AUDIO

SEPTEMBER, 1963
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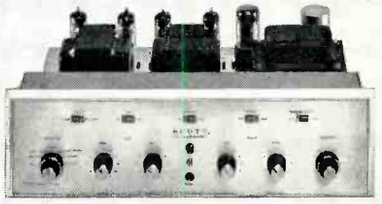
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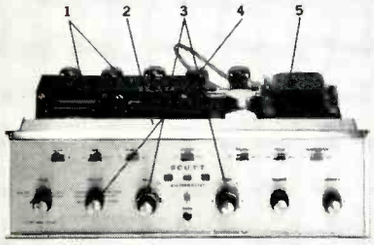


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Power per channel (IHF) watts	40/40	25/25	15/15
Power band (cps)	19-25,000	19-25,000	25-15,000
Hum Level (db)	—80	—80	—70
Tape Monitor	Yes	Yes	Yes
Dual Tone Controls	Yes	Yes	Yes
Stereo Headphone Output	Yes	Yes	Yes
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High Level Inputs	3	3	2

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Number 1 in a series of discussions by Electro-Voice engineers



THE E-V DESIGN PHILOSOPHY

WAYNE A. BEAVERSON
V. P., Engineering

Electro-Voice engineers approach the design of audio components on a very simple basis: design to get an output that faithfully reproduces the input. The input may be electrical (loudspeakers) with an acoustical output; or acoustical (microphones) with an electrical output; or mechanical (phono cartridges) with an electrical output.

In each case, design parameters also include minimum distortion, maximum stability and long useful life. All this must be developed within a functional envelope that is aesthetically acceptable.

Another requirement is wide range frequency response coupled with high signal-to-noise characteristics commensurate with justifiable costs. Insensitive transducers can burden the user with gain or power requirements that add unnecessary cost and complexity. Where sufficient gain is available, however, sensitivity can sometimes be reduced to achieve other design goals.

Perhaps our pragmatic approach to component design results from our experience with all types of audio transducers. We know that high performance standards can be achieved in sound pickup, reproduction, storage, and reinforcement. We are therefore less prone to compensate one type of transducer for imagined deficiencies in other transducers within the system. Compensation is effective only when we intimately know every system characteristic. Obviously this is impossible when transducers are sold in component fashion, as is typical of high fidelity. When a "package" can be tailored, however, considerable economy can often be effected.

Cost, of course, is always a consideration in new product design. For this reason, we make available a product series from which the customer chooses a unit that just meets his performance requirements. However, the designer has a moral obligation to protect unsuspecting consumers from false economies. For example, economizing on magnet structure size and weight in a loudspeaker is easy. But loss of magnet, while reducing cost, will also affect efficiency, forcing the consumer to purchase a higher-powered amplifier at a cost that may possibly exceed the saving in speaker cost. He has also lost the benefit of additional magnetic flux that can significantly improve the speaker performance.

It can be seen that designing lower-cost products without sacrificing critical performance characteristics requires considerable technical acumen on the part of the engineer.

These are some of the many technical and economic considerations we investigate before any Electro-Voice product is marketed. Basic to the success of such an investigation is the E-V philosophy of fidelity that has been developed and refined over a wide range of products and during a period of many years.

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Coming NEXT Month

Construction—

How to build a new type of transistorized microphone mixer composed of separate modules each designed for its own special purpose. The author, Peter Stark.

Measurement—

Continuing his series of articles on test and measurement, Mannie Horowitz contributes some new thoughts on harmonic distortion and how to measure it.

Musical Instruments—

Winthrop Pike discusses many of the fundamental problems encountered in attempting to play classical organ music on an electronic instrument, and gives some excellent pointers on the selection of a stoplist suitable for the organ literature.

and

Equipment Profiles—

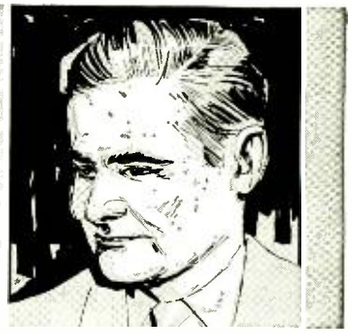
The Heathkit Electronic Organ Kit
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In the October Issue

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AUDIO CLINIC

Joseph Giovanelli



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Include stamped, self-addressed envelope.

Noisy Tuning

Q. When I tune in a station on my FM tuner, there is a noticeable fluttering or rustling sound as I try to tune sharply on the station. What can be causing this? Larry D. Roesler, Chicago, Illinois.

A. The noise you hear when tuning in a station is probably caused by the wiper of the variable capacitor making an intermittent contact with the moving rotor assembly. Use some contact cleaner on this wiper and the problem will most likely vanish.

Vertically Mounted Systems

Q. I am considering a top-opening cabinet which would mount the record changer, and tape deck horizontally, but would hang an integrated amplifier and AM-FM tuner vertically.

Is there any disadvantage? Should a small fan be used for cooling? Jerome R. Hanson, Salt Lake City, Utah.

A. Mounting the tuner vertically will probably not result in malfunctioning of or shortening the lives of its parts. However, when the tuner is mounted above an amplifier, the heat rising from the amplifier may be distributed over the surface of the tuner in such a way that the stability of the oscillator may be decreased. This, in turn, may result in the tuner wandering off station. If possible, therefore, place the tuner below your power amplifier. Because of the manner which you are mounting the equipment, there may be some confusion as to the meaning of the terms "above" and "below." Above means away from you, and below means toward you in this particular connection.

In an installation using a separate preamplifier, it too should be mounted below the power amplifier.

The amplifier may be affected, especially the rectifier tube or tubes; check a tube manual as to whether the tubes used can be mounted in all positions.

Ventilation is always necessary when equipment is located in cramped quarters. In addition, when equipment is vertically mounted, heat rises and passes over its entire surface rather than rising away from the tops of the tubes as it would when the equipment is mounted normally. The heating of the entire unit may shorten the lives of some components, such as electrolytic capacitors, even with good ventilation. Convection currents may not remove enough of the heat from these components. Therefore, forced air cooling is probably desirable in such an installation.

Line Voltage

Q. The specifications given by the manufacturers of my tape deck and amplifiers are measured with the equipment operating under a line voltage of 117 volts. I assume therefore, that for optimum performance with these components that they should operate with this line voltage.

The line voltage in my house varies with the number of appliances in operation, the time of day, and so on. The only way I have of measuring these variations is by observing the bias meter on my power amplifier. Maximum variation of the meter reading on each output tube is about ⅛-in. For example, in the morning with few appliances in operation, the bias meter may read about 1/16-in. above the line on all tubes. At night, with many appliances in operation, the meter may read 1/16-in. below the line on all tubes, a difference of ⅛-in. The use of a constant-voltage transformer has been suggested.

This brings up the question of audible difference, as opposed to measurable difference. I would not like to purchase any of these transformers and find after careful A-B comparisons, that there is absolutely no audible difference with or without the transformers in the circuit. Hence, I would like your opinion, as to the possibility of an audible difference with the use of such a device.

Also, what other advantages might be derived from its use? What are the disadvantages? Is one constant-voltage transformer required for each component? Robert De Salvo, Franklin Square, New York.

A. You wanted to know about problems which might be encountered with fluctuation in line voltage. Most power lines exhibit a considerable amount of voltage variation, depending upon the appliance load and upon the wire size of the line. This is especially true in old buildings where the wiring is inadequate to cope with all the appliances now available.

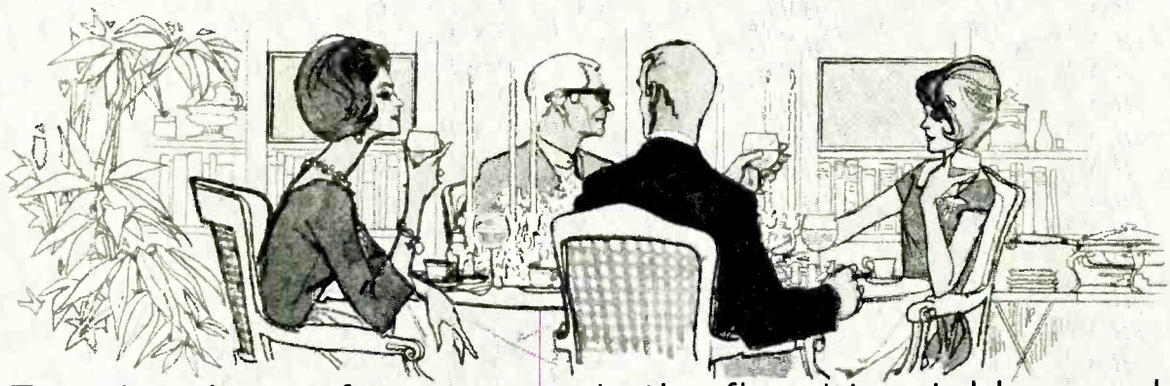
The variations in your particular location may not be great enough to warrant concern. The amount of variation of the bias meter pointer is not an indication of the amount of variation in line voltage.

If you are unable to hear the difference in performance in your music system with normal line voltage and lower line voltage, you need not be concerned about the voltage fluctuation.

It is possible that the difference in distortion between the conditions you describe can be measured. I personally do not think this is important, so long as the slight changes in the amount of distortion present cannot be detected aurally. There is no danger to the equipment when the voltage drops.

A far better indicator of line voltage change is the operation of the rewind motor of your tape recorder. If you find that the motor is sluggish when the voltage drops, you can be sure that the voltage drop is

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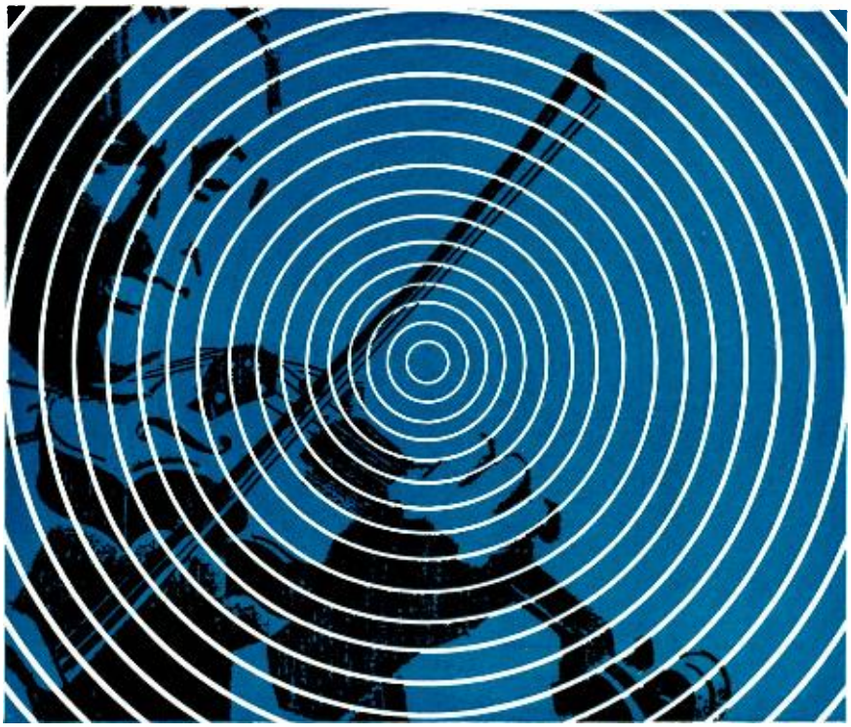


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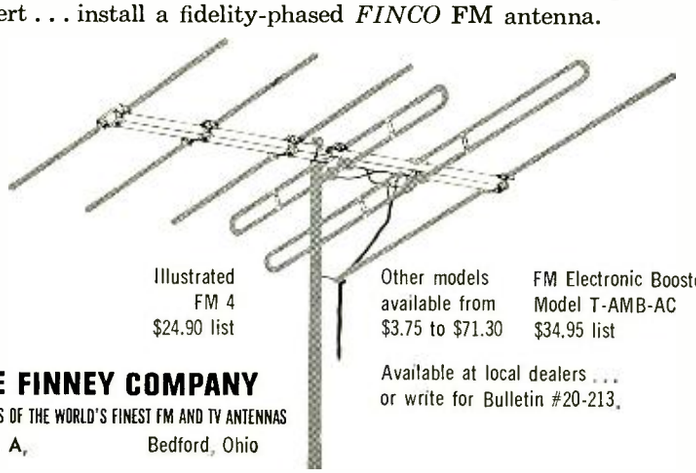
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significant. You probably can, under those conditions, hear the deterioration of performance in the amplifier against what it will be when the voltage is correct.

To put all of this more succinctly, all equipment has a range of input voltages over which it will operate properly. This information is often stated in the instruction manual. If your line voltage change exceeds this range, you should take steps to remedy the situation. You will need a voltmeter in order to obtain an answer to your question.

Constant-voltage transformers have advantages only when you know you need them as already described. Assuming that you position them a few feet from the equipment to be regulated, there should be no added hum or noise picked up by the equipment because of their use.

You should be able to run several appliances from a single constant-voltage transformer, depending upon the wattage consumed by the appliances and upon the power-handling capacity of the transformer.

You should read the instructions which accompany the transformer very carefully so as to be sure of these factors and to determine if the transformer requires a minimum power. I have seen some units of this type which do require a minimum power being taken from them in order for them to regulate the voltage correctly.

Of course, you can do without the constant-voltage transformer completely if you buy a variable-voltage transformer. This type requires a meter across the output of the transformer to show the voltage at all times. The operator of the equipment will have to see that the voltage does not rise too high. If the operator fails to do this, there is a possibility of damage to the equipment. You can see that if regulation is necessary, a constant-voltage transformer is the best type to use.

FM Reception with Master Antenna Systems

Q. My question concerns FM reception in fringe areas. I have tried putting all kinds of antennas and adaptors on my FM tuner to improve reception. To date, I have failed. I want to connect my tuner to the master antenna in the apartment building in which I live.

If doing this is not satisfactory, could you inform me how I could improve reception without putting an illegal antenna on the roof of the building. Bernard J. Cohen, Bronxville, New York.

A. To answer your question satisfactorily a brief discussion of the operation of a master antenna is in order.

Because of a need to distribute the incoming signals to a number of receivers the signals must be amplified after leaving the antenna.

Some amplifiers are "broadband" units. Such amplifiers will pass all signals from Channel 2 through Channel 13. The FM band lies within this range. In an installation using a broadband amplifier only one such unit is required.

Other amplifiers used in association with master antennas are "narrowband" devices, amplyfying but a single channel. An installation employing this kind of an amplifier uses several of these units—one for each of the locally available TV channels.

If a master antenna system of this latter type is used to distribute FM signals, an additional amplifier designed to passed the band of frequencies between 88 and 108 mc must be utilized.

(Continued on page 79)

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LETTERS

"You Pays Yer Money . . . !"

SIR:

It would be difficult *not* to comment on a few of the statements made in Mr. William Hecht's article "A Fresh Approach To Compact Speakers" in the March issue of AUDIO. Mr. Hecht refers, on page 32, to "a voice coil of insufficient length" as a source of transient distortion. While a long voice-coil winding certainly improves low-frequency output, it also, unfortunately, degrades resonance damping (and presumably transient response). This is due to additional coil mass and the series resistor effect of overhanging turns. This is a case of trading one desirable performance element for another, and is typical of the kind of compromises the speaker designer must make.

I am in no way arguing the merit's of "eddy-current" damping, however, I think it is misleading to ascribe a higher order of merit to this type of motional damping as opposed to other kinds of friction damping. Essentially they are all "affected by frequency" as Mr. Hecht writes. It is easy enough to over-damp (mechanically) the bass range of a compact system in any number of ways. The suspension viscous treatment, the spider fabric weave, the shape, size, and porosity of the dust button, and the enclosure damping treatment can all be designed to provide lower mechanical Q (higher damping). The crux of the problem revolves around how much bass damping to incorporate consistent with mid/low-frequency balance and performance below 70 cps.

CHARLES MCSHANE,
Consulting Engineer,
Sherwood Electronic Labs.,
4300 N. California Ave.,
Chicago, Ill.

Class-D Amplifiers

SIR:

Mr. Cooper's articles on class-D audio amplifiers struck a responsive chord. I had done some talking about such an amplifier, but as Mr. Cooper indicated, it was with a coffee cup instead of a soldering iron in my hand. However, I should like to point out an error which Mr. Cooper made in his second article.

Mr. Cooper described two basic types of modulation; the first, in which the time at which the wave is sampled depends upon the instantaneous value of the wave at the trailing edge of the pulse, is called natural sampling, and the second, in which the wave is sampled at exactly regular intervals, is called uniform sampling. Mr. Cooper then states that uniform sampling is preferable because each carrier-frequency component has only a single pair of sidebands. This is not true. Not only does each carrier-frequency component have its full complement of sidebands, but the spectrum also contains harmonics of the message wave. As Black comments in his book on modulation theory, we have a deterioration of quality when the sampling is uniform instead of natural. I have not read the paper by Parks and Moss, but they undoubtedly convert the duration-modulated pulses into amplitude-modulated pulses before demodulation. This is a standard procedure in telemetry work, but it would eliminate the advantages of the duration-modulated system for this application. It is indeed unusual when the simpler of two methods turns out to be the better of the two, but this is one of the cases when we are lucky.

Thanks to the advances in transistor technology, there are several inexpensive transistors available which are fast enough to eliminate the need for the catching diodes described in the article. The 2N706, which costs $1.57 from any mail-order house switches in nanoseconds, and is fast enough for any conceivable circuit. A suitable output transistor, which sells for the same price, would be the 2N696. Using these transistors, it is simple to build an amplifier which will operate at 200 kc and above.

MICHAEL S. BALL,
1300 Dixie Lee Lane,
Sarasota, Florida.

SIR:

Mr. Ball is quite right about the two systems of modulation. It had, indeed, already been pointed out to me, by an engineer working in this field, that the relevant paragraph in Parks and Moss does not mean what both he and I thought at first sight.

I have not checked whether he is right about the 2N706, that, is, whether it will switch enough current far enough. My wrist can shift a squash racquet fairly far but it does not do much to a tennis racquet. Anyway, my guess is that most versions of this kind of amplifier are being built with whatever is handy.

In a private communication (i.e. a polite letter to me, not one finding fault and addressed to the editor) Mr. Johnson has pointed out that he works at 10 volts for safety and that the transistor must have a satisfactory current gain at high currents and must be able to cut off from full current without avalanching or punch-through at full voltage. He suggests as a possibility the 2N1305–6 family. He also points out that in *Fig.* 12 (June, 1963) R_{11} should be 470 ohms and that C_5 and C_6 are crossed over.

GEORGE FLETCHER COOPER

Off-center Center Holes

SIR:

With all of the money being spent today on improving the quality of recordings, it comes as a surprise that nobody has bothered about the small matter of proper placement of the center hole in a record.

The majority of turntable and record changer manufacturers show a reasonable degree of pride in maintaining a fractional percentage of wow. Musicians take pride in being able to maintain the exact pitch on long sustained notes. Why don't the record manufacturers take pride in retaining this information by properly placing the center hole?

I have measured deviations of about 1/16 in. with some as great as 3/32. In order to have wow of not more than 1 per cent at the 3-in. radius, the center hole cannot be off more than 1/64 of an inch. In pursuing this end, every attempt should be made to reduce this wow to a fractional percentage, keeping in mind that these records must be able to slide over the spindle.

If the hole is accurately placed in the center of the grooves, then the accuracy of placement provided by some turntable manufacturers, (using a spring loaded tapered spindle) will not be in vain.

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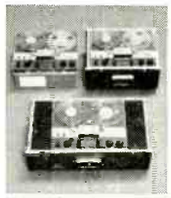
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LIGHT LISTENING

Chester Santon

The Merry Widow (New English Translation) **Columbia Tape OQ 517**
The Merry Widow (Highlights) **M-G-M SE 4098**

The recording industry has never been one to ignore Franz Lehar's most popular operetta. "The Merry Widow" seems set for a banner year in 1963 with a host of new releases designed to appeal to more than one category of listener. The fanciest new package is Angel's complete recording with Elizabeth Schwarzkopf repeating in stereo the role she sang for the label ten years ago. In this four-track stereo tape, Columbia's English version of the operetta offers a 47 minute tour of the score with Lisa Della Casa of the Metropolitan Opera in the title role. MGM's version, on the other hand, occupies only one side of a stereo disc featuring a performance of idiomatic verve by a knowing German cast. Some Lehar fans will veer toward the new Columbia version just to find out how the lyrics fare in this latest English translation. Franz Allers leads a fine domestic cast for Columbia, a cast that surmounts most of the problem that occurs whenever you try to match English words to a foreign score. Miss Della Casa's accent, far more European than it is American, slows her down in some phrases but her portrayal of the wealthy Hanna Glawari is all the warmer and more believable because of it. Laurel Hurley, John Reardon, and Charles K. L. Davis display more than adequate Continental flair in their roles and Columbia's sound is crisply to the point.

The MGM record is one of a series of four stereo discs devoted to operetta highlights featuring European casts originally released not too long ago by the Polydor division of Deutsche Grammophon. Having heard the mono pressings of the actual Polydor imports, I can vouch for the accuracy of the sound in the transfer to the domestic label. Highlights from the "Count of Luxemburg" fill out the other side of this disc. In addition to Lehar's work, this series features operettas by Ralph Benatzky, Eduard Kunneke, and Oscar Strauss. Along with SE 4098, two other records in the series are distinguished by the truly outstanding voice of Sandor Konya, the young Hungarian tenor whose operatic appearances in Europe and at the Met have not interferred with a fast-rising career in the leading operetta roles once handled by Richard Tauber and Peter Anders.

The Phoenix Singers
Warner Bros. Tape WSTC 1485

Does the Warner Bros. label have an inside track somewhere in the processing plant of United Stereo Tapes? Some of their four-track tape releases during the past year or so have delivered sound that is several cuts above the "specs" of reels that went through the UST plant during the same period for other labels. Since the possibility of favoritism toward a specific label is out of the question under the economics of assembly-line production, we are left with the assumption that Warner's product is delivered to Ampex on a recording that responds very nicely to four-track conversion. In the case of this reel by a new male trio called the Phoenix Singers, several other factors help the sound of the finished tape. The voices have a completely fresh quality and the enthusiasm of the performers is typical of a group on the first rung of the ladder of fame. You won't find a trace of the coyness that so often infects the work of some folk ensembles. Roy Thompson, Ned Wright, and Arthur Williams move easily through a far-ranging program that would stump many of the more famous groups of folk singers. Work songs, calypso, a French tune and the Australian *Jolly-Swagman* (or *Waltzing Matilda*, if you prefer) are handled with the same easy conviction found in the trio's treatment of the two fine spirituals that close the album.

Paul Lavalle: 18 All-Time-Great Marches
M-G-M SE 4114

The Band of America that Paul Lavalle has been leading these many years is a conspicuous exponent of march music treated in unorthodox fashion. Although the band can handle a conventional arrangement of a march with the best of them, it has made its reputation on the "extras" it brings to its performances by means of variations in rhythm and tonal color. Many marches in this collection are played "straight" but the selections that immediately serve to identify the band are the free-wheeling paraphrases that Paul Lavalle likes to indulge in. This recording finds the band really shooting from the hip in Lavalle paraphrases of *Dixie, Garry Owen, Parade of the Wooden Soldiers,* and other staples of the repertory. Old-time band leaders would hardly know what to make of some of the Lavalle ideas but the listener in search of extra zing in his collection of band music will find little fault with the Band of America approach. The sound on this latest Lavalle disc is a bit on the puzzling side. Most of his previous releases have featured a commendably realistic frequency response. The relatively weak response of the bass instruments in this recording may be traceable in part to the distant mike pickup employed.

Paulo Alencar: Great Hits of Brazil
Kapp Tape KTL 41051

In a recording made in Rio de Janeiro, Paulo Alencar's orchestra and chorus bring us up to date on current happenings in Brazilian light music. If the folk tunes and popular songs of South America heard in this reel show traces of American influence in their arrangements, the answer lies in Alencar's extended visits to this country. His studies at the Curtis Institute and the Juilliard School of Music, along with an interval spent in the NBC Symphony Orchestra, help to explain the cosmopolitan treatment he brings to the music of his native land. Most of the tunes in this album were chosen by popular vote in the national competitions that take place during the Rio Festival and Mardi Gras celebrations. The studio acoustics in this recording are on the dry side and the highs on the tape require a fair amount of rolloff.

Les Djinns Sing Songs of Paris
ABC-Paramount Tape ATC 829
Emilio Pericoli Sings Golden Hits of Italy
Warner Bros. Tape WSTC 1489

Outstanding European musical attractions cannot contend that tariffs of any kind are keeping them out of the American market. Not only is the process of infiltration an easy one (assuming an act really has something to offer) but the time it takes to reach a large audience here can be surprisingly short. Les Djinns, a teen-age chorus of 60 vivacious French girls, made an immediate hit locally with their first ABC album some three years ago. In their fourth release to reach these shores, Les Djinns prepare the way for their forthcoming tour of the States sometime in 1963 with a program of songs deeply involved in Paris life. Bells always seem to figure prominently in the repertory of French popular choral groups (remember Les Compagnons de la Chanson?) and the Djinns are no exception. *Le Carillon* and *Les Cloches de Paris* give the group an excellent opportunity to imitate more than one type of bell.

The tape from Warner Bros. gives wider circulation to an Italian baritone who holds a record of sorts in the matter of acceptance by the American public. Emilio Pericoli's first release in this country, *Al Di La,* hit the Top Ten of the best-seller lists. His "lucky break" song is but one of a dozen Italian-flavored tunes he delivers on this reel in English as well as his mother tongue.

Dennis Day: Shillelaghs and Shamrocks
Reprise R 6065

If the presence of only one Dennis Day album on dealer's shelves has been bothering Emerald Islanders and Jack Benny fans with a long memory, this new release should be welcome news. Those who own Day's earlier album will find little or no evidence of the passage of time in the sound of his voice. The years somehow manage to make an exception whenever they're dealing with the larynx of an Irish tenor, particularly one who has led the clean life dictated by a salary from Jack Benny. In a burst of non-frugality that may haunt him in later years, Benny himself "contributes" the liner notes on the album jacket. The greater part of this release is devoted to Irish songs in bright tempos that sound best with a male chorus in the background. Pete King's Chorale is a model of correctness in his arrangements of the old favorites—*MacNamara's Band, Dear Old Donegal,* and *It's the Same Old Shillelagh.* Mrs. Day's industrious son has his finest moments when the chorus behind him recedes a bit during such tenor specialties as *Danny Boy* and *Too-Ra-Loo-Ra-Loo-Ral.*

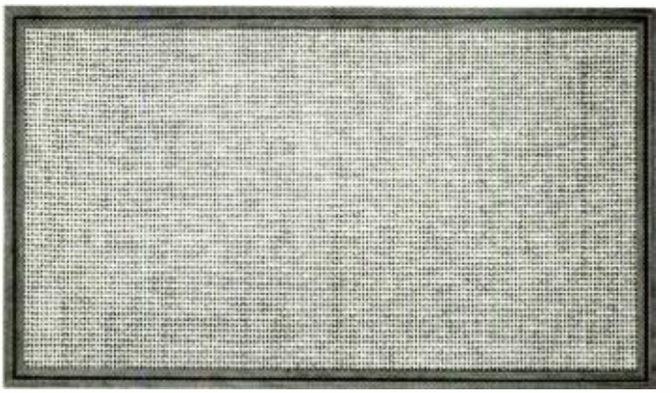
Percy Faith: American Serenade
Columbia CS 8757

Theories pertaining to recording techniques change over the years but the basic musical ingredients of successful albums remain about the same. One of the more steadfast adherents to this view is Columbia's veteran arranger-conductor, Percy Faith. No matter what the origin of the popular American music Faith may be dealing with in any given album, he consistently comes through with recordings of lasting value. Unfettered by rigid formulas that other conductors have ridden to success, Faith has always subordinated the style of his arrangements to the inner appeal of each tune he has recorded. This approach appears easier than it actually is because it takes an exceptional group of musicians to carry out an arranger's wishes with such effortless ease. In his latest release, the careful blending of instrumental choirs is applied to a program of music associated with the cities and states of America best known to Tin Pan Alley. The list of tunes ranges from the specific (*Autumn in New York* and *Moon Over Miami*) to the general coverage of *Sunset* from Ferde Grofe's "Grand Canyon Suite." Since the arrangements already carry a built-in relaxation factor, it is not surprising that the equalization of the record has been modified somewhat for low-level listening.

Adventures in Paradise, Vol. 3
ABC-Paramount Tape ATC 827

Here is more incitement to escapism by the lineup of talent responsible for ABC's earlier best sellers devoted to music of the Pacific Islands. The vaults of this label contain more than enough material to round out another release of light music that sounds at its best when strained through the fronds of a coconut palm. Alfred Apaka gained quite a reputation through his many Hawaiian recordings on the Decca label as well as appearances on the Ed Sullivan television show. Roy Smeck, continuing a career of more than thirty-five years as a guitar and ukelele star, has his own separate collection of albums on the ABC-Paramount label. Terorotua and his Tahitians and the Islanders under the direction of Sid Feller complete the varied assemblage of tropical tunemakers. If you insist on diversity in your Hawaiian-style albums, this could very well be your dish. In the sound department, four-track tape has a very easy time with this sort of musical material. AE

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FEBRUARY, 1963

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– AUDIO
MAY, 1963

"over-all, I would rate the XP-4A as one of the best most truly musical reproducers available today."

– HI FI STEREO REVIEW*
DECEMBER, 1962

*NOTED equipment reviewer Julian D. Hirsch, in the same lab report, also noted: "...the XP-4A... proved to be an unusually wide-range, smooth system... the response was virtually flat from 5,000 cps to beyond the limits of audibility...Tone burst tests showed very good transient response... In listening tests, the XP-4A ...was...very smooth and natural-sounding...had an especially fine and satisfying presence...a healthy amount of undistorted output in the 30-to-40 cps range."

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This 2½-cubic-foot speaker system rivals in sound quality the huge theater-size systems of just a few years ago.

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NEW LITERATURE

• **Audio Cables.** The 1963 Electronic Wire Catalog from Belden Manufacturing Company features four new cables for mono and stereo applications. Belden 8416, a dual-channel audio cable, is a 25-AWG two-conductor, parallel, coaxial cable. Each conductor is tinned-copper-shielded with 35 pf/ft. capacitance on each channel. This cable can also be used for headphone cords and language lab applications. Belden 8417 is a single miniature connecting cable shielded with patented "Beldfoil" shield. This 100 per cent shield eliminates all outside interference. Belden 8701 is a 22-AWG, three-conductor, parallel, speaker cable. Belden 8700 is a miniature, 28-AWG, 33-ohm coaxial cable. Insulated with polypropylene the cable is only 0.054-in. in diameter. Operating temperature is 105 deg. C. Belden Mfg. Co. 415 S. Kilpatrick Ave., Chicago 44, Ill. **K-10**

• **Cardioid Microphone "Fact and Ficton" Guide.** A new, highly definitive guide detailing specific unidirectional characteristics and performance features that should be expected from a true cardioid microphone has been announced by Shure Brothers, Inc. The Guide explains common claims for, and misconceptions about, so-called cardioid microphones with facts based upon a precise mathematical formula which limits and defines the term "cardioid." In addition, it describes six common sound problems caused by inefficient microphone rejection of unwanted sounds and microphone ineffectiveness in picking up the desired sound. Specific information on how these problems can be solved through the use of a quality cardioid unidirectional microphone with a uniform pickup pattern is also provided. Copies are available free of charge from Shure microphone dealers or by writing directly to: Shure Brothers, Inc., 222 Hartrey Avenue, Evanston, Illinois. Ask for Folder No. 184 **K-11**

• **Telstar Story.** Copies are available of the 72-page, illustrated, color, reprint of the April, 1963, issue of the Bell Laboratories Record. It contains ten semi-technical articles about the engineering that went into the Telstar project, the communications equipment in the satellite, the Andover ground station, and the satellite launch operations. Free booklets are available by writing: Telstar Record, Bell Telephone Laboratories, 463 West Street, New York 14, N. Y. **K-12**

THIS MONTH'S COVER

Lt. Col. John H. Ralph, owner of the cover installation, enjoyed this system overseas (obviously in Japan). Now back in the United States, he still feels his system is tops. His equipment includes: Citation I preamp, Leak Stereo 50 basic amplifier, Sherwood S2200 FM-multiplex tuner, Thorens TD-124 turntable, ESL arm-M7D Shure cartridge with N21D stylus, Denon tape deck with Griffon recording and playback preamp (both not available here), Wharfedale three-way speakers (dual 15, 8, and 3-in. with Whafedale dual-control crossovers), Pioneer PAX-30E coaxial 12-in. dual-remote speakers, Sony 464D portable tape recorder for dubbing and remote work, Aiwa semi-cardioid dynamic microphones. The cabinet was custom-built in Japan.

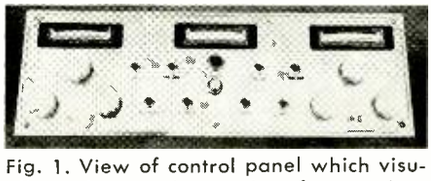
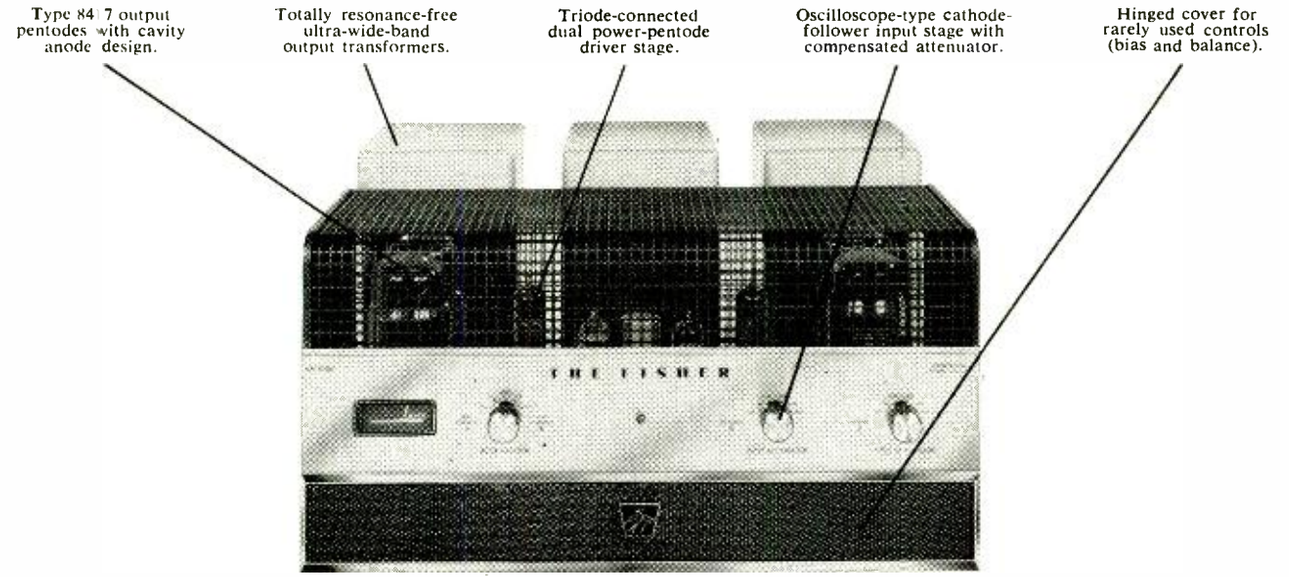


Fig. 1. View of control panel which visually indicates the mode of operation, and also has two V-U meters, one for each channel, and a line-voltage meter.

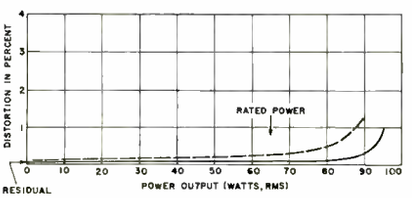
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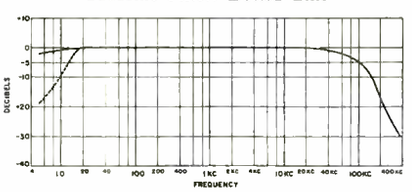
The Fisher SA-1000 is a challenge to the severest critics and most discriminating judges of professional sound reproducing equipment, both as to specifications and listening quality. Its music power rating is 150 watts IHF Standard, with *both* channels driven. The RMS power rating, again with both channels driven, is 130 watts (65 watts per channel). However, as a glance at the intermodulation curve will show, each channel will deliver 80 watts at 0.5% IM distortion, thus indicating the extreme conservativeness of the official rating.

Total Harmonic Distortion at 1 kc: Solid Line
Intermodulation Distortion (60 cps/7 kc, 4:1): Dotted Line



The output stage of the SA-1000 is engineered around the newly developed 8417 beam power pentodes, *never before used in any electronic device*. Designed specifically for use in this amplifier, the 8417 offers extreme linearity, resulting in greatly reduced distortion, and has unusually low drive-voltage requirements, permitting the previous stages to 'coast' at their lowest possible distortion levels. The unique *cavity anode* design of the 8417 is an important factor of its superior performance characteristics.

Frequency Response (0 db = 4 watts)
Subsonic Filter: Dotted Line



Each pair of 8417's in the SA-1000 drives a giant output transformer via plate-cathode coupling – a modified and improved 'ultra-linear' configuration that provides 12 db of the most desirable and stable type of negative feedback in the output stage. The custom-wound output transformers are unlike all others in that their response rolls off below 5 cps and above 200 kc without the slightest peaks or dips. (See the frequency response curve.) This results in exceptional stability and superb square wave reproduction.

The driver stage, too, is entirely novel. A triode-connected 6UH8/ELL80 dual power pentode circuit developed by Fisher engineers is capable of delivering 40% more drive to the output stage than is required – and at a remarkably low impedance. The result is very low distortion, the fastest possible recovery time, great stability and hence outstanding transient response.

For the pre-driver and phase inverter stage, an ECC83/12AX7 dual triode is used in a DC-coupled cathodyne configuration characterized by extremely low distortion and phase shift. A feedback loop from the output transformer secondary to the pre-driver cathode provides 17 db of distortion-reducing feedback.

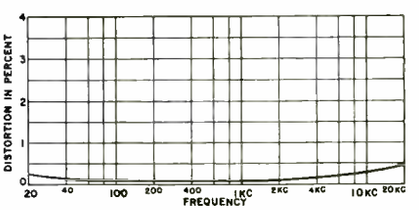
The input stage of the SA-1000 is of a type widely used in laboratory oscilloscopes but never before in high-fidelity amplifiers. A compensated input attenuator in conjunction with a cathode-follower circuit permits adjustment of the input signal from 0 db to – 12 db in closely calibrated 3 db steps without the slightest effect on input impedance and frequency response. This feature in effect provides five different input sensitivities, ranging from 0.5 to 2.0 volts (for full rated RMS output), so that the preamplifier volume control can be operated strictly within its optimum range.

