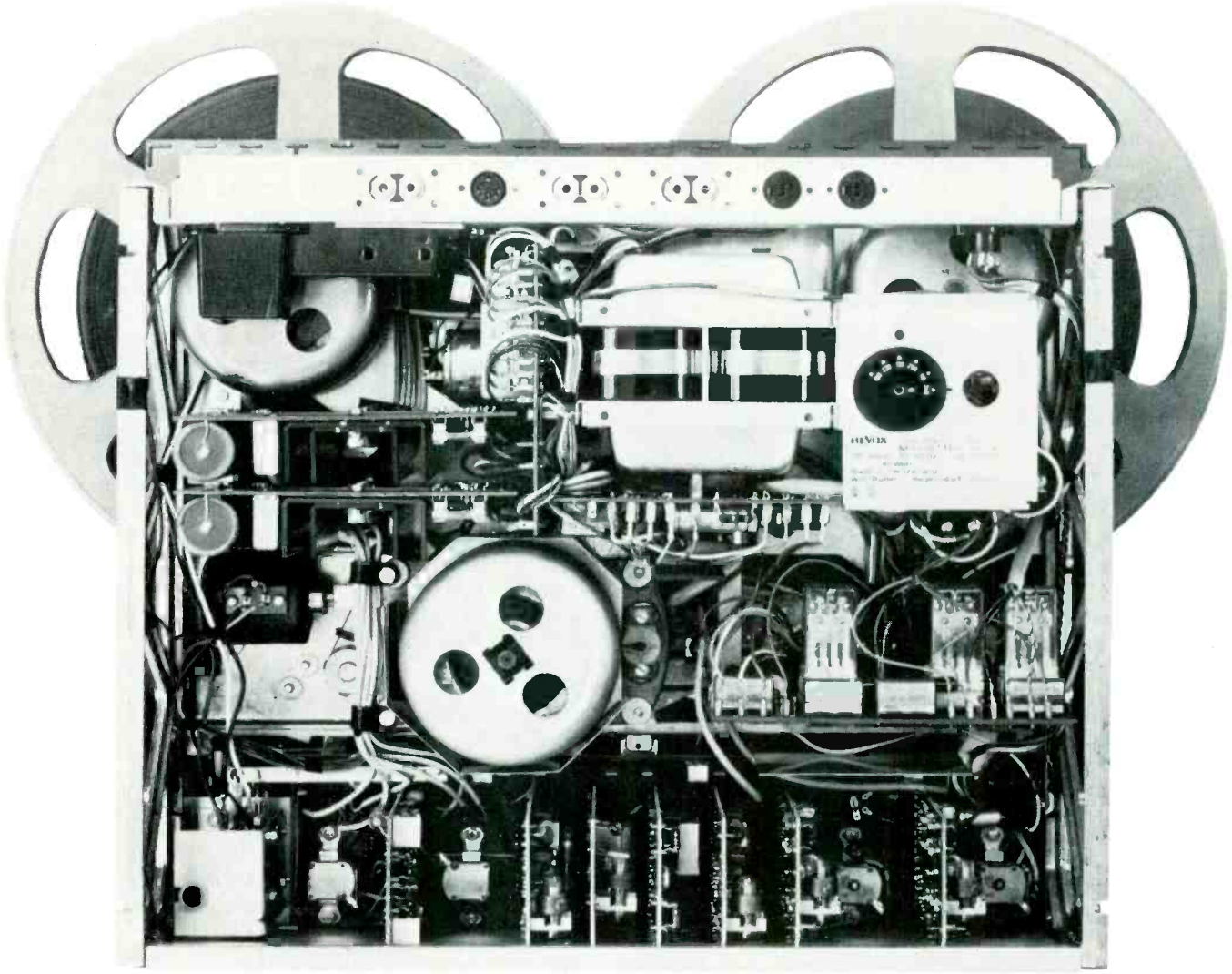


Fig. 2—Equivalent test points to those shown in Fig. 1 for typical discriminator circuit.



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FM IF ALIGNMENT USING AM SIGNAL GENERATOR AND VTVM—SELECTOR IN FM POSITION					
	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	RADIO DIAL SETTING	CONNECT VTVM	ADJUST	REMARKS
4.	High side thru .01mfd to pin 2 (grid) of FM Mixer. Low side to chassis.	10.7MC (Unmod.)	(FM) Point of non-interference.	DC probe to point Ⓑ. Common to chassis.	A11, A12, A13, A14, A15, A16, A17	Adjust for maximum deflection.
5.	"	"	"	DC probe to point Ⓒ. Common to chassis.	A18	Adjust for zero reading. A positive and negative reading will be obtained on either side of the correct setting.

TABLE I

Alignment instructions given by manufacturer for meter-method i.f. alignment. (*Courtesy Howard W. Sams & Co., Inc.*)

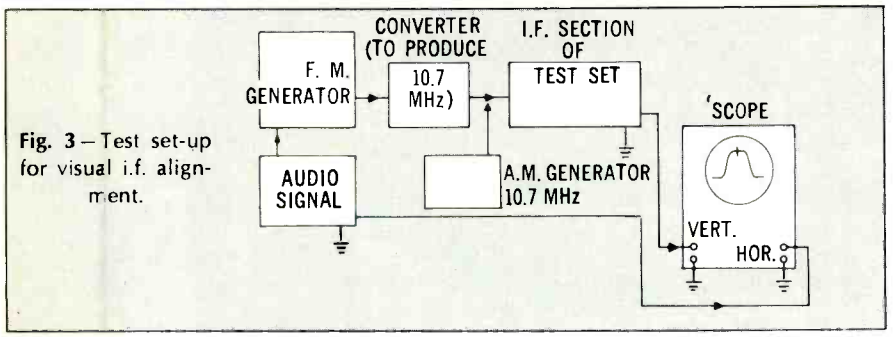


Fig. 3—Test set-up for visual i.f. alignment.

side" the frequency range, as such a setting will also result in a zero or near zero indication. The desired "zero" is the one which occurs between a positive and a negative swing of the meter. That is why it is easiest to perform this adjustment with a zero-center meter. Even a slight movement of the tuning adjustment slug to either side will cause a rapid movement of the meter pointer either to one side or the other, about zero center.

Alignment of Discriminators

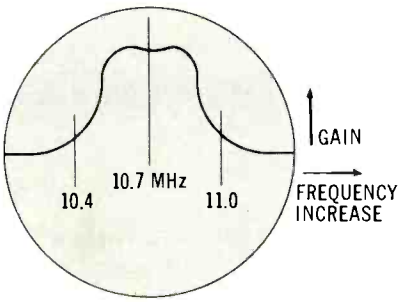
One form of discriminator detector is shown in Fig. 2. Points B and C are designated to correspond to the equivalent points used in the ratio detector of Fig. 1. Procedure is much the same. Point "B" is used for peak alignment of the i.f. transformer primaries and secondaries and the discriminator primary, while point "C" is used for zero-centering the voltage by adjustment of the secondary of the discriminator transformer.

Table I shows how a manufacturer might designate the above procedure in tabular form. The A11 through A18 designations refer to schematic designation points which correspond to the various primaries and secondaries of the i.f. transformers and the ratio-detector transformer.

Alignment with Oscilloscope

The well-equipped service shop generally will not align FM sets (particularly high fidelity units) using the generator-meter method outlined above. For one thing, the simpler method presumes that each and every i.f. transformer is to be tuned to exactly 10.7 MHz when, in fact, some manufacturers require that specific stages be "stagger tuned" to specific frequencies other than 10.7 MHz. In this way they are able to achieve "wideband response" so necessary for distortion-free audio recovery and good stereo mutiplex decoding. Even if the manufacturer were to list specific frequencies for each i.f. transformer (e.g. T1—10.75 MHz, T-2—10.67 MHz, T3—10.7 MHz), the usual inexpensive AM r.f. generator normally found in service shops is incapable of such accuracy. Normally, you're lucky if 10.7 MHz (as read on an inexpensive r.f. generator) is even close to 10.7 MHz in fact.

Fig. 4—Oscilloscope trace movements correspond to frequency (horizontally) and gain (vertically) relationships of i.f. system under test.



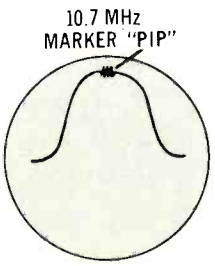


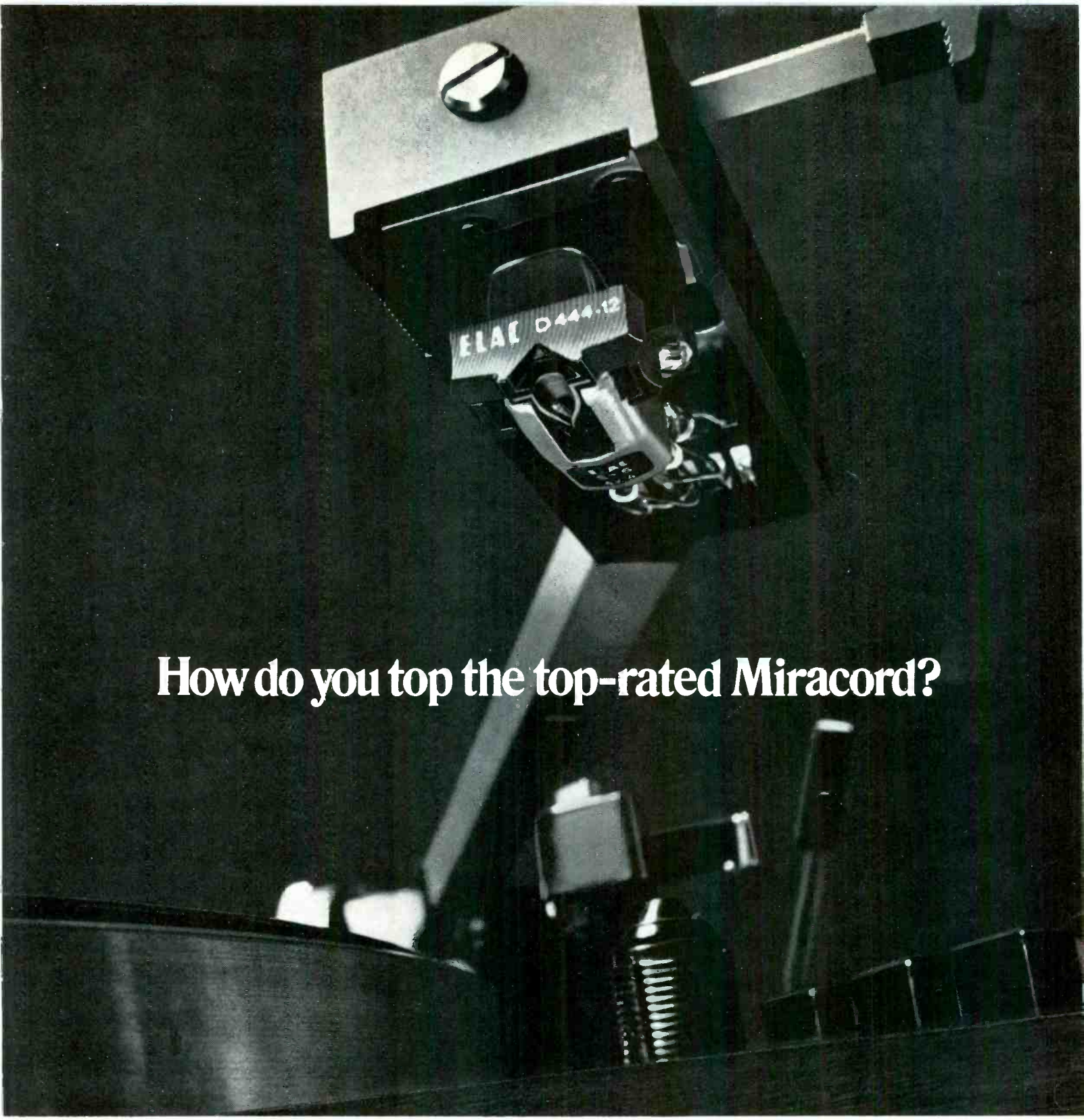
Fig. 5—By introducing unmodulated 10.7 MHz from a second generator (loosely coupled), a "pip" appears on the response curve. This aids in "centering" the response at 10.7 MHz.

A much better method of alignment involves a visual display of the entire i.f. response, made possible by the use of an oscilloscope and an FM r.f. sweep generator. Figure 3 is a block diagram of the test set-up required. The generator must be capable of producing a frequency-modulated output, variable in amplitude from perhaps just a few microvolts to several tenths of a volt. The modulating frequency, whether applied externally or provided by a built-in audio oscillator, must be able to shift the carrier frequency at least ±200 kHz. Notice that the audio modulating frequency is applied to the horizontal input of the oscilloscope. The vertical input to the 'scope is actually taking the place of the VTVM used in the previous discussion. The unmodulated AM r.f. generator used previously can now prove useful in providing a reference or "marker" frequency at 10.7 MHz, as will be shown shortly.

To view the overall i.f. response of the tuner in question, the vertical input to the 'scope may be connected to the final limiter grid (in the case of tube sets), to point B of Fig. 1 (providing the "storage" or charging capacitor of the ratio detector is temporarily disconnected), or to an a.g.c. (automatic gain control) voltage point, providing a.g.c. voltage is developed from the last i.f. stage or limiter.

The oscilloscope "sweep" selector is set to "external," thereby defeating all internal horizontal sweep circuits. Horizontal movement of the 'scope trace will be governed strictly by the positive and negative swinging audio sine-wave used to modulate the r.f. carrier. To clarify, let us suppose that positive-going voltage causes the trace to move to the right while negative-going voltage causes leftward movement of the scope trace. Let us also suppose that positive-going audio voltage causes the radio frequency in the generator to move *up* in frequency while negative-going audio causes a downward shift in carrier frequency. Figure 4 relates all these movements of scope trace and frequency in a graphic manner, showing where the trace will be for a given radio frequency and where the r.f. will be at every point in the audio modulating cycle.

We have noted, previously, that most i.f. systems have a band-pass characteristic which is about 200 to 300 kHz wide. That is, maximum gain occurs at exactly 10.7 MHz (when everything is properly tuned up) and remains fairly constant (though not perfectly so) for about 100 kHz to either side of 10.7



How do you top the top-rated Miracord?