A switchable subsonic filter has also been designed into the input stage, in keeping with the widely held engineering opinion that, for the majority of practical applications, response should be flat down to 20 cps only and then fall off as rapidly as possible. (See dotted part of frequency response curve.)

The power supply of the SA-1000 is one of the most elaborate ever used in a stereo power amplier. Regulation and filtering are of the highest order and all silicon diodes as well as filter capacitors are most conservatively operated.

Bias is readily adjustable on each channel by means of the built-in laboratory-type calibration meter, but the controls for these rarely needed adjustments are ingeniously concealed behind an attractive hinged cover – another Fisher exclusive.

Total Harmonic Distortion (One Channel) at 65 watts RMS
(Note that from 20 cps to 10 kc distortion does not rise above ¼% even at maximum rated power.)



The SA-1000 is priced at only $329.50*. It is also available as the K-1000 StrataKit for only $279.50*. Both carry the famous Fisher Warranty covering all tubes and diodes for a period of one year from date of purchase.

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AUDIO ETC.

Edward Tatnall Canby



1. MAGAZINE MURMURS

Those moments when, occasionally, I look at a back issue of this journal and read a paragraph or two out of my own (and the industry's) past are apt to be traumatic experiences for me. Ghosts—only two or three years old. Prophesies of solemn weight, some come true, thank Heaven! Some are mercifully gone with the winds of time and just as well forgot. I like the true ones best.

Thus I've recently been drawn back for good reason to our issue of July, 1961. I must report that we did pretty well in that issue. The back-number charge that you'd pay for it right now (if we had any copies left, which we don't. ED.) would probably be worth it. In my department (natch, one of my principal concerns), I find two discussions that apply quite vividly to the then dim-distant future, September, 1963, as well as to the far-away summer of '61. Mainly there was a hot item of unfinished business entitled "Remember the Magazine?" which has me quite warm under the collar. No—not *this* magazine. We all remember *it* and will for long. What I meant was the kind of magazine we generally like to call a cartridge, thereby compounding confusion. A tape cartridge.

You'll remember that 'way back in the late fifties there had been a sensational RCA tape cartridge for the home, launched as I remember in two successive years with the biggest Guns of publicity. Strangely enough, they went off with only a muffled pop. RCA tried and tried, but nothing much ever seemed to happen to its tape cartridge. Now (1963), the RCA cartridge is still manfully with us, in the guise of a new and handy portable home recorder, stereo. The once-vaunted RCA tape cartridge library is not being very widely promoted right now. I have three or four of them left (along with the monstrously big original RCA player) which I expect to preserve for posterity, in case RCA forgets.

Then in 1960, CBS—who else?—discreetly announced another cartridge. Discreet is definitely the right word. The thing wasn't *launched*; it was simply announced, and demonstrated. Prematurely, maybe; but RCA had to be fought on solid ground when the fighting was good.

This CBS cartridge, developed by CBS Labs for 3M, was far more revolutionary than RCA's which had used conventional tape at 3¾ ips. (But RCA did start off the 4-track development with theirs, keep in mind. It was sort of taken out of their hands, into 7½ ips 4-track "manual" roll tape, which still blooms commercially.) The CBS cartridge was startlingly different. It was much smaller, with a new and narrower tape, extra-slow speed, and the astonishing ability to be changed—like a disc changer. But as I noted in the July, 1961, issue, a year or so after the first CBS announcement, the policy in regard to this cartridge-tape venture appeared to be one of very great caution. No more RCA-like publicity blasts! Not, at least, until the field was *very* thoroughly re-explored.

Not until all sorts of specialized applications outside of the straight home entertainment field had been probed, moreover—for the tape cartridge was potentially a marvelous gadget in a wide variety of automations and memory services quite aside from home hi-fi.

Indeed, I pointed out that there were then two reasonable approaches to the tape cartridge—the "one-niche" and the "multi-niche." Either you limited your cartridge deliberately to a special and specific function—as did Westrex that summer with its battery portable miniature cartridge recorder. Or you launched your cartridge quietly into whole raft of little markets, each of which might on its own be insufficient to support the venture, though together, and with the basic cartridge easily adaptable to various uses, these multi-niche applications could turn in a joint profit. That was clearly the CBS intention. CBS wasn't likely to go in for narrow specialization.

Said I, for the multi-niche approach, "just make the one device [the basic tape magazine and associated equipment] in the millions, load it up and fire it off in many directions at once, in the thousands, niche by niche. Scatter your first, but aim carefully, choose hittable targets." The targets for such a magazine were obviously plentiful. In fact, I suggested, "it is conceivable that the propagation of recorded music might never show up at all, or turn up as a relatively minor side-operation." I seem not to have been far off. We must remember that home-entertainment audio is a relatively tiny bump on the side of the huge and growing electronics colossus.

I'd be happy to quote you my humorous 1960 speculations as to possible other uses for the Columbia-3M tape magazine but will refrain, for fear of being repetitious. But if you have or can find a copy, look back and read all about the fanciest idea I had, the hypothetical CBS Automatic Household Programmer. It would even have let the cat out at eleven o'clock each night. Some cartridge!

Well, I stuck my neck out, in 1961, and prophesied that no tape magazine was ever going to *replace* anything—and especially, it would never replace the good old fashioned LP disc.

There were those, then, who prophesied the doom of the disc in short order. They were wishful thinkers. They still are. This, I gather, was well understood by the CBS people, who since then have made no overt and loud attempt—as they did with the LP itself—to launch a wholly new "system" designed *to take over from disc*. Caution, sober investigation, into carefully limited markets, was obviously to be the tape magazine future as far as this revolutionary CBS gadget was concerned.

And so—time passed. No magazine. No fancy launchings. No formal announcements. Only continuing small rumors, here and there, which indicated that the tiny tape cartridge was oh-so-definitely still alive. Thus last winter I got a typical confirmation of my "multi-niche" guess. Friend of mine is an aircraft engineer, and engine-engineer, if such a term may be used. He checks on aircraft performance. Measures it. Whaddya know—one day we start talking; he'd met a good friend of mine, he said with some surprise: "I didn't know you knew *him*." Vice versa with me. It was a high official of CBS Labs. Their business? The measurement and recording of aircraft performance, on tape. What gadget? The CBS-3M tape magazine, natch.

I gather that some arm of CBS wanted to take on a comprehensive contract for some species of aircraft performance measurement; I also gather, between you and me, that the aircraft company figured maybe CBS would be over its head and out of its element, not being exactly aircraft specialists. No reflection on the basic gadgetry, the tape magazine and associated equipment.

Multiply that by X and you have the measure of cartridge activity in the multi-niche category, *not* including home entertainment, from 1960 to 1963. Pretty extensive, I would expect.

Well—what an anticlimax! Couple of months ago I opened our July issue to Page 30 and there, spang on the EQUIPMENT PROFILE page was the tape cartridge, large as life (which is pretty small).

'Course it wasn't called CBS, or even 3M, and it differs markedly from the original CBS system. As I said, any new approach to the home market in the tape-magazine field was bound to be circumspect and very cautious. Note, then, that neither of the big outfits behind this gagdet was directly named in the title. Instead, the device was finally being launched—more than three years after its first public announcement—as the Revere Stereo Tape Cartridge System. Our Equipment Editor naturally mentioned the CBS-3M origin. (After all, we ran Dr. Peter Goldmark's original article on the thing back in our May, 1960, issue.) And the accompanying photo shows a tape cartridge plainly marked "Scotch," and practically everyone knows that Revere is a subsidiary of 3M.

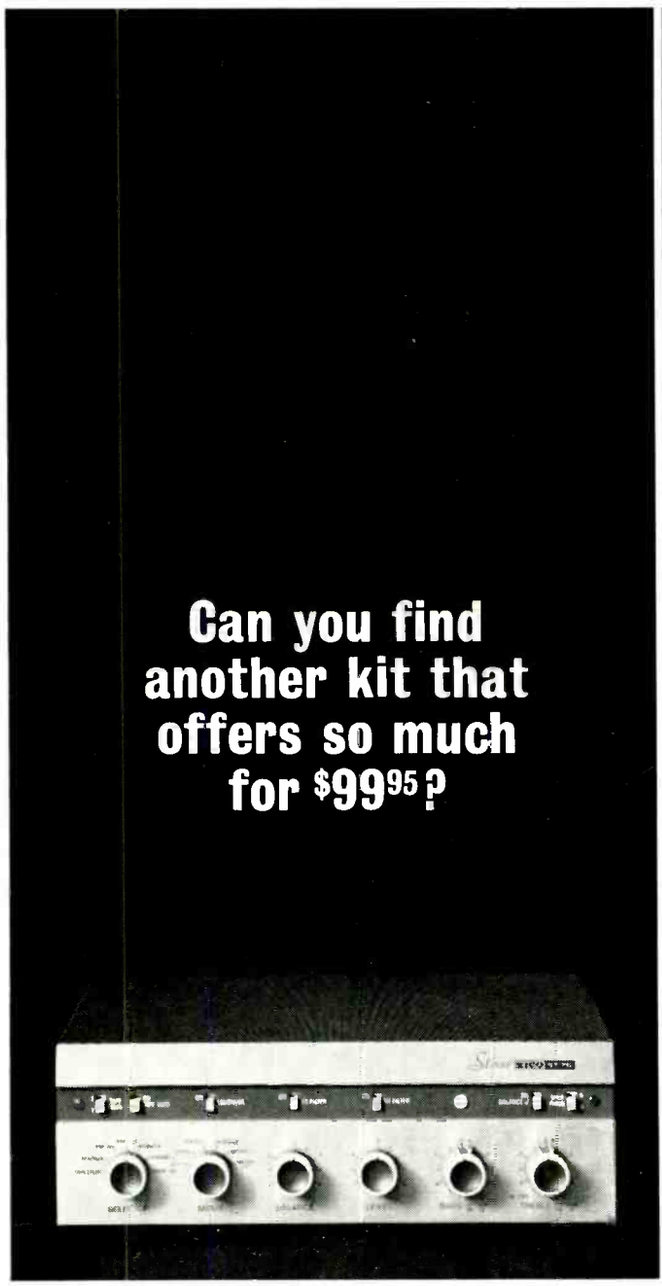
Also, as a mild afterthought in the middle of a paragraph, our editor noted that "at the present time there are 50 cartridges from Columbia Records and ten from Musictapes, Inc., with ten more to come soon from Command Records. It seems likely that many more will be made available when the unit achieves general distribution."

Phew! If *that* is the announcement of a home-music revolution—as it might well be on purely technical grounds—then it surely is a modest one. The editor, of course, is correctly reflecting the Revere/3M approach. It is deliberately, as I see it, that of a polite murmur of publicity—as mild a publicity campaign as I ever hope to to see. So far anyhow.

If you will, just stop to think what might have happened if the Revere/3M Big Guns were turned loose to blast out the message of this genuinely revolutionary little tape magazine. Then sit back and be amazed. Suppose, for instance, that this automatic miniature changeable hi-fi stereo tape cartridge had been called Dynahoove, or maybe Dynasnoove, and had been launched late last spring with Dyna-hoopla. Wow!

Well it wasn't. And so my prophetic story ends on a prophesiably undramatic note. I never even heard about the darned thing until I opened to that page 30 in the

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EICO ST70, 70-WATT STEREO AMPLIFIER



EICO ST97 FM STEREO TUNER

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ST70 DATA: As the center of your stereo system, the ST70 accommodates all program sources. It even has separate inputs for both turntable and record changer preamplified tape signals and tape head with correct equalization for both fast and slow tape speeds. A center channel output feeds directly on a center channel speaker or, where desired, extension speakers throughout your house without any additional amplifier. Critical parts—filter capacitors, rectifiers, output tubes—all operate well below their ratings to assure long, trouble-free life. Oversize output transformers deliver full rated power all the way down to 30 cps. . . . And as a kit builder, you'll like the spacious layout. We got rid of all those tight places. Kit $99.95. Wired $149.95 (includes metal cover).

SPECIFICATIONS ST70 *Output Power:* 70 watts (continuous sine wave 35-watts per channel) *IM Distortion:* 1% at 70 watts. *Harmonic Distortion:* less than 1%. *Frequency Response:* ±½ db 10-50,000 cps. *Inverse Feedback:* 17 db. *Stability Margin:* 10 db. *Hum and Noise Level:** mag. phono —63 db; tape head —54 db; tuners, auxiliaries —78 db. (all measurements according to IHFM standards.)

ST97 DATA: Building the ST97 FM stereo tuner requires no instruments, no critical adjustments. The front end and IF stages are fully pre-wired and pre-aligned. The tunable coils of the stereo demodulator are factory-adjusted. With four IF stages plus a stable, sensitive front end, the ST97 pulls in clear stereo even under fringe conditions, and EICO's filterless zero-phase shift stereo detector (patents pending) maintains reliable channel separation. EICO's unique traveling tuning eye makes tuning simple and precise. Stereo stations are automatically identified by a pilot light. Semi-kit **$99.95**, Wired **$149.95**. (Includes metal cover and FET.)

SPECIFICATIONS ST97. *Sensitivity:* 3μv (30 db quieting), Sensitivity for phase-locking (synchronization) in stereo: 2.5μv. *Full limiting sensitivity:* 10μv. *Detector Bandwidth:* 1 megacycle. *Signal-to-Noise Ratio:* —55 db. *Harmonic Distortion:* 0.6%. *Stereo Harmonic Distortion:* less than 1.5%*. *IM Distortion:* 0.1%. *Frequency Response:* ±1 db 20 cps-15 kc. *Capture Ratio:* 3 db. *Channel Separation:* 30 db. *Controls:* Power, Separation, FM Tuning, Stereo-Mono. AFC-Defeat (all measurements to IHFM standards).

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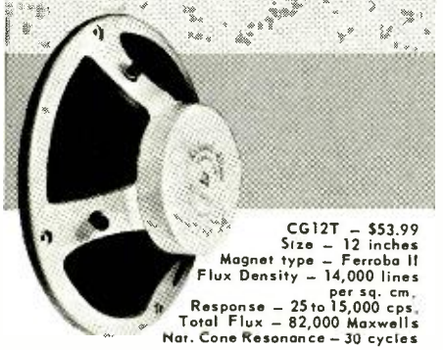


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July, 1963, issue. Just about what I would have expected, as of 1961.

The editor never told me. Guess he just forgot, or maybe he hadn't read the July, 1961, issue. (He wasn't editor then, anyhow.) No publicity handouts, no free cocktails, no airplane rides and no speeches. Nothing. Revere hasn't said anything to me. (Perhaps they think I'm merely a stereo fan—photo stereo. My camera is their ex-Wollensack model, and a beauty.)

So one of these days when you get a chance, *you* go out and buy, borrow, or steal a Revere. Marvel at the ingenuity of the cartridge itself and its wholly new heads, tapes, handling machinery. Marvel especially that such a machine could *happen*—plus 50 Columbia tapes to match—with the tiniest publicity campaign in the entire history of home hi-fi. (Fact is, of course, that Revere/3M has not yet made any national announcement or splurge of publicity. Indeed, the RSTCS has been introduced city by city, starting last November in St. Louis. Chicago was introduced to it in May, and New York is just now getting the "treatment." Ed)

P.S. Whoa—I'd better cover my defenses. It's always possible that there *will* be a big splurge, later on when distribution gets distributed. If I'm invited you can be sure I'll attend. And meanwhile I'm going to try to persuade the editor, or someone, to lend me a Revere Stereo Tape Cartridge System and a handful of those little Columbia music-bisquits. Will report.)

2. ELEVEN AND A HALF

I'm not finished yet with July, 1961. The second half of my July, 1961, department was entitled "Miniature Dream-Fi." It concerned some fancyings of my own on the possibilities for a genuinely portable, genuinely hi fi "stereo." To be sure, I went all-out and tried to figure a beach system which would run minus power lines and yet produce flossy stereo sound. But my basic idea kept popping through—a compact, portable phono with two tiny speakers attached (and removable) as part of the system, the whole to display via the most ingenious thinking available, a maximum size-*vs.*-quality ratio. Something really hot from the sound standpoint: not a mere "mass produced" portable stereo, of which there were already plenty on the market.

It was obvious what had put me onto this kick. The compact little KLH Model Eight FM radio. "There is your nucleus," I said, "in the shoe-box Model Eight speaker." The idea was to squeeze "a maximum of good sound into an arbitrary minimum of space, via maximum-throw small speakers and probably with the aid of a specially-curved amplifier output." I went on to describe the possibilities and probabilities. "This system would be good, maximum-good, using every bit of ingenuity that the mind can discover, taking advantage of our newest technology all along the line. It might cost $150–200 or more. It would be worth it, and no chance for confusion with a million 'ordinary' portables, made out of plaid-covered cardboard and plywood with cheap speakers and cheaper amplifiers for their so-called hi fi. Not that at all. Something much better. Maybe it ought to cost $300."

Well, I guess KLH was reading me. KLH has meanwhile moved on through Nine and Ten and beyond. Their new Model Eleven is a portable stereo It is in a good many respects the precise answer to my challenge, for it does indeed aim to do exactly what I dreamed about, minus only a few practical compromises. Mine was to be battery-portable (for the bench) but with 117-volt alternative connections. I suggested one of the ingenious wind-up motors; a workable battery-driven table might do as well today. KLH has put a Garrard changer into its Eleven, which means that batteries will not do, even though the rest of the Model Eleven, being all-transistor, could well be operated minus house current. The Garrard is equipped with a Pickering magnetic stereo cartridge (Stanton Fluxvalve to you), not the fanciest model but almost as good—and far ahead of the usual "hi-fi" transducer in the mass market. The playing department, then, while of excellent quality, is the one aspect of this Model Eleven which can be called conventional. The rest is right up my fanciful alley, including the pair of compact speakers based on the Model Eight, the built-in electronics, the transistor drive minus heavy transformers (if I'm right), the snap-on arrangement that mounts the speakers on the main case to make "one little suitcase-sized bundle," as I put it in 1961. As I had speculated, the speakers are mounted in semi-weatherproof configuration for carrying, their insides pointed in; the covering material is nicely glazed and could even take a few showers; the speakers demount and can be laid apart at a great distance, or the connecting cables led over doortops and under rugs. KLH gives you an unconscionably long stretch, enough to spread the little speakers out to the sides of an auditorium. I did that very thing in one of my first trials of it, at a lecture.

My "dream-fi" of 1961, to be sure, was going to be more compact than KLH Eleven. I wanted a folding phono motor and table, to fit between the two speakers in the folded-up package. It's easy to daydream, of course. KLH has problems of practicality. You can't fold up a Garrard AT-6, nor can you squash it down flat, which is one reason why the Eleven is perhaps a bit bigger than one might have hoped for, given the size of the tiny speaker boxes!

Indeed, my one major reservation is simply that this particular bit of practicality seems to go too far. The Garrard is small as changers go but it is hardly a miniature, and its overhead mechanisms and under-deck spring mountings take up undue space—in a suitcase—and offer undue shakeability—in shaky spots where portables are apt to be played. The KLH cover, for this reason, is rather big and a bit clumsy, in order to fit over the Garrard. One has an unaccountable urge—in this very special situation— to mash down the whole changer and its swinging arm so that a really *flat* cover could be snapped on. Purely romantic—it ain't possible. (Maybe what we need is a Revere tape cartridge changer! But that'll have to wait.)

The older KLH Model Eight is one of those pieces of equipment that grows on you. After a goodly span of years, mine is even now my best and most official FM radio, though without stereo. It is a minor miracle, that little two-box system, an excellent and very sensitive tuner and a perfectly astonishing little speaker, which habitually sits on the floor at the foot of one of my "large speakers and just as habitually fools me into thinking the large speaker is in operation. Don't think *you* wouldn't be fooled. You never heard such a big sound from such a little scource. Not anywhere else.

Not anywhere else *except* in the KLH Model Eleven, with two speaker boxes that are each slightly smaller than the rectangular wood-encased Eight. The Model Eleven speakers are necessarily in a different type of enclosure, somewhat rounded

(*Continued on page 81*)

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Condenser Microphone with Transistorized RF Circuitry

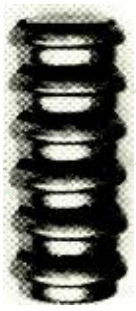
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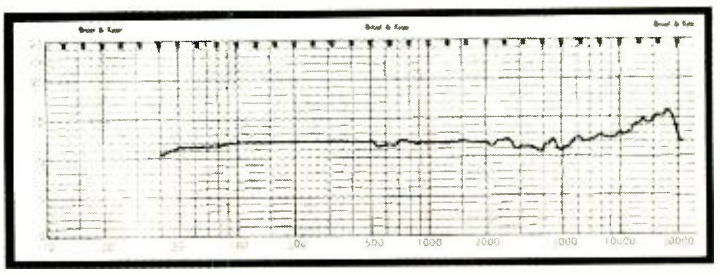
Actual size of Sennheiser Condenser Microphone Model MKH 104. Professional Net **$195.**

Actual size of Battery Adapter Model MZA 6. Professional Net **$18.**





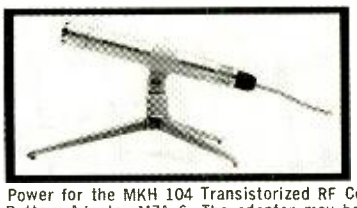
For complete technical specifications, call or write Sennheiser Electronic Corporation (N.Y.). For demonstration of this model and the full Sennheiser line, call or write Harvey Radio Co., Inc., franchised distributor for the New York metropolitan area.



This response curve is not a theoretical projection. It was individually plotted for a random-picked Sennheiser Model MKH 104 Condenser Microphone, and it is virtually identical in shape and output level to the separately plotted, signed curves provided with all Sennheiser Transistorized RF Condenser Microphones in this series. (All Sennheiser professional microphones are packaged with individually plotted curves.) Note the broad frequency response, exceptional flatness and the controlled peak at the upper-frequency extreme. Also note the absence of peaks and dips in the critical portions of the spectrum. Need we say more?

The actual size photographs on this page are not simply of the microphone itself; they depict the entire system, including the compact, low-voltage, power supply. The microphone barrel contains a transistorized, 10 mc RF push-pull oscillator feeding a bridge circuit. The output of the bridge circuit is then amplified by an additional stage before being applied to the microphone terminals. This Sennheiser configuration guarantees stability, noise suppression, and smooth extended response at good output levels.

Low-impedance circuit design renders the system insensitive to interference from magnetic fields. The rugged, meticulously designed structure assures insensitivity to mechanical noise, air-pressure shock waves, and high humidity.



Versatile mounting of the MKH 104, with or without the Battery Adapter connected, adapts the microphone to any conventional arrangement. The lightweight, collapsible desk tripod shown here is an optional accessory.

Power for the MKH 104 Transistorized RF Condenser Microphone is readily furnished by Battery Adapter MZA 6. The adapter may be plugged directly into the microphone base or anywhere along the microphone cable. It holds 6 miniature mercury cells of the hearing-aid type, Mallory RM-625 or equivalent. One set provides 50 to 60 hours of continuous operation.

WHO IS SENNHEISER? If you have worked with quality microphone systems, you are familiar with Sennheiser products. Established in 1945, Sennheiser Electronic has become Europe's largest manufacturer of quality microphones, supplying them to world renowned manufacturers who have been marketing these products under their own brand names for use in professional recording and broadcasting, high fidelity systems, tape recorders, dictating machines, hearing aids, and many other applications. "Sennheiser" is synonymous with leadership in microphone engineering.

TECHNICAL DATA

Acoustic system:	pressure responsive
Directional characteristic:	spherical (omnidirectional)
Frequency range:	20 to 20.000 cps
No-load transmission coefficient at 1000 cps (Sensitivity measured in anechoic chamber):	approx. 2mv/dyne/cm²
Impedance:	approx. 800 ohms, unbalanced, ungrounded (accessory cable-transformer matches to 200 ohms)
Noise voltage:	approx. 10μv
Distortion at sound pressures to 100 dynes/cm²:	1%
Overload level:	approx. 300 dynes/cm²
Power-supply voltage:	8 V ±1 V
Operating current:	approx. 5 ma
Temperature range:	−10° to +70°C (+14° to +158°F)
Dimensions:	¾ in. diameter; 5 in. long
Weight:	3 oz.

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ABOUT MUSIC

Harold Lawrence

drama, poetry, news and music, his chief preoccupation is with things musical. One of Barraud's responsibilities is the commissioning and selection of contemporary works to be broadcast over R.T.F. "Naturally, I don't have the time to read every score that is submitted to us," Barraud explained. "With 3000 composers in France producing at least one work a year, you can see that this is impossible. The French government, under the Minister of Information, has set up a *Comité de la Musique* especially for this task. This committee is composed of twelve of France's leading men of music, none of whom is connected to the R.T.F. You will probably recognize

EDITOR'S REVIEW

A FIGURE OF MERIT FOR FM-STEREO TUNERS

LAST MONTH we noted that FM-stereo tuners are being specified as though they were mono tuners. We felt IHF standards should be devised specifically for multiplex tuners. We would like to carry the thought one step further this month and suggest that a figure of merit would be the best and most convenient way to specify this type of equipment. In the past we have been rather leery of schemes specifying equipment by means of a figure of merit. We felt then, as we do now, that such a rating system is inappropriate for equipment where subjective taste factors are important (loudspeakers are a good example of this). However, in the case of FM tuners, the only variable of great significance, aside from the technical properties of the tuner, is geographic location; there are no taste factors involved.

To make the system work we would take the important technical attributes of an FM-stereo tuner and weight them in accordance with reception problems of a geographic area. Thus we would know which characteristics are most important for a particular area. Then the weighted characteristics could be totalled to an over-all figure of merit for a particular geographic area.

For example, let us take an area where sensitivity and selectivity are very important. We would weight these parameters, let us say, 8 and 9 respectively on a 10-point scale. In another area they might be rated 2 and 9. Thus a tuner with sensitivity of 2 μv and selectivity of 40 db would have a figure of merit of 376 in one area and 364 in another. (Multiply the characteristic by the weighting.) Obviously this is a rather simple way of presenting our thought, and also it needs further work to become a workable system, but it does show the basic idea.

One objection we would anticipate would be the necessity for having a different weighting for each locality. On the other hand, after some analysis, it becomes obvious that we do not have a large number of different geographic conditions to deal with. It might really be simpler than appears at first glance.

As a good starting point we might take the parameters and rough weighting described by Mr. von Recklinghausen in his two-part article which concludes in this issue. Of course we may not agree with the weighting he has assigned to the various parameters, but it is a starting point.

Another question which might arise is why such a figure of merit is necessary. Simply because it is not easy to assess the performance of a tuner in a particular area with the specifications as they are supplied at present. Notice, for example, that Mr. von Recklinghausen lists ten characteristics, with the one we usually hear most about at the bottom of the list. Notice also that there are several characteristics on that list which are *not even listed* on most specification sheets. As a matter of fact, even if they were listed, most people couldn't make heads or tails of them.

We *do* need a figure of merit for tuners.

Who should do the work? The best candidate would be that organization which first started standardizing tuner parameters, the Institute of High Fidelity.

DIAPHRAGMS AND MICRONS

We have received a sizable amount of correspondence in the last few months concerning the articles by Rennwald and Williamson (electrostatic speaker, condenser microphone). Many of the questions centered about the problem of locating the diaphragm material for both these projects. Strangely enough, the material was the same in both cases although the thickness was different. The material is Mylar® with a coating of metallized aluminum. The Mylar is made by DuPont, but unfortunately they do not apply the aluminum. Instead, if you contact the DuPont Company, they will give you sources which do metallize Mylar. By the way, for those who live in Canada, the material mentioned by Mr. Williamson, Melinex, is available there as it is in England.

The other problem that disturbed many people was the thickness of the material used by Mr. Williamson. He gave the thickness as 6μ. For those who have been unable to locate this unit, he was referring to a metric unit called microns, or millionth of a meter. Thus:

1 micron = 0.00003937 in.
6 microns = 0.00023622 in. $\cong$ 0.25 mil

Obviously, it would be best to obtain the exact thickness he used to duplicate his results. On the other hand, we understand that DuPont does not make less than a 0.5-mil thickness. Naturally, if that is all you can get, use it. It will work.

For those building the electrostatic speaker and combined amplifier designed by Mr. Rennwald, please be informed that some errors and changes have been brought to our attention. If you are at the amplifier stage please write and we will send you the corrections.

WE'LL MEET YOU IN NEW YORK, LOUIS

Unfortunately for New York, it doesn't rhyme with Louis, and the names it does rhyme with sound peculiar. Anyhow, we will meet you during the New York High Fidelity Show on the fourth floor of the New York Trade Show Building, 35th and 8th Ave., September 11–15. We will be pleased to meet you and discuss any topic that pleases your fancy—about audio of course. Especially, we will be interested in ideas for articles and other projects. If you have built something you are particularly proud of, why don't you stop by and tell us about it.

By the way, there are going to be some rather interesting things at the Show this year. First of all there will be several full-fledged live-*versus*-recorded performances. The purpose of these performances is to demonstrate that equipment available at the Show can produce music which is as close to the live as possible. Also there will be a great deal of emphasis on the ability of components to integrate with almost any decor. In addition, there will be an exhibit which shows how phonograph records are made.

A *piece de resistance* will be a 64-page booklet, describing high fidelity and the component concept, which will be given free to everyone who attends.

Last, but far from least, will be the four floors of manufacturers' exhibits, showing the latest and best equipment available.

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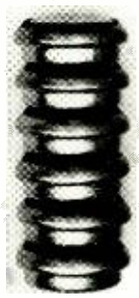
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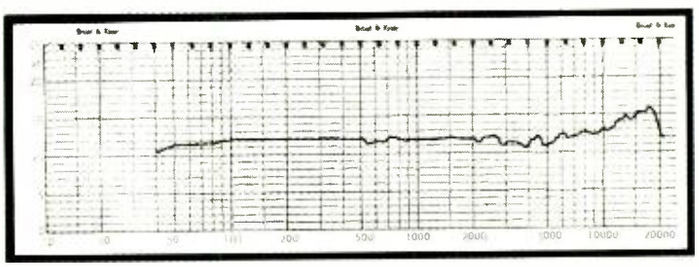


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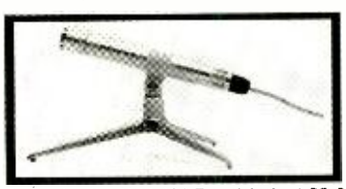




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Impedance:	approx. 800 ohms, unbalanced, ungrounded (accessory cable-transformer matches to 200 ohms)
Noise voltage:	approx. 10 μv
Distortion at sound pressures to 100 dynes/cm²:	1%
Overload level:	approx. 300 dynes/cm²
Power-supply voltage:	8 V ±1 V
Operating current:	approx. 5 ma
Temperature range:	−10° to +70°C (+14° to +158°F)
Dimensions:	¾ in. diameter; 5 in. long
Weight:	3 oz.

For complete technical specifications, call or write Sennheiser Electronic Corporation (N.Y.). For demonstration of this model and the full Sennheiser line, call or write Harvey Radio Co., Inc., franchised distributor for the New York metropolitan area.

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ABOUT MUSIC

Harold Lawrence

A Visit to the French Radio (Part One)

Paris. The *Radio-télévision française* (R.T.F.) is on the move. From all over Paris, engineers, technicians, secretaries and "speakers" (French for announcers, pronounced "speak-*airs*") have started to converge on the circular building along the Quai de Passy, not far from the Eiffel Tower, the new home of the government's mammoth broadcasting industry: *La Maison de la Radio.*

For years, R.T.F. programs have originated in some ten broadcasting centres of varying size and technical capability scattered throughout the city from Buttes-Chaumont to the Champs-Elysées. The problems confronting the managers of such a sprawling operation were staggering. By no means the least of these, getting around Paris during the *heures d'affluence* (rush hours), can be understood by anyone who has observed the columns of honking autos wrapped in tight knots around the Place d'Iéna and other traffic traps in and about Paris. Decentralization also meant partial duplication of personnel and technical equipment, as well as a less than ideal coordination of men and ideas.

By creating a new home for the R.T.F., the government hopes to replace its loosely-knit organization with an efficient broadcasting center containing the latest electronic equipment and utilizing the most up-to-date studio techniques.

Four radio stations will broadcast from the *Maison de la Radio;* all are owned by the state, which rules the air waves. The stations, or "programs," are called *Paris Inter-France 1, Regional-France 2, National-France 3,* and *Haute Fidélité-France 4,* although they are commonly referred to as *France 1, France 2, France 3,* and *France 4.* The first two broadcast popular music, semi-classical music, news, sports and other light radio fare. *France 3* is the French equivalent of the B.B.C. Third Programme, and *France 4* the FM "good music" station.

I arrived in Paris after completing a series of recording sessions with the London Symphony toward the end of July. Parisians were fleeing the city in all directions, leaving the capital in the hands of the tourists. Those Frenchmen who stayed on sang the refrain: *"Je regrette, monsieur, mais Monsieur X est en vacances."* (I'm sorry, sir, but Mr. X is on vacation.) In view of this, I had very little hope of finding anyone to talk to at the R.T.F. Fortunately, the directors of *France 3* and *France 4,* and the latter's musical director, had not yet joined the exodus, and would be in their offices during the next few days.

From the outside, the *Maison de la Radio* looks like a modern sports stadium, except for the 50-foot-high glass panels lining the front of the building, and the contemporary wooden sculptures (totem-pole style) adorning the lobby. A sort of shell-within-a-shell, the *Maison de la Radio* is divided into four elements: 1. an outer shell, containing reception halls and 1000 offices; 2. an extension of the outer shell, housing five large halls; 3. an inner shell, including some fifty studios; and 4. a rectangular archives tower.

Construction was still in progress when I entered the administrative section. Painters, electricians and carpenters were everywhere, and if you didn't watch your step, you might find yourself tripping over a paint bucket or plunging down a hole in the floor. The office of the director of *France 3,* Henry Barraud, was quite a distance from the elevators, down a winding gray corridor, and past maroon-colored doors. M. Barraud, slender, tall, and gray-haired, sat behind a bare gray metal desk, in a gray room looking out into the gray archives tower. It all seemed like part of the set used for H. G. Wells's movie, *Things to Come.*

Sensing my reaction, to the building, Barraud said, "It's not quite as bad in my office. We are in the room of one of my colleagues which I borrowed for this meeting. My own overlooks Paris and the Seine. I have another advantage, too: not all of my walls are metal; one of them is a *real* wall, and I intend to use it. You see," Barraud rapped his knuckles on the wall behind the desk, "the walls in this office are like nearly all the walls in the *Maison de la Radio*—metal. Which means you can't nail anything into them."

During our talk, we could hear the click-click of the high heels of secretaries passing by in the corridor outside our room. Barraud smiled sadly, "No matter where you are, you can't get away from those heels; except, of course, in our studios."

Apart from the looks and sounds of the new building, what did Barraud think of the move? "It was certainly long overdue. Now our people won't have to tear halfway across Paris to get from one centre to another. All our archives, our technical, musical and administrative staffs will be in one place, except for one or two centres which we may still retain for special purposes."

M. Barraud, an active composer as well as administrator, guides the destinies of one of the most powerful cultural arms of the French government. Although he oversees all programs on *France 3,* including drama, poetry, news and music, his chief preoccupation is with things musical. One of Barraud's responsibilities is the commissioning and selection of contemporary works to be broadcast over R.T.F. "Naturally, I don't have the time to read every score that is submitted to us," Barraud explained. "With 3000 composers in France producing at least one work a year, you can see that this is impossible. The French government, under the Minister of Information, has set up a *Comité de la Musique* especially for this task. This committee is composed of twelve of France's leading men of music, none of whom is connected to the R.T.F. You will probably recognize their names: Roland Manuel, Henri Sauguet, Louis Fourestier, and Jean Rivier, to mention a few."

"The Music Committee," Barraud continued, "meets every two weeks to examine new scores. Their recommendations are given to me, after which they are submitted to the Ministry of Information, or, more specifically, to M. Roger Peyrefitte."

In creating programs for *France 3,* Barraud functions as a sort of government impresario. He engages artists and musical organizations both at home and abroad; he surveys the output of composers, tried and untried; and he commissions works of all kinds for performance both in public and over the air. The R.T.F. employs six orchestras, none of whose personnel is interchangeable. They are 1. *l'Orchestre National,* 2. *l'Orchestre Philharmonique,* 3. *l'Orchestre Lyrique,* 4. a chamber orchestra, 5. a light orchestra, and 6. a virtuoso ensemble founded by Marius Constant, the brilliant musical director of *France 4.* Musicians total more than 365, and this does not include singers and choral groups.

Where do these performances take place? I asked Barraud. "When our new studios and halls are finished—and this should be early in 1964—we shall have at our disposal five halls here in the *Maison de la Radio,"* Barraud replied. "One will be a fully equipped theatre, with revolving stage and elaborate lighting arrangements. Two will be devoted to large-scale musical performances. The public will be invited to one of these concert halls, which will have a seating capacity of 1000. . . . Would you like to see them?"

Along the way, I asked Barraud how he liked the acoustics of the new halls. "It's too early to tell," he ventured, "but the concert halls sound a bit *sèches* (dry) to my ears. I think you'll find the theatre has better acoustics." Did he have any say in the construction and design of these auditoriums? "No," Barraud said, "but technicians seldom consult musicians."

All three halls are located on the Seine side of the *Maison de la Radio,* off the entrance to the outer shell. There is much work to be done.

Even without the seats and most of the rugs, both concert halls seemed to lack resonance. I clapped my hands in the first hall and was greeted by a sort of repetitive echo, or "slap," that sounded like the whirring of a large bird's wings. When I pointed this out to Barraud, he said, *"Tiens.* I wonder if the acousticians are aware of this." In the same hall (the one to which the public is not invited) artists had just completed the installation of an immense tapestry covering the entire back wall, a creation of Roger Bezombes out of odd pieces of rugs, tapestries, and remnants. "A great luxury this," Barraud commented, "no one will see it but the musicians who play here." Barraud did not hazard a guess as to what effect all this damping will have on the sounds produced by these musicians.