Equip it with today's most advanced cartridge, the new Elac 444-E. The Elac 444-E and the Elac/Miracord 50H have much in common. Both are made by ELAC of West Germany. Both have recently received national recognition. The Miracord 50H is acclaimed by leading high fidelity editors and experts. Elac 444-E rated superior by 50 discerning high fidelity salesmen. These experts tested the Elac 444-E in their home systems and compared it to their present cartridges. A few comments:

"A great groove-tamer for the straight-from-the-studio sound lover! All of today's terms won't describe the utmost enjoyment I experienced."

"...probably one of the finest cartridges I've had the privilege to evaluate. I find it superior in all respects."

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ELAC/MIRACORD

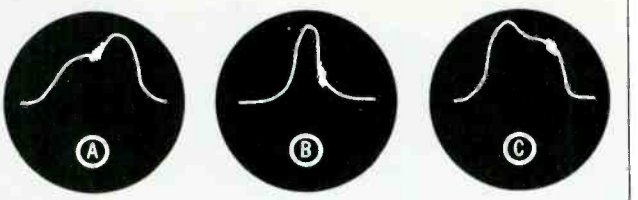


Fig. 6 – Displays of misaligned i.f. sections illustrate (A) improper "flat top," (B) narrow, off-center response, (C) off-center, wide-band response.

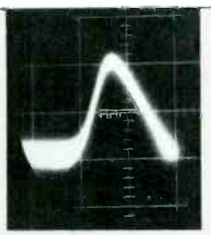


Fig. 7–Typical i.f. response, measured at the AGC take-off point of a receiver.

Fig. 8 – Evidence of too narrow a bandwidth ('scope settings are the same as in Fig. 7).

Fig. 9 – Assymetrical i.f. response due to improper stagger tuning.

Fig. 10–"Classical" S-curve display measured at detector output. The linear portion of the curve in this case extends ±120 kHz above and below center "zero" point.

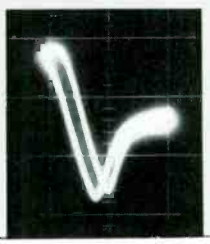


Fig. 11–Ratio-detector output not properly centered about "zero."

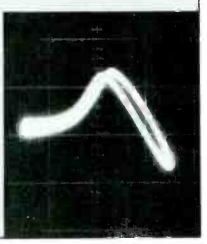


Fig. 12 – Another example of improperly aligned ratio-detector secondary.

TABLE II

Alignment instructions given by manufacturer for r.f. and i.f. alignment using visual 'scope technique. *(Courtesy Howard W. Sams & Co., Inc.)*

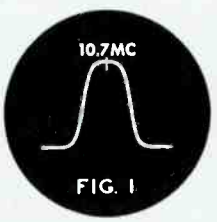


FIG. 1

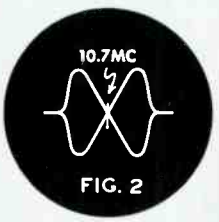


FIG. 2

FM IF ALIGNMENT USING FM SIGNAL GENERATOR AND OSCILLOSCOPE –SELECTOR IN FM POSITION

Use frequency modulated signal with 60% modulation and 450KC sweep. Use 120% sawtooth voltage in scope for horizontal deflection.

	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	RADIO DIAL SETTING	CONNECT SCOPE	ADJUST	REMARKS
4.	High side thru .01mfd to pin 2 (grid) of FM Mixer. Low side to chassis.	10.7MC (450KC Swp)	(FM) Point of non-interference.	Vert. amp. to point Ⓑ. Low side to chassis.	A11, A12, A13, A14, A15, A16, A17	Disconnect stabilizing capacitor C4. Adjust for maximum gain and symmetry of response similar to Fig. 1 with markers as shown. Reconnect C4.
5.	"	"	"	Vert. amp. to point Ⓒ. Low side to chassis.	A18	Adjust to place marker at the center of crossover lines similar to Fig. 2. SLIGHTLY retouch A11 for maximum amplitude and straightness of cross-over lines.

FM RF ALIGNMENT – SELECTOR IN FM POSITION

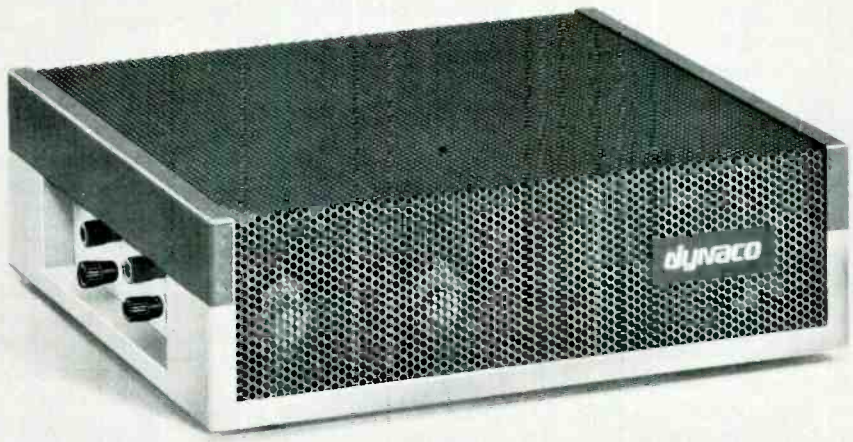
	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	RADIO DIAL SETTING	CONNECT VTVM	ADJUST	REMARKS
6.	Across FM antenna terminals with 150Ω in each lead.	105MC (Unmod.)	(FM) 105MC	DC probe to point Ⓑ. Common to chassis.	A19, A20, A21	Adjust for maximum deflection.
7.	"	90MC	90MC	"	L5, L4, L3	Adjust for maximum deflection by expanding or compressing coil turns.

MHz, falling off rapidly beyond these points.

By having the trace of the 'scope move along with the changing r.f., and with the vertical input responding to amplification of the i.f. system, the 'scope trace will display, repetitively, the "classical" i.f. response curve, Fig. 5, which we have shown so many times. By coupling the r.f. generator loosely to the system, the jagged "pip" shown in Fig. 5 will appear as an added feature.

Now, it is easy to see that correct alignment can be discerned at a glance and, more importantly, incorrect alignment, as shown in various forms in Fig. 6 is equally easy to spot. Such might not be the case in the generator-meter alignment method discussed earlier. Using this visual method, it is also possible to observe such other pertinent phenomenon as the effect of varying signal strength on bandwidth, the shifting of center frequency of alignment with increased signal strength, overload characteristics of a given i.f. system (how does the response curve hold up when really huge r.f. signals are applied) and many, many more. In short, the FM generator-oscilloscope method of i.f. and detector alignment is by far the more sophisticated and effective of the two practical methods discussed here. Why, then, do so few service shops and home labs use this method? Simply because a good FM r.f. generator costs a great deal of money—well over a thousand dollars, if purchased new. Considering the fact that most service shops have already had to spend a great deal of money in equipping their establishments for TV repair and then color TV repair, it is not surprising that they don't all rush right out to purchase a $1500.00 generator. Too bad, too, since most shops have oscilloscopes equal to this particular task. The test equipment manufacturer who develops a good FM generator for under $200.00 will do the high fidelity industry a great service. While a great many FM generators do appear in the trade catalogs for even less than this figure, do not be misled. All they are good for is a spot-check of frequency calibration and a rudimentary kind of alignment usage. Their problem lies in their inability to provide an accurately calibrated attenuator. What good is such a generator for use with an FM receiver claiming a sensitivity of 2 microvolts if the generator "leaks" a couple of hundred microvolts right out of its metal cabinet? To provide proper shielding and a calibrated attenuator costs a great deal of money

(Continued on page 82)



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This unprecedented longevity is explained by Dynaco's unswerving devotion to performance, reliability, and unmatched low cost. The Stereo 120 kit is only $159.95 or $199.95 factory assembled. It is easily the most desired of all solid state power amplifiers. At less than half the cost of comparable amplifiers, such consummate value just naturally gets around.

Dynaco introduces new products only when they fill a real need. They never render previous models obsolete.

We can't promise that the Stereo 120 will still be our newest amplifier in 1979.

But we do know it won't be out of date.

DYNACO, INC., 3060 JEFFERSON ST., PHILA., PA. 19121

Equipment Profiles

This Month:

- **Fisher Model 500-TX Stereo FM/AM Receiver**
- **Ampex Model 1461 Stereo Tape Recorder**
- **Empire Model 999VE Stereo Cartridge**
- **Shure Model 548 Microphone**

Fisher Model 500-TX Stereo FM/AM Receiver

MANUFACTURER'S SPECIFICATIONS: **FM Tuner Section.** IHF usable Sensitivity: 1.7 μV. S/N: 65 dB. Capture Ratio: 1.5 dB. Selectivity (Alternate Channel): 70 dB. Image Rejection: 65 dB. Spurious Rejection: 100 dB. Stereo FM Separation: 38 dB @ 400 Hz. **AM Tuner Section.** Sensitivity: 10 μV. Selectivity: 80 dB. **Amplifier Section.** IHF Power @ 8 ohms: 190 watts ±1 dB. RMS Power Output: 65 watts/channel @ 8 ohms. Power Bandwidth: 8 Hz to 35,000 Hz. THD: 0.5% at rated output. IM: 0.8% at rated output. Frequency Response (Aux): 20 to 25,000 Hz ±1.5 dB. S/N: Phono: 60 dB. Tone Control Range: Bass: ±12 dB @ 50 Hz; Treble: ±12 dB @ 10 kHz. **General.** Dimensions: 16 7/8 in. W x 4 13/16 in. H x 14 1/2 in. D. Price: $449.95.

The flexibility normally associated with Fisher products has been expanded in completely new directions in this "top-of-the-line" receiver. In addition to an ample quantity of controls, this new receiver features *four* ways in which to tune in desired FM stations. First, of course, there is the usual flywheel/dial-scale combination similar to that found in most receivers (and a lot smoother acting than some). The upper right portion of the gold colored dress panel, beyond the massive tuning knob, has six combination controls, as can be seen in Fig. 1. Each of the central four of these consists of a tiny push button, surrounded by a concentric multi-turn rotatable knob. Each of these rotating knobs, in turn, controls a miniature tuning-dial pointer running vertically above the knob. Thus, four most-listened-to stations can be presented by means of these controls. The left-most of the buttons is depressed for manual tuning, whereas its concentric outer knob turns on or defeats the built-in AFC circuits. The right-most of the six little controls, when depressed, introduces two more methods of tuning, which Fisher has dubbed "AutoScan"™. Directly below the six controls mentioned are two dark-colored buttons (on the lower right section of the panel). Depressing the left button will cause this remarkable circuit to start scanning the FM broadcast spectrum in a "downward" (in frequency) direction until the next station is tuned in. If the button is depressed just momentarily, the circuits will "lock on" to the next listenable station. If the button is held in, scanning will continue until the low end of the dial is reached. The right-most of these two buttons does exactly the same thing, but scanning is then the direction of the higher frequencies, until 108 MHz is reached.

Fig. 1—Fisher Model 500-TX Stereo FM/AM receiver with optional remote-control tuning.

While the scanning principle itself is not new (better automobile radios have had similar features for years), the remarkable thing about this system is that there are *no* moving parts! Nothing moves except the pointer on a dual-purpose tuning meter, the upper half of which is calibrated in MHz. In manual tuning (or even in pre-selected push-button tuning) this same meter is used as a signal-strength indicator for accuracy of center-channel tuning. In the case of the AutoScan circuit, the unit is designed to stop at the precise center-of-channel point. Therefore, the meter can be used to indicate frequency rather than signal strength. Clever dual illumination (alternatively) of the upper and lower halves of the meter scale clearly tells the user which function the meter is performing at any instant.

Because the front-end of this receiver is "voltage tuned" (there is no variable capacitor in the normal sense of the word) for FM operation, the tuning schemes already described are further augmented by an accessory "remote control" hand-held device which simply duplicates the "up-scale" and "down-scale" buttons of the AutoScan feature. Supplied with twelve feet of cable, the optional remote control (Model RK-30, $9.95) enables the user to change stations from his chair without approaching the receiver itself.

The lower half of the front panel is fairly conventional, featuring, starting at left, a stereo headphone jack, four-position rotary selector switch (Aux, AM, FM, and Phono); a speaker switch (off, remote, main, main plus center channel, and all); a mode switch for mono, stereo, or tape monitor; dual concentric bass and treble controls (each channel may be controlled separately or, with the familar clutch control arrangement, each dual knob can be rotated as one if desired) and finally, a volume control which, in its counter-clockwise position turns off power to the unit. Six additional miniature push-buttons located at the lower right complete the panel layout. The two used for AutoScan tuning have already been described. The others are of the push-

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

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to-make, push-to-release type. They control loudness-contour, a low-frequency filter, a high-frequency (scratch) filter, and the muting circuits are engaged, a light above the tuning meter indicates this fact. It is located right alongside Fisher's familiar "Stereo Beacon" light which denotes the reception of an FM stereo program. For all that this front panel contains, it is amazingly "uncluttered" in appearance and is totally tasteful, esthetically. We rather wish, though, that Fisher had added yet another button, so that the power on-off function could have been divorced from the volume control.

Examination of the rear panel (shown in Fig. 2) discloses a pair of convenience power outlets, a line fuse, terminal strips for main and remote loudspeaker connections, as well as a strip for direct connection of a "center channel" or remote-mono speaker, FM and AM antenna terminal strips and the usual input, tape output, and monitor jacks. A slide switch next to the phono input jacks selects gain settings for high- and low-level magnetic cartridges (2.5 mV or 10 mV for full output). A very handy addition is the presence of a pair of "jumper" cables, connected from packs labelled "Reverb in" to those labelled "Reverb out." Intended for insertion of Fisher's reverb unit *betwen* preamplifier and power amplifier sections, it's nice to be able to interpose other equipment (such as frequency filters, presence controls, and the like) of one's own choosing without having to "tear into" the wiring of the actual receiver. A multi-pin socket on the rear panel enables connection of the RK-30 AutoScan Remote Tuning Control mentioned earlier.