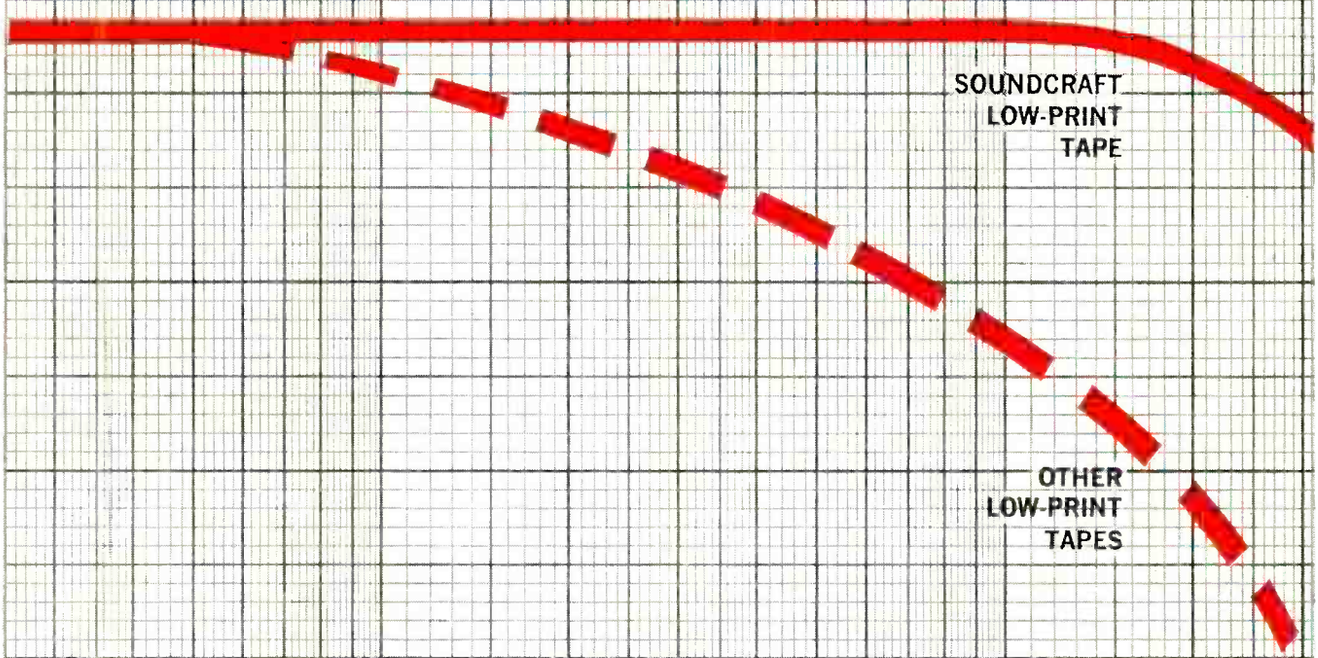
(TO BE CONTINUED)



Fig. 1. **La Maison de la Radio.** (R.T.F. photo.)

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EDITOR'S REVIEW

A FIGURE OF MERIT FOR FM-STEREO TUNERS

LAST MONTH we noted that FM-stereo tuners are being specified as though they were mono tuners. We felt IHF standards should be devised specifically for multiplex tuners. We would like to carry the thought one step further this month and suggest that a figure of merit would be the best and most convenient way to specify this type of equipment. In the past we have been rather leery of schemes specifying equipment by means of a figure of merit. We felt then, as we do now, that such a rating system is inappropriate for equipment where subjective taste factors are important (loudspeakers are a good example of this). However, in the case of FM tuners, the only variable of great significance, aside from the technical properties of the tuner, is geographic location; there are no taste factors involved.

To make the system work we would take the important technical attributes of an FM-stereo tuner and weight them in accordance with reception problems of a geographic area. Thus we would know which characteristics are most important for a particular area. Then the weighted characteristics could be totalled to an over-all figure of merit for a particular geographic area.

For example, let us take an area where sensitivity and selectivity are very important. We would weight these parameters, let us say, 8 and 9 respectively on a 10-point scale. In another area they might be rated 2 and 9. Thus a tuner with sensitivity of 2 μv and selectivity of 40 db would have a figure of merit of 376 in one area and 364 in another. (Multiply the characteristic by the weighting.) Obviously this is a rather simple way of presenting our thought, and also it needs further work to become a workable system, but it does show the basic idea.

One objection we would anticipate would be the necessity for having a different weighting for each locality. On the other hand, after some analysis, it becomes obvious that we do not have a large number of different geographic conditions to deal with. It might really be simpler than appears at first glance.

As a good starting point we might take the parameters and rough weighting described by Mr. von Recklinghausen in his two-part article which concludes in this issue. Of course we may not agree with the weighting he has assigned to the various parameters, but it is a starting point.

Another question which might arise is why such a figure of merit is necessary. Simply because it is not easy to assess the performance of a tuner in a particular area with the specifications as they are supplied at present. Notice, for example, that Mr. von Recklinghausen lists ten characteristics, with the one we usually hear most about at the bottom of the list. Notice also that there are several characteristics on that list which are *not even listed* on most specification sheets. As a matter of fact, even if they were listed, most people couldn't make heads or tails of them.

We *do* need a figure of merit for tuners.

Who should do the work? The best candidate would be that organization which first started standardizing tuner parameters, the Institute of High Fidelity.

DIAPHRAGMS AND MICRONS

We have received a sizable amount of correspondence in the last few months concerning the articles by Rennwald and Williamson (electrostatic speaker, condenser microphone). Many of the questions centered about the problem of locating the diaphragm material for both these projects. Strangely enough, the material was the same in both cases although the thickness was different. The material is Mylar® with a coating of metallized aluminum. The Mylar is made by DuPont, but unfortunately they do not apply the aluminum. Instead, if you contact the DuPont Company, they will give you sources which do metallize Mylar. By the way, for those who live in Canada, the material mentioned by Mr. Williamson, Melinex, is available there as it is in England.

The other problem that disturbed many people was the thickness of the material used by Mr. Williamson. He gave the thickness as 6μ. For those who have been unable to locate this unit, he was referring to a metric unit called microns, or millionth of a meter. Thus:

1 micron = 0.00003937 in.
6 microns = 0.00023622 in. $\cong$ 0.25 mil

Obviously, it would be best to obtain the exact thickness he used to duplicate his results. On the other hand, we understand that DuPont does not make less than a 0.5-mil thickness. Naturally, if that is all you can get, use it. It will work.

For those building the electrostatic speaker and combined amplifier designed by Mr. Rennwald, please be informed that some errors and changes have been brought to our attention. If you are at the amplifier stage please write and we will send you the corrections.

WE'LL MEET YOU IN NEW YORK, LOUIS

Unfortunately for New York, it doesn't rhyme with Louis, and the names it does rhyme with sound peculiar. Anyhow, we will meet you during the New York High Fidelity Show on the fourth floor of the New York Trade Show Building, 35th and 8th Ave., September 11–15. We will be pleased to meet you and discuss any topic that pleases your fancy—about audio of course. Especially, we will be interested in ideas for articles and other projects. If you have built something you are particularly proud of, why don't you stop by and tell us about it.

By the way, there are going to be some rather interesting things at the Show this year. First of all there will be several full-fledged live-*versus*-recorded performances. The purpose of these performances is to demonstrate that equipment available at the Show can produce music which is as close to the live as possible. Also there will be a great deal of emphasis on the ability of components to integrate with almost any decor. In addition, there will be an exhibit which shows how phonograph records are made.

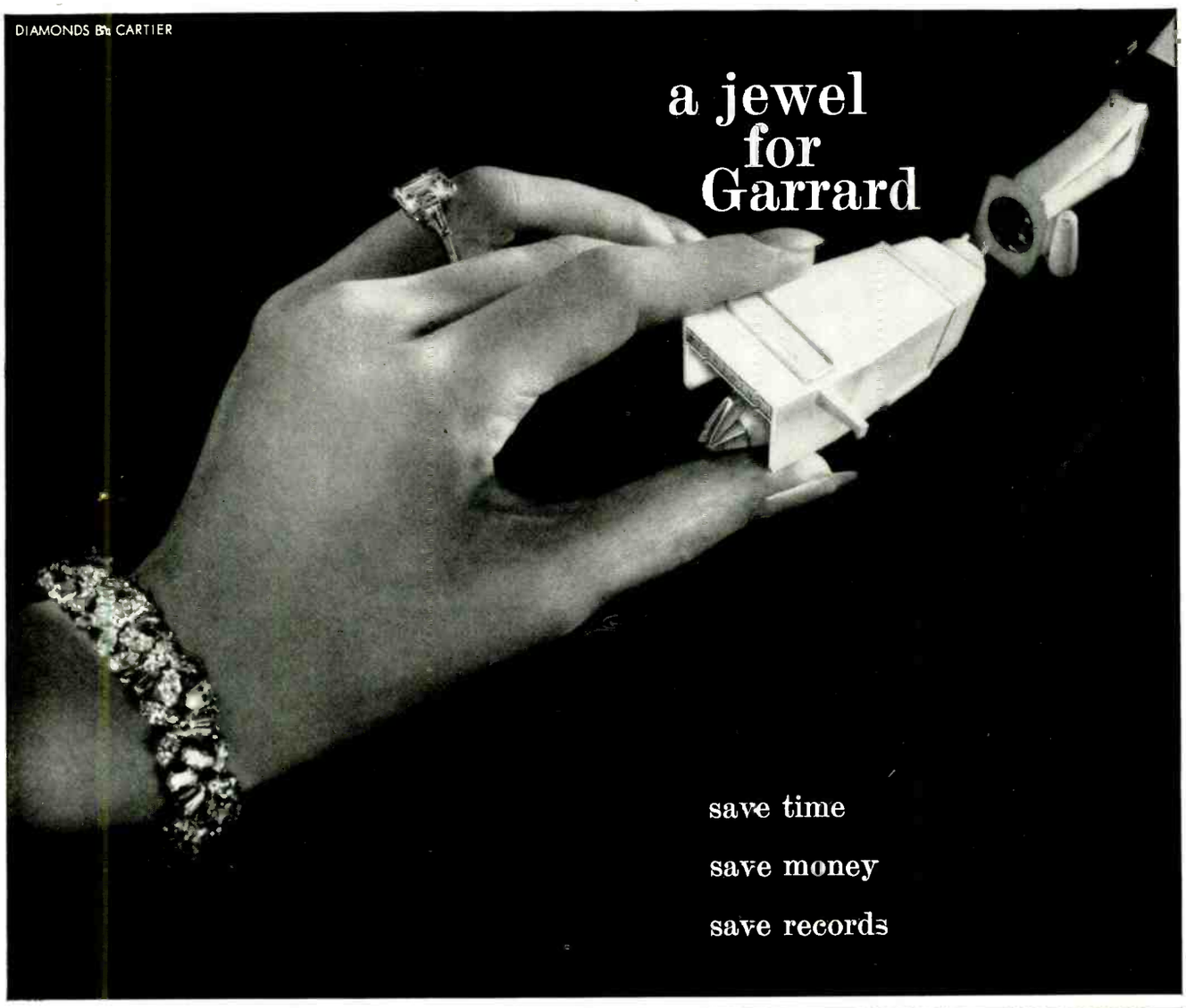
A *piece de resistance* will be a 64-page booklet, describing high fidelity and the component concept, which will be given free to everyone who attends.

Last, but far from least, will be the four floors of manufacturers' exhibits, showing the latest and best equipment available.

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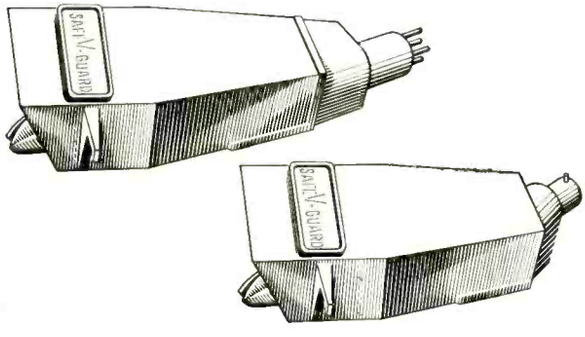


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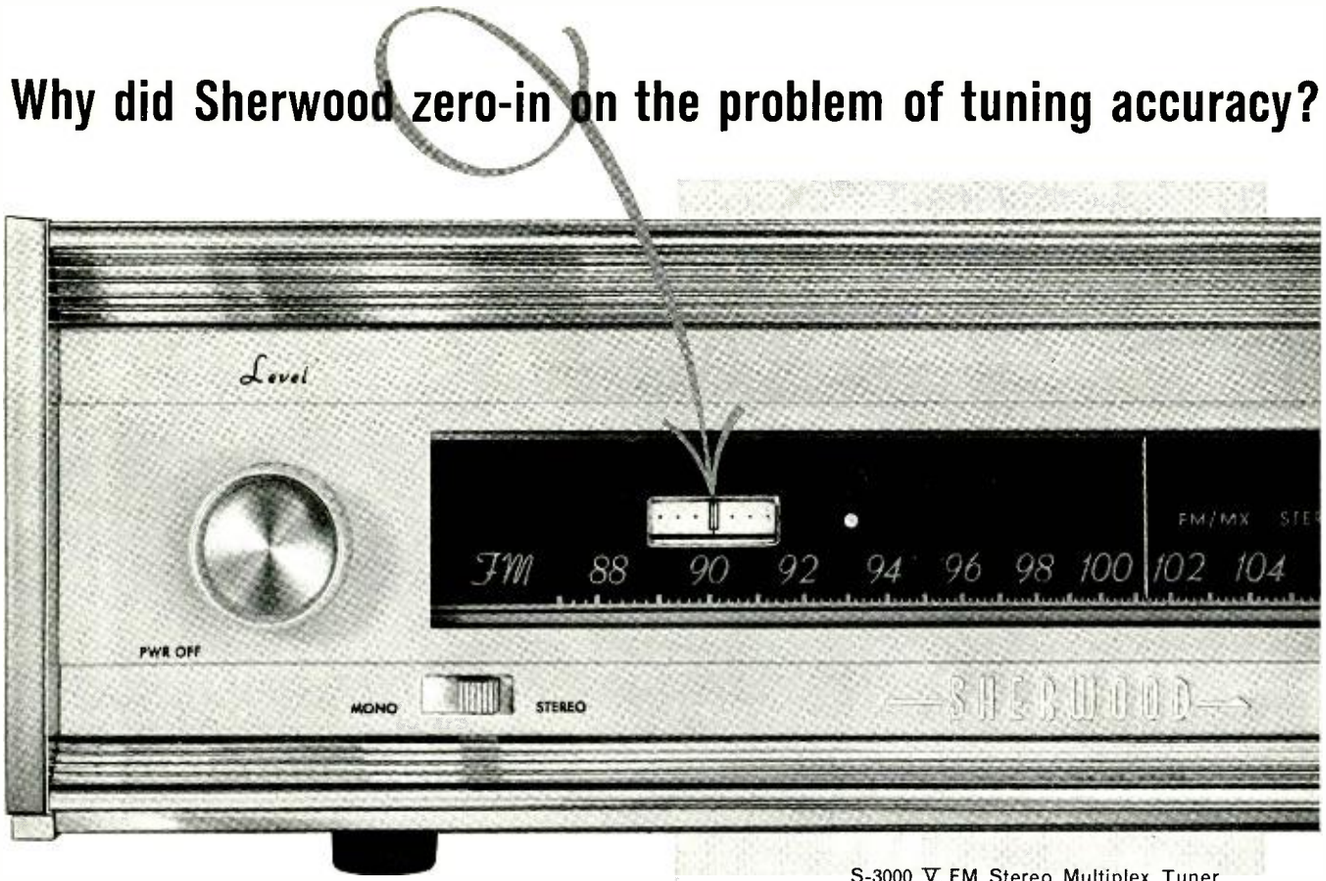
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Mobile FM-Stereo Reception

NORTH C. HAM*

Stereo reception with an automobile FM receiver has proven feasible for a large percentage of the Los Angeles metropolitan area.

THE PLEASURE of two-channel audio reproduction in an automobile was the motivation for embarking on the project of building a mobile FM-stereo receiving system. Immediately many questions arise concerning the feasibility of such reception—questions such as: 1. Would the near spacing of the two-channel speakers and the close proximity of the listener within the automobile confines produce the desired subjective reaction; 2. What is the effect of differential phase delay between the two audio channels created by r.f. transmission; 3. What problems result from doppler effect, multipath reflections, and signal-to-noise threshold when frequency modulation at vhf is used; and 4. What general implementation problems must be conquered?

The fact that a few broadcast stations were broadcasting FM-AM stereo in the Los Angeles metropolitan area made it possible to obtain answers to questions 1. and 2. before any further work was expended. The two-channel reception and acoustical radiation was accomplished by installing a mobile FM receiver within the automobile in addition to the normally installed AM receiver. The loudspeakers were placed at the rear deck behind the back seat (sedan automobile), one on the left side and the other on the right side spaced approximately 3 ft. apart. The usual arrangement of directing the speakers to radiate upward against the rear glass window was used. (See *Fig.* 1.) Subjectively there was a marked enhancement of the program.

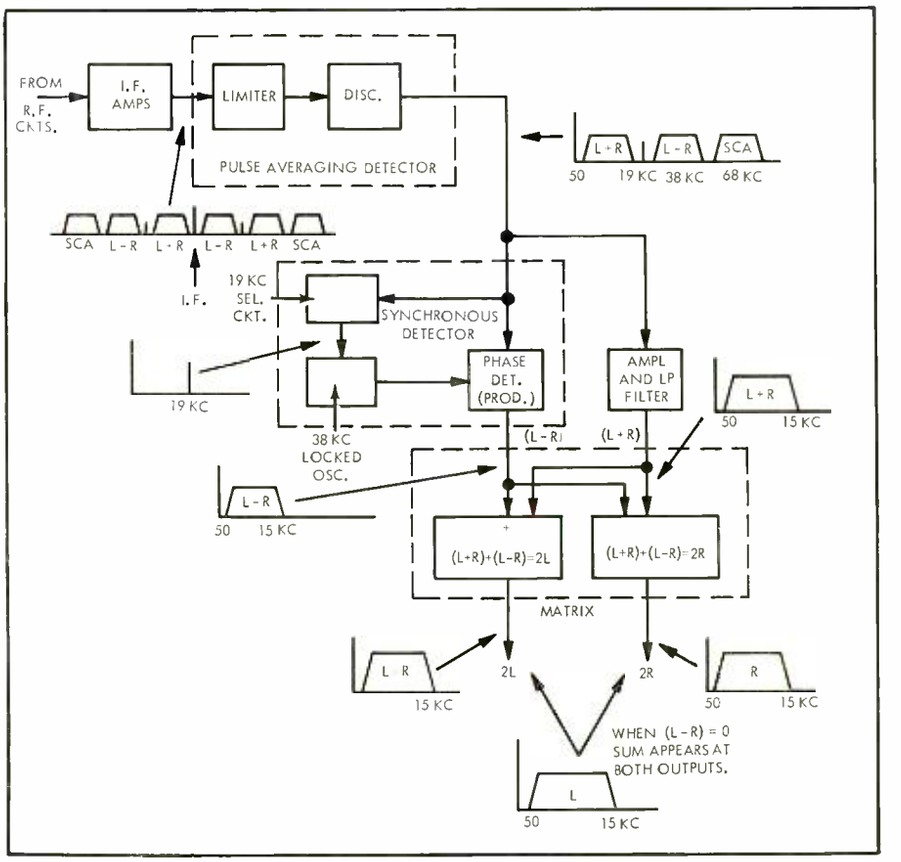


Fig. 3. Receiver detection process for recovering sideband information.

The sound, although emanating from the two closely spaced speakers, is reflected from the rear window (glass having a very high reflection coefficient to sound waves) in conjunction with the surrounding side windows and windshield, and low resultant time delay between incident and reflecting wave produces the illusion of enveloping sound. Similarly, while the transmission was achieved by two widely different radio frequency carriers with varying propagation characteristics, the resultant phase error (this has not been quantitatively measured at this time) under mobile conditions produced no subjective listener objections. The FM-AM process has definite limitations because of propagation factors, fidelity, requirement of two receivers and limited program broadcast by this media, and thus I directed my effort toward FM–FM multiplexing of two-channel stereo.

Problems with the FM-FM form of

* *1116 N. 29 Place, Phoenix, Arizona.*

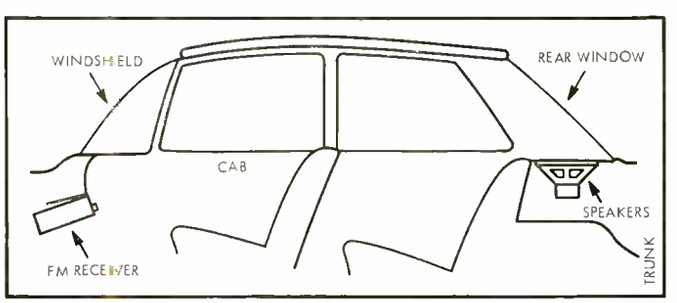


Fig. 1. Loudspeaker placement.

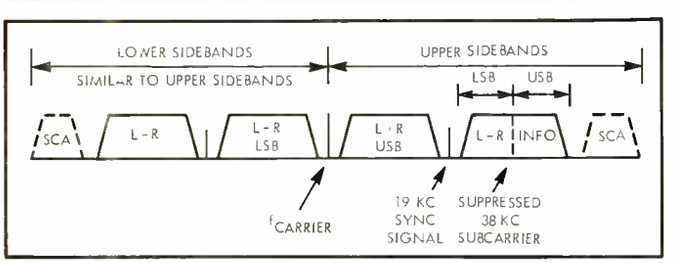
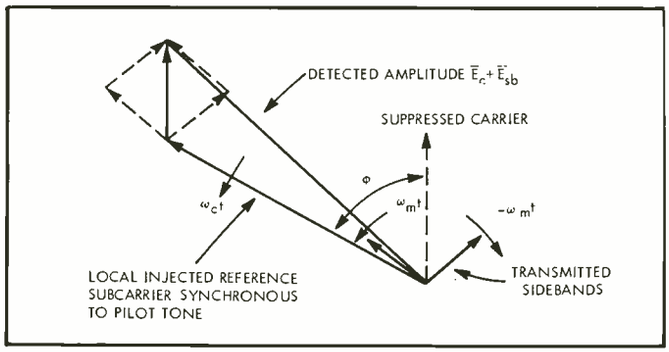


Fig. 2. Spectra of FM-stereo transmission.

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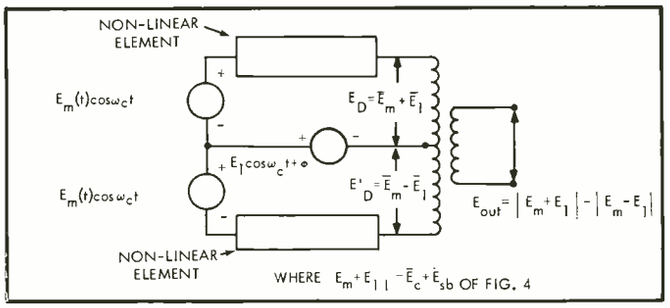


Fig. 4 (left). Relationship of reference subcarrier to sidebands.
Fig. 5 (above). Balanced phase detector (product detector).

transmission at vhf during mobile operation are associated with propagation factors. A review of the multiplexing process will clarify these factors. The L+R information is transmitted as the normal upper and lower sidebands grouped closely around the FM carrier for compatible or monophonic broadcast while the synchronizing signal and the L–R information sidebands are further away from the carrier. (See *Fig.* 2.) The sync signal (pilot signal) which is phase coherent to the suppressed 38-kc subcarrier falls conveniently at 19 kc within the spectrum gap between the L+R sideband and the lower L–R sideband components of the 38-kc subcarrier.

The detection, or demodulation, process for recovering the L and R information involves demodulating the entire spectrum from the r.f. (or i.f.) region and translating it down to d.c by the action of the frequency discriminator. (See *Fig.* 3.) The demultiplexer then strips out the 19-kc sync signal, by selective circuits, amplifies it and uses it to phase synchronize a 38-kc subcarrier oscillator. The 38-kc phase coherent signal is used as the local injected reference signal for demodulating the L–R sideband information from the product detector. The resultant L+R and L–R information components are then further processed, such as matrixing, to obtain the desired L and R audio channels.

The system of DSB-SC (double-sideband, suppressed-carrier) transmission has the disadvantage in the necessity of knowing $\cos\omega_c t$ at the receiver. This method is referred to as coherent or synchronous detection since the detector must have a carrier wave that is in synchronism with that used at the transmitter.

For DSB-SC demodulation, the output from the product detector is equal to the absolute magnitude of the vector sum of the reference carrier and the transmitted sideband signals. (See *Fig.* 4). The expression for the transmitted sideband with suppressed carrier is shown by:

$$e_{sig}=E_m\cos(\omega_c+\omega_m)t+E_m\cos(\omega_c-\omega_m)t \qquad Eq.\ (1)$$

where $\cos(\omega_c+\omega_m)t$ represents the upper sideband and is shown as the rotating vector $\omega_m t$ in *Fig.* 4. The process of demodulation is accomplished by multiplying the local reference subcarrier to the sidebands signal. Equation (1) can be rewritten to a mathematical expression for DSB-SC as follows:[1]

$$e_{sig}=KE_m(t)\cos\omega_c(t) \qquad Eq.\ (2)$$

which still states that a pair of sidebands are symmetrically located about the subcarrier frequency, ω_c. The process of multiplying the local reference subcarrier to the received sideband signal is shown in *Fig.* 5 with these results:

$$f'(t)=[(KE_m(t)\cos\omega_c t)(\cos\omega_c t+\Phi)] \qquad Eq.\ (3)$$

[1] Schwartz, Mischa, "Information Transmission, Modulation, and Noise," McGraw-Hill, New York.

where Φ is any arbitrary phase difference of ϕ degrees between the original and reinserted subcarrier. The output becomes:

$$f'(t)=\tfrac{1}{2}E_m(t)[\cos(2\omega_c t+\Phi)+\cos\Phi] \qquad Eq.\ (4)$$

and after filtering the high-frequency terms $E_m(t)\cos 2\omega_c t+\Phi$ located about twice the subcarrier, the output is:

$$f''(t)=\tfrac{1}{2}E_m(t)\cos\Phi \qquad Eq.\ (5)$$

$$Output=K'\cos\omega_m t\cos\Phi \qquad Eq.\ (6)$$

The maximum output occurs when $\Phi=0$ deg. and disappears when the injected subcarrier is 90 deg. relative to the original carrier. The suppressed-carrier detector is thus phase-sensitive and synchronous detection must be used to ensure maximum output.

The completion demodulation process involves two forms of detection: a pulse-counting averaging detector (discriminator) and a synchronous post detector (phase detector). The characteristics of these detectors in relation to the S/N ratio is shown in *Fig.* 6. It is obvious that the main detector (discriminator) should have a lower "threshold" point than the post detector for a properly designed system.

The "threshold" of the detector is the operating point at which it ceases to perform its task. In this case where the information is program material the "threshold" would be influenced by the subjective listener. Hence this point may be where its performance is degraded by some arbitrary amount or where it ceases to perform completely. The synchronous detector functions distinct from the discriminator in that its "threshold" appears to be well defined and ceases to perform below this point. The conventional description of the FM discriminator "threshold" has been defined as the knee of the curve, the point *K*, where the output S/N is decreasing at a faster rate than during the condition of high signal strength. However in the case of stereo broadcast transmission, the "threshold" generally occurs below this point, such as point S_1.

Doppler effects can be neglected since the maximum doppler shift in received frequency will be less than 10 cps when driving at normal freeway speeds. The

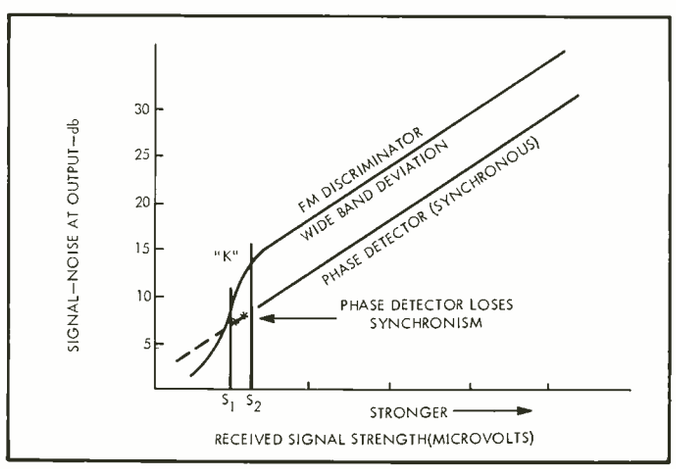


Fig. 6. Relationships of signal-to-noise at the output and input signal level.

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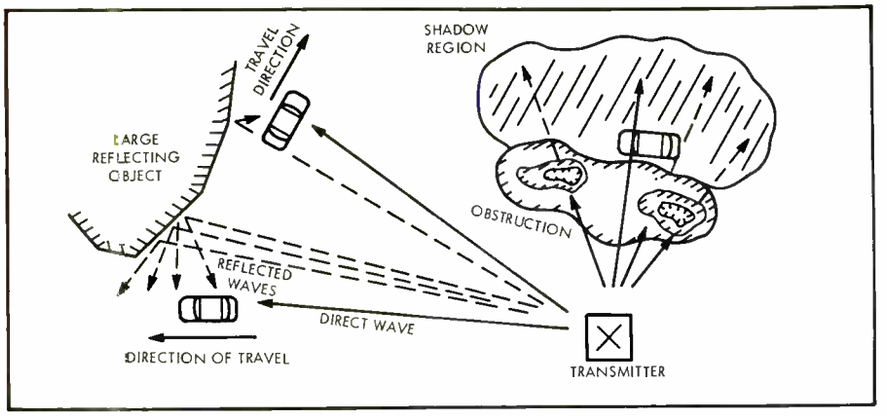


Fig. 7. Main and reflected waves creating multipath interference.

doppler shift can be calculated from the formula:

$f_{doppler} \simeq \frac{v}{c} f_T$ *cps*, where v = velocity of moving vehicle, mph; c = speed of propagation, mph; f_T = transmitted frequency, cps. FM receivers that employ discriminator feedback to the local oscillator will further reduce this factor.

Multipath factors should degrade the reception in several distinct ways. One is the effect upon the phase and amplitude change to the 19-kc sync signal, another is the phase delay differential of the L–R subcarrier sideband information relative to the L+R main carrier sideband information, and finally the resultant S/N ratio at the receiver. Multipath interference is the phenomenon of the transmitted signal arriving at the receiver by a direct path simultaneous with a secondary or indirect path by reflection from objects in the vicinity of the receiver. (See *Fig.* 7.) The result is that the received signal is a composite of the main signal plus a time delay, Δt, of the same signal. If the time difference is very small compared to the period of the modulating frequency, the effect is constructive or destructive interference between the two received waves. If the resultant signal strength after destructive interference is still above threshold, the net result is a lower output signal-to-noise ratio and subjectively appears as no degradation. Anomalous phase and amplitude changes to the received 19-kc sync signal has the effect of changing the phase reference of the 38-kc locked-oscillator signal either by a direct phase shift or a momentary loss in sync signal—a resulting phase ambiguity between the 38-kc inserted subcarrier relative to the original subcarrier. The result is that a momentary non-optimum phase exists between the L–R sidebands and the 38-kc local subcarrier. Since this composite signal is eventually matrixed with the L+R composite signal, as shown in *Fig.* 3, both the L and R audio signals are reduced in the same relative amplitude with the net effects of reduced audio volume.

However, when the multipath destructive interference reduces the effective received signal strength below the threshold of the synchronous detector, the result is a loss of the L–R sideband information and only L+R monophonic signal appears at both loudspeaker outputs. When the car is in motion it will intercept alternate constructive and destructive peaks and nulls along the path of motion (see *Fig.* 7), and the signal will "flutter" in and out with high- and low-amplitude variation, varying signal-to-noise ratio, and stereo-mono reception all occurring at a periodicity dependent upon the rate of motion and the spacing of these wave combinations. The spacing of the wave combination is also dependent upon the direction of car motion relative to the transmitter and the terrain conditions. The reception is still listenably modified by the tolerance of

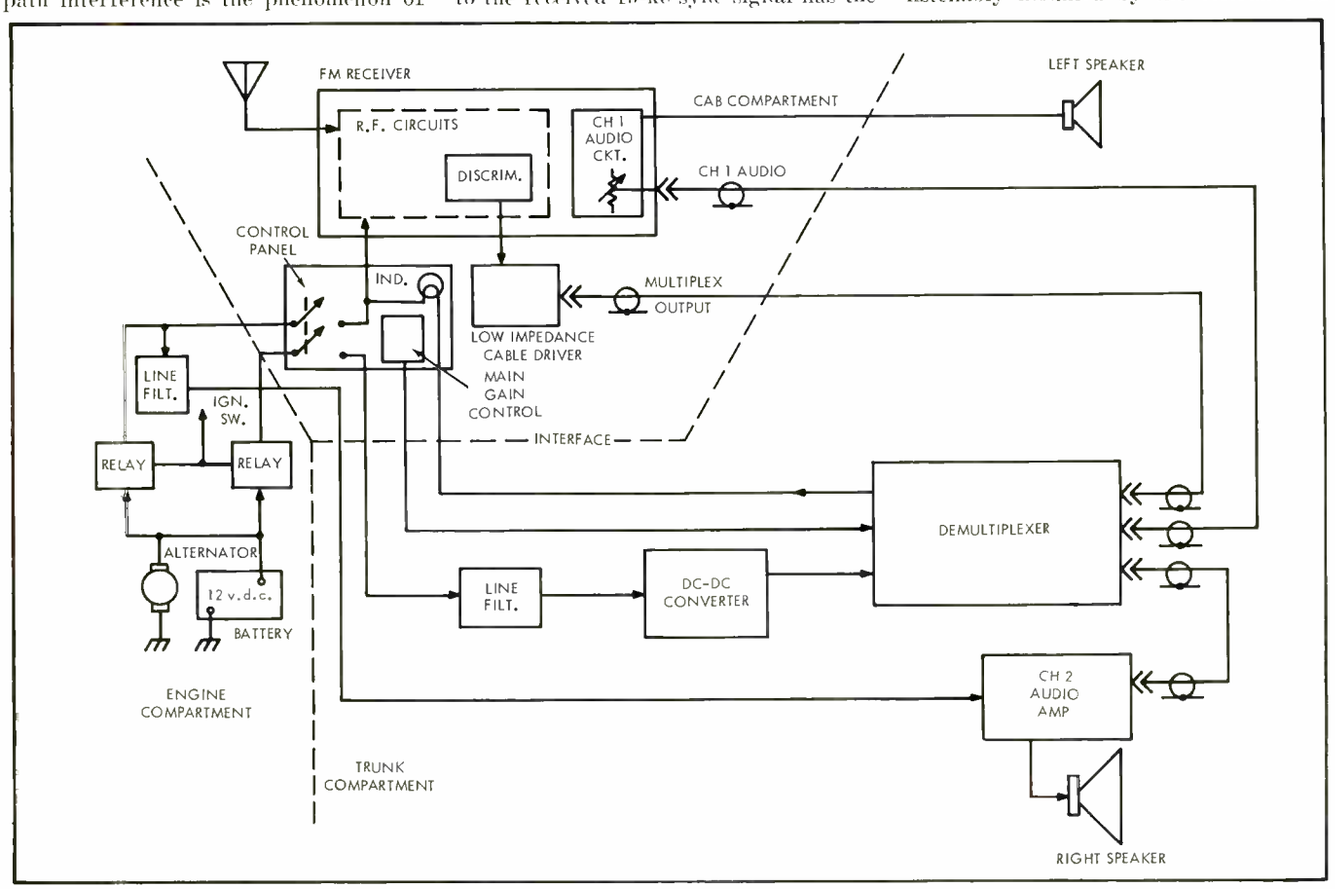


Fig. 8. Block diagram of receiving system.

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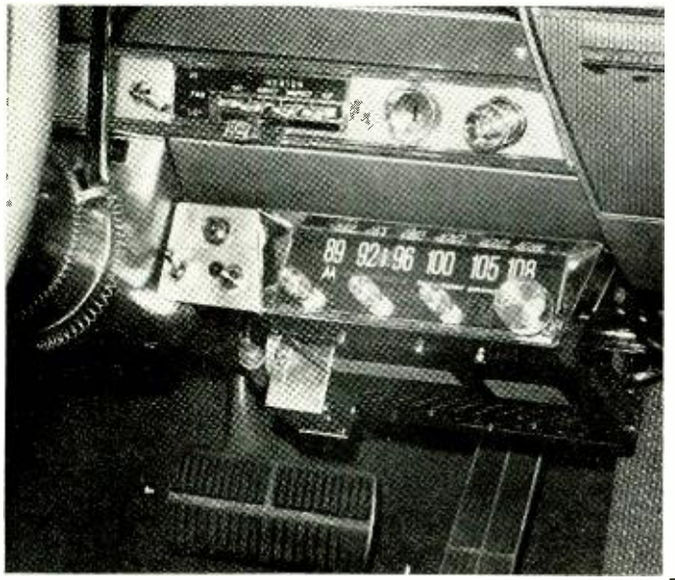


Fig. 9. FM receiver with control panel and cable driver.

the listener and the degree of signal strength variation below threshold. In the extreme case when the destructive interference reduces the signal below the threshold of the main receiver discriminator detector, complete loss of audio output occurs at the "flutter" rate, and the received station is not listenable under these conditions.

The discussion up to this point has been largely qualitative and more rigorous analysis would require complete information on the transmitted portion of the system, quantitative information by instrumenting the various subsystems of the receiver and continued field test. Suffice to say, since the primary objective was to determine the feasibility of reception and its enjoyment, it has proven more than adequate. Quantitative data may be obtained in subsequent tests and means of improving the receiving system is discussed in later sections.

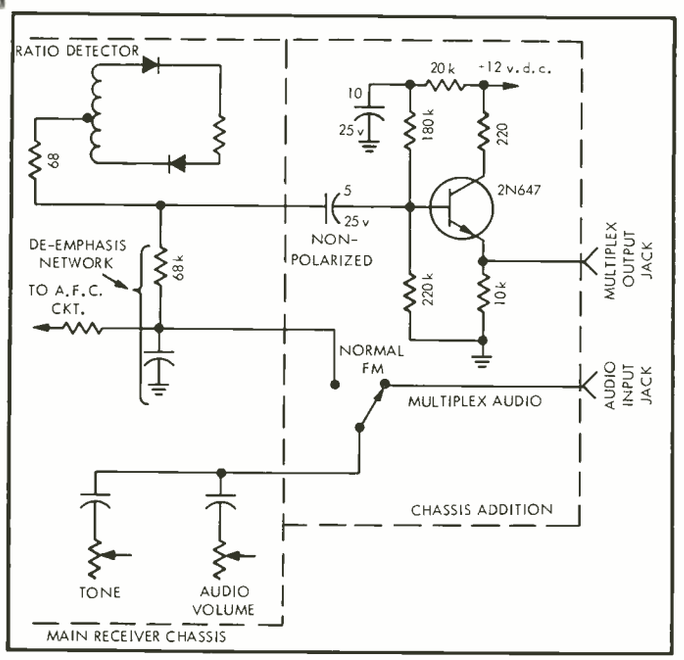


Fig. 11. FM receiver modification and cable driver.