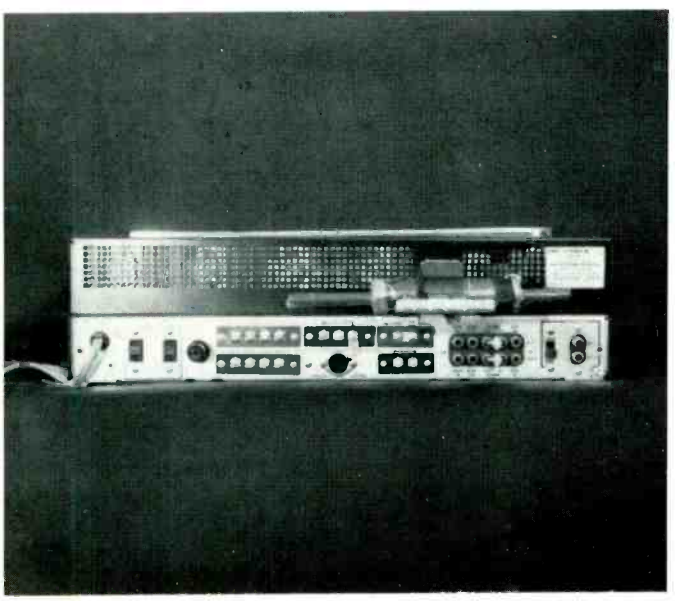
A hefty AM ferrite antenna swings away from the metal rear of the receiver as soon as the unit is unpacked, since many users forget to "pivot" this rod antenna away from the surface of the chassis to ensure best AM reception. Our only criticism of the rear layout (and it is one which we've mentioned before with respect to other Fisher products) is the continued use of closely spaced, non-barrier terminal strips for speaker connection points. Admittedly, everyone cautions about avoiding shorts between speaker leads when hooking them up, but not every user will use spade lugs under terminal strips. Most will still twist the strands of wire together and do the best they can to shove them under the heads of the screws, often leaving a stray strand or two sticking out just enough to reach the terminal of opposite polarity.

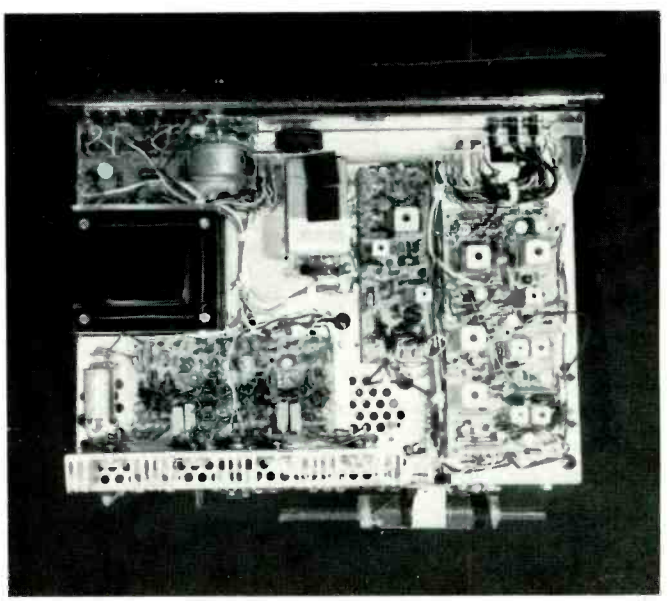
Performance

The Fisher 500-TX is very easy to get used to. Naturally, we concentrated on FM, because of the many tuning innovations. Station lock-in is flawless. That is, when the auto-scan stops on a station it stops on the exact "center" of that channel. Because this tuner is of a wide-band design, this is difficult to prove when listening to an actual station (had the "scan" stopped a bit off center, we would not have been able to detect it audibly except in the case of very weak stations which do not cause full limiting). Accordingly, we put our own "station" on the air, in the form of a signal generator, being swept ±300 kHz at a carrier frequency of 97 MHz and a signal strength of 100 μV. The photograph in Fig. 4 shows the detector "S" curve obtained using the AutoScan and letting it "home in" on our signal. Note that it locked in on precise center of the curve. This test, by the way, is far more severe than would be encountered in normal station selection because of the extremes of modulation we employed.

As noted, then, AutoScan is probably more accurate in tuning to center of desired channel than can be accomplished manually, but our particular unit did exhibit one little quirk. Because we have so many stations on the band in our area, so closely spaced together (we logged 43 on this unit, 15 of them in stereo), our AutoScan had a tendency to race ahead of itself just a bit. That is, when we took our finger off the "scan" button (either the down-scale or the up-scale one), instead of stopping on the very next station up or down the line, the circuit would often skip over the next station and settle in on the next one after that. No amount of "quick-finger" releasing seemed to alter this situation. It should be noted, however, that this occurred only when we let the AutoScan change frequency over a wide range. If we tapped the button just to go from one station to the next, everything worked fine. In other words, as a random scanner (when you just want to go from

Fig. 2—Rear-panel layout of Fisher 500-TX receiver, and a topside view of chassis with cover removed. We counted ((via schematic) 55 active solid-state devices, excluding diodes and rectifiers, of which two are multi-circuit ICs.





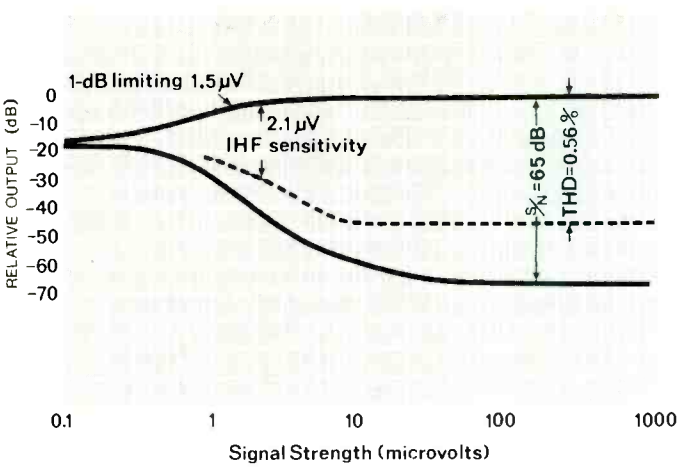


Fig. 3—Stereo FM characteristics of the Fisher Stereo FM/AM 500-TX receiver.

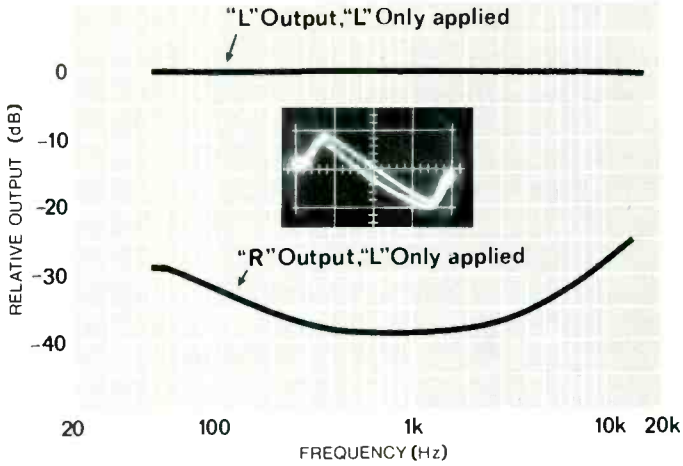


Fig. 4—FM separation measurements. The photo shows the "S" curve observed at the output of the tuner section.

Fig. 5—Harmonic distortion and intermodulation distortion measurements.

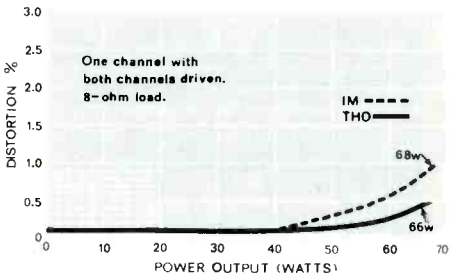


Fig. 6—Power bandwidth illustrates frequency range at half power. Also pictured is square-wave response.

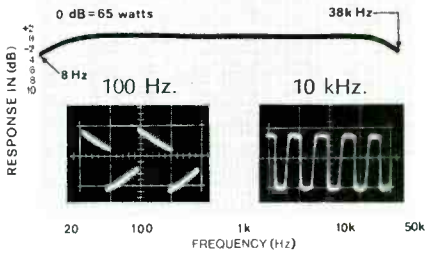
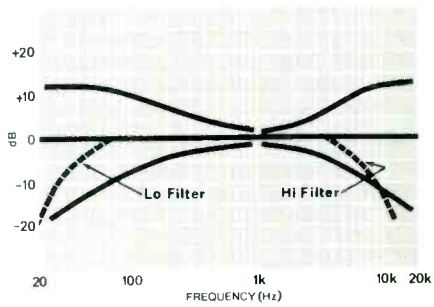


Fig. 7—Tone-control characteristics



station to station to see what's on) it is truly a wonderful thing to have, but to get from 106.5 MHz down to 93.5 MHz in a hurry, you'd be better off using the manual flywheel tuning or setting up the desired frequencies on any of the four "pre-select" buttons.

FM sensitivity measurements edged up close to the spec's 1.7 μV IHF sensitivity figure, hitting 2.1 μV at 98 MHz, as shown in Fig. 3. Usable sensitivity was everything we could have desired and limiting took place at a remarkable 1.5 μV. Ultimate signal-to-noise ratio was 65 dB, as claimed. Stereo FM performance was excellent (see separation curves of Fig. 4). And the muting action was positive, introducing no audible distortion in the case of marginally acceptable stations, or any others for that matter. Muting was overcome by signals of as low as 5 μV.

We can confirm the power output specification, as given in terms of r.m.s., as actually exceeding the 65 watts per channel claimed, as shown in Fig. 5. Rated distortion (0.5%) is achieved at 66 watts, while IM reaches 1% at 68 watts. Power bandwidth extended from 8 to 38,000 Hz, based upon 65 watts per channel, as shown in Fig. 6. Tone control range was adequate and quite symmetrical (See Fig. 7). The low and high-frequency filters are also plotted in Fig. 7 and are of the 12 dB/octave type, making them useful and meaningful.

Since we spent a great amount of time experimenting with the FM tuning features of this receiver, we felt we had to devote some listening time to the 500-TX in amplifier-only terms. We "lived" with this unit for purposes of recorded music reproduction for nearly two weeks, subjecting it to every conceivable type of recorded material — from synthesized electronic music to baroque. Always, we sensed that here was an amplifier section with great power reserve that could handle just about anything we fed to it at very loud levels in large listening rooms. We decided, too, that this kind of power rating is just begging for remote speakers, so we operated a pair or these in another room (out of earshot) to see if "halving" the power availability to the "main" pair would in any way impair the dynamic response available. It did not!

Finally, we decided to add a "center channel" speaker in the main listening area. Unfortunately, since there is no separate level control for this center channel output, we found the center-channel fill destroyed some of the stereo illusion. Of course, a local "pad" could be added to a center speaker used in this way. As a remote mono speaker, though, the center channel connection is useful as it is, since it enables you to have stereo in two locations and, if you desire, a mono equivalent in a third location.

The Fisher 500-TX is a top-grade receiver whose performance might easily challenge that of even some of the better separate tuners and amplifiers in Fisher's own line or in competing ones. It's obviously slanted towards FM, but all the wonderful tuning convenience features cannot obscure the fact that it's a powerhouse of an amplifier that is capable of excellent transient response (see square-wave photos of Fig. 6, particularly the lack of "rounding" in the 10-kHz presentation), and truly "big," "clean" sound.

Ampex Model 1461 Stereo Tape Recorder

MANUFACTURER'S SPECIFICATIONS:
Speeds: 7½, 3¾, and 1⅞ ips. Preamp overall frequency response: 7½– ± 4dB 70-15,000 Hz; 3¾– ±4 dB 50-7500 Hz; 1⅞– ±6 dB 50-3000 Hz. Preamp S/N from peak record level: 7½, 46 dB; 3¾, 43 dB; 1⅞, 39 dB. Flutter: 7½, 0.15%; 3¾, 0.2%. Speed accuracy: 7½, ±2%; 3¾, ±3%. Fast wind time (1200 ft. tape): 150 sec. Tone control range: +8, −10 dB at 10 kHz; +15, −6 dB at 100 Hz. Power output per channel: 8 W rms into 8-ohm load. Dimensions: 23½" wide x 14" high x 8½" deep. Weight: 46 lbs. Price: $485.00.

This three-speed, ¼-track recorder/reproducer is equipped with facilities for reverse play, with the automatic reversing being dependent on a 20-Hz signal which the user places on the tape at the ends of the recorded portion of the tape. This signal is generated by a mechanical device which rotates in the field of a coil, so no additional electronic equipment is necessary. It is fed into the recording amplifier after the record-level control, so it is only necessary to press the button to put the reversing signal on the tape at the proper level. This may be done on both ends, and when desired, the machine will run continuously until stopped. If desired, the machine will reverse at the end of the forward play, and then stop when the tape has played through in the reverse direction.

Another feature of the 1461 is the automatic-threading reel. To thread the machine, you put the left reel of tape on, draw out about 18 in. of tape and drop it in the slot, and start the transport. The automatic reel picks up the tape and starts it winding properly on the take-up reel. This feature will appeal to the non-technical user.

The overall width of the case, shown in Fig. 1, is the result of the storage space for two "cube" speakers. Each of these 6-in. cubes connects to one of the channels by phone jacks at the rear of the case, and for portable use, they fit into the case one above the other, at the left side, and may be heard through the grille cloth. For stereo use, however, they should be removed from the storage space and placed to the right and left of the unit at suitable distances —a maximum of 10 feet is permitted with the attached cords.

At the center and above the head cover can be seen the speed-change lever which actuates a forked arm that moves the capstan-drive belt to the desired one of the three pulley diameters. At the far left in Fig. 1 are the two record-level meters which indicate the signal level during the recording operation, and when switched to tape monitoring they indicate the output level from the tape itself. Their indications are not affected by the volume control during playback, and during recording they are not affected by the record equalization, which is most desirable.

Below the meters at the left is the tone control, with the small knob for treble boost or cut, and the large knob for bass. Next to the right is the playback level control—the small knob for channel 1 and the large one for channel 2. Neither of these affects the recording and they act only upon the speaker output, not the monitor or line outputs.

Another small panel at the right, Fig. 2, accommodates the record buttons. These may be depressed while the tape is stationary so as to set levels, and must be held down when the play lever is actuated if you wish to record. Otherwise they jump up to the normal position. To their right are the two microphone input jacks, and below them is the reverse button to put the 20-Hz signal on the tape. To its left is a slide switch which changes equalization. One position is labeled 7½, while the other is marked 3¾-1⅞. The two slower positions use the same 120-μsec equalization, so only two switch positions are necessary.

Below this panel are the record-level control at the left, and the selector at the right. The small knob on the level control adjusts recording level on the left channel, and the large knob adjusts level for the right channel. The small knob of the dual selector switch sets the reverse mechanism to operate only at the end of the forward run, or to play continuously.

Fig. 2–Microphone input jacks, the record buttons, the reversing-signal button, and the equalization control switch all appear in the lower right corner of the panel, along with the mode selector switch and the record-level controls.

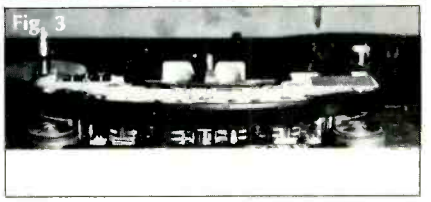


Fig. 3–The four heads are seen under the head cover, along with the two capstans.

The left lever at the center of the head cover is the fast-wind control, while the right one is the play lever. Below and between them is the direction lever, which actually reverses the motor rotation, and thus the direction of tape motion. Under the head cover are four heads—erase, record, forward play, and reverse play, shown in Fig. 3, and two capstans, each with its pressure roller. This use of two capstans ensures tight contact with the heads without the need for pressure pads.

Facing the rear of the housing, the line input and output phono jacks are located at the upper left corner in a recessed opening. The storage space at the right for the two cube speakers is accessible when a hinged panel is opened. In the partition between the

Fig. 1–Ampex Model 1461 Auto-Thread, Auto-Reverse, Three-Speed Tape Recorder. The speaker compartment at left hides two stowaway speaker systems that can be removed and spread up to 20 ft. apart for stereo playback.

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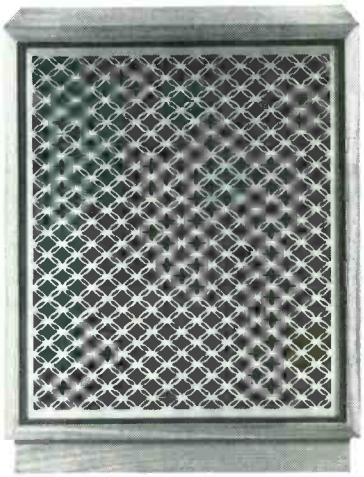

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speaker space and the recorder chassis are the two speaker jacks, and a three-circuit jack which provides for the connection of stereo headphones. When the plug is inserted in the 'phones jack, the speakers are cut off.

Circuit Description

The two channels are electrically identical, of course. The play-amplifiers utilize four transistors each, the first two an equalized pair with switching to provide the different equalizations for the 7½-ips speed and the two lower speeds. The monitor selector switch is between the two pairs of transistors, and correctly interconnects the two channels for mono, and connects the output pair to either the playback preamp or the record preamp for source or tape monitoring. The record-level meter is at the output of the play amplifier, and thus directly across the monitor output.

The record amplifier is composed of three transistors, the first two as a feedback pair to provide sufficient gain from the microphone input, while the third introduces the high-frequency boost required for the recording process. It is followed by two bias-trap circuits, and feeds the record head, with the bias adjustment controlling the amount of bias.

The bias oscillator, operating at 96 kHz, consists of a pair of transistors in push pull, followed by the necessary bias switching. The power supply utilizes a pair of diodes to provide 43 V for the power amplifier section, together with a voltage-dropping resistor and a zener diode to regulate the supply to the record and play sections to 27 V.

The power amplifiers use a single-transistor input, followed by a Baxendall-type tone control, three booster stages, and a complementary-symmetry output pair which puts out a signal of 10 W per channel into 8 ohms. The reversing process is furnished by a four-stage amplifier tuned to 20 Hz with its output fed to a solenoid which actuates the reversing switch. Thus there is a total of 33 transistors and 25 diodes in the unit, in addition to the aforementioned zener which regulates the supply to the low-level stages.

Performance

The 1461 beats its specifications in every particular, as shown in the curves of Fig. 4. The record/playback curves show a boost at 10 kHz (for 7½ ips), and a similar boost at 7500 Hz at 3¾ ips, but in view of the excellent response from a standard tape, it is likely that the bias was adjusted for the conventional tape, rather than the 202 which we normally use for tests, and which usually requires less bias than conventional tape. The record/play response at 7½ ips was measured at 50 to 21,000 Hz ±4 dB (the spread listed in the specifications), 50 to 12,000 at 3¾ ips, also ±4 dB, and approximately 30 to 4700 Hz ±4 dB (although the specs list a spread of ±6 dB) at 1⅞ ips.

The 3-per cent distortion point occurred at 8 dB above the indicated zero recording level at 7½ ips, with distortion at zero level measuring 1.8 per cent. This gives S/N's of 50, 44, and 40 dB at 7½, 3¾, and 1⅞ ips, respectively. Channel separation was measured at 41 dB, which was the same for adjacent-track mono recordings. Flutter-and-wow was measured at .08 per cent at 7½ ips, 0.17 at 3¾, and 0.21 at 1⅞, all of which are excellent.

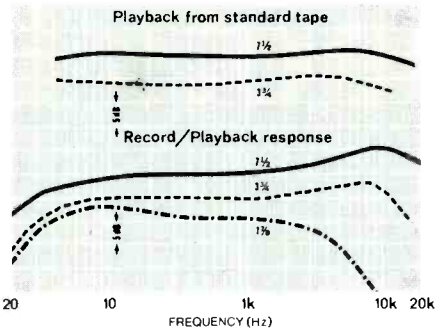

Fig. 4—Performance curves—Upper pair: playback from standard tape at two speeds. Lower set: record-playback response at the three speeds.

Ampex lists speed accuracy at ±2 per cent at 7½ ips and ±3 per cent at 3¾. We presume they mean speed "error," since we would normally refer to these "accuracies" as 98 and 97 per cent, respectively. Actually, the error at 7½ ips was 2 per cent and zero at 3¾.

The input signal for a zero indicated recording level was a minimum of 1.3 mV at the microphone inputs and a maximum of 30 mV, which would accommodate practically any microphone available. The microphone input impedance is 150k ohms, which is adequate for any dynamic, although not suitable for crystal or ceramic microphones. The line-input minimum was 0.3 V for a zero-level recording, with a maximum of 3.0 V. The line output measured 0.51 V at the same zero level, and the speaker output with the volume controls at maximum was 6.5 V across 8 ohms, which corresponds to 5 watts per channel, although the maximum output was measured at 10 watts/channel with increased input signal.

Two Ampex model 702 dynamic microphones are furnished with the 1461, together with simple plastic stands for them. These are suitable for the average recording use, although the instruction book lists three other models which might be selected optionally if the principal use for the recorder involved considerable microphone pickup.

The two model 1414 loudspeakers which are furnished with the machine have a usable output from 50 to 12,000 Hz, and are remarkably flat over that range—an unusual response for such small enclosures. They make a fine complement to the recorder, which according to the table in the January issue would be rated as "good to excellent" in every particular. It is easy to operate, sounds good, and the advantage of the reversing feature should not be overlooked, particularly when it can play continuously. One could record a reel full of choice musical selections at 1⅞ and furnish 8½ hours of continuous stereo background music with a minimum of operating manipulation—just turn it on and let it run.

When it is desired to place a reel on the right spindle to feed back to the left spindle—as one would normally do if no reversing feature were present, the automatic-threading reel may be removed without tools and a new, longer spindle screwed in. This must be done if one wishes to put a reversing signal at the end of the second side, but it is a simple operation and one which is amply described in the instruction booklet, which, by the way, is excellent. In addition, we must not forget to mention that a complete schematic is furnished with the instrument, as well as an empty reel, two reel retainers, and a soft compartmented carrying case for the two microphones.

Overall, the Ampex Model 1461 is an attractive, complete, portable tape recording/reproducing system. Its automatic tape threading and automatic reverse features should be appealing to persons who are "all thumbs" when it comes to handling open-reel magnetic tape. Further, the compartment for speaker storage is a clever idea since one can play back tapes monophonically without setting up the two speakers. Insofar as portability is concerned, the stowaway-speakers make it easier to carry (but at 46-lbs. one is not likely to travel too far on foot with it). As measurements have indicated, its audio performance should please even those with discerning ears. Handling of the machine is good, too, though the mechanically-operated Play/Record and Fast-Wind controls may "clunk" a bit too loudly for one who likes solenoid-relay-operated controls.

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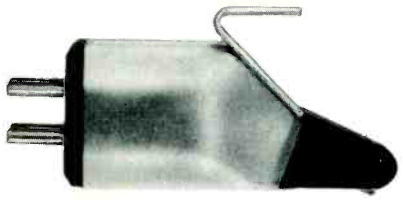
Empire Model 999VE Stereo Cartridge



MANUFACTURER'S SPECIFICATIONS: Sensitivity: 1 mV/cm/sec. Tracking force: 0.5 to 1.5 gr. Frequency Response: 6-35,000 Hz. Crosstalk: 30 dB. Stylus tip radius: 0.2 x 0.7 mils. Vertical Tracking Angle: 15 deg. Compliance: 30 x 10^{-6} cm/dyne. Price: $74.95.

Here is one of the top low-tracking-force cartridges on the market today. It comes from a manufacturer whose ant-eater-shaped trackers are long familiar to audiophiles. Now Empire has put their experience into the premium model 999VE elliptical-stylus-equipped stereo cartridge. It turns out to be their best effort to date.

The lightweight unit has a front-removable stylus assembly. It wasn't always like that with Empire cartridges. We remember when, not so long ago, the entire cartridge first had to be demounted from the arm shell, then separated in two before getting at the stylus assembly—from the inside! But now it is easily and positively seated from the front. The tight seating is made possible not only because the piece of tubing which carries the stylus assembly has a flat spot that positions it relative to the pole pieces, but also, the purple plastic support has side flanges which grip the flat sides of the cartridge when the stylus assembly is inserted. So, unlike many cartridges which exhibit some play, with resultant misalignment in this area, the 999VE doesn't appear to exhibit any shift.

The thin, tubular, aluminum stylus shoe is hinged into a truncated cone, and the elliptical diamond stylus is well protected against accidental damage by its plastic surround. The damping material at the hinging point is probably responsible for the very low mechanical impedance at high frequencies, which lifts the high-frequency resonance peak out of the audible range.

The 999VE's electro-magnetic system is Empire's version of the moving-iron principle, using four small perpendicular magnetic cores as pole pieces. Rear-mounted ceramic magnets concentrate the magnetic force at the pole pieces so that the pickup gains efficiency without using large coils. Nonetheless, the cartridge's sensitivity of 0.95 mV per cm/sec is slightly low, though adequate to drive the kind of preamps and receivers with which the cartridge is likely to be used. The vertical tracking angle was out a little from the standard 15 deg., but this is par for the course.

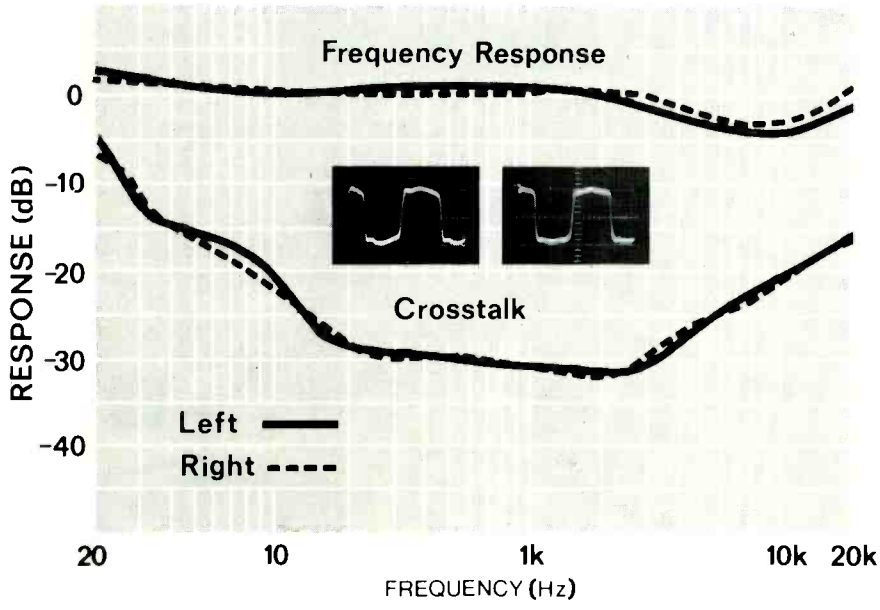
We installed the cartridge in an SME Model 3012 tone arm for our tests, using a tracking force of just over one gram (though this was just to be on the safe side because most material could be tracked at below one gram). Our new Graphic Level Recorder was used to plot the response curves automatically (synchronized with CBS Labs STR100 test record). Figure 2 is a redrawing of the curves, and shows the response to be 20-20,000 ±2.5 dB. Separation was certainly tops, with over 30 dB in the mid-range, and 16 dB at 20 kHz. Furthermore, both channels behaved unusually alike, attesting to the accurate alignment of the stylus assembly relative to the coils. As a result, stereo perspective was excellent. The resonant peak of 2.5 dB occurred at 22 kHz, which is out of the audible range. The price paid for pushing the resonance peak out to beyond audibility seems to be a very slight dip in the 8-kHz region. The rest of the curve is practically a straight line.

Tone-burst photos of Fig. 2 show a critically damped response without any ringing. The square-wave response is outstanding and better than any previous cartridge tested. Shielded cables from the tone arm to the preamplifier must be relatively short, however, because any termination other than 47,000 ohms (the longer the cable, the larger the capacitance) will degrade the response of the leading edge of the square-wave, and therefore the high frequencies. The standard length of cable supplied with most tone arms and automatic turntables should do nicely.

We were delighted with the playback quality of the cartridge when we listened to records played back with it. It recreated a sound which had a strong bass, clear and mellow midrange, and highs without any harshness. A 2-dB increase of the treble tone control on our preamp brought the highs up to what we are accustomed to as "flat," but this is a matter of taste. The cartridge tracked all variations in discs, including new and old monos, on which it did a great job. The perfect lateral square-wave response deserves credit for this. Because the bass is flat all the way down, audible rumble is laid bare on all but the quietest turntables.

In conclusion, Empire's new 999VE is an ideal companion to the finest turntables and tonearms around.

Fig. 2—Frequency response and cross-talk of the Empire Model 999VE stereo cartridge. Response of the cartridge to 1000-Hz square waves are also shown, with left-channel only shown at 3.54 cm/sec (left) and right-channel response to lateral modulation of 5.0 cm/sec velocity.



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Shure Model 548 "Unidyne IV" Microphone

MANUFACTURER'S SPECIFICATIONS:
Type: Dynamic. Polar Pattern: Cardioid (Unidirectional). Frequency Response: 40 to 15,000 Hz. Impedance: Dual—150 and 40,000 ohms. Sensitivity: EIA Rating (G_M) —151 dB. Cable: 15-ft. 2-cond. shielded with Cannon XLR-3-11C connector on microphone end. Case: Black and chrome satin-finished all-metal with stainless steel grille. Dimensions: 1 9/16" dia. x 6 1/8" long. Weight: 9 oz. Price: $60.00 net.