Receiving System Implementation

The receiving system is comprised of the basic FM automobile receiver together with the demultiplexer, secondary audio amplifier, and auxiliary power converter and control panel, as shown in *Fig.* 8. The basic receiver is the Motorola FM-900 receiver which was chosen because of its sensitivity and ease of adaptability. This receiver is a complete



Fig. 10. Audio amplifier, multiplex adapter, and d.c.-d.c. converter in position under rear deck of car.

receiver containing the entire r.f, i.f., discriminator, and audio amplifier circuitry. Modification involved the extraction, at the proper point, of the transmitted spectrum; an emitter-follower, low-output impedance, cable, driver for sending this signal to the demultiplexer unit; the proper cabling for returning the audio signal from the demultiplexer to the receiver audio amplifier; and the addition of the control panel. The demultiplexer is the ELCO MX-99 unit chosen because of its post detector and matrixing method and its size factor. The second audio amplifier and the d.c.-d.c. converter are transistor circuits.

The separation of the components were as shown in *Fig.* 8 because of the space availability in this particular automobile. The cable driver and control panel are attached to the FM receiver forming an integral unit, as shown in *Fig.* 9, while the remaining components are mounted on a plywood platform that nestles behind the unused space near the spare tire well, as shown in *Fig.* 10.

The electrical modification to the FM receiver is shown in *Fig.* 11. The multiplex output is derived from the discriminator output point preceding the de-emphasis network and applied to the emitter follower. If a particular tuner does not have the desired response at the higher modulation frequencies, a phase lead network may be inserted to compensate for the "roll-off" at the high frequencies.[2] The nominal signal amplitude at this point is approximately 5 volts peak resulting in an output level of about 4 volts peak to be applied to the demultiplexer. The audio circuit is connected to a small switch to allow audio input from the normal de-emphasis source or from the multiplexed channel 1 source. Both the emitter-follower and the channel 1 driver within the demultiplexer unit are low-impedance drivers and the shielded cables (25 pf per foot) in the lengths used had no noticeable degradation upon the higher frequency response.

The modification to the demultiplexer unit, see *Fig.* 12, involves the rewiring of the vacuum-tube filaments to operate from the 12-v. d.c. car battery source, input connection to the power supply filter network from the +360-v. d.c., d.c.-d.c. converter output voltage, the addition of the stereo indicator relay for the remote light indicator at the control panel and the automatic removal of the 38-kc local oscillator injection during non-stereo reception and, the addition of the main gain control circuitry. The main gain control circuitry permits an overall stereo volume adjustment without

[2] Shottenfeld, R., and Abilock, S., "Signal sampling for FM stereo," AUDIO, Dec. 1961, p. 22.

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altering the 19-ke sync signal. The main volume control is thus remotely controlled from the receiver control panel (momentary type spdt lever switch) while the differential gain matching between channel 1 and channel 2 is accomplished by the normal FM audio amplifier gain control. The remote control technique used may appear sophisticated; however, it was found the simplest expedient of changing the audio circuit gain with the one-megohm potentiometer. This scheme does not require any additional gain nor does it upset the phasing of the sideband information. The 12-v. d.c. reversible motor and relays are of the garden variety of components, readily obtainable from surplus dealers. Fortuitously this scheme was ideal from the human engineering viewpoint because of its momentary lever action where the down position is for reduced volume, and vice versa, with the length of actuation determining the degree of change. Changes occur in stepped amounts and result in the least distraction to the driver's attention from the road. Other schemes such as bias-controlled vacuum tubes or voltage-control attenuators could be used dependent upon the complexity and ingenuity desired. *Figure* 13 is the schematic of the particular d.c.-d.c. converter used to provide B + for the multiplex adapter vacuum tubes. This scheme was chosen because the d.c-d.c. converter oscillator frequency of approximately 3 ke could be efficiently filtered to reduce conducted interference in the 12-v. d.c.-supply line. In this respect "L-section" line filters, utilizing 80-mhy/2.5-amp. chokes together with appropriate bypass capacitors, were necessary to reduce a.c. interference in the alternator, FM receiver d.c.-d.c., and multiplex adapter d.c.-d.c. converter. (See *Fig.* 8.)

The second channel audio amplifier is a transistor power amplifier, as shown in *Fig.* 15. The volume control permits adjusting the nominal audio power for this channel and is normally set in conjunction with the main gain control for the desired dynamic control range. The normal FM receiver audio gain control is used to balance the channels. Additional decoupling in the 12-v. d.c. lead to the bias network of the input transistor, Q_1, was necessary to further reduce conducted interference. The 500-pf bypass across Q_2 was necessary to remove high-frequency instability in the feedback loop.

The usual problems of chassis loop currents, improper grounding, and attention to additional filtering and bypasses to the automobile electrical system must be fought through on any system installation and depend upon the characteristics of the particular automobile.

It can be stated here that the reception

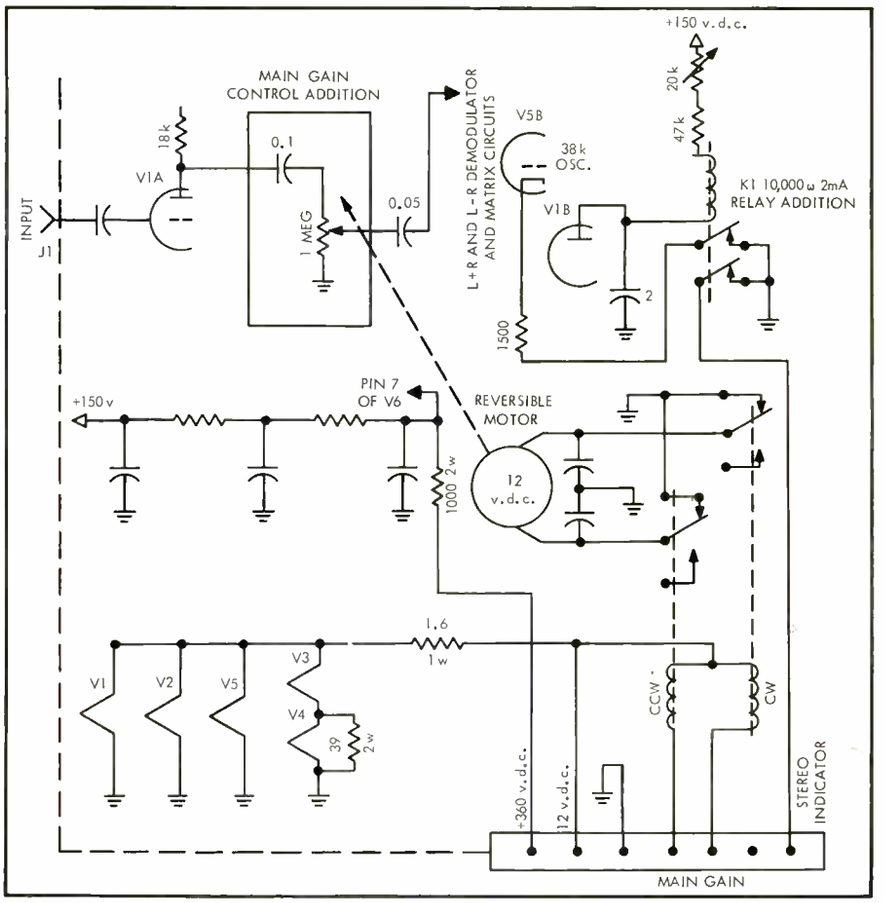


Fig. 12. Modifications to multiplex adapter.

of FM-stereo within a moving passenger automobile is feasible and practical and certainly enhances the enjoyment of FM reception. The coverage is limited largely by the transmitter site location, effective radiated power, receiver sensitivity and propagation anomalies. In general,

(*Continued on page 62*)

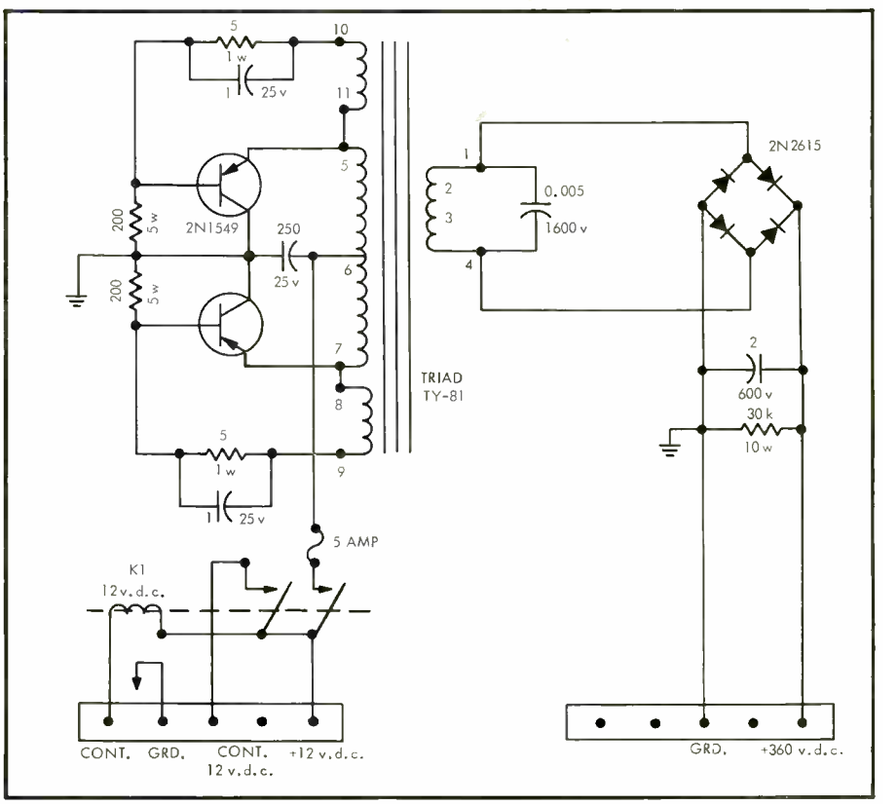


Fig. 13. D.c.-d.c. power converter.

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Crossover Design

NORMAN H. CROWHURST*

This two-part discussion covers all the practical aspects of crossover design, from choice of circuit configuration and calculation of the necessary values, to making your own coils and checking out the over-all result. This first part covers the broader questions of circuit choice and value calculation.

In Two Parts—Part I

THE BASIC FUNCTION of crossovers needs no introduction to the readers of AUDIO. However, there are some aspects in their function that need clarifying before design data can be intelligently applied. The earliest crossover designs were adaptations from classic filter theory. Apart from the fact that, even correctly terminated, such filters do not perform precisely according to their theory, a practical loudspeaker "load" never correctly terminates a crossover filter at all frequencies. This fact, for various motivations, led to the adoption of the type known as "constant resistance."

This term was strictly for the amplifier's benefit. But, without explanation, it led to some misunderstandings. Although some people still believe it to be so, a constant-resistance network does not enable any pair of impedances to be connected to the output, with the input automatically presenting constant resistance to the amplifier. What "constant resistance" means is that, if the low frequency and high-frequency terminals are each terminated with the true nominal impedance for the design, as a resistive value, then the input terminals will present this same resistive impedance to the amplifier, at all frequencies.

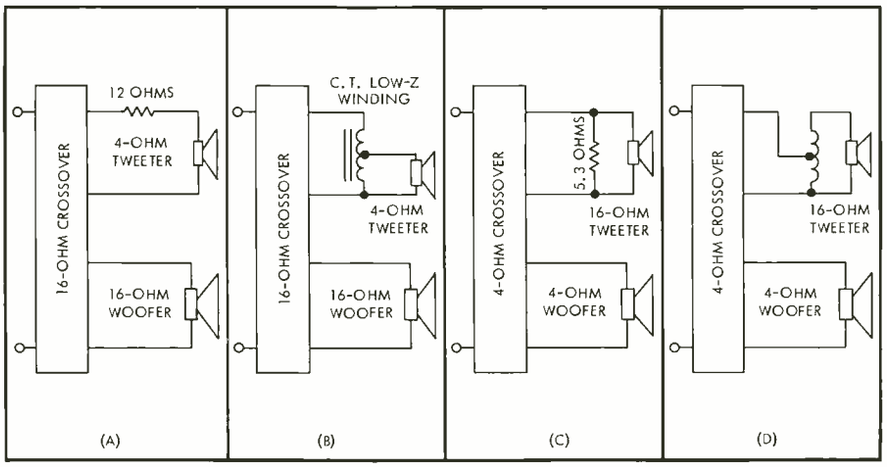


Fig. 2. Methods of combining units of different impedances, so as to match correctly a crossover unit and the amplifier feeding it.

This is more than could be said for networks designed on classic theory. Because of this, the so-called constant-resistance types have more tolerance for the inevitable variations, due to the impedance characteristic of loudspeaker units, than do the classic types, which are already "off" with true resistance termination. But the constant-resistance type have no more magical properties than their classic forebears.

At the majority of frequencies, removed from the immediate vicinity of crossover, either type of network reflects the terminating impedance back through the filter that's operative for the particular frequency, virtually unchanged. In the vicinity of crossover, termination with units whose impedance is close to nominal and close to resistive in this range, will result in close approximation to constant-resistance load for the amplifier in the same range, and in correct distribution of energy between the two outputs. Deviation from this ideal will cause less serious departure from theoretical performance than was the case with classically derived filters.

Having explained that bit, we now come to the question of choice of configuration. First let's clarify the designation of filters by a "db per octave"

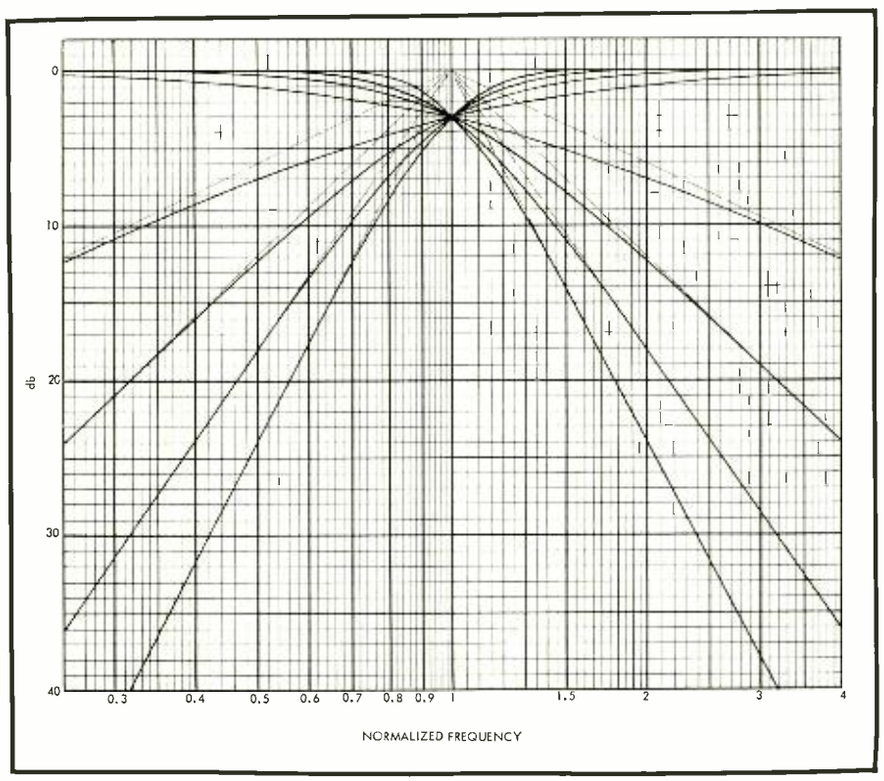


Fig. 1. Response curves of the four constant-resistance crossover types compared. The nominal slope in db/octave is where the curve meets the ultimate asymptote. It is precisely half this value at crossover.

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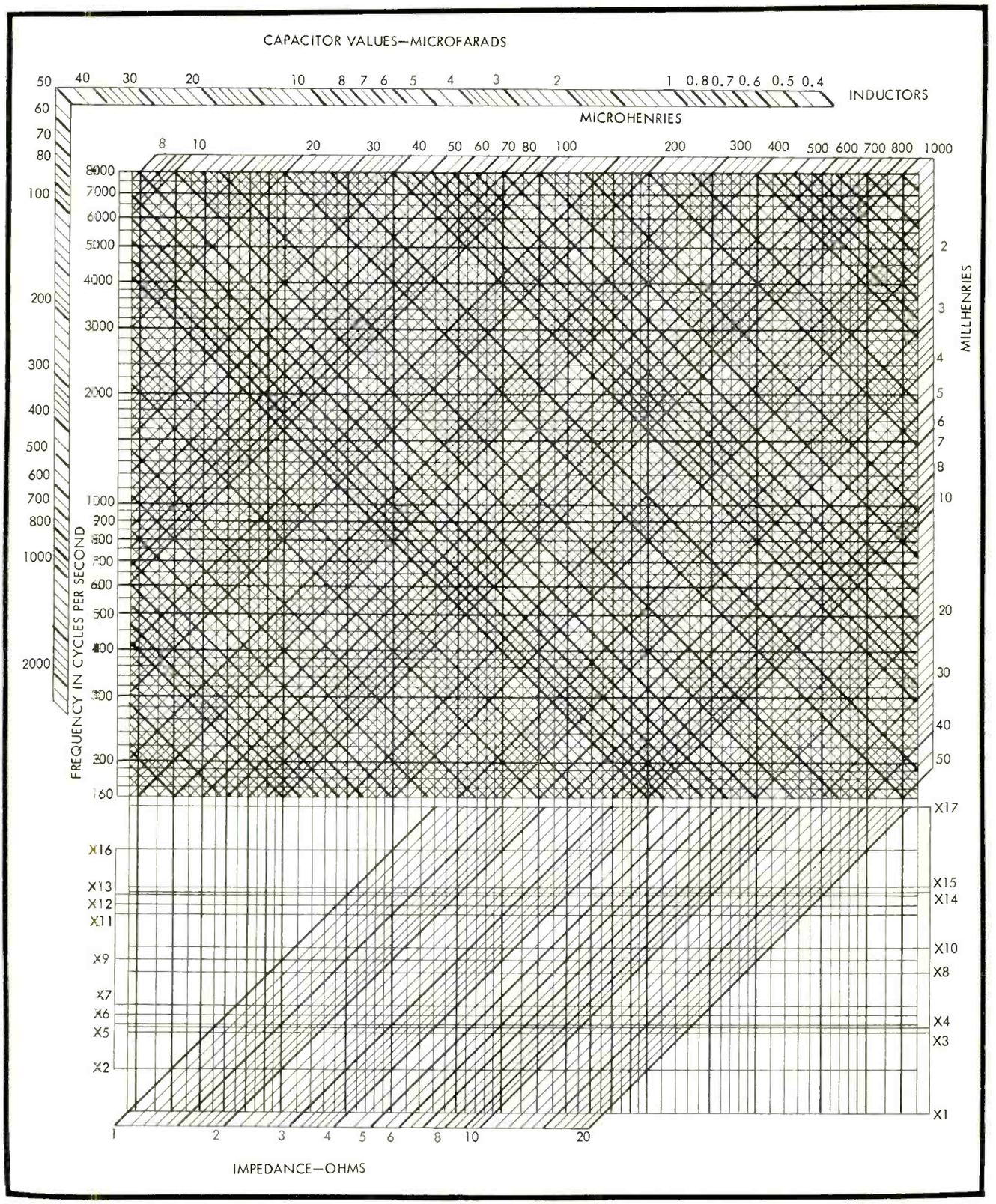


Fig. 3. Chart for calculating element values in a crossover of any of the types shown in Fig. 4. As described in the text, it can also be used to find values for multi-way crossovers.

figure. This seems to have different meanings when used by different people. The meaning we will use, which has the widest general acceptance, refers to the ultimate cut-off slope (*Fig.* 1). At crossover frequency, where each output should receive precisely half the total power, there should also be precisely half the nominal ultimate phase shift to each, and the slope will be precisely half the nominal ultimate value for the configuration.

On that basis networks come in db/octave figures that are multiples of 6. A simple network, using a capacitor in series with the tweeter and an inductor (or the voice-coil inductance itself) in the woofer circuit, results in 6-db/octave crossover. Two elements in each filter (four in all) result in a 12-db/octave crossover. Three elements in each filter

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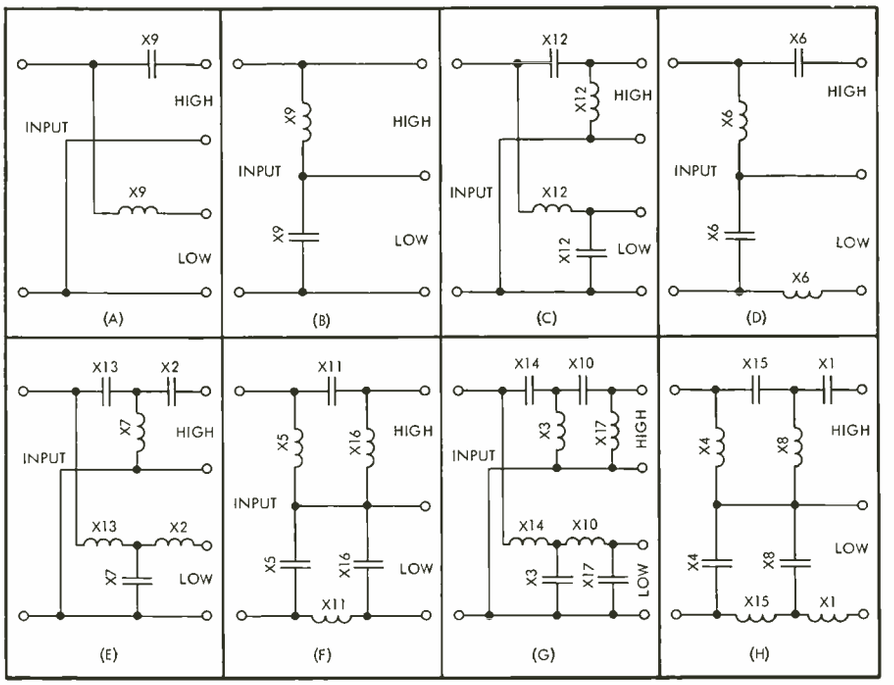


Fig. 4. The four basic constant resistance crossovers, arranged for parallel connection (top row) or series connection (bottom row). The elements are coded to identify the reference lines used to find their values on the chart of Fig. 3.

(six in all) result in 18 db/octave, while four in each result in 24 db/octave.

At the half-power point, the loss in each output is 3 db and the slope half the ultimate values above quoted, in each output. Phase angle is half ultimate too, which is 90 deg. for 6 db/octave, 180 deg. for 12 db/octave, 270 deg. for 18 db/octave and 360 deg. for 24 db/octave. As each output varies from zero phase shift (a theoretical ultimate within the pass band) up to this ultimate value (at theoretical infinite attenuation) and the two are complementary, these figures are the phase difference between the two outputs *at all frequencies*, when correctly terminated.

If we were only concerned with the usually stated ideal of delivering only the frequencies below crossover to the woofer and only the frequencies above crossover to the tweeter, then we would prefer the filters with the steepest db/octave slope in effecting this transition.

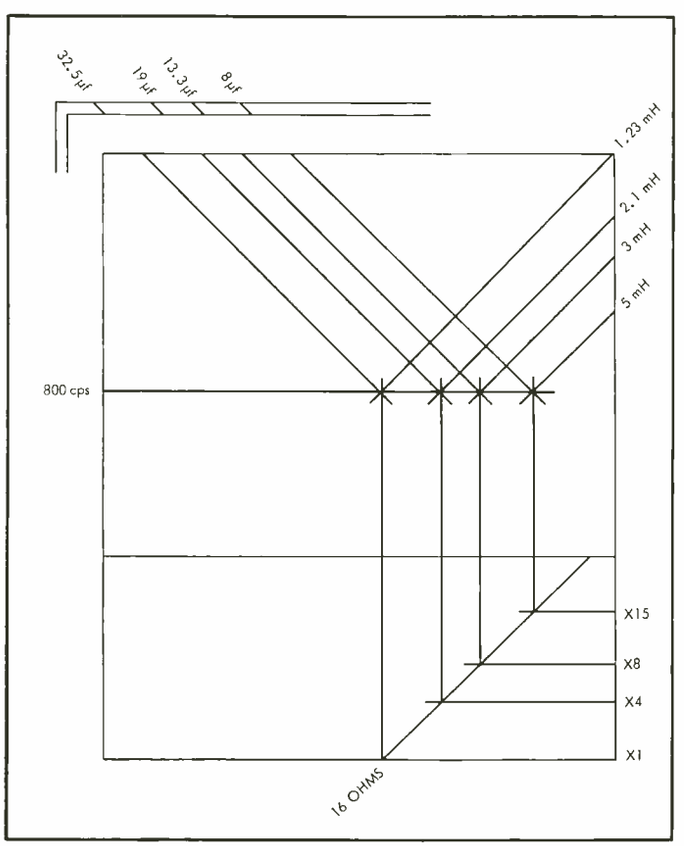


Fig. 5. Illustrating how the chart of Fig. 3 is used to calculate values for a crossover of the type shown in (H) of Fig. 4.

But there are other factors. Apart from the obvious fact that more elements make the crossover more costly, the increased slope is not all gain. The more elements the filter contains, the more critical is its exact response upon precisely correct termination.

Even assuming we take care that each is correctly terminated, within say an octave on either side of crossover, this does not say that the 24-db/octave type is necessarily the best for the job. All crossovers introduce progressive phase shift, which is a time delay discriminative of frequency. In the simpler circuits, this phase shift closely approximates a constant time delay. The sharper the cut off, the more abrupt the change in phase shift in the immediate vicinity of crossover, and the consequent variation in time delay with frequency at this point.

This means that, especially noticeable on transients, the signal fed to the loudspeaker units will have the time relationship of its component frequencies shifted much more by the sharper circuits. On this basis alone, we would plunk for the

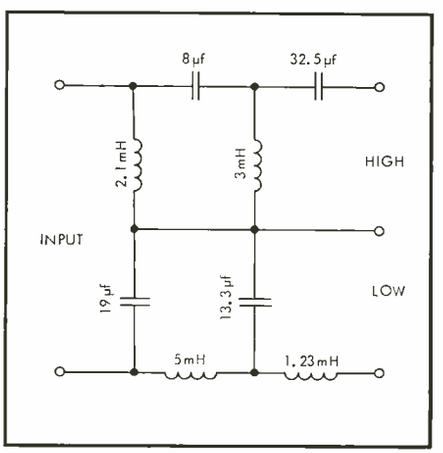


Fig. 6. The values found as shown in Fig. 5, inserted in the schematic.

simplest, or at most the 12-db/octave type.

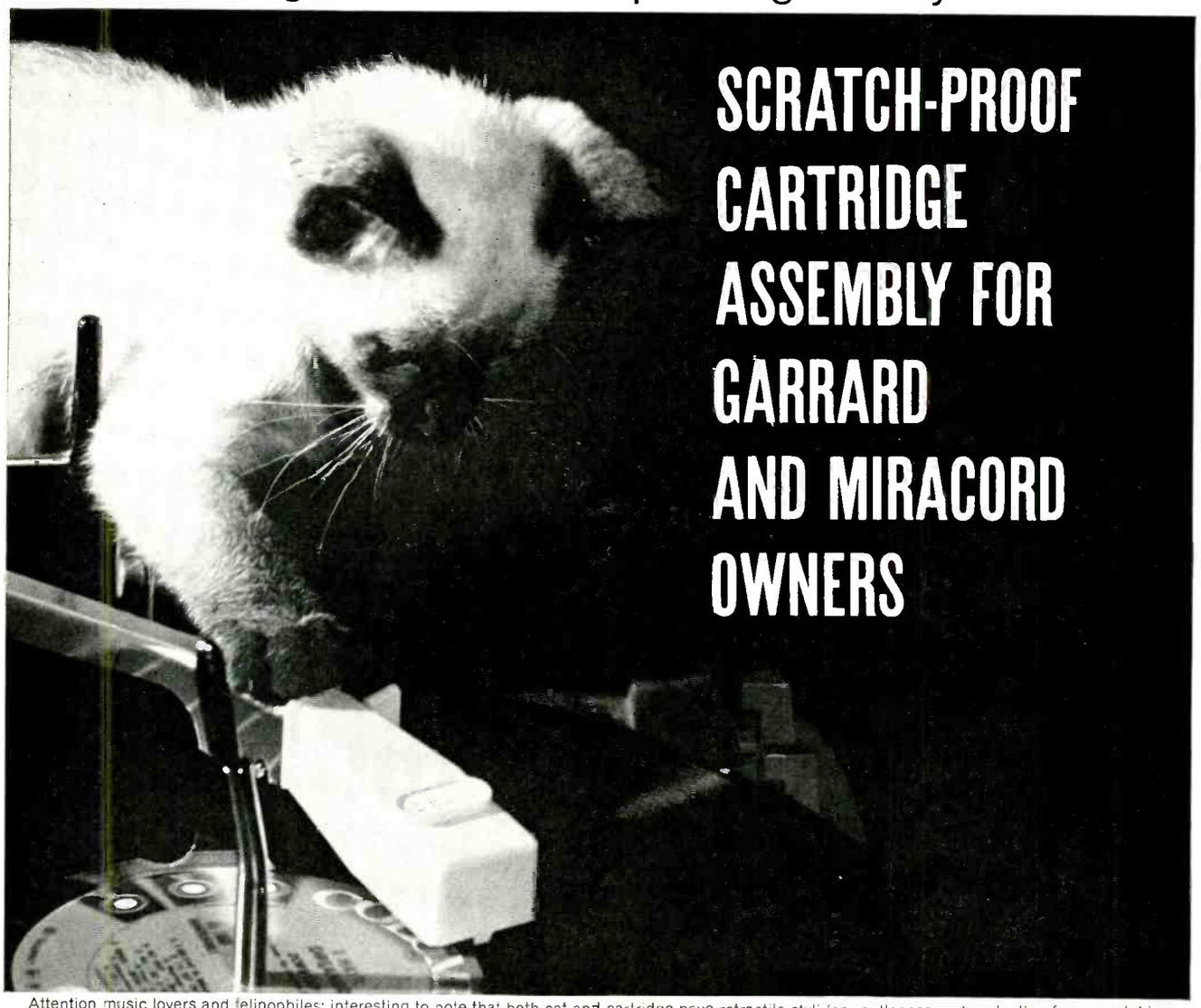
As with most things in audio, we have to end up with a compromise which depends on the type speakers used. In some types, notably those with correctly matched horn radiator, there is a rapid transition from correct acoustic loading, allowing the unit to handle its full rated power, to almost no loading at all, resulting in distortion and/or damage to the unit, if available power is not rapidly curtailed beyond the proper range of use. With this type of system, there may be good argument for the steeper-slope crossovers.

With systems made up of cone radiators on the other hand, there is, relatively, no sudden cut-off frequency in the acoustic sense. Maybe cone break-up in the woofer leads to rough response above its allocated range, while cone excursion should be controlled below the allocated range of the tweeter. For these

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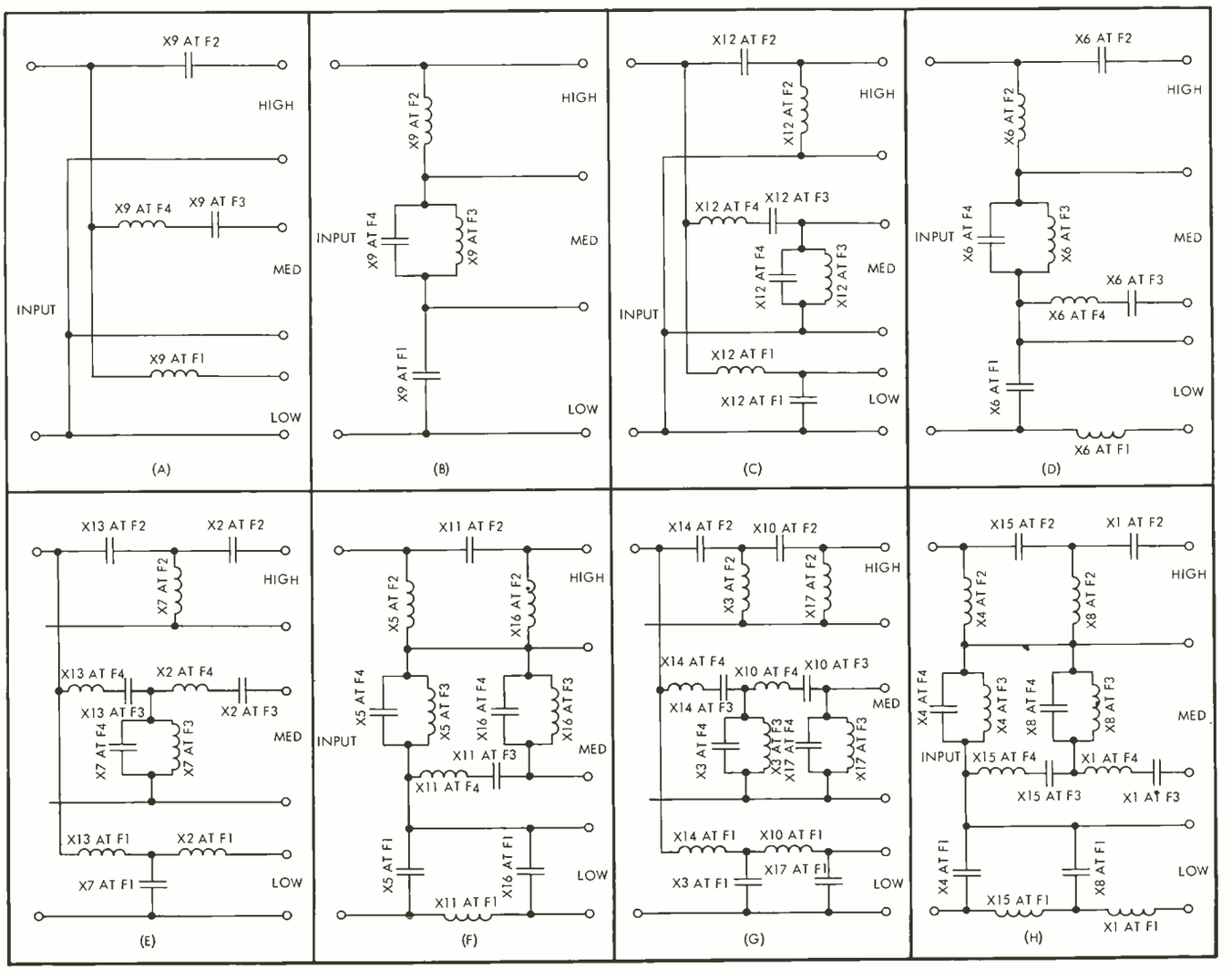


Fig. 7. One set of possible configurations for a three-way crossover, corresponding to each of the basic types shown in Fig. 4. Each element is coded with a reactance and frequency: the reactance refers to Fig. 3 and the frequency to Fig. 8.

applications, the 6- or 12-db/octave, according to the rapidity with which such effects begin, or the margin of protection needed, will be quite adequate.

A question we are often asked relates to the use of differing impedance units in the same system. While this is possible, steps should be taken to achieve correct matching. As the woofer invariably has to work at maximum efficiency and requires maximum damping, it is best to design the crossover at its impedance, and use the appropriate amplifier impedance tap to match, padding the other unit with either series or shunt resistance to give it the same impedance value.

For example, if the woofer is 16 ohms and the tweeter 4 ohms, use a series resistor of 12 ohms in the tweeter circuit. This will result in a 6-db loss, which means some other method should be used if the tweeter does not have this much spare sensitivity over the woofer. Any speaker transformer with a center tap on the low-impedance winding will serve to achieve this matching (*Fig.* 2). Alternatively, if the tweeter impedance is higher than that of the woofer, a shunt resistance or a step-up auto-transformer will enable correct matching to be achieved.

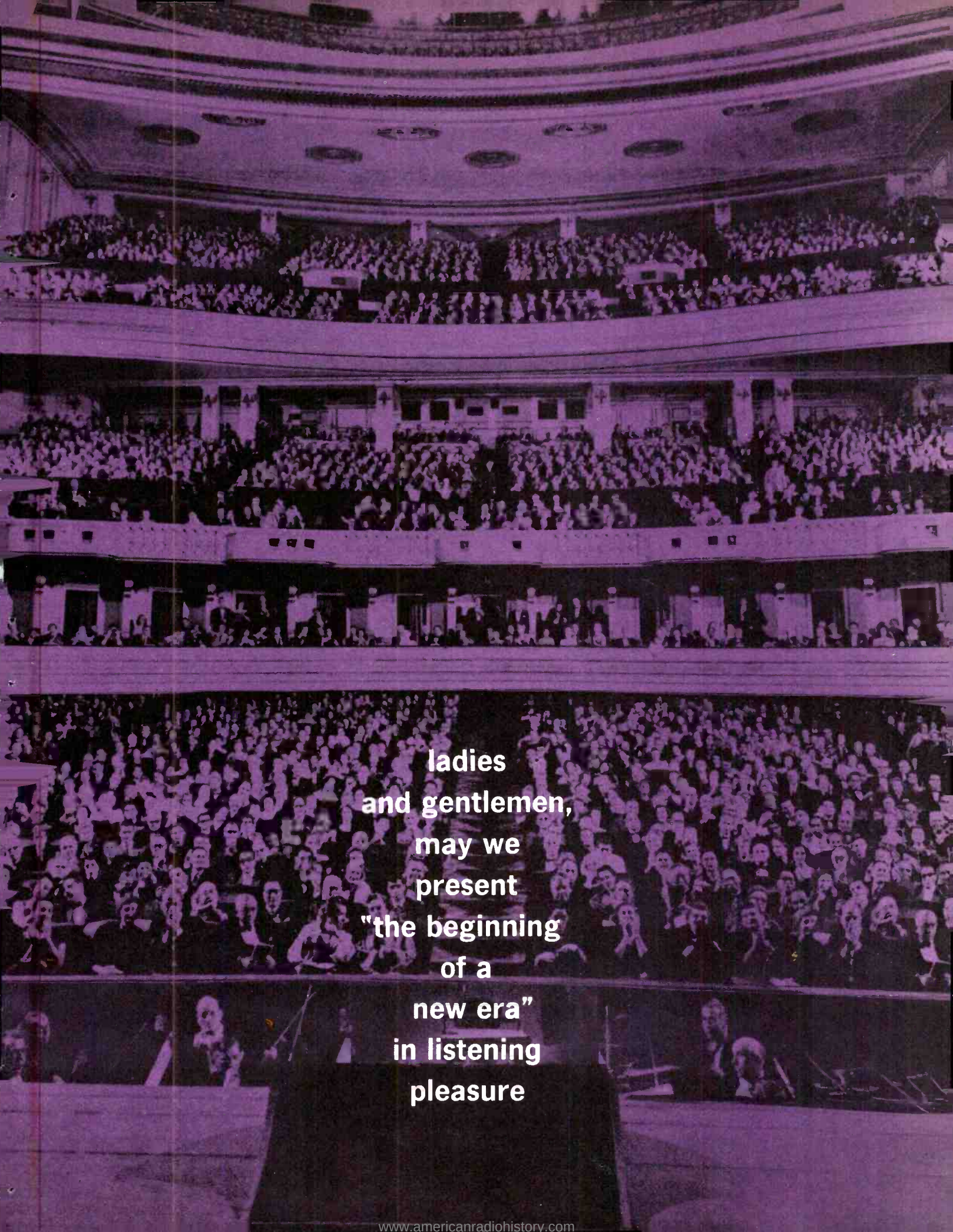
Figure 4 shows the family of constant resistance crossover configurations from 6 db/octave to 24 db/octave. To achieve better match, where the woofer unit's voice-coil inductance possesses appreciable reactance at crossover, use configurations (A), (D), (E), or (H), where the low-frequency output has a series inductance element; the value of voice-coil inductance can be made part of the output inductance element. Voice-coil inductance is not usually constant, because part of it is due to acoustic radiation effects, as well as the electrical inductance of the coil in the magnetic gap.

A good compromise value may be calculated by finding the frequency where the impedance is just double its minimum value. Assume this value is simple reactance and calculate the equivalent inductance from a reactance chart, or the formula $L = X_L/2\pi f$ (in henries, when f is in cps). Merely subtract the value so obtained from the calculated value for your crossover and get a coil to provide the rest.

The chart of *Fig.* 3 provides for calculating all the crossover elements, in terms of the reactance coding shown on *Fig.* 3. Values for networks (A) through (F) use references at the left, while values for (G) and (H) use references at the right of the chart. For example, suppose a 16-ohm horn system uses an 800-cps crossover of the 24-db/octave variety and configuration (H). It uses reactance elements X_1, X_5, X_8 and X_{15}. *Figure* 5 shows how the chart is used to obtain the values shown in the circuit of *Fig.* 6.

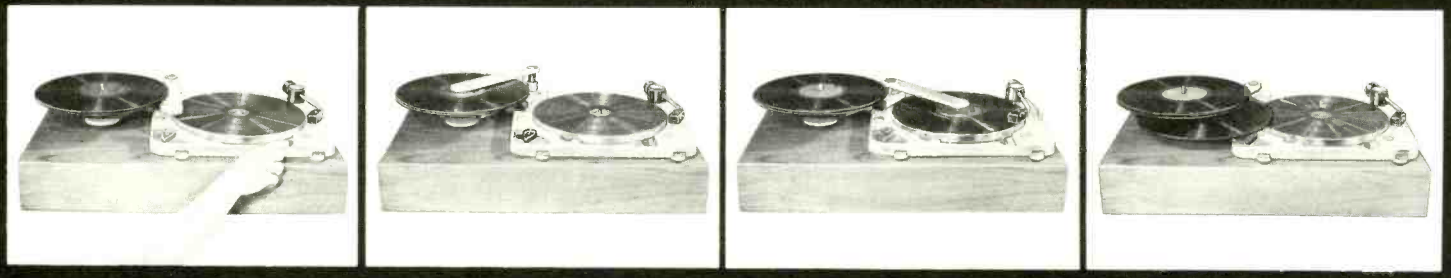
That handles two-way systems in all their varieties. Now we come to the design of crossovers for multi-way (more than two-way). We only show three-way, but systems with more crossovers use the same method, extended. The "end" units —lowest and highest—follow the same design as two-way, while intermediate bands employ band-pass sections. The complete set of three-way configurations is shown in *Fig.* 7. Here, as well as specifying reactance, we have to specify

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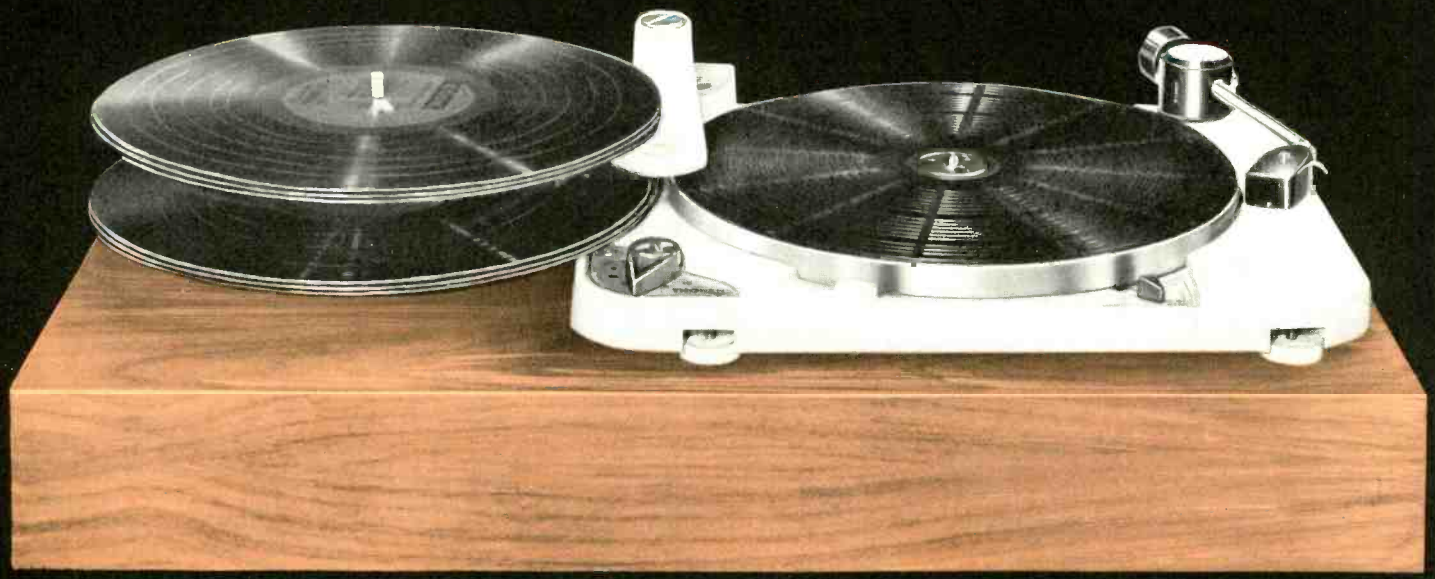


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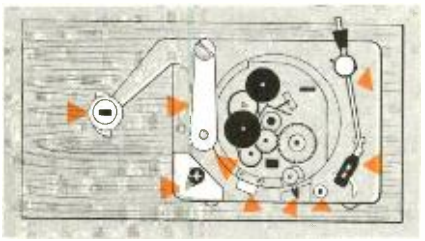
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Here are only a few of the benefits that are built into the Thorens TD-224:



NO RECORD STACK ON TURNTABLE

The Thorens TD-224 eliminates the problems created by stacking of records on the moving turntable. *No distortion, no straining, no wavering.* The record stacking is completely separate from the turntable. No other changer offers this benefit.

CARTRIDGE QUALITY

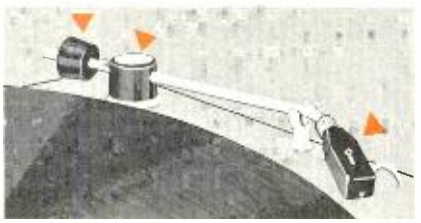
This is the only record changer which can properly utilize the finest professional cartridges with highest lateral and vertical compliances. Because of its features, Thorens engineers recommend that the finest-quality cartridges be used, for maximum re-creation of music.

SINGLE PLAY OF RECORDS

The TD-224 plays records as every professional turntable does, *individually*. You can hear the difference this makes in your enjoyment.

CONSTANT STYLUS ANGLE

The angle of the stylus is constant because the tone arm is in a set position, perpendicular to the record surface. Vertical tracking error is as minimal as on professional turntables. The TD-224 is the only present day changer that can make this statement.



FAMOUS BTD-12S TONE ARM

The TD-224 incorporates the famous Thorens BTD-12S Tone Arm, a classic of Thorens-Swiss craftsmanship. No other arm offers so many unique benefits: Lowest possible inertia assures accurate tracking even on warped records, minimizes record wear and styus wear; Precision ball bearings on *all* axes; All adjustments: precision-calibrated gram-force, stylus positioning slide, balancing counter-weight. Unique vertical pivot keeps stylus vertical at all times, automatically, not by usual critical adjustments. Plug-in shielded cable connector and a complete 5-wire system throughout gives maximum shield from hum. Resonance well below audible frequencies. Less than 0.5°/inch tracking error. Quick-change plug-in shell for all standard and ultra compliance cartridges. No wonder Thorens engineers decided that no other tone arm would do for the TD-224 *Masterpiece*.

CONSTANT TORQUE

The torque on the motor is constant, since there never is more than one record on the turntable at a time. The result is true fidelity from every record you play.



BUILT-IN RECORD CLEANER

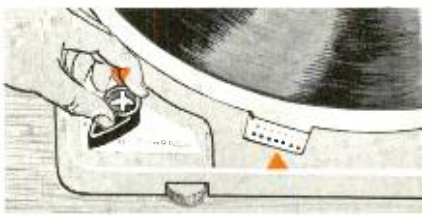
With the use of present day advanced light-weight tone arms and pick-up cartridges, old-fashioned methods of cleaning records have become obsolete. Thorens had to invent a new way to help you keep your records clean. They incorporated the Cecil E. Watts principles in the TD-224 tone arm brush. A patented continuous record cleaning device is mounted on the record feed-in arm, and cleans the records during play, without interfering in any way with the tone arm. Static charges due to dust are thereby eliminated.

ILLUMINATED STROBOSCOPE

Made famous by the Thorens TD-124, one of the most remarkable of all the features of the TD-224 is the built-in stroboscope, illuminated and visible throughout the entire playing cycle. The stroboscope permits control and adjustment of the turntable speed even while the record is being played.

EXCLUSIVE PITCH CONTROL

The variable speed control allows you to correct even extremely small differences of speed with slight touch of an adjusting knob, thereby providing true re-creation of music even to the most critical ear. A musician, in fact, can get precisely "on pitch" with any instrument he wishes to play. The strobe, moreover, reveals visually what may be undetectable to the ear. For example, a



1% variation in speed changes the pitch only 1/6 of a semitone. The strobe, however, indicates even this slight variation, and enables you to maintain the speed at a rate constant to the highest accuracy of 0.1% by adjusting the fine speed knob.

MANUAL PERFORMANCE

For transcription turntable performance, the TD-224 can be played manually as well as automatically with the changer.

MANY OTHER FINE FEATURES

- 4-Speed operation, with variable speed adjustment control.
- Plays automatically up to eight records (3/4 inch stack).
- Intermixes records of any diameter between 7" and 12" provided speed, groove-shape and center hole diameter are alike.
- Automatically shuts off when all records have been played. World famous Thorens drive system and motor, made famous by the Thorens TD-124.
- Level indicator aids in perfect levelling.
- OFF position disengages idler wheel automatically to prevent idler flats.
- Far exceeds NAB specifications for rumble, wow and flutter for transcription turntables.
- Operates at any voltage from 100/250 volts, 50/60 cycles AC.
- FULL ONE-YEAR WARRANTY.

DIMENSIONS:

Base measures 27" wide, 14 1/2" deep, 4 1/4" high.

Maximum height for operation: 9 3/4".

The superb TD-224 *Masterpiece* offers features never before available in a single instrument. Its durability and performance specifications far exceed NAB standards for studio equipment. This is an instrument to be cherished as the finest in the world for the re-creation of sound by records.

See the participating Franchised Dealers listed on next page.

www.americanradiohistory.com

SEE AND HEAR THE TD-224 MASTERPIECE AT THE DEALER NEAREST YOU

ALABAMA
BIRMINGHAM
Lawrence Hi-Fi Center
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MOBILE
Hoover Stereo Theatre
1651 Government Street

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PHOENIX
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2711 Ea. Indian School Rd.
High Fidelity Sound Systems
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TUCSON
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18532 East Alosta Ave.
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Bakersfield Audio
2534 F Street
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CULVER CITY
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2772 W. Olympic Blvd.
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Rudi Pock — Hi Fi
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1759 E. Colorado St.
High Fidelity House
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SAN FERNANDO
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San Marino High Fidelity
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Teachout Associates
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SAN RAFAEL
Catania Sound
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SANTA ANA
High Fidelity Associates
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WEST LAFAYETTE
Sound Productions
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DES MOINES
Stereosound Studio
1214 Grand Ave.

KANSAS
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LAKE CHARLES
Electronics Unlimited Inc.
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The Music Shop Inc.
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2532 Linwood Ave.

MARYLAND
BALTIMORE
High Fidelity House
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MASSACHUSETTS
BOSTON
Copley Camera Shop
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NATICK
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Soundco Electronic Supply Co. Inc.
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Sound Specialists Co.
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Stereoland
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Tape Recording Industries
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GRAND RAPIDS
Electronic Sound Equipment Co.
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Detroit Audio Co.
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Bamberger's
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BUFFALO
F. M. Sound Equipment Co.
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Marrt Electronics
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Roosevelt Field Shopping Center
HEMPSTEAD, L. I.
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Macy's (under construction)
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Alcor, Inc.
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JAMAICA, L. I.
Audio Exchange Inc.
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NEWBURGH
Seaman's Photo & Hi Fi
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Leonard Radio, Inc.
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Terminal-Hudson Electronics Inc.
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Soundex Electronics
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CRANSTON
Sound-O-Rama, Inc.
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2101 Colby Ave.
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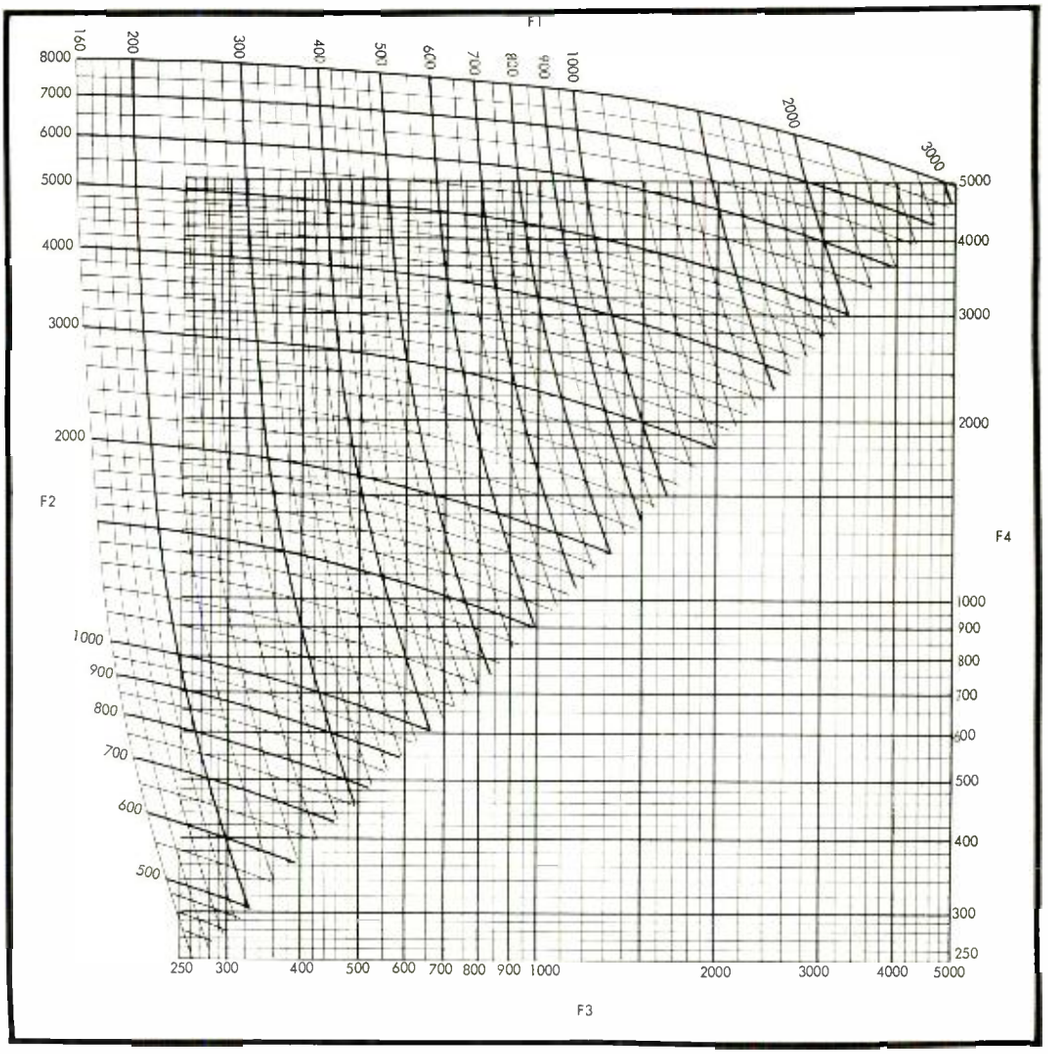


Fig. 8. Chart for deriving modified reference frequencies, f_3 and f_4, from the actual frequencies, f_1 and f_2, in a band pass filter.

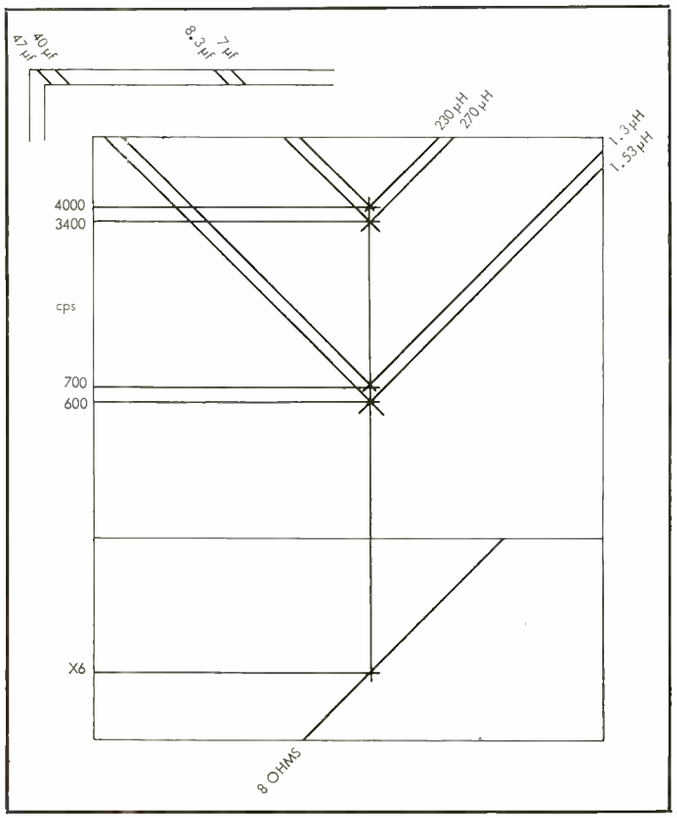


Fig. 9. Illustrating how the chart of Fig. 3 is used to calculate values for a three-way crossover of the type shown in (D) of Fig. 7.

frequency, where for the two-way system frequency was all the same.

The configurations shown are one possible form in each case. In the configurations of *Fig.* 3, where each network provides two-way output, the choice of configuration is fairly simple. In both groups, the configurations identified in (A), (C), (E), and (G) have series input elements for each section and require connecting in parallel at the combined input, while those identified in (B), (D), (F), and (H) have shunt input elements for each section and require connecting in series at the combined input.

For the two-way system, the latter group lead to the logical simplicity of using the tapping point as a common lead. But with three or more ways, there is more than one tapping point. The tapping points can only be common at the input end now, except in the simplest network (B). Providing the configuration of each section of the network is correct, the only requirement for overall constant resistance effect is that the groups in (A), (C), (E), and (G) are connected in parallel and those in (B),

(*Continued on page 79*)

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HERMAN BURSTEIN*

(Note: To facilitate a prompt reply, please enclose a stamped, self-addressed envelope with your question.)

Following are letters received from readers of this column commenting on subjects previously discussed here:

Microphone for Taping Heartbeats

Shure Brothers, which makes microphones as well as other products writes: "This is in reference to your column in the December, 1962, issue of Audio. Under 'Taping Heartbeats' you were asked a question about what microphone to use for recording of heart sounds. Shure Brothers has recently announced a new heart-sound microphone which will solve this problem exactly." The letter and an accompanying bulletin describe the microphone as follows: SP-5 series, ranging in price from $97.50 to $147.50, controlled magnetic type, smooth frequency response from below 10 cps to 1000 cps, and about 0.2 mv output for adult normal heart.

Correct Mixing and Miking

Electro-Voice, which also makes microphones as well as other products, writes: "In your January issue, a reader inquired about correct mixing and microphone placement techniques. While it is quite true that the professional engineer depends greatly upon the 'cut and try' method, his approach is quite direct and efficient—it is the outgrowth of his general experience, his thorough knowledge of the equipment he is using and its performance, and his understanding of the acoustical environment in which he is operating. All this is considerably less a 'great mystery' than might at first appear to the non-professional.

"Certain fundamentals must be observed for good recording: 1. When more than one microphone is used, it is essential (particularly for stereo) that such microphones have closely matching characteristics. 2. As a general rule, microphones should be used sparingly, i.e., never use two until you are certain one will not achieve the effect you want. 3. A microphone should not be closer to the sound source than is necessary for control of 'room sound,' i.e., reverberation, and the presence effect you want. 4. Be sure your monitoring equipment is such that it faithfully reproduces the sound you are recording—it is your basic reference standard.

"Much of the (desired) information is covered in the 'Microphone Facts' bulletins published by Electro-Voice . . . We will gladly send these to your readers upon their request." (Signed. *Paul K. Franklin.*) (Readers wishing to receive these bulletins should send request to Editor, Audio.

* *280 Twin Lane E., Wantagh, N. Y.*

Selective Flutter

A Canadian reader writes: "I was much interested in a letter that appeared in the February, 1963, issue under the heading 'Selective Flutter.' My tape recorder recently developed a mild case of the difficulty described by your reader. The tape transport mechanism is almost identical to the system used in his machine. I have not yet completely solved my problem but think I am on the right track. A common cause of trouble in mechanical items is loss of spring tension. The shaft of the left-hand tension arm is attached to a small drum, to which is attached a long, very compliant spring. I have experimented with an increase in tension (using rubber bands), and the added tension seems to almost eliminate the difficulty. I suspect the spring should be shortened, having probably lost some of its tension. My trouble is also selective, that is, it starts to happen around the middle of the reel. This suggests that the angle at which the tape meets the tension arm has something to do with the problem. Around the middle of the reel, the tension arm starts to flutter slightly, perhaps due to mechanical resonance, and this flutter is of course transmitted to the recording. I intend to experiment with 3 parameters: 1. Tension of the tension arm; 2. Tape tension (which can be varied by adjusting the slider on a bleeder resistor in the voltage supply to the feed and takeup reels); 3. Mass of the tension-arm."

Random Clicks

In your May, 1963, column there is a letter about random low-level clicks heard on playback of certain tapes in use. I too had this problem with certain tapes with my tape recorder. In an attempt to solve the problem I had written to the tape manufacturer and to the recorder manufacturer with no results. It finally took me a couple of years to solve the problem, but I did and here is how: I determined that the noise was actually coming from the uncoated side of the tape, not the coated side. I made and placed an extra idler wheel between the supply reel and recording head and had the tape thread in such a way that the outside or uncoated surface had to slide along this wheel. This took off the static charge and the tape became quiet. As soon as I stop the recorder and move the tape off this extra wheel, the noise begins almost immediately. I also had tried various methods of grounding the recorder and the heads but to no avail. I also had replaced the head, but the new one was just the same. (Signed *R. P. Burns.*)

VU Meters vs. Eye Tubes

"I disagree with Mr. Allen who says that the VU meter is preferable because it responds logarithmically to the signal. The reason any indicator is used at all is to show the maximum allowable signal. Also I don't go along with Mr. Burks (who prefers the magic eye tube). He seems to imply that he rides gain while recording in order to keep the signal level high. I infer that his excessive tape hiss is caused by troubles in his tape recorder.

"I must admit that I can find no rational preference for the VU meter, except that it is what I have used for years. If I were designing my own tape recorder electronics, I would use magic eye tubes because they are cheaper." *Eric G. Wiener*, Musical Director, Manchester Recordings.

Double Equalization

Q. I have a record-playback tape machine. The playback amplifier is NAB equalized. If I use the tape-head input of my integrated amplifier, will this combination degrade the signal if the playback equalization is not exactly the same in each component? Or is the double equalization redundant? If the double equalization is necessary, how may I be sure that the equalization is the same in each component?

A. The output of your tape machine should **not** be fed into the tape head input of your amplifier. It should be fed into a high-level input, such as one marked "tape amplifier" or "auxiliary" or "tuner." The tape machine provides all the necessary equalization. It you were to feed the signal into the tape head input, there would be two bad results: 1. You would have excessive bass boost, something like 30 db too much at 50 cps. You can imagine how this would sound in terms of the audio signal and in terms of magnified hum. 2. You would probably overload the input tube of your integrated amplifier, resulting in excessive distortion. The input for a tape head is designed to accept a signal on the order of a few millivolts, whereas the input for a tape amplifier will accept a signal of several volts before distortion becomes excessive. Your tape machine probably puts out a signal of 1 volt or more.

The tape head input of your amplifier is intended only for a signal taken directly from the playback head of a tape deck. This signal is a few millivolts. In this case your tape head input should be used to provide the necessary amplification and equalization.

Adding "Echo"

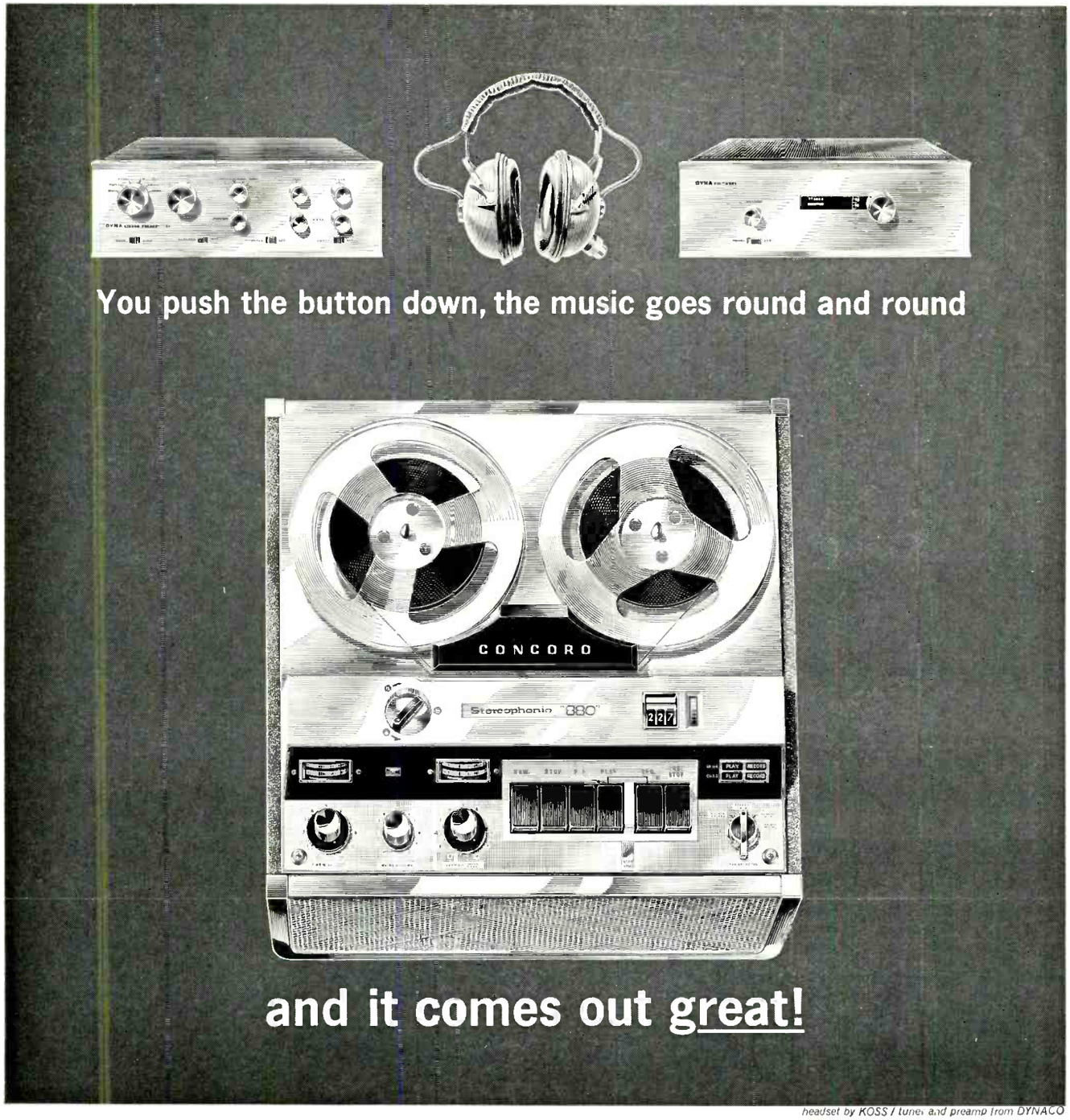
Q. I would like to know how to add an echo effect when making tapes from phono records. What I am after is a controllable method of producing a series of echoes, each at a lower volume than the preceding one. I have tried several ideas, but seem to be limited by the time lapse between the record and playback head, or by a series of uncontrolled echoes. Perhaps a reverberation unit might be the answer.

A. In its simplest form, the echo effect is achieved as follows: As you simultaneously record and play back, the signal from the playback head goes through the playback amplifier and thence into the record amplifier, where it is mixed with the input signal. I gather that you are probably following this procedure. The difficulty, however, as you recognize, is the time lapse between the record and playback heads, which tends to give more of a bouncing echo sound than the reverberation effect you appear to be after.

Best results will be obtained at maximum speed of the tape recorder, for this will shorten the time span between the original signal and the echo. Possibly you are feeding too much playback signal into the record amplifier.

(*Continued on page 79*)

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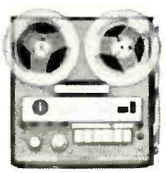
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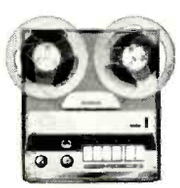
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Vertical Tracking Distortion in Practice

DUANE H. COOPER*

The widespread use of conservative recording levels accounts for the little distortion actually heard, because of vertical tracking error, in many stereo discs.

THE DISCOVERY THAT large amounts of distortion, in stereo disc reproduction, may be traced to vertical tracking error,[1,2,3] poses a strange problem. The search for the cause of this distortion was undoubtedly stimulated by a concern for extending the quality of playback and by a strong suspicion that distortion could be heard on more occasions than seemed warranted. Now, however, the problem seems to be that the theory[4] predicts much more distortion than had been expected, a curious state of affairs. The problem becomes one of accounting for so little distortion.

There have always been mechanisms for generating distortion in abundance. The record groove could be overmodulated in amplitude, producing groove crossover, or, in the vertical direction, a sharp limiting effect due to exceeding, on the upward swings, the average depth of cut. Such overmodulation produces lacquers that are usually considered to be total failures, and they never receive further processing. Again, the groove may be overmodulated in velocity so that the back facets of the cutting stylus could emboss steeply-inclined groove walls. This happens when the cutting velocity is allowed to equal the groove speed. Cutting technicians adjust their levels so that this rarely happens, although some lacquers are passed in which this defect is at least fleetingly present. Finally, the groove may be overmodulated in acceleration, so that the undulations are too sharply curved for faithful tracing by a stylus of given curvature. This flaw may happen rather often, but at the higher modulating frequencies such that the harmonics so generated may fall beyond, or nearly so, the range of hearing. These flaws are all well known, and monitoring means exist for keeping the frequency of their occurrence in hand.[5]

Other sources of distortion may probably be dismissed, considering the high quality of the cartridges that exist today. There remains distortion due to vertical tracking error, and it seems harder to dismiss. There is little satisfaction to be gained from arguing that the L + R signal is what is mostly heard, and that, since this is the lateral signal, it is unaffected by vertical tracking error. The theory will not have it so; if the vertical signal is distorted by tracking error, then, because of crossmodulation, the lateral signal is contaminated by almost the same degree of distortion.[4] This is subject to experimental check; in those instances in which the distortion is heard, switching to the mono L + R mode provides no noticeable relief. This fact accounts for some of the trouble FM multiplex experiences in providing a clean L + R signal for mono patrons.[6]

There may be more satisfaction in arguing that stereo provides a distraction from the annoyance of tracking distortion. Unfortunately, the critical listener tends to become increasingly immune to this distraction, the more he becomes accustomed to the values of stereo reproduction. I dare say that there is hardly one who owns a stereo disc on which he has never heard distortion, though we all own some of which we have a very good opinion. We wonder, "why aren't they all as good as those some," or, rather, "why are those few so good?"

Actually, I think that the "good" ones are many, and I think that the answer to these questions is one of level. In simple fact, the theory tells us that, during the past five years, while we have unwittingly been trying to "live with" a large vertical tracking error, the vertical or L – R channel has been handicapped with a greater susceptibility to overmodulation than the lateral or L + R channel. This handicap may not have been widely known, but even so, cutting technicians do listen to their handiwork, and do try to adjust their equipment to produce an excellent product. The result has been many stereo discs in which the vertical, and even the lateral, modulations have been quite conservatively cut.

The evidence for conservative practice is there in the five-year history of stereo disc production. Anyone wishing to take the trouble can measure the levels used, and estimate the consequent distortion. Left *vs.* right Lissajous patterns on an oscilloscope can provide a basis for estimating peak levels of the L + R, or horizontal signals, simultaneous with the monitoring of L – R, or vertical, levels. A persistent phosphor is recommended.

I have been making a survey of the lateral and vertical levels in the stereo discs in my private collection. I find that I can rather reliably sort them into three categories. The names I have chosen for these categories are "Conservative," "Daring," and "Radical." These names are intended to be descriptive of the cutting levels as measured against the handicap imposed by a vertical tracking error of some 20 to 30 degrees. They are not intended to be descriptive of the frames of mind of the cutting technician, since the vertical tracking error was not then known to be so serious. I also find that sorting by levels, and sorting by impressions of audible distortion, give agreement satisfying to me.

A description of these categories is given below. I do a rather daring thing myself, and quote precise peak levels. I am serious about these levels in the sense that they define boundaries between categories, where, of course, there are no precise boundaries. Because I am nervous about this, and about the absolute calibration of the test record I compare these levels against, there are some gaps between my categories. Also, the categories are more severe for British and European discs, because they suffer from a greater handicap of vertical tracking error.[3]

The categories are as follows:

I. Conservative

A. Distortion can be discovered upon careful listening.

(*Continued on page 71*)

* *University of Illinois, Urbana, Illinois.*

[1] E. R. Madsen, "Vertical tracking angle —a source of LM distortion," AUDIO, vol. 46, November, 1962, p. 21.

[2] C. R. Bastiaans, "Further thoughts on geometric conditions in the cutting and playing of stereo discs," *J. Audio Eng. Soc.* vol. 11, January, 1963, p. 6.

[3] B. B. Bauer, "Vertical tracking improvements in stereo recording," AUDIO, vol. 47, February, 1963, p. 19.

[4] D. H. Cooper, "Tracking distortions as phase modulation," *IEEE Trans. on Audio* (in press).

[5] J. G. Woodward and E. C. Fox, "A study of program-level overloading in phonograph recording," *J. Audio Eng. Soc.*, vol. 11, January, 1963, p. 16.

[6] Editorial: "Record distortion," AUDIO, vol. 46, November, 1962, p. 18.

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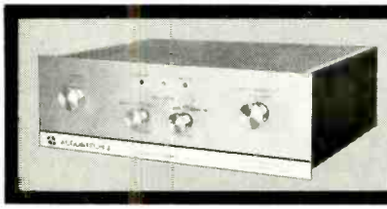


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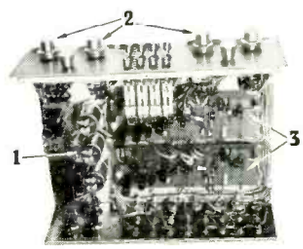
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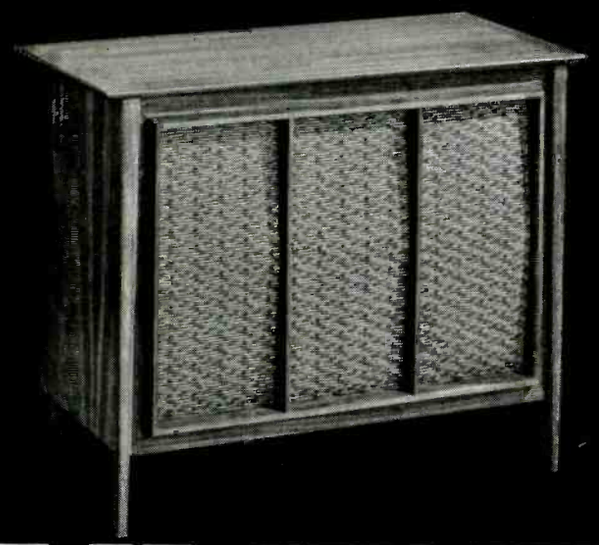
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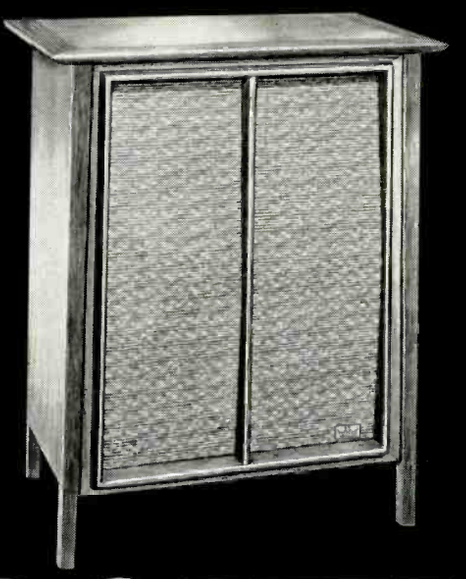
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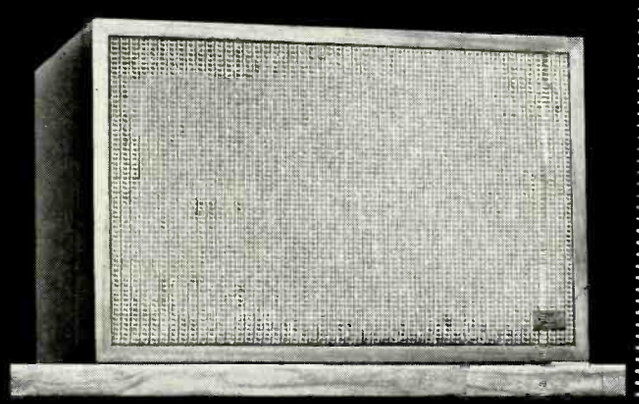


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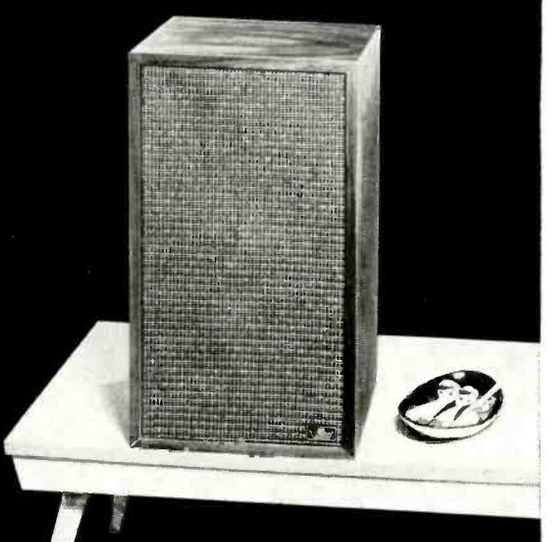


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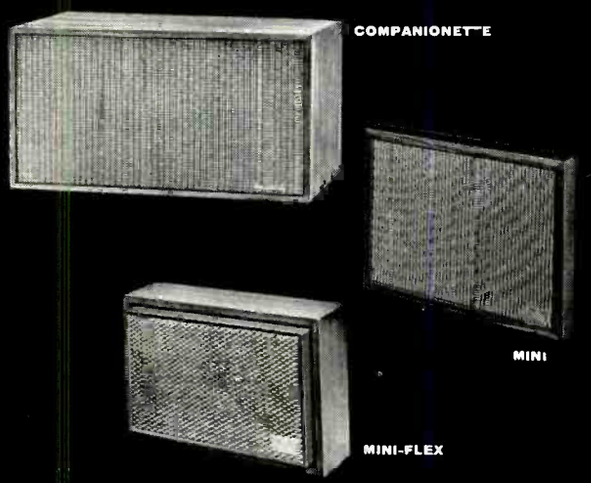


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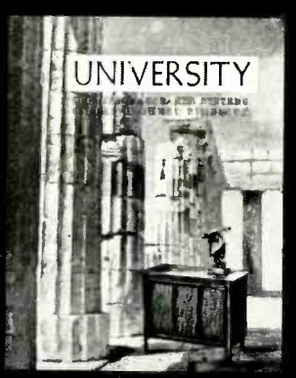


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FM Tuner Characteristics—and Their Relative Importance

DANIEL R. von RECKLINGHAUSEN*

Last month this author described the three characteristics he considers most important for a modern FM tuner. This month he continues his description of tuner characteristics and ends up with table which gives his order of importance.