The Model 548 Shure microphone is a slender dynamic unit. It provides wide-range reproduction of music and voice combined with the cardioid pattern which is so effective in coping with critical public-address system installations where feedback can become a problem. Response is down about 6 dB at the sides, and more than 15 dB at the rear up to 5000 Hz, decreasing to 12 dB at 10,000 Hz with the usual super-cardioid pattern. It is particularly clean on voice, since response begins to drop off at about 200 Hz, being down 10 dB at 40 Hz, and with a rising characteristic starting at 1000 Hz and being up 5 dB in the 6 to 10 kHz range. It begins to drop off at 12,000 Hz, although there is usable output up to 15 kHz.

In appearance, the microphone resembles the earlier Model 545, which is of smaller diameter. The 548, however, has enough space to provide for a more effective shock mounting of the cartridge, as well as for the impedance-matching transformer. From its use of a Cannon XL-3-12 connector, it is obvious that this unit is a professional model. Two secondaries are wound on the transformer, with the high-impedance winding normally connected to the output receptacle, with the usual ground connection to terminal 1 and the "hot" lead connected to terminal 3. To change to a low-impedance connection, the male insert at the end of the handle is removed and the lead to terminal 3 is disconnected and taped up, and another lead reconnected to the terminal. The lead to terminal 2 of the insert remains connected as the other low-impedance lead. This arrangement permits the use of the shielded two-conductor microphone cable for a balanced input which is ungrounded, and thus suitable for feeding typical microphone amplifiers in which the center tap of the primary is usually grounded.

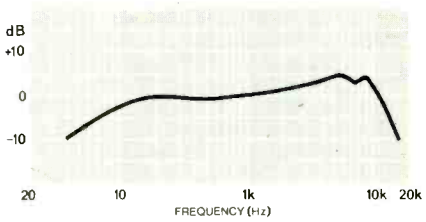
Fig. 1. Shure Dynamic Cardioid Microphone Model 548.

As is well understood by most audio experimenters and professionals alike, the low-impedance connection permits a much greater length of cable from the microphone to the amplifier without deleterious effects on frequency response, and in those instances where an amplifier is being used which has only a high-impedance input, yet a long cable is required, a line-matching transformer is available for coupling a low-impedance microphone line to the amplifier input.

The Shure 548 is also available as Model 548S, which has an integral swivel mount in which a switch is located for use in those applications where a switch is needed. Our tests were with the 548, however, which is provided with a slip-in swivel adapter which is adjustable through 90 deg. from a vertical position to the horizontal. The adapter is designed to mount on a stand having a 5/8-27 thread—which is standard for U. S. microphone stands.

Performance

Figure 2 shows the frequency response measured in the open air away from reflections, and Fig. 3 shows the polar pattern for the microphone. The mass of the microphone is sufficient to minimize handling noise, so that it could be passed from hand to hand with relatively little disturbance resulting. The wind, pop, and blast filtering of the 548 is quite effective, and should be adequate to avoid the need for any additional or accessory filtering.



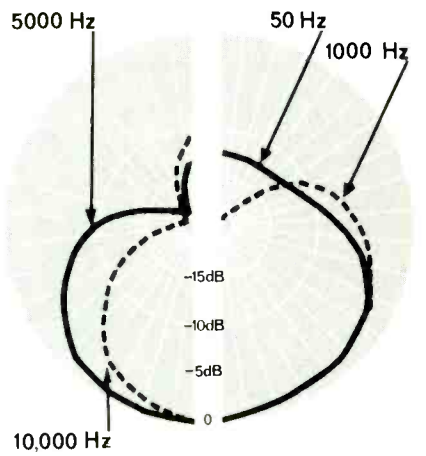


Fig. 3. Polar diagram for the 548.

On voice recording, the results were judged to be most realistic, with a smoothness — particularly on female voices — that belies the measured response. On male voices, the built-in response eliminates any chestiness and provides a crisp quality which would do credit to any broadcast announcer.

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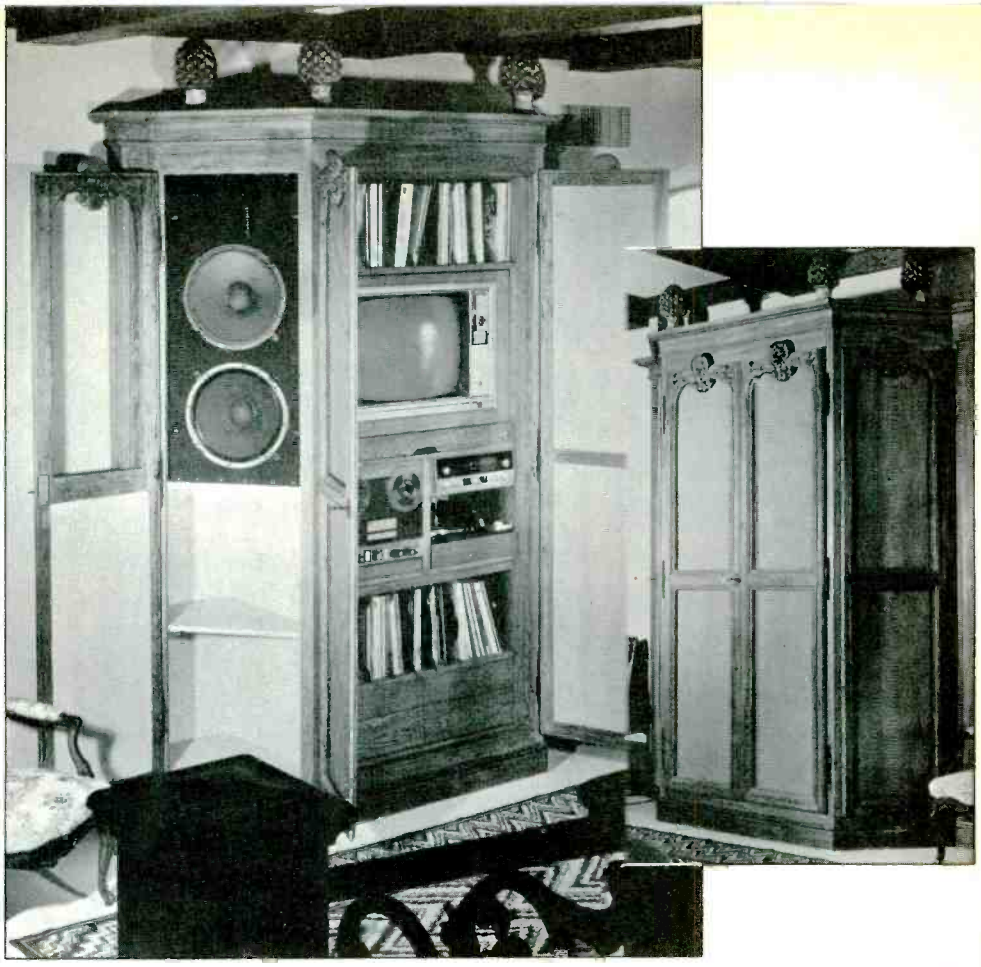
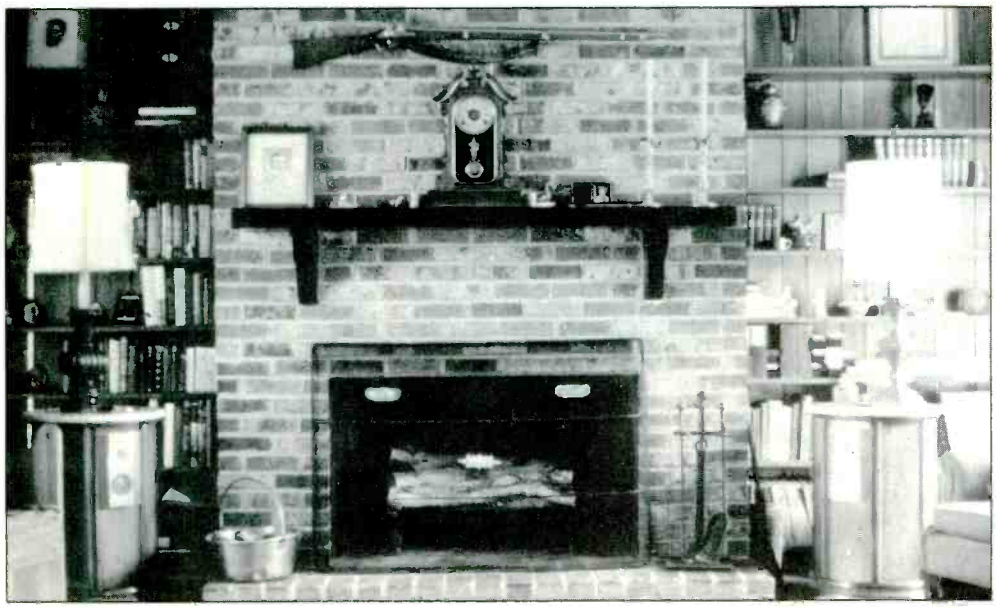
Sound & Decor Styles

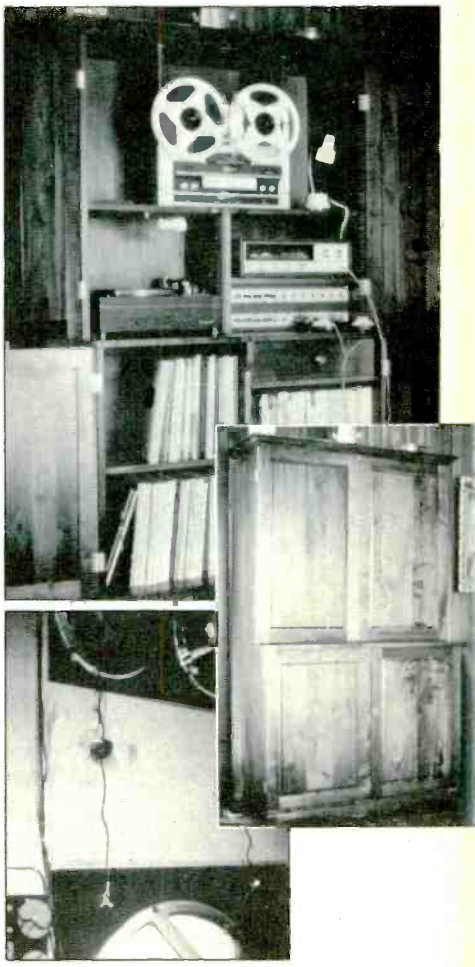


Elegant Built-Ins

Jerome Ohrbach, Bel Air, Calif.—The music system pictured here was designed to blend harmoniously with existing decor in the home of Mr. and Mrs. Ohrbach. The imported oak cabinet houses a complete entertainment system in their informal living room. Designed to match the French country house decor of the home, two JBL S7R loudspeaker systems are used; the fabric covers the upper sections of the doors, serving as grill cloths for the speakers.

To match the classical French decor in the boudoir, a false, divided door disguises the television receiver and the music system controls (the latter in the bottom half of the door), while JBL D123 speakers are mounted behind the overhead panel. Patterns in the silk panel "grill cloth" are changed to correspond with the seasons of the year.





Music Room

John A. Hageman, Nashville, Tenn.—Here's a room that the writer says is a product of his interest in music, electronics, and the lively art of conversation. (Television is viewed in another part of the house.)

The room measures 30 x 18 ft. with a 9-ft. beamed ceiling. During room construction, all speaker leads and shielded signal leads from the organ preamps were run under the floor and terminated in convenient wall jacks or in the shop-utility room (where the organ amplifiers are located). Another planned feature was the installation of four, 15-in., three-way speakers and a 30-in. woofer in a wall dividing the music and shop-utility rooms.

The four speakers were mounted on 3/8-in. steel plate, 37-in. square, welded to a shallow flange of 1/4-in. steel plate. The whole assembly was then rigidly bolted in a wall frame of double 2 x 4's. The 30-in. woofer was similarly installed beneath the other speakers, and both speaker panels covered with grill cloth. Two home-grown Karlson enclosures with 15-in. speakers are also on this side of the room. All the above speakers

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are high-efficiency types and are connected by phone jacks in a series-parallel arrangement to one channel of the stereo amplifier. They can also be jacked into separate amplifiers driven by the organ preamps.

At the other end of the room, twin speaker enclosures flank the fireplace. These are permanently connected to the other channel of the stereo amplifier.

The receiver, turntable, tape deck, records and tapes are housed in a custom-built walnut armoire designed by the writer. Tape deck and receiver inputs and outputs are brought out to the front panel in a single-type jack field. This allows flexibility to connect other tape facilities, turntables, etc., and eliminates the necessity of moving the heavy equipment cabinet to reach the back panels of this gear. The Model "L" Steinway Grand rounds out the musical equipment.

Musical equipment and audio gear are as follows:

1. Schober concert model, AGO specs with Reverb-a-tape unit and modified for independent amplification of manuals and pedals by two Schober 40-watt amplifiers.
2. Model L Steinway grand.
3. Sherwood 7800 AM-Stereo FM receiver.
4. Garrard Lab 80 turntable with Shure M-55 cartridge.
5. Roberts 3190 tape deck with Electro-Voice 664 mikes.
6. Four wall-mounted Allied-Electro-Voice, 15-in., 3-way speakers.
   Two above speakers in Karlson enclosures.
   Two Empire Grenadier 9000 speaker systems.
   One Electro-Voice 30-W Woofer.

Electronic Organs

NORMAN H. CROWHURST

PART 8 of a series: Side Effects, Coupling, and Reverberation

DRUMS AND OTHER side effects from electronic organs divide into two main groups: resonant and random. The resonant type uses a circuit similar to an oscillator, but in which the gain is not quite sufficient to sustain oscillation. The keying introduces a step transient into the circuit, which causes it to "ring" at its resonant frequency. Drums and blocks, as well as the triangle and castanets, use this method.

The other group uses random sound —noise—as a basis. This is then fed through frequency-selective and/or envelope-shaping that produces the resulting sound. The wire brush and cymbal use this method, and the snare drum includes it for part of the overall sound. Quite separate from the manner of generating these signals comes the method of keying them, or combining them with the main organ sounds.

A variety of oscillatory circuits is used for producing drum and other resonant effects. They must have the correct frequency and also the correct decay rate. They need stimulation by an impulse, which also needs to be of the correct relative magnitude and form.

One form of electronic resonator is the phase-shift oscillator, which is adjusted to critical damping, so it decays realistically for the sound it is to represent (Fig. 8-1). Frequency is adjusted by varying R1, after which decay rate is selective by adjusting R2, which degenerates gain. Capacitors marked "C" set the range within which frequency is adjusted.

An alternative with this basic circuit is to make it regenerative, but biased to cut-off (Fig. 8-2). The impulse then sends it into its gain condition, at suitable amplitude, and the decay is effected by its return to cut-off, which trims the magnitude of the oscillation progressively as it goes, until it's gone completely. Here the emitter resistor does not degenerate gain within the oscillator because the feedback circuit uses emitter as a "ground," but the emitter resistor does provide d.c. feedback so that the keying voltage has more precise control of amplitude limiting and decay rate.

Another form uses the twin-T, but with values that produce phase-reversal at the critical frequency, adjusted in gain so that the circuit does not oscillate, but decays at a realistic rate (Fig. 8-3). An impulse is injected into the twin-T suitably to stimulate oscillatory action of suitable magnitude.

For most drums, the output is taken from a relatively pure point, which will be the collector of the phase-shift type. However, the bass drum should have more harmonics for realism, so its output can be taken from a junction where harmonics are emphasized a little more. The output of the twin-T type may be filtered by an R-C network to reduce harmonics.

The random-sound type effects need gating. The noise generator may be of any type. Some form of diode, biased to a point of low reverse voltage and current, where resistance changes rapidly with current, followed by amplification, does fine (Fig. 8-4). The generator may be kept running continuously or may be keyed "on" only when required.

The sound is gated by appropriate amplitude-limited circuits that are normally cut-off and admit noise only when triggered to do so. One way is to use the d.c. voltage from the envelope-controlling circuit as collector supply for the noise amplifier stage. Diodes isolate separate outputs and collector loads associated with the gating (Fig. 8-5).

To get the required effect the noise is colored by resonant circuits as its envelope is controlled by the gating (Fig. 8-6). For realistic effect, the cymbal needs some form of "shimmer." This fluctuates the intensity of sound rhythmically. It can be achieved either by another resonant circuit, or by tak-

(Continued on page 79)

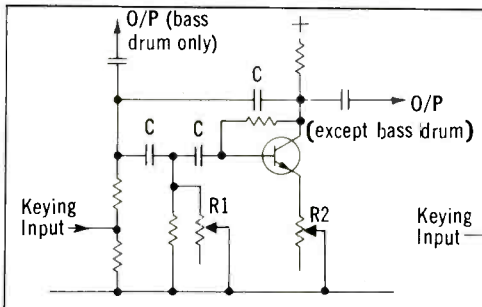


Fig. 8-1—One form of oscillatory circuit for generating drum, block and other resonant percussive sounds. This circuit is adjusted not to oscillate, but to be active.

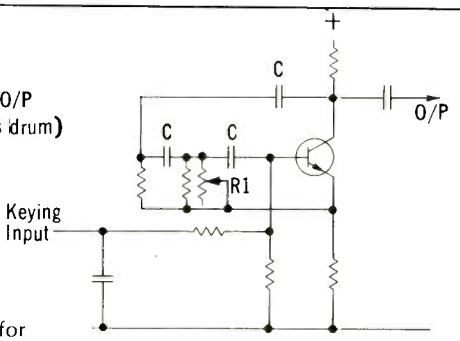


Fig. 8-2—Another variation of the phase-shift oscillatory circuit. This one does oscillate when it is not cut off. Controlled cut-off shapes the decay form.

Fig. 8-3—A twin-T network used for making the resonant sound. This, like Fig. 8-1, is adjusted not to oscillate.

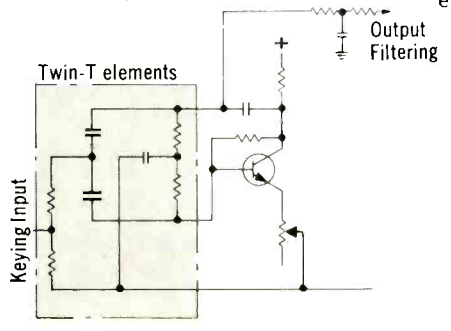
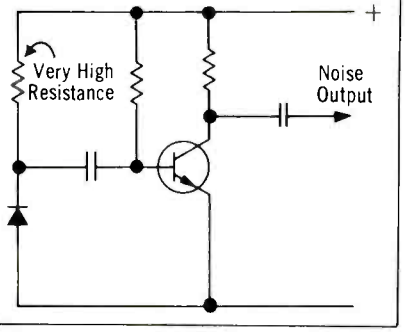


Fig. 8-4—The usual form of noise generator employed in organs, with some variations.



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If you want more expression in the high frequency end, choose the Madera with its compression driver and cast aluminum exponential horn at only $149.50. It's driven by the same 10-pound magnet structure that's used in professional studio systems. And if you want the finest bookshelf available at any price, select the $179.50 Bolero.

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AUDIO MUSIC REVIEW

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Wind Music

The Golden Age of Wind Music. Ensemble of trumpets and trombones, Oboe Ensemble of Detmold College of Music, Recorder Ensemble of Hanover College of Music, Wilhelm Ehmann. **Vanguard Cardinal VCS-10046 stereo.**

German and English Music of the Late Renaissance for Brass. Eastman Brass Quintet. **Vox Candide CE 31004 stereo.**

Here are two excellent wind music recordings, both sure to please the fans even though, in varying ways, neither is authentic in instrumentation. The German recording combines three unlikely ensembles, recorders, oboes and trumpet-trombone. The American disc features high-powered modern brass.

The German record on Vanguard's Cardinal label offers early Baroque music in two formats, works for one or several wind "choirs," often in opposition, and solo pieces for one or two instruments with continuo accompaniment (on a small organ). In the ensemble pieces the pace is somewhat stolid in a Germanic way, but the playing is earnest and musical; our interest is claimed by the interesting contrasts of sonority between oboes, recorders and the big trumpets and trombones—an expert balance of unequal forces in terms of volume. Very tricky recording job. As for the solos and duets, all for trumpets or trombones, I found them lumpish. Too heavy in effect as played on the modern instruments. But the ensemble pieces make up for them, and the recorded sound has the requisite big liveness to set off the brass and woodwinds.

The Eastman players offer a tightly balanced program, the whole first side devoted to a survey of the music of Samuel Scheidt out of 17th century Germany, the second side all English from the same period. Many of the works are instrumental versions of vocal originals including some familiar madrigals.

The Eastman playing has that instantly recognizable professional glitter that is particularly associated with our leading music schools, where technique sometimes is even more important than

music. These performances are impeccable, almost superhuman, the sound power is enormous; here you have five great musical Cadillacs or Lincoln Continentals with power-everything! Inside the huge space of New York's Manhattan Towers ballroom they sound like fifty brasses or maybe five hundred. Of course, such a sound is not even remotely like that which might have been associated with the original music; these are transcriptions and wholly anachronistic.

But, happy to say, art conquers all! The Eastman men are *musical*. They play the old music with respect and with good phrasing, a fine *legato* breath and plenty of rhythmic *élan*. I'm a purist but I enjoyed every minute. My only real objection is to the bottom instrument, a great, big, fat tuba. Like Bach on a saxophone. He plays just fine—but a tuba is a tuba any way you listen.

The fi is extraordinary, thanks to the instruments, to the mammoth acoustic surround, to excellent recording by Marc Aubort and, of course, the now familiar dynamic virtues of the Dolby system. A hi fi demo, definitely.

Performances: B, B *Sound:* B+, A—

Nationalism

Smetana: My Fatherland (Má Vlast). Leipsic Gewandhaus Orch., Vaclav Neumann. **London CSA 2222 (2 discs) stereo.**

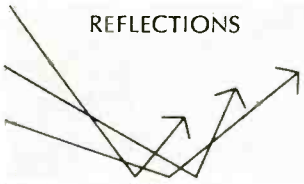
The album cover of this recording of the great epic series of six Czech tone poems is a montage of dramatic scenes

not all cardioid microphones are alike . . .

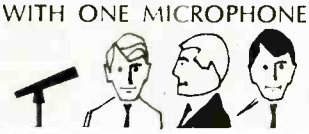
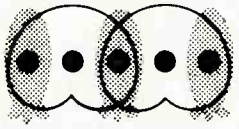
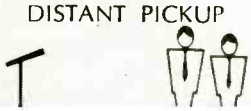
the SHURE UNISPHERE® I

TRUE CARDIOID UNIDIRECTIONAL DYNAMIC MICROPHONE SOLVES ALL THESE COMMON MICROPHONE PROBLEMS!

PROBLEMS CAUSED BY INEFFICIENT REJECTION OF UNWANTED SOUNDS BY THE MICROPHONE

SITUATION	PROBLEM	CAUSES	SOLUTION
REFLECTIONS 	Feedback occurs where a so-called "cardioid" microphone is used and the speakers are placed to the rear of the microphone. A common occurrence in churches, auditoriums, and meeting rooms.	Sound bounces off hard surfaces on the walls, floor and ceiling, in and around the audience area and the microphone used is not effective in rejecting these sounds at all frequencies, and in all planes about its axis.	The Unisphere rejects sound at the rear with uniformity at all frequencies. Sounds bouncing off floors or other surfaces are uniformly rejected.
COLUMN LOUDSPEAKERS 	Unexplained feedback. Column loudspeakers are used to distribute sound more evenly to the audience in churches and auditoriums.	Feedback occurs when rear and side sound lobes of column speakers coincide with rear and side lobes of so-called "cardioid" microphones.	The Unisphere solves the problem because it has no rear or side lobes. Thus it rejects the side and rear lobes of the sound column speakers.
REVERBERANT BOOM!	A disturbing, echoing effect of low frequency sound often found in churches, large auditoriums, and arenas.	Low frequency reverberation and boominess occuring when microphone fails to retain unidirectional characteristics at low frequencies.	The Unisphere maintains a uniform pattern of sound rejection at all frequencies, even as low as 70 Hz. The response has a controlled roll-off of the low end — low frequency reverberation diminishes effect of boomy hall.

PROBLEMS CAUSED BY THE MICROPHONE'S INEFFECTIVENESS IN PICKING UP THE DESIRED SOUND

GROUP COVERAGE WITH ONE MICROPHONE 	A single microphone does not provide uniform coverage of a group. This is commonly experienced with choral groups, quartettes, instrumental combos, and speaker panels.	The particular "cardioid" microphone used lacks a uniform pickup pattern, so that persons in different positions within the general pickup area of the microphone are heard with varying tonal quality and volume.	The Unisphere affords uniform pickup of the group with a resulting consistency in volume and sound quality among the members of the group.
USING MULTIPLE MICROPHONES 	Variation in the pickup level and tonal quality exists throughout the broad area to be covered. This may occur in stage pickup of musical and dramatic productions, panels and audience participation events.	The pickup pattern of the microphones used is too narrow, causing "holes" and "hot spots." The off-axis frequency response of the microphones also varies.	The Unisphere permits smoothness in pickup as true cardioid pattern gives broad coverage with uniformity throughout coverage area. Eliminates "holes," "hot spots," and variations in sound quality, simplifies blending many microphones.
DISTANT PICKUP 	Too much background noise or feedback results when working with microphone at desired distance from sound source.	Long-range microphones are less directional with lower frequencies. Lobes or hot spots allow background noise or feedback.	Use the Unisphere to gain relatively long range with effective rejection of sound at all frequencies at the rear of the microphone.

SHURE BROTHERS, INC., 222 HARTREY AVE., EVANSTON, ILL. 60204

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from last summer's Czech invasion, with tanks, students, flags and even a banner with the now-familiar names of Dubcek and Cernik on it. But the parallel is not well taken in musical terms, even if it may sell a few extra copies. This is music from Old Bohemia of the 1870s, very far removed from our world of modern tanks and machine guns, from satellites and from East versus West. A much simpler age, and a simpler music.

There are six tone poems, each with a descriptive title invoking the milder glories—mostly scenic and mytho-

logical—of the Bohemian countryside. Only two are familiar in the old-fashioned international concert repertory. *Vltava* or The Moldau, that familiar depiction of the principal Czech river in musical terms, and From Bohemia's Meadows and Forests, "a general description of the feelings which the sight of the Czech countryside conjures up," as the composer put it. Originally, the six were supposed to be heard as one, at a sitting, and if you will believe the notes, are often so heard today in Czechoslovakia. Their themes, after all, are inter-related—so how can you appreciate one without all the others?

Well, dutifully, I tried. But this is such old fashioned music now! It has all the pomposity of the full Wagnerian idiom but its language is far tamer and gentler; I got through the first and second tone poems, then somewhere in the third work I fell gently asleep, in spite of myself, and dreamt pleasant dreams that had nothing whatsoever to do with Bohemia until I was jarred awake by the end of the side.

This is neither to disparage the music nor the performance, which is worthy if not exactly brilliant. But it takes an active imagination to place one's self back a century and to feel strength in this now-distant concept of ardent nationalistic expression. However much he is still worshipped by his present compatriots, Smetana is not a big enough composer to raise that expression into a more timeless sphere. His

music is sincere, moving, but very dated as we hear it now.

Performance: B *Sound:* B

Janacek: Sinfonietta (1926).
Prokofieff: Waltzes (Suite for Orchestra), Op. 110 (1946). Moscow Radio Symphony Orch., Rozhdestvensky. **Melodiya Angel SR-40075 stereo.**

The Czechs have a belated 20th century hero in Janacek, only recently beginning to emerge as a general-interest composer. His most important work was done after the age of 60 (like César Franck). Thus he rates as virtually a "modern" between-the-wars composer, though he was born in 1854, when Schumann was still alive and Brahms ending his 'teens. The Sinfonietta of 1926 is not exactly modern in any dissonant sense, and yet it is ever-so-clearly out of the 20th century in its kaleidoscopic harmonies and its brassy fanfares—there are 14 trumpets and seven more big brass in the trombone-tuba lower range, plus the full string orchestral complement, woodwinds, and all the rest. A big sound, if a little symphony, and if you enjoy full-orchestra symphonic modern in a very moderate vein you'll take to Janacek. Even if he doesn't sound particularly Czech.

My favorite here is the Waltz Suite of Prokofieff, six waltz segments drawn from two ballet scores, a movie, and an opera, War and Peace, the whole put together in 1946.