In Two Parts—Part II

WE HAVE SHOWN that it is difficult for an FM tuner to reject strong interference from an adjacent FM channel when distortion in the desired channel is to be kept low. But all is not lost, basic FM theory indicates that the stronger signal will predominate at the output of the tuner to a larger degree than at the input; the weaker signal is captured by the stronger one. Even if the adjacent-channel signal is stronger, it may not cause interference. Tuning away from the interfering signal (at the expense of increased distortion) and having it on the slope of the selectivity characteristic will make the weaker signal receivable, although not perfectly.

Since there are only 110 FM channels available with about 1100 FM stations on the air, any one channel will have an average of 11 stations operating on the same frequency. Most of them are separated geographically so that only one station is receivable in an area. However, in highly populated regions it is common to find at least one frequency at which two or even more stations provide adequate signals for most listening purposes. Here, the problem of co-channel interference exists. This is particularly true of the "A" channels which have lower-powered transmitters at fairly close geographical spacings.

Co-channel interference is likely to increase in the future with more FM stations going on the air and the increase in transmitter power permitted by the FCC. Interference will be increased even more due to the FCC's recent ruling permitting wireless microphones to operate in the FM band. The tuner should be able to reduce this interference as much as possible and "capture" is the phenomenon with which this is done.

Anyone who has listened to short wave signals with a communications receiver is familiar with the beat tone which occurs when the local beat-frequency oscillator (BFO) is turned on while listening to a station. As the BFO frequency control is adjusted, the strength of the tone remains exactly the same, varied audibly only by the frequency response of the audio and speaker system of the receiver. With two unmodulated signals at the input of the limiter-detector combination of an FM tuner, exactly the same beat tone occurs. The main difference is that strength of the tone now is strictly proportional to the frequency of the tone. Here, the phase differences between the two signals change 360 deg. per second for every cps difference between the two signals. This is effectively phase modulation of the stronger and originally unmodulated signal. Since phase modulation is the same as frequency modulation increasing in deviation with "modulating" frequency, the voltage amplitude of the beat tone will increase with frequency difference of the two signals.

The de-emphasis network of the tuner will attenuate the beat tone proportional to frequency above the turnover frequency of 2120 cps as determined by the standard 75-microsecond time constant. Then, after de-emphasis, the output voltage of the beat tone will remain constant with frequency at high frequencies and will decrease below 2120 cps. Since 75 kc is the maximum deviation, any beat tone will be attenuated at least $75/2.12 = 35.4$, or 31.0 db. This is the basic signal-to-interference improvement of the monophonic broadcasting system.

If it is also assumed that the interference has an equal chance of being

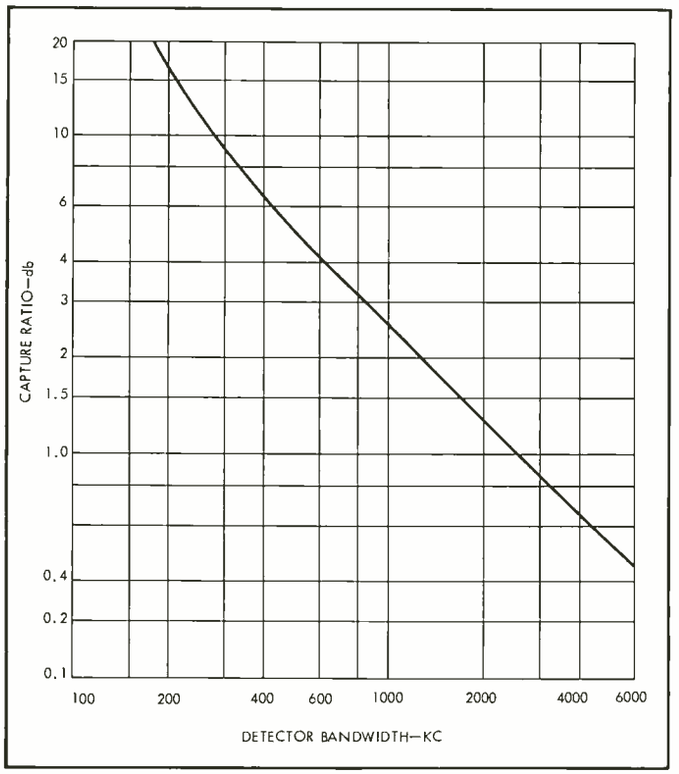
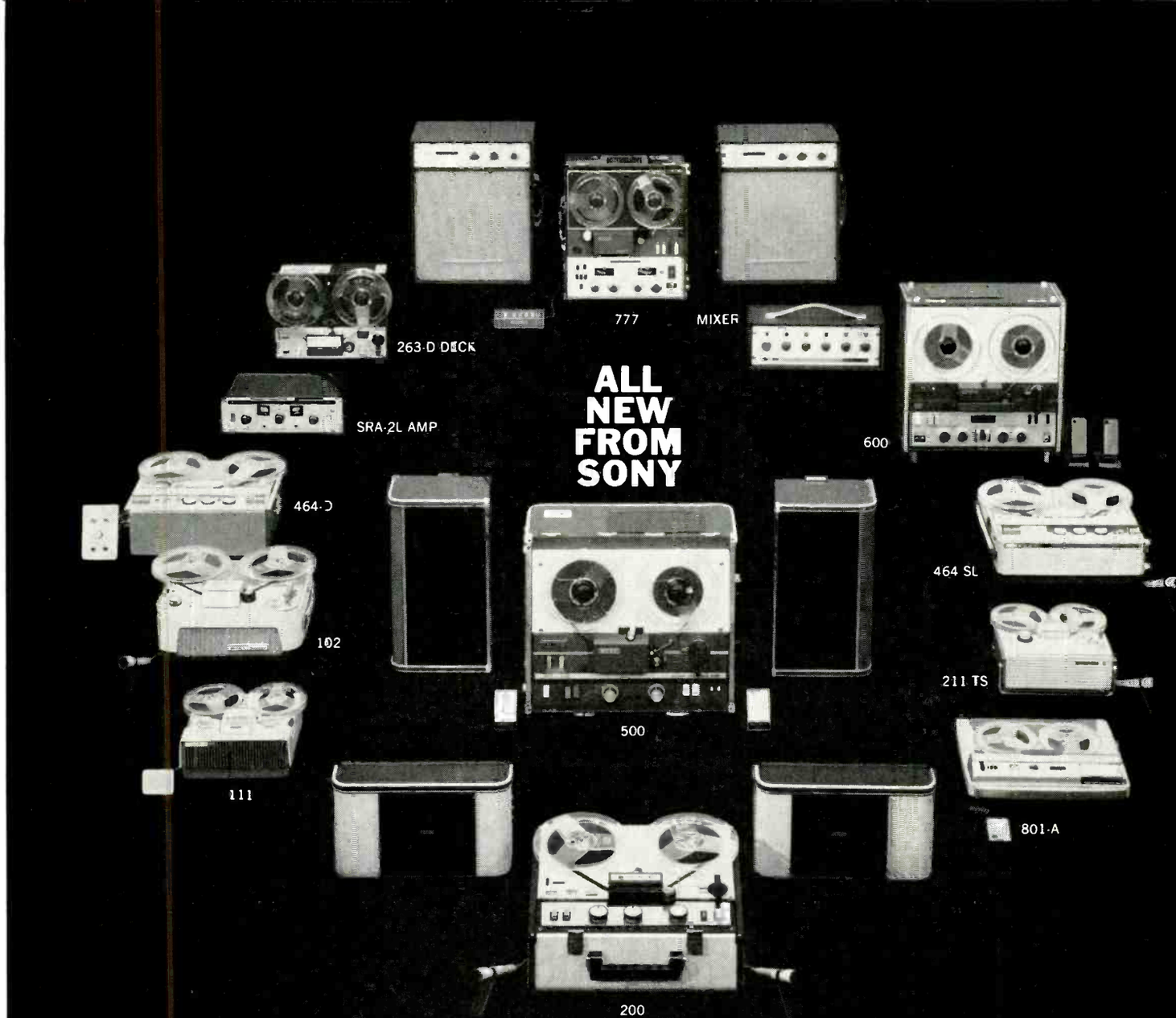


Fig. 8. Minimum capture ratio (± 75 kc co-channel signal) versus detector and limiter bandwidth.

* *Chief Engineer, H. H. Scott, Inc., Maynard, Mass.*

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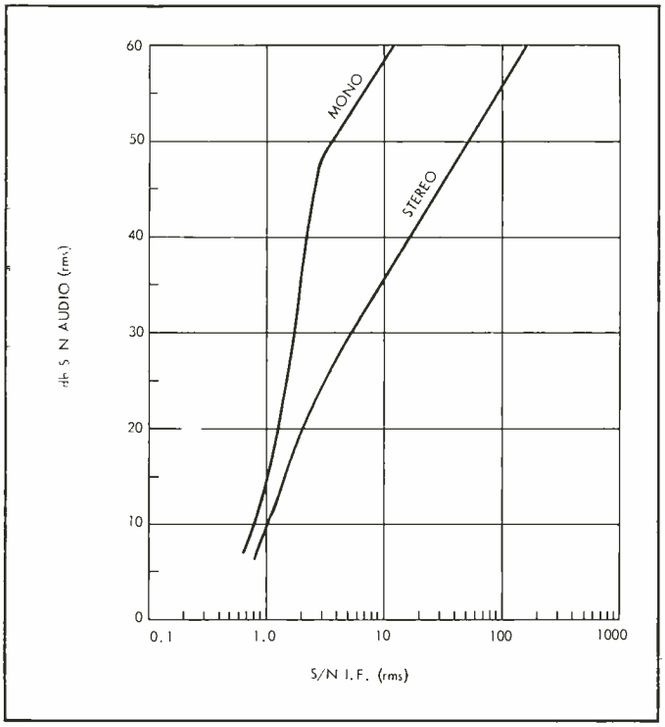


Fig. 9 Theoretical signal-to-noise ratio of audio output versus i.f. signal-to-noise ratio (gaussian i.f., 150-kc bandwidth, 75-kc deviation, 75 μs de-emphasis).

anywhere in the 150-kc minimum bandwidth *and* the tuner's audio response is cut off after 15 kc, a further improvement of 7.7 db results. The total improvement is then 31.0 + 7.7 = 38.7 db.

In stereo operation, the tuner is also sensitive to frequencies up to 15 kc either side of 38 kc away from the carrier. This degrades the 38.7-db figure by 23.3 db to 15.4 db and interference or noise will be considerably worse in stereo than in mono operation.

The FM improvement figure of 38.7 db (in mono, 15.4 db in stereo) holds for all FM tuners as long as the ratio of signal-to-interference is relatively large (for example 10 to 1). With a perfect limiter and detector system, this analysis of capture holds true even if the interference is slightly smaller than the signal. Of course, if the interfering signal becomes any stronger it will "capture" the desired signal.

Perfect things do not exist in this world and the limiter-detector system is no exception. In limiting two signals of similar magnitude, very rapid phase changes occur when the two signals are in opposite phase. This causes a frequency "spike" of very high instantaneous deviation. If the limiter or detector, because of limited bandwidth, cannot accommodate such a "spike," the interfering signal cannot be captured as well as theory predicts. *Figure* 8 shows the ratio of desired-to-interfering signal (the capture ratio of the detector system alone) below which the FM improvement becomes degraded.

The response of the i.f. system, if not perfectly flat in the passband, will alter the ratio of signal-to-interference. Here, the interference has a good chance to be on the peak of the response with the desired signal being attenuated by the i.f.-filter response elsewhere in the passband.

It has been shown in the analysis of distortion that a flat passband or "near perfect" filter is not the best for FM reception. A low-distortion filter (see *Fig.* 7) does not have a flat response in the passband. If such a filter should be 2 db down at $\pm$75 kc, the capture ratio at any one frequency due to that filter alone will vary between 0 and 2 db. With sine-wave modulation of the interfering signal, the capture ratio of this filter alone will then be approximately 1.0 to 1.5 db.

5. Detector Bandwidth

In actual listening to stations, mono or stereo, the interfering and desired signal will be program material other than a sine wave and the average modulation will be considerably less than 100 per cent. This places most signals near the top of the i.f. response. The usual method of capture measurement involves sine-wave modulation; the lowest measured capture ratio of a tuner is not an indication of the tuner's over-all quality because it will involve the sum of the capture ratio contributions of both the i.f. and the limiter-detector system. It is the capture ratio of the detector which is of importance and therefore the detector bandwidth is the next most important specification. The total optimum capture ratio with a 2-mc detector then would be between 2.2 and 3.0 db.

Some limiter-detector systems involve multiple limiters with relatively narrow (compared to wideband detectors) tuned circuits between the limiter stages. They do achieve a good capture ratio for monophonic work but the relatively narrow bandwidth of the tuned limiter circuits with their non-linear phase slopes has a tendency to cause high-frequency distortion. This happens the same way as with non-linear i.f.-filter phase shift. No additional limiting or limiters will remove this distortion. Therefore, detector bandwidth is more important than capture ratio even though capture ratio was presented first.

6. AM Rejection

Bandwidth is not the only important specification of the limiter-detector combination. After all, the limiter must be an amplitude limiter and has to remove any residual amplitude modulation from the signal. A perfect limiter, which exists only in theory, has a constant output when its input varies from zero to infinity, or has any value in between from fractions of microvolts to thousands of volts.

As a practical matter, the input signal to a limiter will most often range from tenths of volts to several volts. Also, it is not as important to keep the output voltage of the limiter constant for very slow

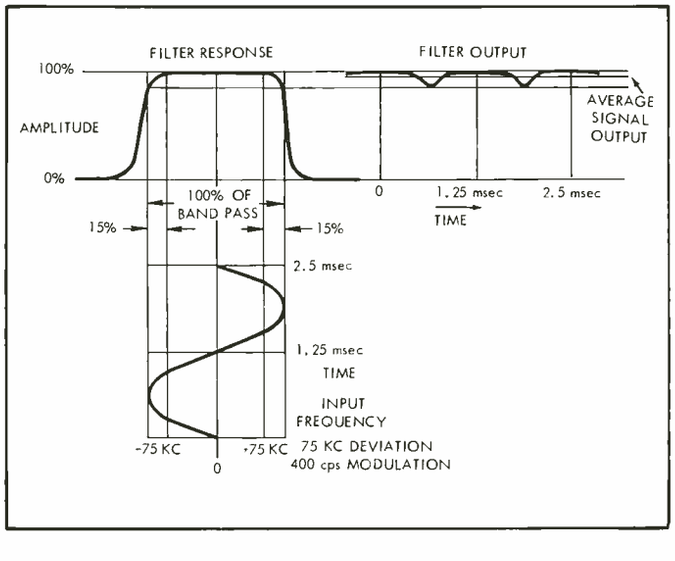


Fig. 10. FM signal through flat-top filter.

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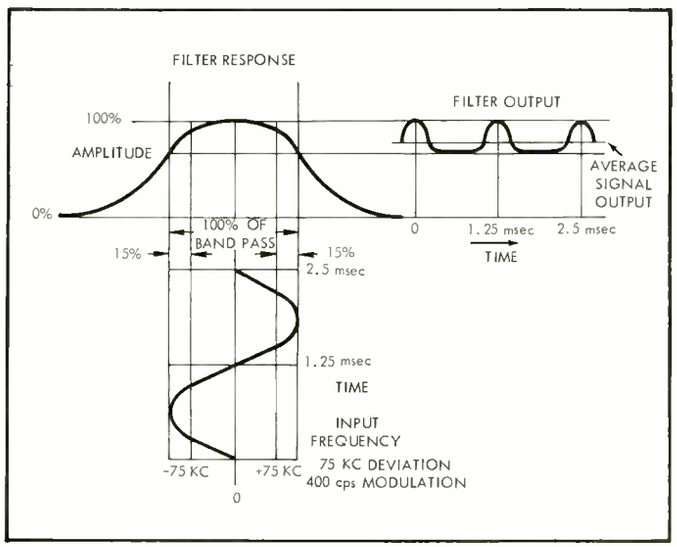


Fig. 11. FM signal through low-distortion filter

changes in signal strength as it is to remove audible amplitude variations. This means amplitude variations in the range of at least 50 to 53,000 cps in stereo operation (50 to 15,000 in mono) have to be minimized.

These amplitude variations are caused by several factors. For instance the signal will vary in amplitude due to the i.f. response as the transmitter deviates in frequency; or amplitude can vary due to multipath reception; or simultaneous reception of a desired and an interfering signal (be it a station, or random or ignition noise) will also cause rapid amplitude variations which have to be removed by the limiter.

The amount of AM rejection of a limiter-detector circuits can be measured and is often quoted in complete tuner specifications. This, then, is the next most important tuner specification.

7. Pulse Noise Rejection

A tuner which has adequate suppression of amplitude modulation (40 db or more) in general also has good pulse-noise suppression. At the present time, it is very difficult to measure large amounts of AM rejection because all amplitude modulators produce a residual amount of phase or frequency modulation. It is therefore useful to make a further measurement of pulse-noise suppression.

For this purpose, a pulse-noise generator is required. Unfortunately, the available pulse generators produce relatively low energy over the bandwidth of an FM tuner tuned to a signal in the FM broadcast band. Therefore, the pulse generator can be used only for measurements involving low pulse interference. Practically, pulse interference in FM systems is created primarily by electrical equipment such as power-line switches, motor commutators, and ignition systems of automobiles. These sources create a far larger amount of interference than could be generated conveniently by a calibrated laboratory pulse generator. Because of this, the measurements of pulse interference of the various stereo receiving methods during the NSRC field tests were made with an electric razor. This qualitative, practical, but nevertheless useful test was made by the FCC observer in charge of these field tests.

To give an idea of the level of interference to be experienced, field strength values of approximately 1000 microvolts per meter can be created at a distance of 500 feet from a passenger automobile. This is the same level as the field strength of an FM transmitter at the edge of its prime service area.

As any FM listener knows, ignition noise can be heard when tuned to a "medium distance" station. This happens because the noise pulse is stronger than the signal and therefore captures the signal for the length of the pulse. With a strong local signal, ignition noise should be inaudible because here the signal is stronger. Completely off station, ignition noise should again be inaudible. Here, the (vector) sum of random noise of the r.f. amplifier and pulse noise has as its total only the same random phase variation as random noise itself. This will produce the same tuner noise output with or without pulse noise. If increased noise is heard, it is an indication of improper limiting in the tuner.

Therefore, an important characteristic of limiting and a good measure of AM rejection is the reaction of the tuner to pulse noise when tuned off station.

8. Shape of Signal-to-Noise Ratio Curve

Another type of noise the FM tuner has to contend with is random noise. This noise is created partly by the radiation impedance of the antenna and partly by the front end circuit of the tuner itself. The tuner reduces the effect of this noise in the same manner as it reduces interference—by capture. As long as the desired signal is considerably stronger than the noise, then the original signal-to-noise ratio at the limiter input will be higher at the audio output of the tuner. The same improvement of 38.7 db (as for other types of interference) will be found for monophonic operation and 15.4 db for stereo.

Even if the capture ratio of the tuner is quite low, this improvement does not hold when the signal becomes only a little stronger than the noise. Since the noise is random, it varies randomly in amplitude about its normal value and can be both stronger and weaker than its rms value. If the rms value of the desired signal is more than 10 db higher than the rms value of the noise, practically all the noise will have been captured by the signal. Only very occasionally will a noise peak be larger than 10 db above the signal, causing an audio pulse. The common practice is to measure the signal-to-noise ratio at the output of the tuner as the ratio of outputs occurring with 400-cps 100-per-cent modulation and no modulation.

At this 10-db point, a knee occurs in the audio signal-to-noise ratio characteristic. It occurs in both mono and stereo operation respectively at $10 + 38.7 = 48.7$ db and $10 + 15.4 = 25.4$ db. At higher levels of signal input, each 6 db of signal increase should cause a 6-db increase in audio signal-to-noise ratio. Below the knee, there is more or less frequent capture of the desired signal by the noise and audio signal-to-noise ratio will degrade rapidly. *Figure* 9 shows a curve of calculated signal-to-noise ratio for a mono FM tuner with a perfect limiter-detector combination. This curve is replotted from data originally computed for a Gaussian i.f. filter 150 kc wide by F.H.L.M. Stumpers of Philips. One particular point worth noting is that an i.f. signal-to-noise ratio of 1.8 or 5.0 db is required to produce an audio signal-to-noise ratio of 30 db.

Only very well designed tuners follow this curve accurately. Others show considerable differences, indicating deficiences in their performance. For example, less steepness of slope below the knee indicates imperfect limiting for very weak signals. A steeper curve indicates an error in measurement since the amplitude distribution of random noise cannot be altered. The occurrence of the knee at a level higher than 48.7 db indicates an error in frequency response of the tuner. A slope of less than 6-db signal-to-noise ratio increase for every 6-db increase in signal indicates a degradation in front-end sensitivity. This holds as long as the ultimate signal-to-noise ratio of the tuner is not reached, which shows residual tuner and generator noise and hum.

Therefore, the shape of the signal-to-noise ratio curve as determined by actual measurement is an important specification of the tuner.

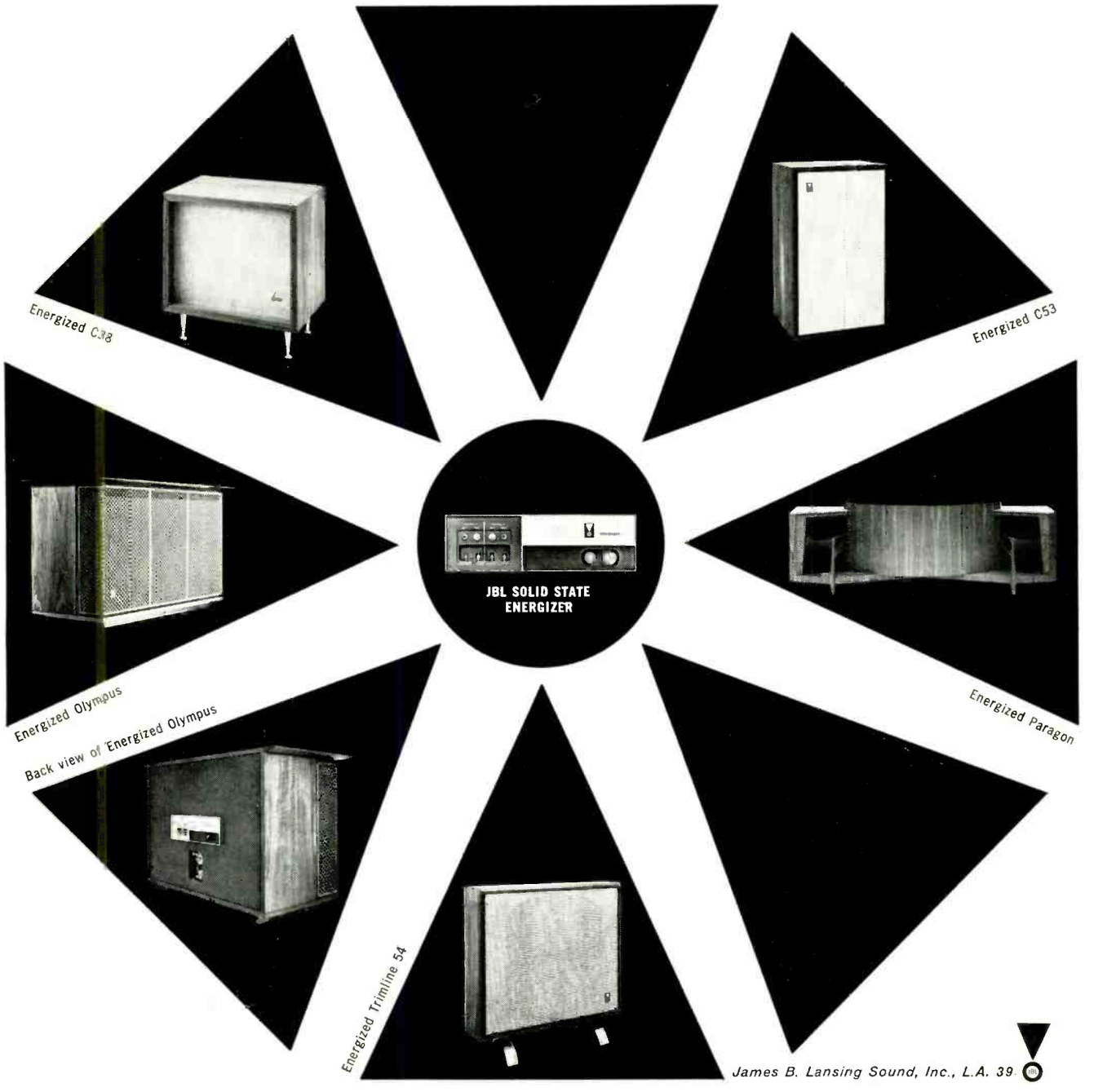
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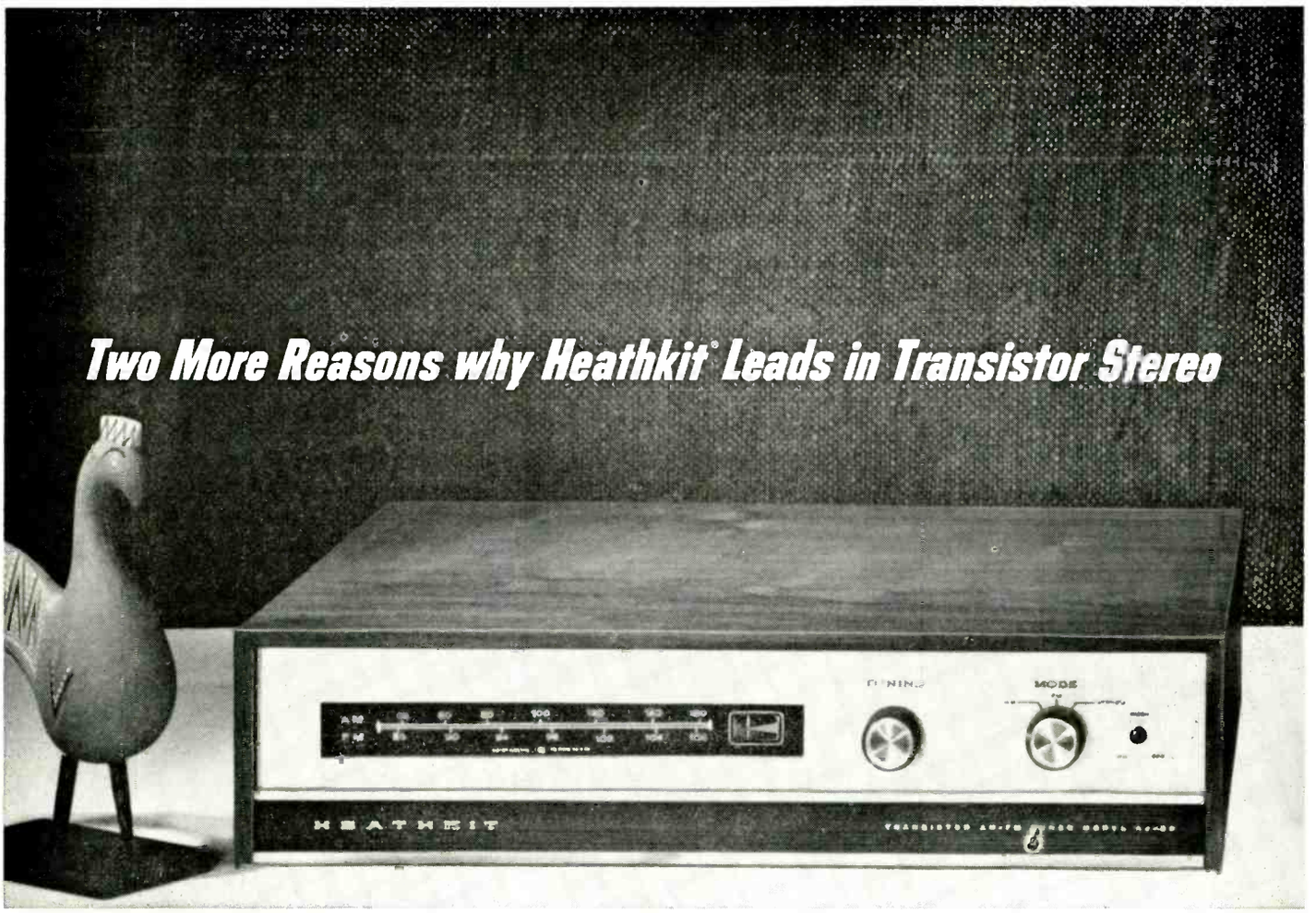
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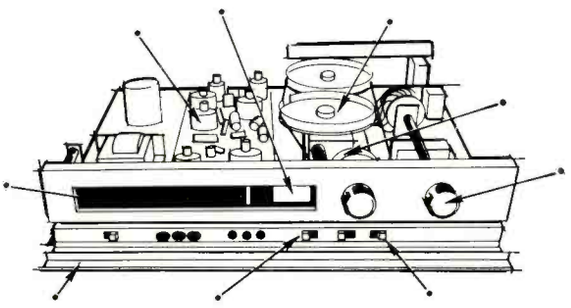
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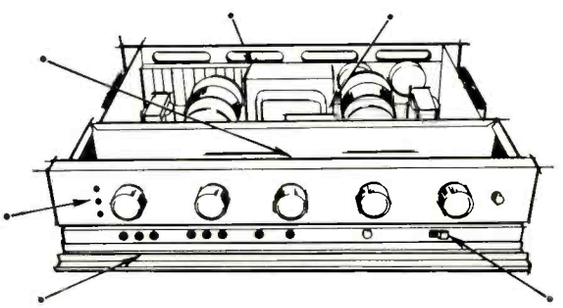


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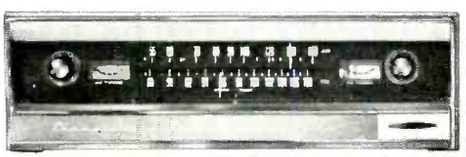
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The same measurements, but with the tuner operating in the stereo mode, more clearly show the effects of improper limiting or degradation of front end sensitivity. If the two actual signal-to-noise curves are less than 23.3 db apart at their maximum distance from each other, the tuner is not likely to have good separation and/or frequency response when operating in stereo. The location of the "knee" in the stereo signal-to-noise ratio is not easy to pinpoint because of the relative similarity in slope above and below the knee.

In measuring the signal-to-noise ratio, if the 400-cps audio modulation is not turned off at the generator but eliminated instead by the sharp rejection filter of a distortion analyzer, we now have a measurement of the distortion of the detector and audio circuits. To a small degree, residual noise and hum at high signal levels are also measured. At low signal levels "modulation" noise begins to appear. This is the method of measurement prescribed by the IHF tuner standard.

The modulation noise occurs when the desired signal is more or less attenuated by the frequency response of the i.f. filter as the signal varies its frequency during modulation. The random noise coming from the front end of the tuner is not altered since it is not changed by the generator. With any input, for more than 50 per cent of the time, the generator frequency will be in the outer 15 per cent of the tuner bandpass as shown in *Fig.* 10. The signal will be attenuated and a higher signal input will be required for an audio signal-to-distortion-plus-noise ratio as for the same signal-to-noise ratio.

9. Difference in Signal Between 30-db S/N and 30-db IHF

Since IHF sensitivity is measured on the steep slope at 30 db of the signal-to-noise ratio curve (in monophonic operation of the tuner) alignment for best sensitivity on this basis for the lowest number of microvolts results in a filter curve with a flat top and with nonlinear phase. Here, the filter bandwidth is just barely wider than 150 kc and the average amplitude of the output signal is just barely under the midband output of the filter. In this case, the r.f. signal required for a signal-to-distortion-plus-noise ratio is only a little larger than for the same signal-to-noise ratio. When both curves are plotted together, they may be separated by 2.4 ± 0.8 decibels, depending upon accuracy of alignment.

As shown in the section on FM distortion, the filter obtained by alignment for lowest IHF microvolt figure has high high-frequency distortion, particularly in stereo operation. Such a filter is generally not phase equalized, causing a further increase in high-frequency distortion. The filter curve shown in (B) of *Fig.* 5 is typical of this. Furthermore, any inaccuracies in alignment resulting in a slightly lopsided filter, overcoupling peaks, or a still narrower filter, cause a still further increase in high-frequency distortion. Therefore, a tuner with its i.f. section aligned for maximum IHF sensitivity does not have minimum distortion.

When the i.f. system of the tuner is designed and aligned for minimum distortion in stereo operation, the filter response of *Fig.* 7 will affect the signal output as shown in *Fig.* 11. Here the output voltage due to signal will vary with modulation more than with a flat top filter. This requires an average signal input 3.5 ± 0.5 db higher for the same signal-to-distortion-plus-noise ratio as for the same signal-to-noise ratio.

As a check on low-distortion operation of the tuner, it is important to know whether the tuner in mono operation has low distortion as found in the IHF test and is this curve separated by 2.5 to 3.5 db from the signal-to-noise ratio curve at r.f. signal levels below 40-db signal-to-noise ratio.

Where does all this noise come from? Part of it may be picked up by the antenna itself. For example, the average peak noise at the antenna terminals may be between 30 microvolts in suburban locations and several hundred microvolts in the city. Even cosmic noise will produce 3 to 4 microvolts. These noises can be reduced by using a more directive antenna than a dipole.

The other main contributor is thermal noise. This exists in any resistance, with the 300-ohm radiation resistance of a folded dipole being no exception. The open-circuit voltage of such a 300-ohm antenna, or the equivalent dummy antenna of a signal generator, is 0.86 microvolt over a 150-kc bandwidth. This noise voltage would increase twice if the bandwidth were quadrupled. A perfect amplifier or tuner which produces no noise itself connected to this 300-ohm resistance would have this voltage as the minimum possible voltage on its input. Also, this tuner would not be permitted to consume any power from the noise or signal power coming from the antenna. This would result in very high signal reflections and standing waves on the antenna lead because such a tuner would not have any resistive component to its input impedance. Such a tuner would have a 0-db noise figure—the best ever attainable.

If a tuner were completely noise-free, but had a resistive 300-ohm input impedance, it would then attenuate the external signal and noise by 6 db. Its in-

(*Continued on page 81*)

Table 2. The best achievable sensitivity of a monophonic tuner.

0.43 microvolt "0-db" input noise =	−7.4 db *re* 1 microvolt
180-kc bandwidth instead of 150 kc	+0.8 db
Tuner noise figure, best	+3.5 db
Input signal-to-noise ratio for 30-db audio signal-to-noise ratio	+5.0 db
Additional input required for 30-db audio signal-to-noise-plus-distortion, best	+1.6 db
Best possible performance at *one* frequency only (98 mc), 150 microvolt =	+3.5 db *re* 1 microvolt
Front-end noise-figure degradation, best	+1.0 db
i.f. "tilt" due to front-end tracking, best	+1.1 db
Best possible performance over FM band (88–108mc), 1.90 microvolt =	+5.6 db *re* 1 microvolt

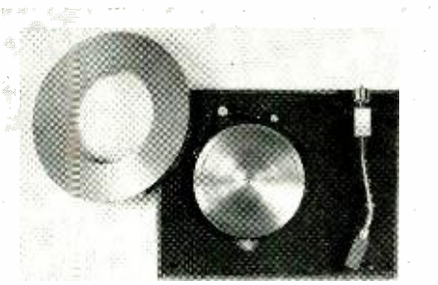
Table 3. The best achievable (monophonic) sensitivity of a tuner aligned for best stereophonic performance.