The Russians took over the waltz far back in the 19th century, developing, particularly in Tchaikowsky, their own special variety of the form, set for large orchestra; full-bodied but always with a tinge of melancholy, a sort of masculine version of the introspective Chopin waltzes. Prokofieff's waltzes, right up through WW II, fall straight into this tradition, brought forward into a 20th century idiom. They have a marvelous bitter-sweet quality, gentle yet passionate, very big in orchestration yet somehow very personal and introspective. And — being Prokofieff — full of memorable melody.

There are familiar tunes in this waltz sequence, notably those from the ballet Cinderella and the New Year's Ball waltz from War and Peace, the huge Prokofieff opera based on Tolstoy's novel. Strangely, though this performance is rich and full-bodied, I remember the old Urania version with the Kansas City Philharmonic as bringing out the wry delicacy of the melodies a lot more poignantly. It's still available, if you'd like a comparison.

Performance: B *Sound:* B

Prokofiev: The Stone Flower (music from the ballet, Op. 118). Bolshoi Orchestra, Rozhdestvensky. **Melodiya Angel SR 40066 stereo.**

These two sides of persuasive ballet music come from the last score on which Prokofieff worked the time of his death in 1953, though the music dates from some five years earlier. It is far from a tired score, nor a derivative one as many of his more popular-orientated works often seem to be. The fresh, folk-style story, of a young Russian stone worker who completes a perfect malachite vase aided by all sorts of supernatural manifestations, evidently brought out the best in Prokofieff. The music is, one might say, almost wide-eyed in its gentle quality, far removed from the more spartan dramatic scores that began with the Alexander Nevsky film music and continued through the war years.

Some listeners who are pianists or piano teachers will find an extra fillip

—a group of tunes from the composer's really beautiful little Children's Suite for piano, incorporated into the orchestral ballet score.

Though these are listed merely as excerpts, the two full LP sides offer an immense amount of vividly contrasted music, modern and yet wholly easy in the listening. Performance by the Bolshoi players, who played for the ballet itself, is of a very high order.

Performance: A— *Sound:* B+

Bizet-Shchedrin: The Carmen Ballet. Bolshoi Theatre Orch., Rozhdestvensky. **Melodiya Angel SR 40067 stereo.**

Is *this* a weird mixture of 19th century France and 20th century Russia of the present moment! A young Russian musician has worked out a "freely arranged" ballet, from the French opera score, for an incredible orchestra of strings and 47 percussion instruments —nothing else. The music is not literally transcribed, but a good part of it follows Bizet's tunes, if not his operatic continuity, without major harmonization except at the joints. What really distinguishes the score, if that is the right word, is the percussion. It is as though a couple of tin factories and a bell collection had casually joined the orchestra. Oddly grotesque clanks, crashes, thumps and gongs mingle with Carmen's elegantly mid-century expression; the Habañera and such find themselves decked out with alarming vibraphone flutters. I'm not sure I like it much, after the first few minutes. The mixture never seems to jell. Bizet stays Bizet, and Shchedrin stays very much Shchedrin.

This judgment, though apropos in this review of the musical recording, should not of course be applied to the total production; for until we can hear the music and see the ballet at the same time—whether live or via film—we can't really judge its musical impact. The ballet, so far, is unavailable in the West, except in Cuba (in case you get hi-jacked). So—buy the record as a Carmen weirdie, and catch the show later, when and if.

Performance: B *Recording:* B

Vaughan Williams: Pastoral Symphony (No. 3); In the Fen Country. New Philharmonia Orchestra, Boult. **Angel S-36532 stereo $5.98.**

Here are two early orchestral works of Ralph Vaughan Williams, dating from 1916 for the Symphony and 1904-07 for the Fen Country, (he died in 1958). Both of them are exquisitely played by Britain's fanciest orchestra under a long-time friend and conductor

of Vaughan Williams' works. Couched in the most persuasively nationalistic terms both in the performance and in the accompanying program notes, this record seems to say, This is England's Best and Most Characteristic Music.

Well, maybe. Just as the Finns have Sibelius, the Norwegians Grieg and the Danes their Nielsen (and the Czechs have Smetana and Dvorak), so, belatedly, the British managed to come up with a few post-nineteenth-century heroes. These begin with Sir Edward Elgar and center upon the much repected V-W himself, who with Gustav Holst brought true British folk music into the musical mainstream. Reading here, one would think that this music was the very embodiment of Britishness. But a non-British ear may tell it quite differently. It's British, all right. But by skillful transplantation from the continent.

The plain fact is that this earlier Vaughan Williams was Britain's late answer to Debussy, a belated Impressionist whose Debussy-like effects are nicely merged with as many that are straight from Sibelius, Grieg *et al.* If that earlier Briton, Henry Purcell, turns out to sound remarkably like Lully (France, born in Italy), then Vaughan Williams is even more of a continental composer but, he nicely modifies the continent's idioms to suit the chillier English climate and to sound gratifyingly British to British ears! Handel did the same.

V-W was not a modernist. He never gave in to the brassy inelegance of early "modern"; his Pastoral Symphony, composed at the end of WW I, is wholly war-free and jazz-free too. It is still very much involved in impressionistic moods (a soulful, wordless soprano singing offstage, for example), expressed in pre-war large-orchestra terms. The youthful "In the Fen Country" is a simpler, more enthusiastic work, unashamedly of its own time when Debussy's *La Mer* was brand new and the impressionist color-orchestra was a thing for a musical youth to roll in, luxuriously. An interesting look at British nationalism, this record, and a sterling performance of sterling music, if you enjoy the British Sound.

Performance: A— *Recording:* B+

Orchestral Music of Erik Satie. French National Radio and Television Orch., Rosenthal. **Everest 3234 stereo.**

No sooner a little than a lot—here is more Erik Satie to supplement the recordings listed last December. Here again we have the inevitable "Parade," that snazzy, irreverent French ballet music of 1917, plus the third movement of *Socrate* for soprano solo and orchestra, and a brace of devilish little pieces including four collectively entitled *En habit de cheval*. which Everest translates, quoting the venerable Vernon Duke, as "In Horse's Garb." If you ask me, it means "In Riding Habit," something just a bit different—but neither title seems to relate to the jolly music, which includes a morsel called *Fugue en papier,* a paper fugue. (The Germans would call it *Augenmusik*. Eye music.)

The final movement of *Socrate* is something else again, a long, serious essay for soprano solo and orchestra in the most polished French style out of Debussy and *Pelléas et Mélisande,* sung by a characteristic French soprano, Denise Monteil. Excellent, and a nice contrast to the other works. No texts—Everest never bothers.

I'd call the French Radio-TV Orchestra's performance of this zany music expert, but stodgy. One gets the impression they don't think it's very funny. Or maybe it was just a job. The stereo sound is enormous, cavernous, with an unusual dynamic range. Dolby-ized?

Performance: B— to A— *Sound:* B+

Obernkirchen Children's Choir—Holiday in Japan. Conducted by Edith Möller. **Westminster WST-17153 stereo.**

Here's what happens to musical nationalism these jet-flight days! First side of this tour recording by the pigtailed German children is given over to stunt pieces, to captivate their hosts—a rather horrible medley of Japanese folk songs arranged in pseudo-European harmony and sung (of course) in Japanese, then a pair of typical U.S. Glee Club Negro spirituals (in fractured suh-thun English), and then more popular Japanese fare. The kids are cute and the language whimsical, but musically the net result is labored, to put it mildly. It always is in such circumstances, however charming it may be to have foreign infants mouth your own language at you.

The second side displays the kids' German repertory and is thus musically far more valid. This group, for all its fame, does not quite have the innocence and spontaneity of the Vienna Choir Boys (Sängerknaben). The voices, even at such an early age, are already trained up to precociousness, with a couple of self-conscious little virtuosos (zooming in with fancy high notes) who need a good spanking, I'd say. The arrangements are somewhat pedantic and so is the style.

Performances: C+ *Sound:* B

Romantic Vienna (Strauss, Schubert, Beethoven, Mozart). Boys' Choir of Vienna Woods, Vienna State Opera Orch., Prof. Karl Etti. **Everest 3240 stereo.**

These Viennese boy singers, though not *the* Vienna boys, the famed *Sängerknaben,* are beautifully trained and styled for this traditional but slightly freakish sort of Viennese music for children plus orchestra—everything from *Ach, du lieber Augustin* to a movement form the Beethoven *Appassionata* Sonata, with Strauss waltz music in between, all arranged for the happy combination of children and symphony orchestra. There's even a medley of Viennese tunes.

Almost any musical arrangement can be effective when it is well styled and the performance is knowing and musical. The excellent qualities of the orchestra here and the wise, tasteful use of the boys' voices makes even the more preposterous numbers on this disc a pleasure to listen to.

Performance: A— *Sound:* B

Light Listening

STUART TRIFF

"Cinema '69," arranged and played by Leroy Holmes and his lush orchestra (U.A. UAS-6669), spotlights a dozen themes from as many current movies. The settings are reasonably faithful to the originals, make enjoyable listening, and the sound is excellent.

Al Hirt's "In Love with You," (RCA LSP-4020), is also one of his best. Outstanding tracks are Bill Walker's arrangements of "Eleanor Rigby," "The Look of Love," and "Autumn of My Life."

Once you get past the title, "Suite for Orchestra, Mezzanine and Balcony," you've had about all the fun there is to be had from this set of orchestral novelties, composed by Richard M. Sherman. Irwin Kostal's artful orchestrations do little to disguise the pretentiousness and striking unoriginality of these pieces. Mr. Sherman is more in his metier in the songs written with brother Robert Robert for "Chitty Chitty Bang Bang," which fill out the disc (UA UAS-6680).

Nostalgia abounds in three re-issues, featuring the talents of Allan Jones, Gertrude Lawrence, and several musical comedy greats of the past. In all three instances, the material is derived entirely from 78's. The Allan Jones collection (RCA Camden CAL/CAS-2256) is disappointing in that it omits several choice items associated with the singer. However, the "Donkey Serenade" *is* here, along with other chestnuts from the pens of Kern, Porter and Romberg.

RCA happily continues to divest its dust-laden, but priceless vaults of materials for their invaluable Vintage Series. "Musical Comedy Originals: 1909-35" (RCA LPV-560), offers more than a dozen theatrical greats, from Blanche Ring to Eleanor Powell, singing songs they introduced in Broadway shows. To list just a few of the many delectable items: Edith Day in "Irene," Eddie Cantor in "Whoopee," Bea Lillie in "Oh Please," Al Jolson in "Vera Violetta," and Libby Holman in "Revenge with Music" . . . a must for serious collectors of show music!

The two best vocal records auditioned of late are those by Eydie Gorme and Vic Damone. "Eydie" (RCA LSP-4093) is an exceptionally well-sung program, spotlighting songs from "Dear World" and "A Mother's Kisses" (closed out-of-town). Fine arrangements by Marty Manning and Peter Matz. Vic Damone's "Why Can't I Walk Away?" (RCA LSP-3984) takes its title from the ballad in "Maggie Flynn," and represents the best sustained singing I've yet heard from Damone, who tends to have his vocal ups and downs. Tracks are a nicely-varied blend of standards ("Stardust," "Like Someone in Love") and contemporary tunes ("Goin' Out of My Head," "Watch What Happens"). Good backings from Jack Pleis, Perry Botkin, Jr., enhanced by warm, intimate stereo reproduction.

Music from "Maggie Flynn" (RCA LSP-4083), features the composers, Hugo and Luigi, fronting a chorus and orchestra in pleasant versions of their own music, but if you opt for the original cast waxing, you're not likely to want this one as well. An instrumental rendering of John Kander's score for "Zorba" (Capitol ST-119) may be recommended for the imaginative arrangements of Claus Ogerman and the vivid stereo reproduction.

Jazz

BERTRAM STANLEIGH

The Lasting Impression of Hugh Masakela
MGM Stereo SE-4468

This is more profound music-making than the bouncy hits that have made Masakela a leading contender on the Top 10 charts. And it wouldn't surprise me at all if a great many of this sensitive young trumpeter's fans find this new platter a disappointment. But for many others, this latest set will come as a revelation of the depth and intensity of Masakela's talents, and it may very well be an indication regarding the direction of his future development. Working with a background of piano, bass, and drums, Masakela plays a half dozen long solos with strong, Afro-Latin influence. He makes no attempt to avoid the difficult, and it must be conceded that there are a few moments when his technique is not up to the rough standards he has set for himself. But he has a great deal to say, and this record serves notice that he deserves more serious attention in the future.

Performance: A *Sound:* A

Alice and John Coltrane: Cosmic Music
Impulse Stereo AS-9148

Two long compositions, Manifestation and Reverend King, about 11 minutes apiece, were taped by Coltrane not long before his tragic and untimely death. A number of other recordings

Grady Tate—Singer

IN THE LAST half-dozen years, probably no jazz drummer has turned up on a greater number of recording dates than Grady Tate. His bright, alert style of performance, matched by a subtle sense of the proper timbre, and a masterful touch with brushes has placed him very close to the top of the drumming ladder—just a rung or so below such musicians as Elvin Jones, Art Blakey, Shelley Manne, Louis Bellson, and those other major "skin" virtuosi who speak out with an important message.

Curiously, for a man so at ease with the drums, Tate never chose these instruments as a means of expression. His ambition and his training had been for a career as an actor and singer, and it was merely a series of coincidences that shifted him from the job of teaching speech and English in a Washington, D. C., high school to that of a top rank drummer playing at the Copa with Peggy Lee, cutting discs with Oliver Nelson, Gary McFarland, Kai Winding, and hosts of others, and doing gigs on the *Today* and *Tonight* shows on TV. With his first album as a singer, it seems likely that Tate will launch a new career as a jazz vocalist.

What seems really hard to believe is that this is only a "first" vocal album. Debut discs usually don't show such control and polish. This isn't the work of a talented beginner who needs experience to bring out his potential. It's the kind of performance that one gets only from a richly endowed, thoroughly experienced singer who has developed and perfected his style over many years and learned all of the techniques to achieve subtle variations of expression by means of a whole palette of tonal gradations and emphatic inflections.

Tenderness, strength, and a strong rhythmic core are all abundantly present, and they are coupled with a rare sense of the meaning of words and flawless diction. But to analyze Tate's many vocal virtues is actually as pointless as extolling the separate ingredients in a perfect sauce. It's the *total* expressive impact of this new singer's message that counts.

The recordings feature arrangements by Gary McFarland and Mike Abene. A rhythm group of bass, guitar, piano, and drums is backed up by a string orchestra in the McFarland arrangements and by a large group of reeds and brasses in the arrangements by Abene. The recording was taped on 8-channel equipment at A&R Studios with the same remarkable success that we noted earlier on the first Skye releases. It is clear that Skye Records, the new recording venture of Gary McFarland, Cal Tjader, and Gabor Szabo, is on its way to an influential position in the jazz disc field.

Grady Tate: Windmills of My Mind.
Skye Stereo SK-4D

that Coltrane had taped himself will be coming out on Impulse in the future. These first self recordings provide some memorably fine performances by Coltrane with Alice Coltrane, piano, Pharoah Sanders, tenor and flute, Jimmy Garrison, bass, Rashied Ali, and Ray Appleton, percussion. As recordings, they aren't bad. Coltrane is agreeably forward, and although there is a slight tendency for the stereo to split into right and left, all of the other instrumental solos come through clearly. While the ensemble sections may not unscramble with equal ease, this is nevertheless a most worthwhile disc, and the fill up pieces with Alice Coltrane and most of the same group are worthy companion pieces in understandably superior sound. If the balance of Coltrane's personal tapings are as good as these, this promises to be the start of a very worthwhile exploration.

Performance: A *Sound:* B— to A

Gary Burton: A Genuine Tong Funeral
RCA Victor Stereo LSP3988

Gary Burton is a young vibraphonist engaged in an active search for new forms of expression. In the past he has aimed at various fusions of jazz with rock and roll and with country and western music. The present excursion is toward a form of formal concert music created with many jazz/pop playing techniques. The music, by Carla Bley, is rather darkly brooding in mood, and in spite of its title, completely western in style and feeling. The Burton Quartet is augmented by four or five additional brasses and reeds, and composer-conductor Carla Bley contributes a slight bit of piano and organ backing. Sound is fine, if you don't mind sudden odd noises popping out of either speaker at intervals.

Performance: A *Sound:* A

Dave Van Ronk: Black Mountain Blues
Folkways Stereo FTS 31022

Another simulated stereo reissue from Folkways, this set by folk singer Van Ronk sounds remarkably good 10 years after its first release. The harsh intensity and deep melancholy that this singer manages to impart to his re-creations of country blues are most unusual in the work of an urban artist whose roots are steeped in a collection of old recordings, rather than in the rural countryside. *Æ*

Performance: A *Sound:* B+

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ABZs of FM

(Continued from page 48)

and requires precision machining and assembly of parts.

Figures 7, 8, and 9 are typical response curves photographed right from the face of an oscilloscope. You can readily see how much information can be gained about the state of alignment of the sets involved just from looking at the photos.

Final alignment of either the ratio-detector or the discriminator is even more easily accomplished using this visual method, for, as can be seen in Fig. 10, the "S" curve discussed earlier is beautifully displayed, revealing such data as linear portion (over how many kHz is the slope uniform, so that recovered audio is distortion free), distance (in kHz) from peak to peak, etc. While zero-centering of the detector response is effective using the meter method, Figs. 11 and 12 show exactly what happens to the response when the secondary of the detector is *not* adjusted for proper zero-center. A manufacturer presenting alignment instructions for the visual method might tabulate these instructions as shown in Table II.

We will take up alignment of the r.f. or "front end" in our next installment.

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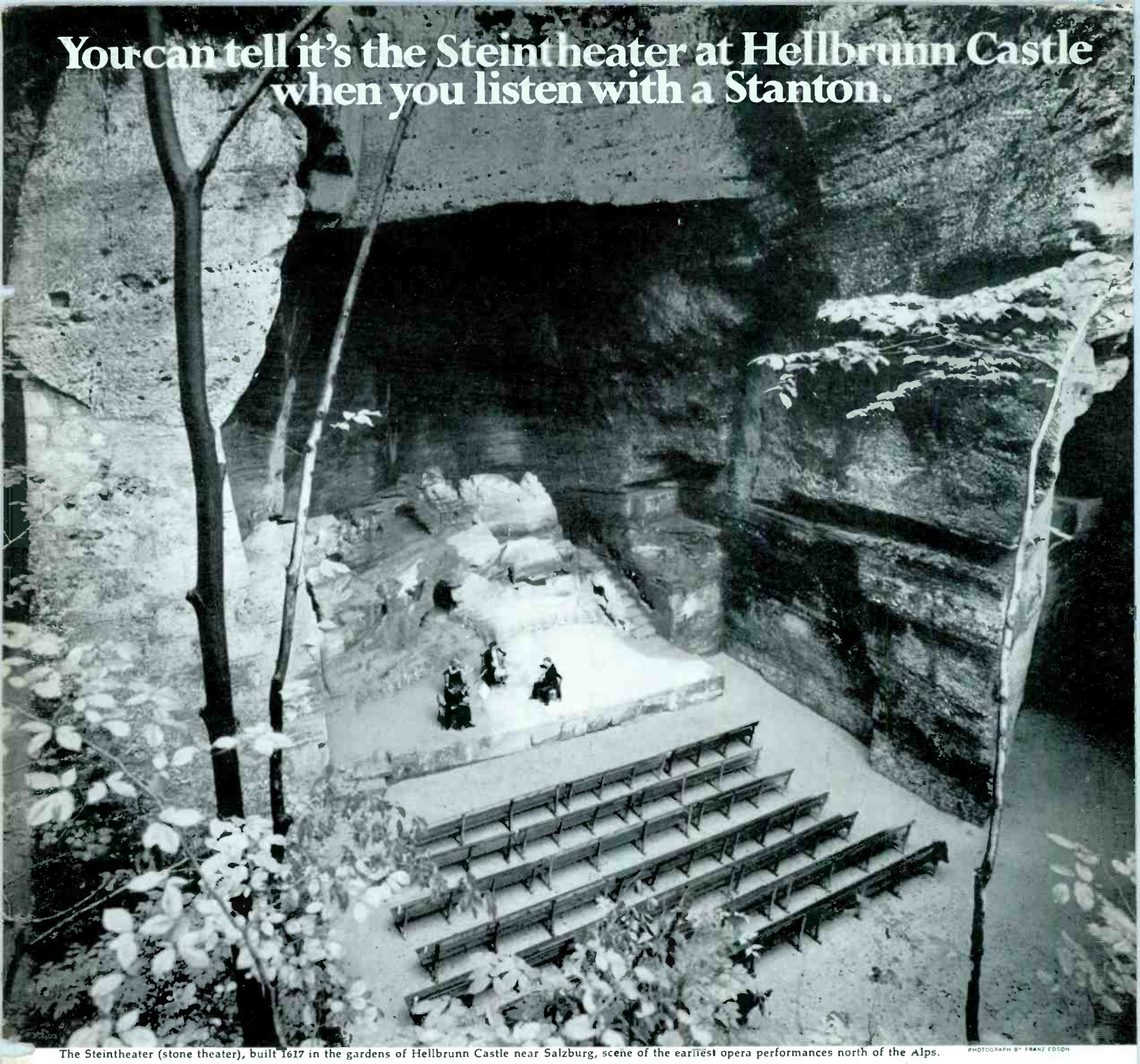
You can tell it's the Steintheater at Hellbrunn Castle when you listen with a Stanton.



The Steintheater (stone theater), built 1617 in the gardens of Hellbrunn Castle near Salzburg, scene of the earliest opera performances north of the Alps. PHOTOGRAPH BY FRANZ EDSON

The ultimate test of a stereo cartridge isn't the sound of the music.

It's the sound of the hall.

Many of today's smoother, better-tracking cartridges can reproduce instrumental and vocal timbres with considerable naturalism. But something is often missing. That nice, undistorted sound seems to be coming from the speakers, or from nowhere in particular, rather than from the concert hall or opera stage.

It's easy to blame the recording, but often it's the cartridge.

The acoustical characteristics that distinguish one hall from another, or any hall from your listening room, represent the subtlest frequency and phase components of the recorded waveform. They end up as extremely fine undulations of the record groove, even finer than the higher harmonics of most instruments.

When a cartridge reproduces these undulations with the utmost precision, you can hear the specific acoustics of the Steintheater at Hellbrunn Castle, or of any other hall. If it doesn't, you can't.

The Stanton does.

"The tracking was excellent and distinctly better in this respect than any other cartridge we have tested . . . The frequency response of the Stanton 681EE was the flattest of the cartridges tested, within ±1 dB over most of the audio range."
Hirsch-Houck Laboratories, HiFi/Stereo Review, July, 1968.

The specifications.* Frequency response, from 10 Hz to 10kHz, ±½ dB. From 10kHz to 20kHz, individually calibrated. Nominal output, 0.7mV/cm/sec. Nominal channel separation, 35dB. Load resistance, 47K ohms. Cable capacitance, 275 pF. DC resistance, 1K ohms. Inductance, 500mH. Stylus tip, .0002" x .0009" elliptical. Tracking force, ¾ to 1½ gm. Cartridge weight, 5.5 gm. Brush weight (self-supporting), 1 gm. *Each Stanton 681 is tested and measured against the laboratory standard for frequency response, channel separation, output, etc. The results are written by hand on the specifications enclosed with every cartridge. The 681EE, with elliptical stylus and the "Longhair" brush that cleans record grooves before they reach the stylus, costs $60. The 681T, identical but with interchangeable elliptical and conical styli both included, costs $75.

For free literature, write to Stanton Magnetics, Inc., Plainview, L.I., N.Y. 11803.

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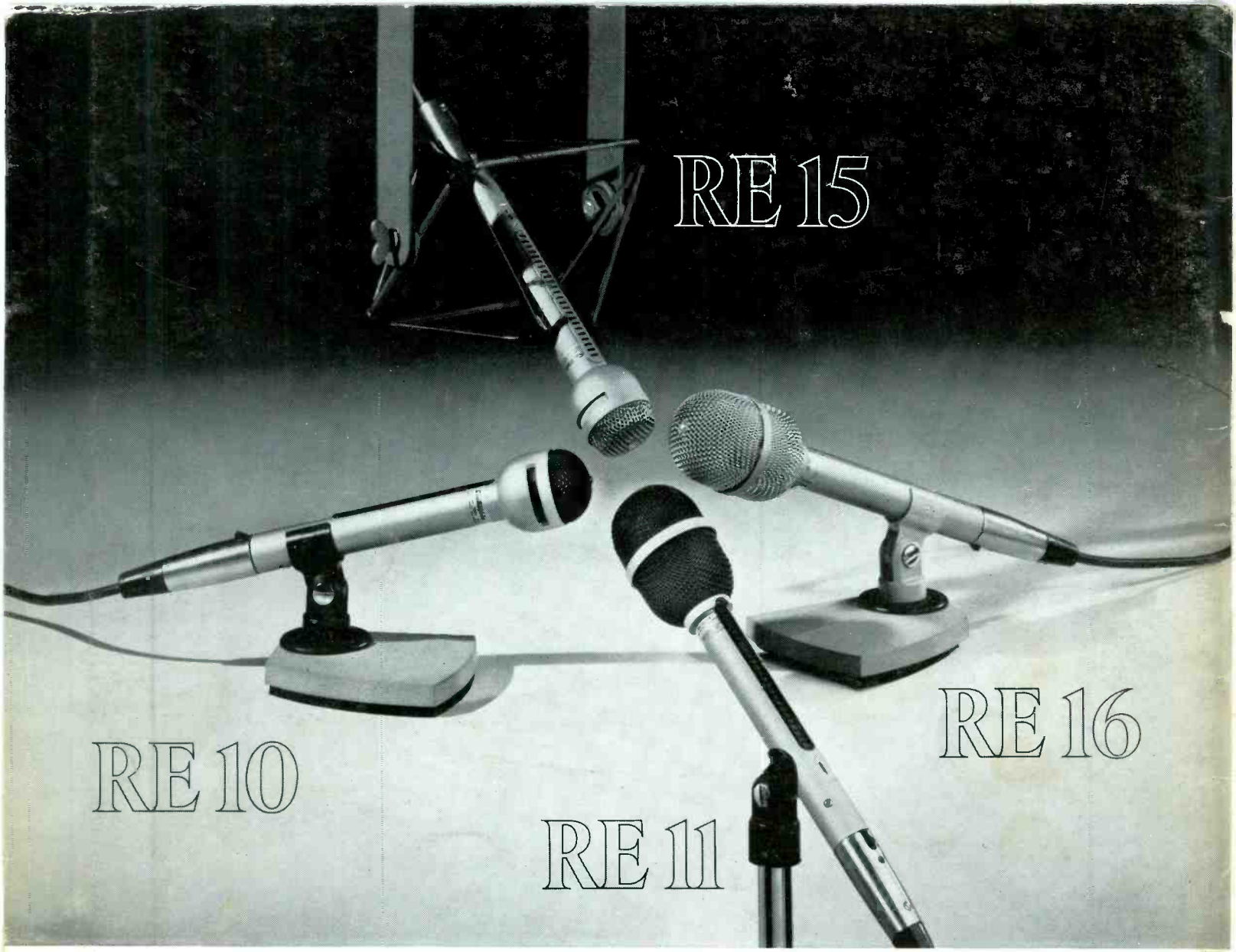

NEW Model RE10 $90.00, shown on Model 421 desk stand $10.50. **Model RE15** $153.00, shown with Model 307 suspension mount $20.70. **NEW Model RE11** $96.00, shown with Model 311 snap-out stand adapter $3.90. **NEW Model RE16** $159.00, shown on Model 421 desk stand $10.50. All prices suggested net.

Freedom of choice!

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Basic to all of these microphones is Exclusive Electro-Voice Continuously Variable-D* construction. Now it offers something you've never heard before with any microphone: no matter what you do, microphone response never varies!

Whether performers almost swallow the microphone, wander far off-mike . . . or even move around to the back . . . you'll still get the same smooth response. Only the level changes.

Once you set equalization it remains constant. You have full assurance that tonal balance won't change between the dress rehearsal and the final performance, no matter what the talent does.

Improved Cardioid Pattern

Only acoustics and noise can limit you. Yet even here these new E-V microphones gain an advantage from the super-cardioid pattern that provides better sound control than ordinary cardioids. With maximum rejection 150° off axis, it is easier to eliminate unwanted sound while maintaining normal stand or boom microphone positions. There's also an integral bass-tilt circuit to cut rumble below 100 Hz. when needed.

Now Select from Four Models

In addition to the original RE15, we've added the RE16. The same fine microphone with an external "pop" filter to solve the problems of ultra-close miking.

The new RE10 is the economy version of the RE15. The same concept and quality, but for slightly less rigid requirements. And the RE11 is the lower cost twin to the RE16.

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*U.S. Patent No. 3,115,207. Trade mark registered.

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