0.43 microvolt "0-db" input noise =	−7.4 db *re* 1 microvolt
228-kc bandwidth instead of 150 kc	+1.8 db
Tuner noise figure, best	+3.5 db
Input signal-to-noise ratio for 30-db audio signal-to-noise ratio	+5.0 db
Additional input required for 30-db audio signal-to-noise-plus-distortion ratio, best	+3.0 db
Best possible performance at *one* frequency only (98 mc), 1.97 microvolt =	+5.9 db *re* 1 microvolt
Front-end noise-figure degradation, best	+1.0 db
i.f. "tilt" due to front-end tracking, best	+0.9 db
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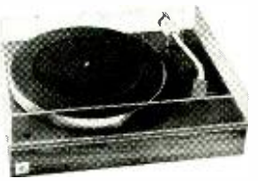
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complete with arm, oiled walnut base, and dust cover, but less cartridge

quoted from HiFi/Stereo review (*Julian Hirsch*)

"The wow and flutter were the lowest I have ever measured on a turntable . . . The speed was exact . . . the only rumble that can be heard with the AR turntable, even with the tone controls set for heavy bass boost, is the rumble from the record itself.

"I found that records played on the AR turntable had an unusually clean, clear quality. The complete freedom from acoustic feedback (which can muddy the sound long before audible oscillations occur) was responsible for this."

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EQUIPMENT PROFILE

FISHER SA-1000 STEREO 150-WATT POWER AMPLIFIER AND K-1000 STRATAKIT

Rarely do we get the opportunity to review both a factory-built unit and the kit version at the same time. We feel that it is a good idea to do so—good from the standpoint of the reader who is trying to make up his mind which version to buy. Is it worth the $50 saving to do it yourself? We'll try to give you some clues.

First of all, however, we must point out that the SA-1000 is intended for the very best stereo systems. It is not inexpensive (about $330), nor is it light (71 lb. distributed unequally over a volume 15⅛-in. wide, 7¾-in. high, and 12-in. deep). It is rated at 150 watts IHF or 130 watts rms with both channels driven. Clearly, Fisher has designated the SA-1000 as the top of its amplifier line, which places it in a very select class.

Among the facilities provided by the SA-1000 are means for bias adjustment and attenuation of the input. The meter shown in *Fig.* 1, and a switch hidden behind the swing-down front panel, permit making bias equal at all four output tubes. The input attenuator controls the input signals in each channel up to 12 db in 3-db steps. A switchable sub-sonic filter is provided to eliminate frequencies below about 16 cps if desired. (This will eliminate those arm resonances and other low-frequency noises we would not wish to amplify.)

Circuit Description

The step-type input attenuator circuit consists of a series of precision resistors, frequency compensated so that response is flat at all steps, which feeds a cathode follower. (The approach is the same as used in instruments such as oscilloscopes.) The cathode-follower input tube is a ECC808/6KX8, a new low-noise tube. Next, the signal is fed to a 12AX7 amplifier and direct-coupled cathodyne phase inverter. The out-of-phase signals are then sent to separate sections of the push-pull driver, a twin triode-strapped pentode, the ELL80/6UH8. The output stage utilizes a pair of beam-power pentodes, the 8417, a new tube with an unusual plate structure which tends to reduce secondary emission.

Feedback (17 db) is provided from the secondary of the output transformer to the cathode of the 12AX7 amplifier section. 12 db of feedback is provided by plate-to-cathode coupling in the output stage.

The power supplies for plate, screen, and bias voltages are completely independent of each other and utilize silicon diodes. This rather luxurious power supply ensures top operation in either stereo or mono modes. The quality of the components is quite high and indicates long life at maximum performance level. In this connection, it should be noted that the driver stage is operated at 50 per cent of ratings. (Operating the 6UH8 40 per cent below maximum, in conjunction with its low output impedance, helps to improve transient response.)

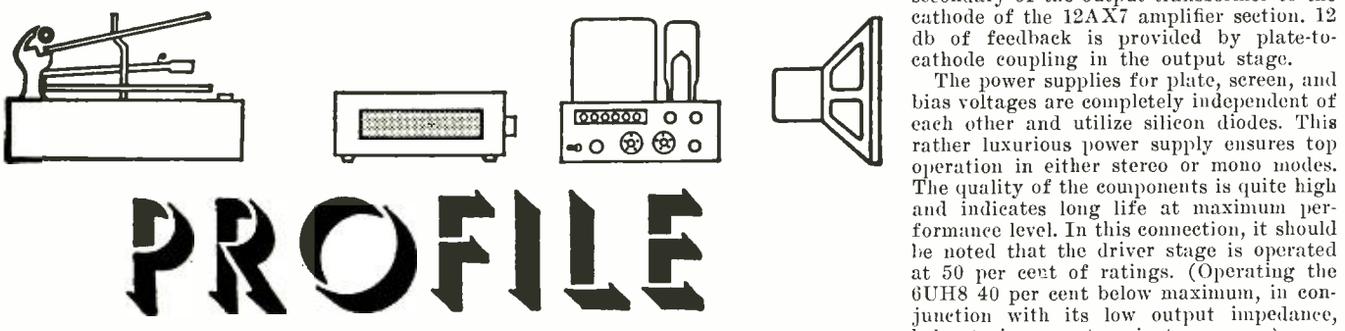
Performance of the SA-1000

Figure 2 shows the frequency response of the SA-1000 within the limits of our test equipment. We do not show both channels because the results were so close that drawing inaccuracies are usually larger. This is also true for *Fig.* 3, which indicates the harmonic distortion at rated power. IM distortion (measured with a 16-ohm load, 60 and 7000 cps mixed 4:1), measured a maximum of 0.4 per cent at rated power to a low of 0.2 per cent at 10 watts rms. Actually the IM never exceeded 1 per cent up to 85 watts rms. Harmonic distortion at 1000 cps as a function of power, remained constant at 0.1 per cent up to 70 watts rms, was 0.2 per cent at 85 watts, and rose to 1 per cent at just under 90 watts. Crosstalk, at rated power and at three different frequencies, never was worse than −79 db. Sensitivity, for rated power at 1000 cps, was as follows:

Atten. (db)	Chan. A (v)	Chan. B (v)
0	0.481	0.492
− 3	0.662	0.681
− 6	0.950	0.975
− 9	1.28	1.31
−12	1.80	1.83

Hum and noise was 90 db below rated power in Channel A and 87 db below in Channel B. Square-wave response was excellent at three fundamental frequencies.

Without question, the SA-1000 is one of the finest amplifiers we have ever tested. In addition, it reproduces music as well as it tests. In our opinion, this is due to the unusually excellent transient response (in conjunction with its unusually excellent everything else).



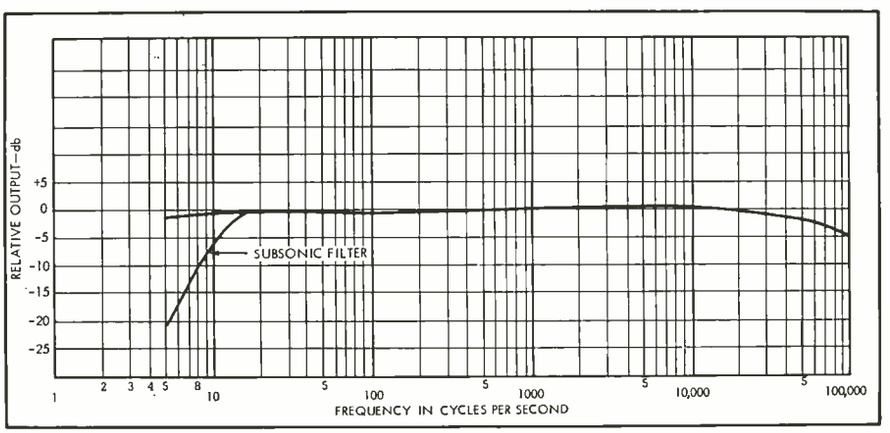


Fig. 2. Frequency response of the SA-1000.

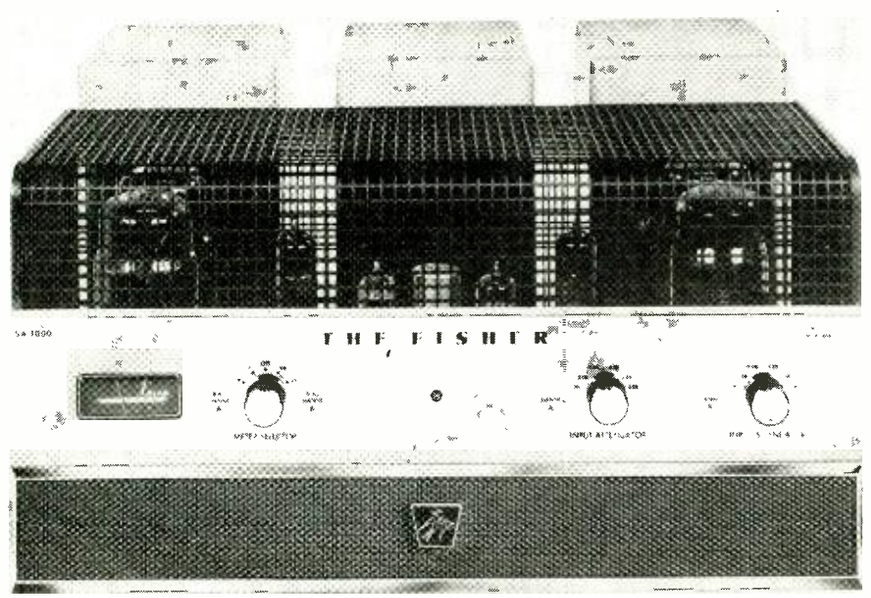


Fig. 1. Fisher SA-1000 stereophonic 150-watt amplifier.

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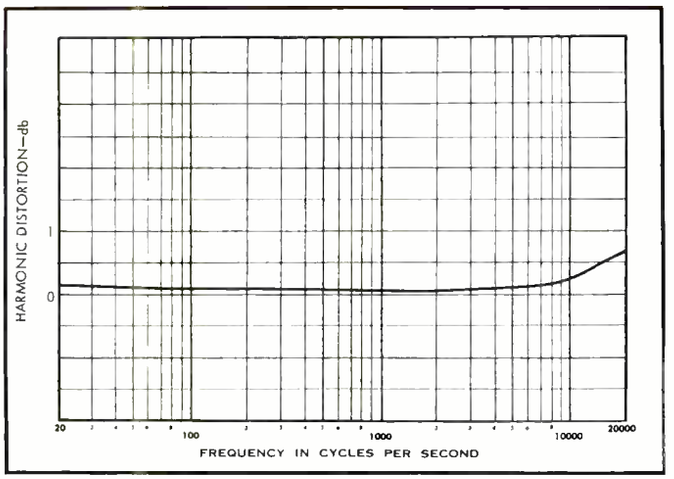


Fig. 3. Harmonic distortion of the SA-1000 at 65-watt rms output.

THE FISHER K-1000 STRATAKIT

Previously we noted that $50 could be saved by building the kit version of the SA-1000. But that is only part of the profit to be made; there is wealth of information to be culled from this kit, and it is not hard to find. But more of that a little later.

First let us describe what the kit consists of. When we first received it, the K-1000 consisted of two boxes—a large heavy one and a small heavy one. Strangely enough, to the uninitiated, the small box (perhaps one-fifth the size of the other) weighs as much if not more than the large one. Of course it contained those massive output transformers. Opening the large box we found the setup shown in *Fig.* 4; a compartmented parts tray on the top and a roughly assembled chassis on the bottom. The parts tray contained 27 numbered parts packets, one spare, and various parts such as tubes and capacitors. The chassis had almost all the mechanical assembly completed and riveted in place. All that remained was electrical assembly, and installing the output transformers. It took us about 14 careful hours to convert those StrataPacks into the equivalent of the SA-1000.

The Instruction Manual

Here's where the wealth of information is located. This manual has taken several strides beyond any manual we have seen to date. First of all we should point out that each one of those numbered parts packets corresponds to an assembly stage, and all the parts necessary for that stage are in there. Thus StrataPack 6 corresponds to Stage 6 in the manual, and the parts it contains are *prepared* for that stage —including cut-to-size wires.

At the beginning of each stage there is a description of *what* is to be accomplished, and in some cases there's even some of the *why*. On top of that there is a certain amount of humor peeking through from time-to-time which relieves the strain of careful assembly. We liked that.

We also liked the timely warnings which preceded certain lengthy procedures; if we didn't have that much time we were told not to start because it all had to be done at once. Sprinkled throughout were tips and reminders which would save the tired builder from needless mistakes.

It hardly needs saying, but we found the manual accurate in all important aspects.

The only real improvement we could think of would be to include a block diagram and brief description of how the various stages of an amplifier work together, on the neophyte level.

How It Went Together

The K-1000 is an easy kit to assemble, well suited for even the neophyte. We do recommend, however, that the purchase of a pair of long-nose pliers and several appropriate nut drivers will make it so much easier. The pliers are for wrapping wires

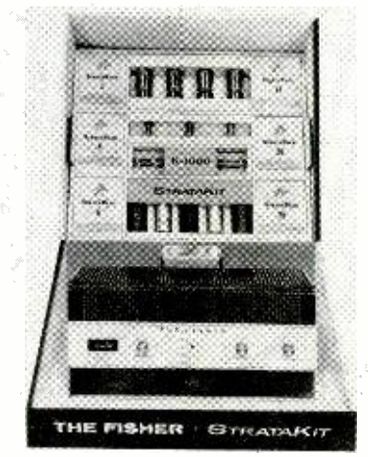


Fig. 4. The Fisher K-1000 Stratakit in its box.

around lugs and the drivers to get nuts started in places where fingers are too big. There is one place, when the output transformers are mounted, where a 3/8 box wrench will be a lifesaver. Borrow one, you use it only once.

The method of balancing the output stages, once the amplifier is assembled, is quite interesting and surprisingly accurate. Basically, the method is to place a resistor between the center tap of the output transformer primary and ground and adjust for minimum signal across the resistor. Obviously a.c. balance requires that the out-of-phase signals cancel the even harmonics at the center tap for minimum distortion. Thus minimum signal across the resistor means maximum cancellation of harmonics. To determine minimum signal across the resistor, without resorting to instruments, the signal is fed into the input of the opposite channel and an indicator lamp is placed across the output of that channel. The indication of more signal is a brighter glowing lamp, and minimum signal is indicated by minimum brightness. The only problem we encountered was to determine with certainty the minimum brightness point. We found it helpful to perform this procedure in a semi-dark room. (Better still, if you have a VTVM available use it instead of the lamp.) Once the lamp brightness technique is mastered, this method produced results almost as good as we were able to obtain with test instruments.

Performance

The question to be answered here is whether we were able to build a unit which performs as well as the factory-built SA-1000. The answer is yes! In fact, for some reason, the kit actually performed better in some areas. For instance, harmonic distortion at rated power never exceeded 0.35 per cent at frequencies up to 25,000 cps. In almost all other performance areas the results were close enough to be within typical manufacturing variations.

In sum, the K-1000 is a superb power amplifier kit which is priced $50 less than the factory-assembled version of the identical amplifier—and you can do as good a job as the factory if you take your time and work carefully. Is it worth spending 14–20 hours to save $50? Only you can answer that one. **K-20**

H. H. SCOTT FM-STEREO BROADCAST MONITOR TUNER, MODEL 4310

The 4310 is unquestionably the finest tuner H. H. Scott has built to date. At first glance one can tell that this unit is meant to be a broadcast monitor, even if the label didn't tell us. Indicators of its category are the price ($475), the various visual monitoring facilities, plus the automatic switching facilities, plus the built-in diversity provision, plus the way it's built. Yes, the 4310 is obviously a broadcast monitor.

On the other hand, the 4310 is also handsomely styled. (See *Fig.* 5) It certainly will improve the appearance of most broadcasting stations. Also, it will improve the appearance of most homes.

The 4310 has two VU meters on the front panel, separated by a signal strength meter. Individual level controls are provided for



Fig. 5. H. H. Scott FM-Stereo Broadcast Monitor Tuner, Model 4310.

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each channel. In addition there is a stepped master level control which goes down 30 db in 3-db steps. Other controls on the front panel include diversity switch, mono-stereo switch, function switch, stereo threshold control, dynaural squelch control, and an a.g.c. partial-full switch. Of course there is the familiar round tuning dial and a tuning meter. Indicator lights are provided to show when the set is receiving stereo or is in standby.

The 4310 will accommodate either a 72-ohm or 300-ohm antenna, balanced or unbalanced. Output impedance is 10,000 ohms. A 600-ohm connection is also provided. There are two convenience outlets.

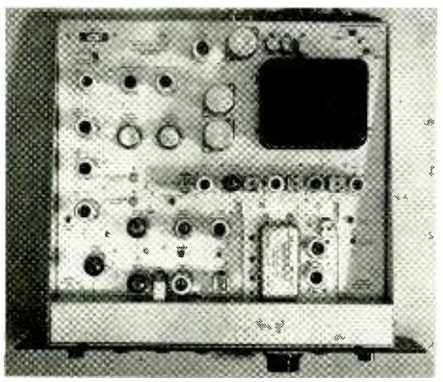


Fig. 6. Top view of the H. H. Scott Model 4310.

The front end of the 4310 uses the same configuration found on most, if not all, Scott FM tuners: that is, a 6BQ7 cascode r.f. amplifier and a 6U8 oscillator-mixer. From there the signal goes through four i.f. stages and two limiting stages before it reaches the ratio detector diodes. Then it goes to the well-known Scott multiplex circuitry. Finally it exits through the audio stages and the output attenuator. Of course there are other odd circuits for the diversity function, relay drivers for squelch and stereo threshold, VU meters, and so on. We needn't spend space to describe them because they are relatively straightforward albeit well designed. From the top view, *Fig.* 6, we can see that the set is carefully laid out. If we could see the bottom view we would discover the usual r.f. rat's nest. Some things never change.

In sum, the 4310 circuit is elaborate but relatively usual for Scott tuners. It does a lot of things.

Performance

Without question, this tuner is one of the finest tuners extant. It pulled in more stations, loud and clear, than any other tuner we have tested. The record now stands at 40 stations.

The performance, in numbers, of the 4310 was as follows: Capture ratio, 2 db; rejection of spurious response, 85 db; selectivity, 53 db; AM suppression, 60 db; signal-to-noise ratio, 70 db; sensitivity (mono), 1.95 μv; frequency drift, 0.015 per cent; audio output, 2 volts.

Of course these numbers do not tell the whole story; they certainly do not tell how the 4310 sounds. As we noted before, the set automatically switches to stereo or mono (mono-stereo switch in stereo position) depending on the signal-to-noise ratio, which you set yourself by means of the stereo threshold control. Thus stereo listening does not become the ordeal it can sometimes be—when the noise rises above your present tolerance, the set automatically switches to mono. Even in mono, if the noise becomes intolerable, the set automatically switches to standby. The tolerable mono level is set by means of the dynaural squelch control. The only problem we encountered with this system was in finding the proper "tolerable" levels which would not have the automatic circuits constantly triggering the relays. Unfortunately the relays create enough noise of their own in the switchover to be clearly audible. On the other hand, the sound quality, because of the lack of noise and distortion, is just superb.

There was just one minor detail of this excellent tuner which we felt could be improved—the location of the VU meters. We found it rather difficult to track both meters simultaneously because of the space between the meters. We know this doesn't affect sound in any way, but it might make some tired-eyed station engineer much happier if they were placed side-by-side, or one over the other.

To sum it all up, we will state unequivocally that the 4310 is unquestionably the finest FM-stereo tuner H. H. Scott has made to date, which makes it one of the finest tuners around. **K-21**

TANNOY 10-INCH MONITOR DUAL-CONCENTRIC

The line of Tannoy Monitor Dual-Concentric loudspeakers needs no introduction to the readers of AUDIO. We have known about 15-in. and 12-in. units for some time. What we had forgotten was the unusual versatility of these units.

For example, when we first received the ten inchers, we decided to try various enclosures to determine which would complement these fine units best. We eventually did just that, but the very first thing we did was to mount them on a pair of sturdy baffle boards and hang them without an enclosure; (naturally we did the easiest thing first, doesn't everyone?). The upshot of that "quick and dirty" procedure was to reaffirm something we have known for a long time—these speakers do not need to be enclosed. In a word, they sounded great.

This points up the most important characteristic of the Monitor Dual Concentrics, they are designed for infinite baffling. Subsequently we did mount the tens in a variety of available boxes, and we did find a few we liked somewhat better than the unboxed baffle. But more of that anon.

First let us describe the basic premise of the Dual Concentrics. What Tannoy has done is make a coaxial speaker in such a way that the throat of the high-frequency unit goes through the magnet structure (pole piece) of the low-frequency unit. It goes through in such a way that the high-frequency unit is not affected by the low-frequency unit. Thus we have highs without the resonance bumps normally associated with concentric units. And this is not just theory, they work that way. In our opinion this unique construction is responsible for the smooth sound quality of these speakers. Well, to get back, the Dual Concentrics are coaxial units supplied with their own crossover network, as shown in *Fig.* 7. The basket of the speaker is a heavy die casting, obviously capable of avoiding resonances from this source.

The manufacturer told us that these ten inchers would operate well in a box as small as 1½ cubic feet, so we tried it in such a small box stuffed with cotton waste (the manufacturer told us about that too, only he called it machinists wiper cotton). Frankly we were amazed, it produced the best sound we have ever heard out of a box anywhere near its size. (The cotton waste made a decided difference, it smoothed out the midrange. Another absorbent material said to do the same job is Tufflex, which is a special cotton pad.)

The only box we liked better than the small one we have described is a horn-loaded unit which is essentially a smaller version of the famous GRF box. The Tannoy people are going to market this smaller horn-loaded system, calling it appropriately enough La Cornetta (the little horn). This system, to our ears, is one of the finest we have heard in a long time. Of course, big brother GRF does sound better, but that's going up in size and price quite a bit ($269 as against $385).

Altogether we found the 10-in. Monitor Dual Concentric to be a very flexible loudspeaker which is in the very best category as a sound reproducer. In the 1½ cubic foot enclosure, properly baffled and stuffed, it will take on almost any existing bookshelf and come out on top, at least for our listening taste. By the way, for those who worry about such things, the free air resonance of the speaker is 27 cps, power handling capacity 20 watts, impedance 16 ohms. **K-22**



Fig. 7. Tannoy 10-in. Monitor Dual Concentric loudspeaker and crossover network.

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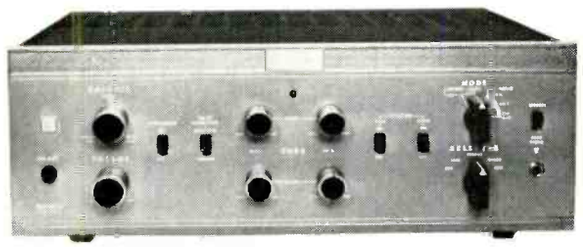
PIONEER.....
for a living image of sound

The Japan of today is renowned for its quality precision products, created from a harmonious merger of Japan's traditional craftsmanship and modern production line systems. And from this merger comes the renowned line of PIONEER audio components.

For professional applications where large power is a MUST, or for deluxe home applications, choose from PIONEER's two large power models, the 72-watt SM-500 stereophonic amplifier, and the 80-watt SM-600 tuner-amplifier.

Each is designed for maximum versatility, each is designed for easy handling, and above all, each provides the same PIONEER reliability and performance.

SM-500



The SM-500 provides a full 36 watts of clean and undistorted power from each of its well-designed channels in stereophonic operation, and a total of 72 watts in monophonic operation. Featuring a precision-finished preamplifier using carefully selected noise-free tubes operating off hum-free DC, the SM-500 has a total of 14 inputs to handle all forms of signal inputs.

SPECIFICATIONS OF THE SM-500
Frequency Response: ±1db from 5 cps to 100 kc. Harmonic Distortion: less than 1%. Hum and Noise: Mag. better than 60db, Aux. better than 80db. Power Requirements: 115/230 volts, 1.4/0.7 amp., 145 watts (max.), 50/60 cps. Dimensions: 11'1/32 (W) x 5'29/32 (H) x 13'9/32 (D) inches.

SM-600



The SM-600 is a compactly put-together complete stereophonic tuner-amplifier providing 40 watts of noise-free power from each of its efficient channels. In addition to normal AM and FM circuits, its tuner section features a built-in multiplex circuit for the reception of superb FM stereo. Its preamplifier has a total of 10 inputs for full versatility.

SPECIFICATIONS OF THE SM-600
FM Sensitivity (IHFM): 1.5μv. AM Sensitivity (IHFM): 6.3μv. MPX. Channel Separation: better than 30db. Frequency Response: ±1db from 15 cps to 100 kc. Harmonic Distortion: less than 1%. Hum and Noise: Mag. better than 55db, Aux. better than 65db. Power Requirements: 115/230 volts, 2.1/1.14 amp., 208 watts (max.), 50/60 cps. Dimensions: 7'23/32 (W) x 5'3/32 (H) x 17'3/32 (D) inches.

PIONEER

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UHER 8000 ROYAL STEREO TAPE RECORDER

We have previously reported on the Uher (pronounced "oo-er") Universal (Oct. 1959) and on the Stereo Record III (Feb. 1960), both of which were then considered rather exciting tape recorders. The Universal had a multitude of features, and only failed as a top-quality home machine in the fact that it was monophonic, its highest tape speed of 3¾ ips, and that it would accommodate only 5-in. or smaller reels. The Stereo Record III provided a number of attractive features, including three speeds and complete stereo performance, and the unit has achieved considerable acceptance as a continuing good performer.

But now comes the Uher 8000 Royal Stereo—4-track stereo and monophonic, four speeds (7½, 3¾, 1⅞, and ⅞ ips), and features galore. And it is completely transistorized, except for the motor, which is conventional. Mechanically similar to the Stereo Record III—and that was a good model to follow with its cast aluminum chassis for stability, heavy capstan-shaft flywheel, and long-life oilite bearings—the unit differs electronically in many respects. In the first place, the 8000 is a three-head machine for monophonic recordings, permitting the monitoring of what is actually on the tape. It has built-in echo facilities, built-in sound-on-sound facilities, multiplay facilities, remote control facilities, mixing facilities, end-of-reel shut-off facilities, and besides all that it can control an automatic slide projector so that once you have recorded a commentary for a slide show, you can subsequently leave it all to the machine.



Fig. 8. The Uher 8000 Royal Stereo Recorder in its attractive simulated leather case.

One master switch controls the mechanical speed selector and the ON-OFF mode. There are seven positions—four speeds, with three OFF positions between. Selecting the speed also adjusts equalization for each. A second switch, together with an interlocked RECORD button, controls all of the electronic functions in its eleven positions, which are marked: 1–4—mono record or play on upper track; 2–3—mono record or play on lower track; STEREO—record or play: MULTIPLAY I—permits recording on the upper track from microphone and mixing with material from lower track; MULTIPLAY II—permits recording on lower track and mixing material already recorded on upper track; DIA-PILOT I—used for recording from microphone and/or from phono record or another tape machine on upper track as commentary for slides: DIA-PILOT II—after making recorded commentary on upper track, this position is used to record sub-sonic tone on lower track at points where a slide is to be changed and for playback with slide projector thereafter, with the slide changing at each point when the tone button was depressed in the second run-through; ECHO 1–4—permits adding delayed sound to an original recording on upper track, the amount of delay depending on the speed of the tape; ECHO 2–3—same operation for lower track; SYN-PLAY I—used for recording on one track for later recording another signal in synchronism with the first but on a second track when the switch is turned to the SYN-PLAY II position. Thus practically any trick type of recording can be made with no external interconnecting or switching.

Just above the piano-key START-STOP-PAUSE keys are two level-indicating meters, one for each channel. To their right are two blue indicator lights—the upper showing when the instrument is set for playback from the upper track and the lower for the second track; both are illuminated for stereo. To the left of the meters are two red lights, showing when each channel is set for recording. Thus for MULTIPLAY I, for instance, the upper red light is on when the recording button is depressed, and the lower blue light is on; in MULTIPLAY II, the two lights are reversed.

Piano-type keys are used for the start, stop, and pause operations; in PAUSE, the pinch roller is held away from the capstan so the tape remains stationary while all other controls are in the same positions. The pause operation provides an instant start and stop action so that words can even be cut in two in recording, so that one can say "Micro—(pause)—phone" in recording, while in playback it will sound like "microphone" without interruption.

The remote-control facility, with the aid of an accessory unit, gives the operator the ability to control balance between channels and to start and stop the recorder at a distance from the machine so that the balance may be adjusted from the listening position rather than from the recorder position.

The playback level is controlled by one knob, balance between channels by a second, and tone—affecting playback only—by a third. The balance control, in monophonic operations, gives normal monitoring from the input signal when in the counter-clockwise position, and from the tape when in the clockwise position. Two recording level controls are provided—the left one for microphone inputs and the right one for inputs from the phono receptacle on the rear apron panel. Also provided on the rear panel are receptacles for the remote control accessory, the slide projector, and for remote speakers or for monitoring headphones, as well as a fuse and a line-voltage selector, since the instrument will operate on any voltage from 110 to 250. The case is of wood, well reinforced, and covered with an attractive plastic resembling black morocco leather, and fitted with a key-operated lock. The unit measures 14 in. wide, 13 in. front to back, and 7 in. high, and weighs 23½ lbs.

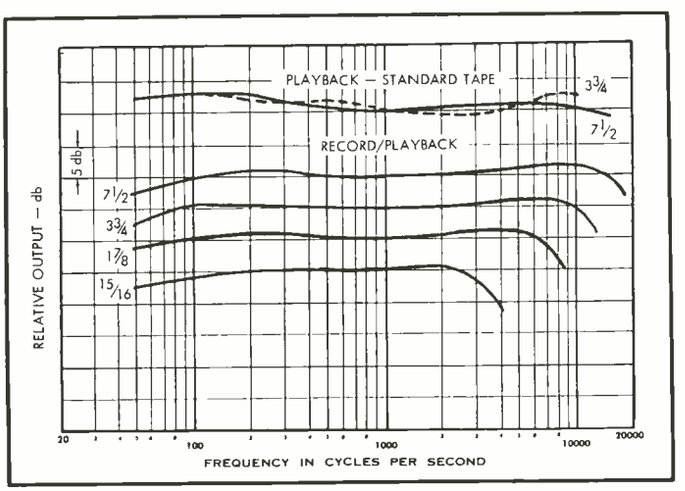


Fig. 9. Frequency-response curves for the Uher 8000. The two curves at the top show response from Standard Frequency Tapes, while the lower ones show record/playback response at the four speeds.

Performance

Figure 9 shows the frequency response of the Uher 8000 in its various modes of operation. The upper curves show the playback response from Ampex Standard Frequency Tapes 31321–01 and 31331–01 at speeds of 7½ and 3¾ ips respectively, while the four lower curves show the response in and out—that is, recorded from a flat signal and played back—for the four speeds. It is seen that on playback from the standard tapes that response is within ±2 db over the limits of the tape frequencies (from 50 to 15,000 cps at 7½ ips, and from 50 to 10,000 cps at 3¾ ips), and on the record/playback curves is within ±3 db from 50 to 18,000 at 7½, with the

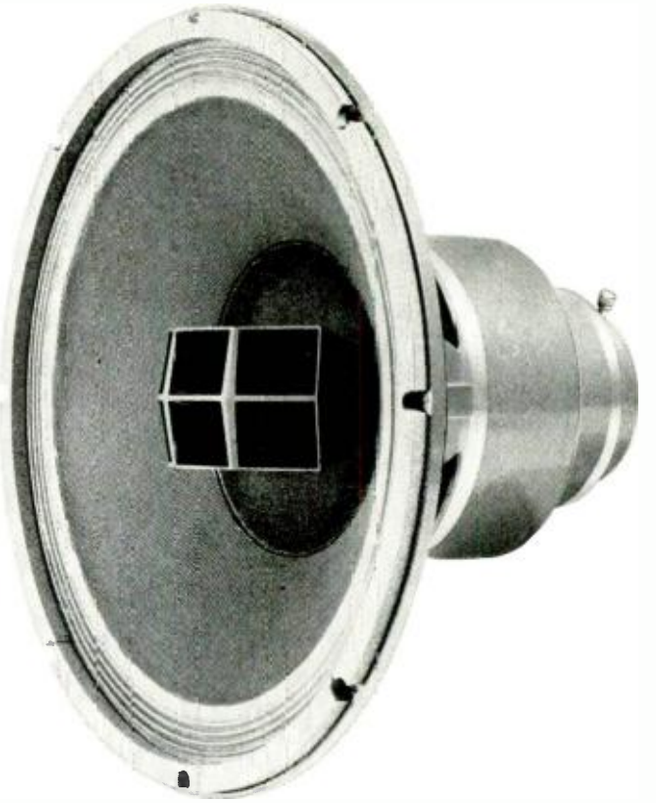
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EQUIPMENT

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Genuine studio PLAYBACK equipment is as superior to conventional "hi fi" components as these components are superior to typical package "hi fi." The reason: PLAYBACK equipment is what the conductors, artists and recording engineers rely on in the studio to accurately compare the realism of a recording with the live rendition.

In professional audio, where no compromise with performance and reliability is tolerated, only genuine PLAYBACK equipment is deemed acceptable. Altec Lansing is synonymous with PLAYBACK because major professional users—studios, concert halls, theatres—have used Altec equipment predominantly since the beginning of modern sound technology.

The Altec 605A "Duplex"® is an outstanding example of such studio equipment and has been judged the finest single-frame speaker in existence. It is the ultimate refinement of Altec's original 604 which had served as the PLAYBACK standard since the birth of long play records.

One hearing will quickly demonstrate why the 605A "Duplex" is supreme. These specifications will explain some of the reasons: The 605A is a 15", two-way speaker system employing a true multicell horn for perfect dispersion of high frequencies throughout the entire audio range. Its guaranteed frequency response is 20-22,000 cycles. The Altec 605A "Duplex" is so free of distortion and false coloration that other speakers sound shrill and constricted by comparison. That's why leading Capitol recording stars such as Judy Garland, Peggy Lee, Nat King Cole and Vic Damone can rely on the "Duplex" in studio PLAYBACK for evaluation of their work before the recording is "wrapped-up."

WIDE VARIETY OF WIDE-RANGE SPEAKERS

The 605A is priced at $168.00 including dividing network. At 35 pounds, it is the "heavyweight" of the line. Two other "Duplex" PLAYBACK speakers of exceptional quality are also available. The 602C is a 15" two-way speaker which provides outstanding performance at the modest cost of $132.00. For those who want genuine PLAYBACK sound in comparatively small space, Altec's two-way 601C is the ideal answer at $108.00.

For "starter" systems on a budget, consider Altec full-range, single voice-coil "Biflex"® speakers: the 15" 415C and the 12" 412C. And, for speakers throughout the home, there's the remarkably smooth 8" 755C "pancake," a popular utility monitor in the broadcast and recording field for many years.

AUDIO'S MOST IMPORTANT FORMULA

Whatever you invest in your system, put major emphasis on the speakers. The speakers are the voice of your system and here, a compromise is most audibly apparent. If, for various reasons, you must compromise with overall quality, it is best not to do so in speaker selection but elsewhere in the audio system. Naturally, you will be assured best results by a stereo system made-up entirely of components of homogeneous quality such as offered by genuine Altec PLAYBACK speakers, amplifiers, and tuners.

Hear Altec speakers, speaker systems and other PLAYBACK components at your nearest Altec Distributor's (see your Yellow Pages). And while you're there, be sure to ask for your courtesy copy of "PLAYBACK and Speech Input Equipment for Recording and Broadcast Studios." Although prepared specifically for the recording and broadcast industry, it provides the obvious answers to better home listening as well. Or, for your free copy, write Dept. A-9.



Interior of Columbia Records' Studio A in Hollywood showing CBS-built cabinets housing Altec 605A "Duplex" Loudspeakers for professional PLAYBACK.



Monitoring with Altec "Duplex" speakers in Capitol's Control Room. More than 70 Altec "Duplex" speakers are used for various PLAYBACK purposes throughout Capitol Records' recording facilities.

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upper limits extending to 13,000, 8500, and 4000 cps respectively at 3¾, 1⅞ and ⅞ ips. Obviously one would not expect to use the lowest speed for high-quality music reproduction, but it is quite satisfactory for recording long periods of voice material such as a lecture.

On multi-track recorders, it is important that channel separation be high if monophonic recordings are to be reproduced without interference from other tracks. Separation measured 54 db between channels, and 51 db between adjacent tracks—that is, with a maximum level tone recorded on track 2, the crosstalk into track one measured 51 db. Signal-to-noise ratio measured 53 db on one channel and 51 on the other, and wow and flutter was under 0.2 per cent at 7½ ips, increasing as the speed was lowered to a maximum of 0.4 per cent at ⅞ ips. At 7½ ips, IM distortion measured 3 per cent at operating level (10 db below 3-per-cent harmonic distortion), decreasing to 2 per cent at 10 db below operating level.

The unit has two built-in 5 × 7 in. loudspeakers, one on each side of the case. The output amplifiers—also transistorized—are capable of putting out a signal of 2 watts per channel, which is adequate for efficient speaker systems. For optimum quality of sound reproduction, however, the machine would normally be used to feed an external power amplifier and loudspeakers, and under such conditions the performance at the top speed is definitely of hi-fi quality.

As an extremely flexible home machine, the Uher 8000 is capable of practically any type of operation that the average recording fan can imagine. One additional feature which can be had with the use of an accessory known as the Akustomat makes it possible to use sound as a controlling medium for the recording operation. The machine can be used as a dictating machine, for example, without the need for a start-stop button—one simply speaks and the machine starts recording, and when the dictator pauses, the machine stops. Thus it may be used to monitor and record sounds of an intermittent nature over a long period of time without actually running except in the presence of some sound. The need for this feature is not universal amongst recorder owners, but there are some applications for which it is most important, and we know of no other machine which has this feature.

At the slowest speed and in the echo mode, the machine can be used to check pronounciation in the study of languages. One simply says a word, and then hears it back a fraction of time later. The various features of the machine provide a wide range of facilities useful in the study of music or languages. In short, practically any use that can be imagined is possible with the Uher 8000. K-23

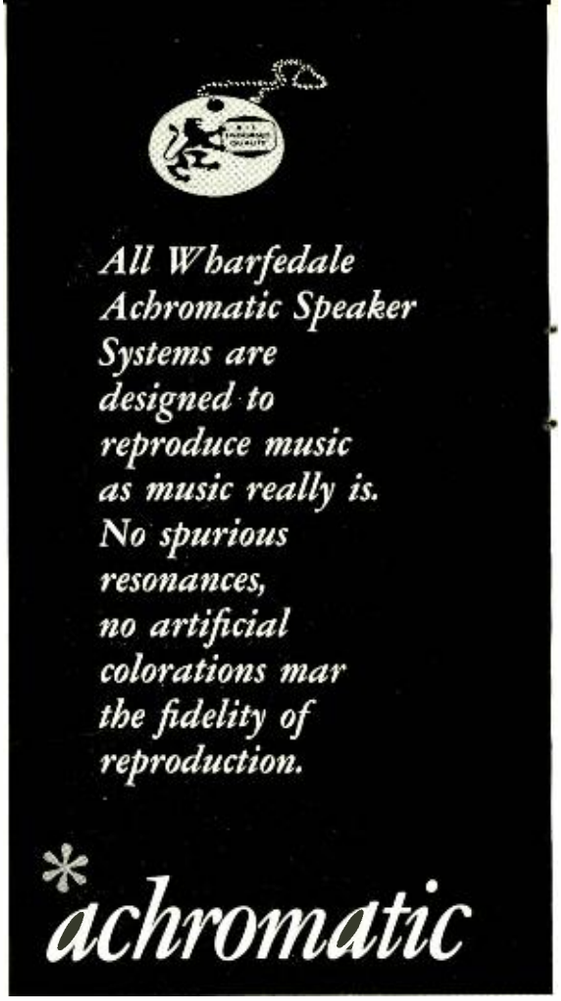
KNIGHT-KIT KG-2000 d.c. to 5 mc LABORATORY OSCILLOSCOPE

Most audio applications of 'scopes do not demand a wide range of response and for most measurements it is usually sufficient if the over-all response of the test equipment covers the range between, let us say, 20 cps and 20,000 cps. When it comes to proper measurement of feedback amplifiers, it becomes necessary to extend the bottom end about two octaves, and preferably four, since the average feedback amplifier does things to the response below 20 cps which have a great effect on the performance. Similarly, response in the range between 100,000 and 200,000 cps becomes important to ensure the absence of oscillations in the very high frequency audio ranges. Thus while the demands of 'scopes—and other measuring equipment—extended to a top of around 20,000 cps some ten years ago, it is now desirable to extend the range to well over 100,000 cps.

(*Continued on page 76*)



Fig. 10. External view of the Knight-Kit KG-2000 laboratory oscilloscope.





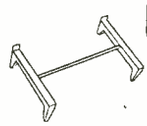
W40—Ultra-compact (24" x 12" x 10") full-range system at a most attractive price. Two superior speakers: A newly developed 8½" low frequency driver with an extremely high flux density magnet—and Wharfedale's outstanding 5" tweeter—the same used in the larger W60 system. True Wood, $79.50. Utility model, $69.50.



W60—In the streamlined look of fine modern furniture or handsomely crafted provincial, this full-range two-speaker system provides superlative performance—making it the automatic choice when the finest reproduction is desired. True Wood, $116.50. Utility model, $101.50. Provincial in genuine Fruitwood, $134.50.



W70—A three-speaker system—handsome by itself, yet still sufficiently compact for shelf or wall integration. The beauty and excellence of performance of this remarkable system makes it unusually attractive to experts and laymen alike. True Wood, $164.50. Utility model, $146.50. Provincial in genuine Fruitwood, $189.50.



B67—Universal Mounting Base for W60, W70 and W90 systems in matching woods. True Woods, $9.95, Utility model, $8.95.

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THE NEW WHARFEDALE W90—Musical integrity . . effortless realism achieved through a new 6-speaker concept ■ Low end realized magnificently through two bass speakers ■ Presence conveyed dramatically through two mid-range speakers ■ Dispersion achieved panoramically through two high-frequency speakers ■ Six transducers—superbly matched and integrated with a unique sand-filled enclosure.

speaker systems by Wharfedale

W90 A detailed description follows. All 6 speakers incorporate certain recent refinements which have made possible the task of creating the W90 system.

The chassis (baskets) are exceptionally heavy and manufactured by casting. The purpose is to preserve absolute rigidity, maintaining the critical relationship between the moving voice coil and the fixed magnet. The stamped baskets found in ordinary loudspeakers are also designed to be rigid. However, this rigidity is often lost as soon as the speaker is mounted firmly against an inexact wooden front baffle. Some speaker designers have even eliminated the basket, weakening the entire speaker structure. Wharfedale baskets are of cast metal. They hold their shape perfectly in mounting, and are strong enough to permit sufficient openings to maintain absolutely correct airloading, essential for the full response of the speaker.



The Cone Surround is an exclusive rolled-rim design, the latest and most effective form of the traditional Wharfedale soft suspension. Earlier surrounds (porous foam or cloth) provided such superior bass damping that they became renowned as an outstanding physical characteristic of Wharfedale speakers. Now, more than ever before, the Wharfedale cone is capable of the long excursions required for true bass energy in a sophisticated tuned duct enclosure. The cone material is special...compounded of long fibred wool (traditional to the North of England home of these speakers) and *soft* pulp! It achieves superior results from the start and its natural resilience assures continuing perfection over the years.



The Magnets are truly impressive, individually and totally. Because of its material, and the special design of the magnetic gap, each provides higher total flux in the gap field than has been true of the magnets in any prior speaker system. The six magnets together make the W90 a "high efficiency" speaker, achieving maximum performance at low amplifier power. All-too-many popular speaker systems are starved for power, depending upon exaggerated amounts of amplifier wattage. In the W90, therefore, the all-important transient bass response is excellent, even at low volume. This clean low end, at reasonable listening levels, is a major reason why all Wharfedales are so pleasant to "live with."



With its six speakers, the W90 is actually a dual 3-way system with all units designed for each other and crossover settings calibrated for undistorted response throughout the audio spectrum. The support effect of the tandem speaker systems results in a sound of exceptional authority, yet in balance over the entire range.

LOW RANGE. Two 12½" low frequency drivers handle the sound from 20 to 1,500 cycles. The listener can expect to enjoy the true, fundamental bass notes, so often masked. The two drivers total a cone area of 94 square inches...thus the W90 tandem idea yields the same result as a single low frequency driver of such massive size and weight as to be impractical in the home.



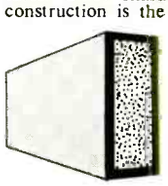
MID-RANGE. Two 5¼" mid-range speakers cover the relatively narrow but vital band of 1,500 to 6,000 cycles. The listener will be startled, for example, by the clarity of the baritone voice and the exceptional resolution of most solo instruments, permitted to stand in correct perspective. The handling of this "fill" range in the W90 is the recognizable key to its satisfying full-throated sound.



TREBLE. Two 3" treble speakers are the well-established Super 3's, much admired for their ability to present the clear treble without stridency...making them eminently listenable, unusual for tweeters. This is no accident. It is the result of cone-type rather than horn-type construction, and refinements such as low-mass aluminum voice coils ultrasonically tinned, powered by magnets so large that they are seldom found even in speakers four times the diameter!



THE W90 is the latest of the Achromatic speaker systems. The literal meaning of "achromatic" is: "Pure sound, uncolored by extraneous modulations." Such modulations, common even in luxury speaker systems, tend to alter the natural sound of music. The W90 enclosure has been designed to preserve the integrity of the speakers' performance, through certain constructional features. Chief characteristic of the Achromatic construction is the sand-filled technique, which consists of packing white sand densely between layers of hardwood. This creates an inert mass, incapable of resonating no matter how deep or strong the bass backwave projected against it. This exclusive technique is the result of years of development by G. A. Briggs. While it costs considerably more than standard construction, it has proven so effective in preventing bass distortion that all Wharfedale Achromatic systems incorporate it. Each woofer is mounted in an individual tuned chamber for its own maximum effect, and isolated from the mid-range and tweeter arrays. Therefore, mechanical coupling, so disastrous in ordinary systems, is eliminated. The high and mid-range speakers are mounted from the rear, isolated from the face of the cabinet with front free-floating. This feature helps to eliminate phase distortion. As a final measure, to insure compatibility with the acoustics of the room, the W90 system incorporates a full control panel. Each range of speakers may be balanced and adjusted to the ear of the listener, the requirements of the particular listening area and the other components in the music system.



DECOR. The new W90 is neither a compact, nor a large speaker system. It is a new and highly versatile size, designed from the sound out. Ideally suited to be used in pairs for stereo, the W90 measures 32¼" x 27¾" x 13⅛". Housed in a meticulously crafted cabinet built to meet every requirement of perfection in sound, the W90 will fit with ease into the living room, and is elegant enough to join the most distinctive furnishings. Its acoustic design adds versatility . . . permitting horizontal or vertical use, as desired. The Wharfedale Universal Mounting Base makes it a superb free-standing unit. In oiled or polished Walnut hardwood, $259.50. Utility model in sanded Birch hardwood, without curved molding or dividers, $244.50. Universal Mounting Base to match, $9.95.

For illustrated literature, write Dept. WM-13

Wharfedale • Division of British Industries Corp., Port Washington, N.Y.

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MOBILE FM-STEREO RECEPTION

(*from page 24*)

when the received signal is above a critical "threshold" the listening quality is very good; below this critical threshold the tolerance is a subjective factor. Fortunately the number, location, and available power of the FM stations broadcasting FM-stereo within the Los Angeles metropolitan area are many, and reception has been good anywhere within the basin area.

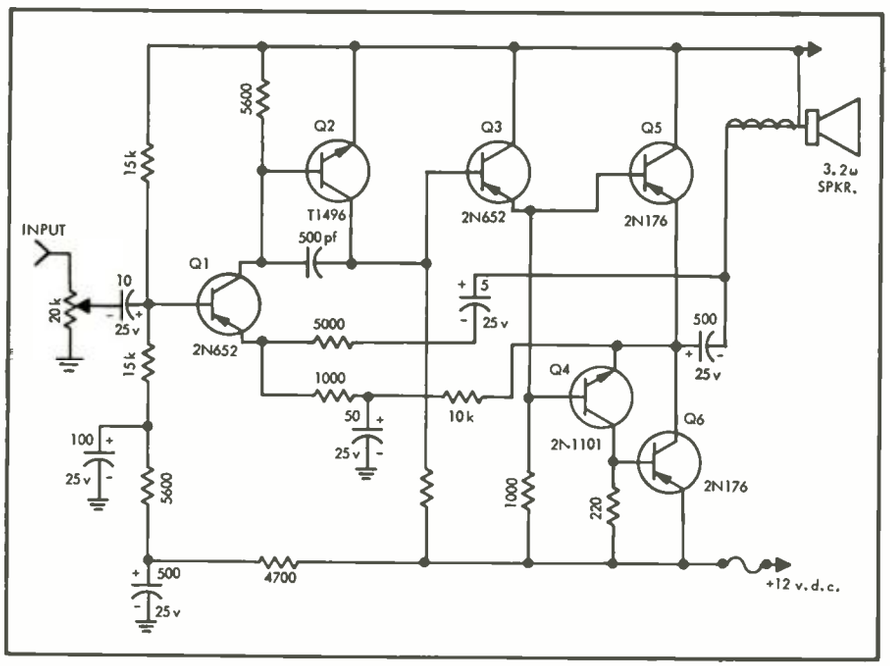


Fig. 14. Audio amplifier for second channel.

Areas for Improvement

Until more quantitative measurement and analysis can be made the only comments towards improving reception concerns efficiency and threshold improvements. Obviously an all-transistor system would eliminate the d.c.-d.c. converter increasing the system efficiency and removing the interference associated with these devices. The particular scheme of detecting and providing the local subcarrier reference signal by the locked-oscillator technique is not the optimum method. The most serious disadvantage is that the 38-kc oscillator signal, which must cohere in phase to the 19-kc sync signal and the L–R sidebands for detection, occasionally becomes ambiguous to the transmitted phase due to momentary loss of "lock" to the sync signal or to large phase shifts under conditions of severe propagation factors. A better scheme for multiplex decoding would be to employ a detector that employs an integrator of long time constant that would retain the correct phase coherence with the 38-kc reference during the periods of signal "drop-outs"; or in other words, a "flywheel" effect to carry over during high "flutter" conditions. Such a detector is the phase-locked loop detector (or automatic phase control, APC) principle as employed in color TV sync circuits.[3] (See *Fig.* 15.) These detectors can obtain very narrow effective bandwidths which improves the "threshold"-to-noise effects. In addition, they can frequency track the sync signal although it was stated early that doppler effects are negligible.

A phase-locked loop that could be used for detecting the pilot and providing the local injection signal has the closed-loop phase transfer function for an optimum condition of:

$$H(s)=\frac{\theta_o}{\theta_i}=\frac{B_o^2+\sqrt{2}\,B_oS}{B_o^2+\sqrt{2}\,B_oS+S^2}$$

where B_o = natural undamped resonant frequency, and S = mathematical variable, complex = $\tau + j\omega$. Two significant advantages of this reference subcarrier detector are associated with the effective bandwidth and its integration time or memory. The bandwidth of this detector can be expressed by:

$$2\,BW_{noise}=\frac{\frac{1}{2\pi}\int_{-\infty}^{\infty}|H(j\omega)|^2}{H^2_{max}}\,d\omega,\ cps.$$

This is the equivalent-noise bandwidth of the detector analogous to a narrow-tuned circuit. A narrow bandwidth has the advantage of recreating the reference signal in the proper phase with less influence by noise. The narrow bandwidth is achieved by the configuration and characteristic of the low-pass filter (integrator) used within the loop and is normally an RC network. This network performs the function of storing the phase error (between the received original subcarrier and local reference) information for a period of time for subsequent comparison with the most recent received signal. Hence, during signal "drop-outs" the output phase of the reference signal is maintained at the latest phase relation which is the best estimate of what the input phase of the sync signal was at that time. When the signal is fully restored above the threshold, the signal is updated to equal the incoming signal.

With further quantitative measurements within the receiving system, methods may be determined for additional improvements and such measurements are anticipated in the future. Æ

[3] Richman, D., "Color-Carrier Reference Phase Synchronization in NTSC Color Television," *Proceedings of the I.R.E.*; Jan. 1954.

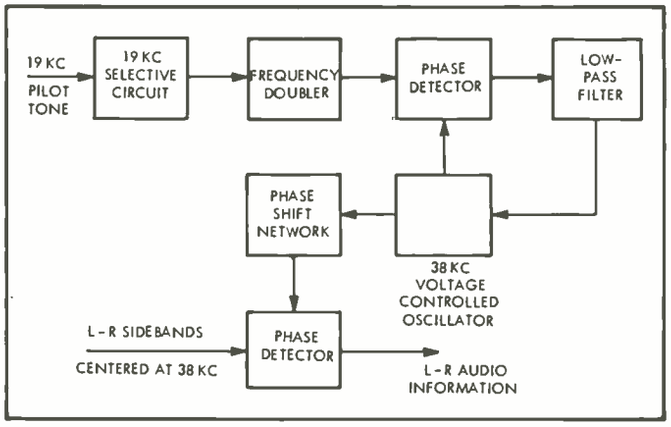


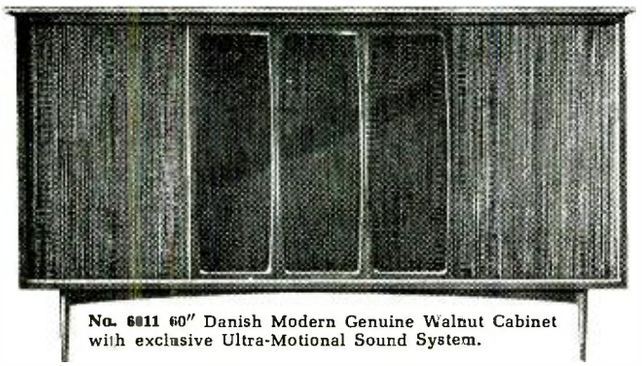
Fig. 15. Automatic phase-control detector for extracting sync signal.

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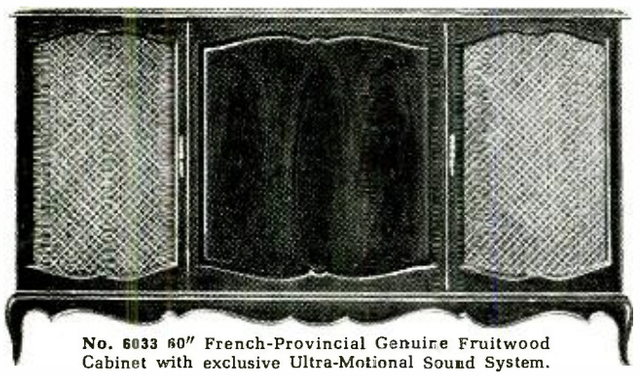
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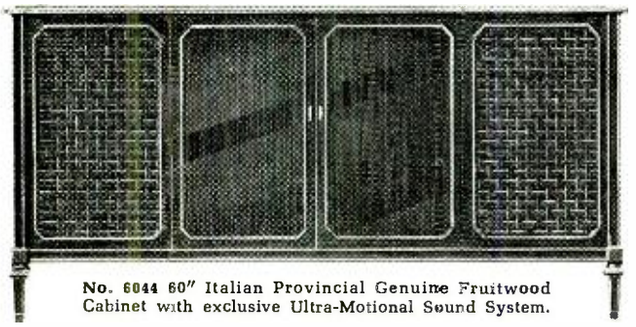
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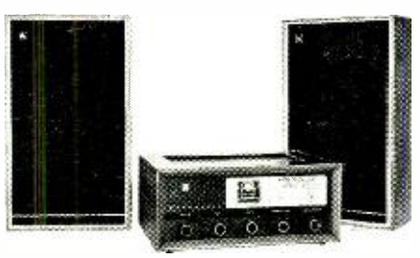
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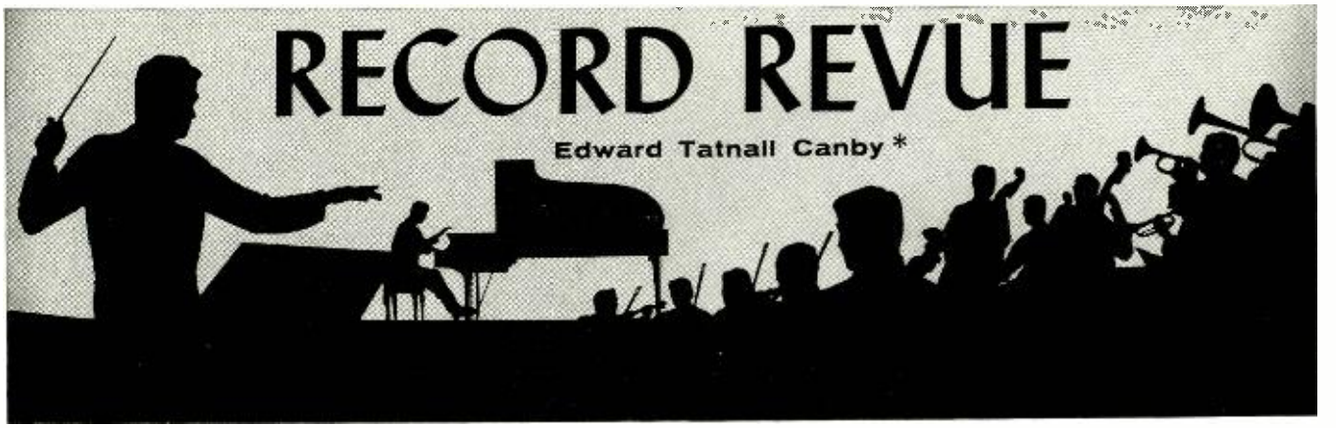
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MUSICIANS' TEMPERAMENT

A. and G. Gabrieli: Sacrae Symphoniae; Ricercari. Paris Instrumental Ensemble, Hollard.

Vox STDL 500.540 stereo

There's no telling what musical outlook you'll find among professionals in the field—some can't see beyond their musical noses and the near-end of their instruments; others somehow gain an insight into musical style that brings unexpected life to unusual music. So it is here, within a single French ensemble.

The music for choirs of brass by Giovanni Gabrieli, the younger of the St. Mark's Cathedral composers of Venice, is superbly played by these French bass men with breadth, fine phrasing, and much dignity. All of Side 1 and the last band of Side 2 are given over to this good playing.

But, out of the same group and under the same director, the woodwind players who perform the Ricercari music of Andrea Gabrieli, the elder, play in the most dreadfully mechanical manner, plodding through the music without a vestige of expression nor, apparently, any idea that this music is more than so many rows of dull notes, to be played one after the other. Unbelievable! If you don't believe me, listen.

Fortunately, the good brass playing takes up most of the recorded space.

Mozart: Concerto for Flute and Harp, K.299. Handel: Concerto for Harp, Op. 4, No. 6. Marcel Grandjany, harp, Samuel Baron, flute; Musica Aeterna Orch., Waldman.

Decca DL 710075 stereo

Here you have a group of old pros, with their accompanying orchestra, gathered together to talk musical shop as only long-time professionals can do—like a bunch of seasoned audio engineers talking audio. The resulting product, of course, is highly professional. It is also, perhaps inevitably, somewhat less than broad-minded. Each performer is an expert at getting over his own specialty. Flute, for instance. Or harp. Each man has lived long enough in his own field so that, somehow, the world has come to revolve, for him, around his instrument. The flute, say. Or the harp.

Thus Grandjany, the greatest French harpist I've ever heard, manages to make Mozart sound just like French harp music. Also Handel. Baron, a thorough-going if somewhat chilly younger flutist, plays Mozart from the flute point of view. And Frederic Waldman, sage elderly conductor, imperturbably allows these gentlemen to indulge in the foibles of their respective and respectable trades.

Somehow, Mozart, and then again Handel, seem to have but the remotest connection with the proceedings.

Their music is played very pleasantly, of course, and with professional dexterity. But when the cadenzas come, the cats are out of the bag—the musical pay-off is at hand. Thus a cadenza for harp (by Marcel Grandjany) is interpolated in the Handel at a point where the normal stylistic expectation is at most a brief run up and down a few scales, and it goes on and on to utter musical absurdity. After all, one gathers, M. Grandjany must have his moment in the stereo sun. . . .

I can only repeat that these gentlemen (and their orchestra) are worthy professionals on a very high level. But their efforts are too much on their own behalf, not enough on that of the eminent composers whose music they are performing, and whose names are billed in big letters on the record jacket.

Mozart: Violin Concertos K.216 in G, K.219 in A. Arthur Grumiaux; London Symphony, Davis.

Philips PHS 900-012

The intricate relationships among international record companies bring us many an unexpected release. Here, on U.S. Philips, is the same Grumiaux who played in so many fine Epic Mozart releases when Epic was still the local outlet for Philips of Europe. (If I'm right, Epic, a CBS label, is now detached from Philips, which in the U.S. is a subsidiary of Mercury—which in turn is owned by the larger European Philips. It's similar to the EMI-Capitol-Angel deal. All clear as mud? . . .)

Somehow, these English Grumiaux recordings seem to me indefinably more lush and fruity than the earlier Epic Mozarts with Grumiaux. He is still a first-line Mozart violinist and no two ways about it. But here the London Symphony sounds too large, plays with too much of a trace of sentimentality; the violin solo is loud, dramatic, and overly big in sound. If my memory is right, Grumiaux himself isn't really as wide-awake and alive here as in the earlier discs on Epic.

Yet the bigger, more dramatic impact is bound to please many who might have found the old Grumiaux Mozart a bit on the chaste side. If so, so much the better; Mozart is still plenty well served.

Schumann: Symphony No. 2 in C Major (Original Orchestration). N. Y. Philharmonic, Bernstein.

Columbia MS 6448 stereo

This is a sequel-recording to the Bernstein-Philharmonic versions of the "Rhenish," No. 3 (actually Schumann's last) and of the early "No. 4," also in the original Schumann orchestrations. (MS 6294, 6256). Bernstein had an inspiration here.

It is valuable and immensely instructive to have these works in their original form—even though for a century Schumann has been subject to extensive "improvements" designed to repair the damage to musical sense caused by the composer's notoriously poor understanding of orchestral textures. So it has been said, anyhow. Here you have the evidence for yourself in terms of actual listening.

Yes—the music is thicker, muddier, richer, loaded with layers of texture and plastered with ornaments and imitations. The sound is undeniably turgid and the sense notably less clear than in the revised "normal" versions we have always heard. And yet, I ask, isn't this thickness perhaps more precisely intended than we may have supposed? It is of the period—as Wagner's silk-lined parlors were of the interior decoration of the time!

Frankly, I like the turgidity—and so does Bernstein, for the best of reasons. It is authentic—both to Schumann himself and to the taste of the period.

But what is best in these three Schumann recordings by Bernstein is his extraordinary feeling for the essence of Romantic expression. This he has developed over the years; I do not remember it in his early conducting. Now, Bernstein does for the inner light of Schumann's expression what the Budapest does for Beethoven's late quartets. I do not think you can know Schumann until you have listened to these unusual performances.

Chopin: Mazurkas, complete. Orazio Frugoni, piano.

Vox VUX 2017 (2) mono

Orazio Frugoni will be remembered as the fiery-eyed young pianist whom Vox began to promote, if I am right, before the LP era began. I do not recall him offhand as anything of a sensation; yet here, in these Mazurkas, he shows himself one of the most subtle and expressive Chopin pianists in the business.

It isn't easy to reel off literally dozens of these little classical dances, all in the same basic rhythmic pattern. Yet Frugoni plays them so that even after a whole side of Mazurkas one is not tired of the breed. His sense for poetic Romanticism is no less than superb—and far ahead of those much younger pianists of the Neo-Romantic school who have not begun to sigh and pant out Chopin with sweat upon their brows! Too often, they quickly become dull; they haven't discovered the means of keeping music alive and Romantic at the same time, as Frugoni has.

Victoria: Four Motets; Missa Quarti Toni. (a) Schola du Grand Scholisticat des Pères du Saint-Esprit de Chevilly, (b) Chorale Sant-Jordi de Barcelone.

Music Guild S-41 stereo

What lengthy names the French and Spanish can think up for their best choirs! Victoria is the famous late-Renaissance Spaniard, whose effective, dramatically mysterious mysteries in choral form have wowed listeners right and left since the early Sixteen Hundreds. The four motets, short individual pieces on Latin texts, are sung by a splendid French choir of men, perhaps monks or Catholic students, with fine, non-wobbly voices and an excellent collective ear for blended harmonies. The Mass, occupying Side 2 of the record, is sung in Spain by a more throaty-voiced but still very musical ensemble, this time including sopranos and altos —boys.

Both of these choirs display an understanding of the free rhythms and expressive word-phrasing of the Sixteenth century that is unusual in our day of clanging rhythms and rigid beats.

Beethoven: Symphony No. 9. Vyvyan, Carter, Petrack, Bell; BBC Chorus, London Symphony, Krips.

Everest 3110 stereo

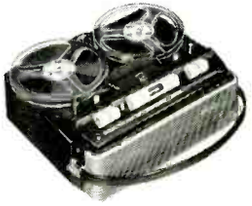
The Krips "Ninth" is well-liked by many critics and is surely notable for its lack of

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Buyer's Guide and Condensed Applications Chart—*Norelco*® 'CONTINENTAL' Tape Recorders

This condensed guide, prepared by the High Fidelity Products Division of North American Philips Company, Inc., offers the consumer the factual data he needs to select the tape recorder best suited to his specific requirements.











	Continental '100' Model EL 3585	**Continental '200'** Model EL 3541	**Continental '300'** Model EL 3542	**Continental '301'** Model EL 3549	**Continental '401'** Model EL 3534
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the eccentricities, the over-tensions and vocal hysteria that are familiar diseases of the famous piece. But I find the performance lacking, too, in color and definition; it suffers from a strict, rigidly paced tempo, a lack of real punch in the more violent passages and of eloquence in the lyric parts. These faults, however, are mild and well mannered and many listeners will prefer this kind of presentation to the more individualistic offerings of other big conductors.

An interesting comparison and a case in point is the recent "Ninth" by the same orchestra under old "Papa" Monteux, recorded by Westminster. It is a more vigorous, more personal "Ninth" by far, more colorful but also, perhaps, more eccentric, in a top-drawer fashion. Similarly, the Westminster sound is dramatic, radical, close-up and multi-miked; I found it exciting and good for the music, but others have said just the opposite. Everest's sound here is more conservative, less colorful, perhaps for many ears more natural.

Note that Everest gets the whole symphony onto one disc, though with the inevitable and uncomfortable break in the middle of the slow movement. (Beethoven is a most unaccommodating composer in this respect?) Westminster uses up three sides, with the fourth given to a rehearsal recording.

SUBLIME TO RIDICULOUS

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This series is a thing some of us have been waiting for since the Nineteen Thirties. It has occupied my listening time almost to the exclusion of other recordings for a month or so, on and off, and every moment has been a pleasure. I wish I could anticipate an indefinitely continued future—through all 104 Haydn symphonies—but, alas, the conductor, Max Goberman, died suddenly late last year and the series is thus terminated, unless another dynamic promotor as dedicated and as musical as Max Goberman can be found.

Truly, Joseph Haydn *was* the father of the symphony, as all the "appreciation of music" books will tell you without presenting a trace of evidence! Simple: Nine tenths of the "appreciation" writers had never heard any of *this* music; they took the idea on faith. Now we have the actual evidence. From Number One right through to Number 104 there isn't a symphony in the enormous series which is not full of life, replete with mature, published, fluent writing consistently far ahead of its time in terms of musical content. Though the later works, of course, are bigger, longer, more complex and more profound, the early pieces, astonishingly enough, are just as "good"; for each in its own terms is a complete fulfillment, not merely a rehearsal for later things to come.

The Goberman-Vienna performances are first rate, combining Goberman's somewhat New Yorkish intensity with the natural know-how of a Viennese orchestra playing music of its own heritage. (The Viennese on their own tend to wax a bit stodgy from our point of view.) The recording of these works is also first rate, made in stereo on half-inch tape, three-track. (How can such a small company afford it??) And as a final superb touch, the entire musical score of each work, in miniature, is bound into the album, along with complete scholarly corrections in detail, plus excellent notes by the Haydn scholar H. C. Robbins Landon.

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Fritz Kreisler in Immortal Performances. (With Rachmaninoff, Farrar, McCormack, Zimbalist, Hugo Kreisler.)
RCA Victor LM 6099 (2) mono

Listeners with a quick ear for current-day style will find a good deal more to notice in these reissue LP's of assorted early Kreisler discs than the mere recorded sound, with its limited tonal range and lack of acoustical liveness. Much more interesting is the pervasive sense of change in the manner of performance, between these renditions and the norm for the same music today. You wouldn't think that the violin could be subject to such change in the manner of playing, especially in such music as Beethoven; yet even in stereo and hi-fi these Kreisler performances

SCORDATURA

Heinrich Biber: Fifteen Sonatas for Scordatura Violin and Continuo; Passacaglia for Solo Violin. Sonya Monosoff, vl.; Melville Smith, organ and harps, Janos Scholz, vla. da gamba, John Miller, Bassoon.
Cambridge CRS 1811 (2) stereo

This splendid album kept me busy for a solid evening—it is a once-in-a-blue-moon rarity that, given solid attention, will delight anyone who has a good ear for beautiful playing and a liking for the now-popular Baroque music.

"Scordatura" is the key word. It indicated a violin deliberately mistuned, or rather, tuned to some special tuning other than the normal. Each of these fifteen Sonatas by the once-well-known Heinrich Biber (born 40 years before Bach and Handel) is composed for a different violin tuning. Sometimes all four strings are de-tuned, up or down; often a thicker or thinner string is substituted, or an A string is used to replace the lower-pitched D string. The result is in every case, first, a unique change of tone quality, different for each work, and second, a whole series of novel double- and triple-stop passages that would be utterly impossible with normal violin tuning.

In effect we have fifteen different stringed instruments here (Miss Monosoff, in fact, had to string up six violins to encompass all the pieces) and fifteen different sorts of violin writing, within the straightforward and simple mid-Baroque instrumental style.

What will appall those who know the violin is the performing technique required—for the written notes in these works do not indicate normal pitches at all, but become tablature; that is, they merely indicate places to put the fingers on the finger board. The sounds are not heard as written but vary according to the tuning of each string.

It is as though for each piece the performer has to play in four different keys simultaneously, one for each string! Or, if you will, make four different transpositions simultaneously. Under the circumstances, only a violinistic wizard could hope to work up the necessary finger coordination, the eyes seeing one thing, the ears hearing another.

What is most astonishing, then, is that with all this nightmare of finger-twisting re-coordination, Sonya Monosoff manages to play not only beautifully but superbly, with the loveliest phrasing and the most perfect sense of pitch I ever hope to hear. Very simply, she makes unforgettable music out of these works, where many another experimenter, having survived the tuning nightmare, might produce no more than a mechanically correct rendition.

She is wonderfully aided by the varied continuo realizations, accompanying her via a modestly changing ensemble, sometimes organ alone (a lovely old one-manual Dutch instrument), sometimes with viola da gamba (an instrument actually made for this composer, it seems), or bassoon, occasionally with harpsichord (mean-tuned, instead of the modern tempered pitch), to contrast lightly with the organ sound. Excellent stereo recording is the ultimate touch in a very nearly perfect album.

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could be spotted at once as already of another age.

What differences? Too many—and too tricky—to describe in mere words! Try for yourself: the music here jumps from Schubert-Beethoven and Grieg (with Rachmaninoff at the piano) to Bach (with Zimbalist) and "Mighty Lak' a Rose" (with Farrar). Also some Rachmaninoff songs, with McCormack and *without* Rachmaninoff. Both acoustic and electrical recordings are included, dating from 1914 to 1928.

So Early in the Morning. Irish Traditional Songs, Rhymes and Games. Collected by Diane Hamilton.

Tradition TLP 1034 mono

Anyone who loves folk *song,* who loves the Irish and the Irish speech and lilt, who thinks children are wonderful and who—most important—knows fine music-making when he hears it, will find this record a most pleasant experience.

Diane Hamilton, guiding light of Tradition Records and an old-time Irish enthusiast (she plays the Irish harp herself and sings Irish folk songs to it) made these tapes on various occasions during her stays with the Clancy family with its dozens of assorted children and grandchildren; so this is a home-style disc, made right in the family, though it would seem there are dozens and dozens of different performers.

Short rhymes, longer ballads, songs by kids, songs for kids sung by the elders, all go into the collection. Many of them are variants of tunes and texts familiar to all of us. Others are new ones in familiar patterns—the "partridge in a pear tree" cumulative song, for instance. Lovely stuff for family listening on your own, via hi-fi.

A Double Barrel Blast: The High Cost of Dying; Listening In On Computer Conversations.

Cook 1078 stereo

Emory Cook is the most cryptic engineer in the record business. Sometimes it's hard to know whose leg he's pulling and whether it's an arm or a leg or maybe, just a shotgun trigger. This one is typical and as zany as they come.

Side 1 is a whiz. We are listening in on a lengthy phone conversation, ostensibly genuine (no one could invent *this* stuff . . .) between a solid Italian-American citizen and an undertaker, ditto. The first-named's Uncle Willie, or something, has died on him in the front parlor—whaddya do about a funeral? It is quite realistic, matter of fact and wholly delightful, even to bits of language commonly heard everywhere, though not on the air, ever. Goes on interminably, pleasurably—and the fact is that I can't imagine how on earth such an incontrovertible documentary ever got taken down on tape. The surprising lack of correspondence between Mr. Cook's jacket write-up and the actual recorded words merely adds a bit more mystery to as charmingly zany a recording as you'll likely hear anywhere.

This computer stuff? Nobody but Emory Cook could subject me to a whole LP-side of corny humor, as supposedly spoken by two rival computers (one analog, one digital) and leave me at the end still genuinely befuddled as to whether these insane conversations actually *are* out of computers, or are merely actor-simulated! You try. *You* guess.

QUARTETS

Haydn: Quartet in D Op. 64, No. 5 ("The Lark"); Quartet in F Op. 77, No. 2 ("Lobkowitz"). Hungarian String Quartet.

Vox STGBY 512.080 stereo

The Hungarian String Quartet musicians, coming from Haydn's own background, are the finest players of these Haydn quartets I have yet to hear. Somehow, one feels, this music is to the Hungarian mind so natural, so inevitable of its sort, that the performers scarcely have to play—the music simply appears of its own accord, justly and perfectly, true in style and knowing in expression! There's no cuteness and self-consciousness of the "Papa Haydn" sort here, nor any false Romanticism; it is all Haydn and very great Haydn. Moreover, the recorded sound is lovely even though the mike pickup is close and with wide spacing of your speakers the instruments may seem to perform in a line straight across the room. No matter; the music is splendid just the same.

Schumann: Quartet in A, Op. 41, No. 3; Stravinsky: Three Pieces for String Quartet.

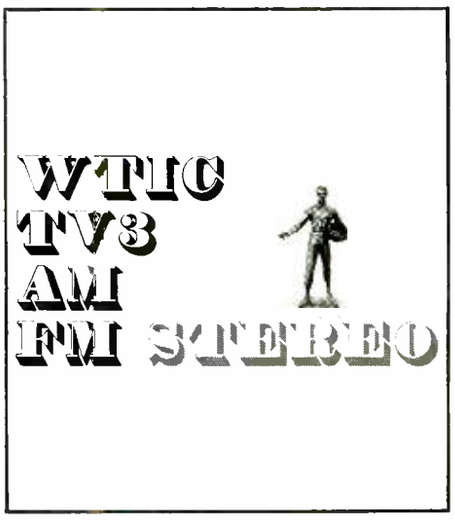
Mozart: Quartet in G, K.156; Ravel: Quartet in F. Quartetto Italiano.

Angel 35733; 35732 stereo

Few "live" listeners to chamber music have the chance to compare the sounds of different quartets as we do who listen to records. The string quartet, you'll discover, varies much more dramatically from group to group than do the larger symphony orchestras. String quartets are highly individualistic—four individual players, four hand-made instruments (usually very old) and a dynamic unity in performance that makes the quartet relationship a kind of super "family" one, and perhaps even more difficult to maintain over the years than any family ensemble.

The Quartetto Italiano is famed for its precision and these young people show it easily in these recordings—notably in the Schumann, with its profuse *rubato* (Romantic slowings-down and speedings-up). But what will strike you even more quickly is the florid, wiry, sensuous tone color achieved, replete with Romantic vibrato. These people are of the neo-Romantic School, it seems, and like other younger performers they seem almost to overdo the Romantic effort.

Yet this sort of ensemble, each player carrying a highly individualistic line yet working precisely with his fellows, affords interesting musical results even in Mozart—not to mention Stravinsky. AE







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JAZZ and all that

CHARLES A. ROBERTSON



STEREO

Woody Herman: **Encore**
Philips Stereo PHS600092

Nothing to appear between album covers so far this year is more worthy of being encored than the anniversary set that introduced the brilliant new Woody Herman band. Requests for a return performance were filled during an engagement at Basin Street West, and the welcome extended by a delighted Los Angeles audience on this in-person recording echoes the demand for more of the same. After giving the band business another lease on life with one of the best groups in twenty-five years as leader, the veteran clarinetist is rolling in good times again and has every reason to celebrate. By way of topping the festivities, he takes the liberty of bringing back one of his old hits for a personal encore and turns out the most riotous reading yet of *Caldonia*.

Under the heavy influence of paying guests, the band is even more thrilling and enthusiastic than before. If a little studio polish rubs off in all the excitement, the loss is restored twice over by the faultless engineering of United Recording's Wally Heider. Each section is allowed to charge in its own stereo direction, but soloists never stray far from a realistic blend with the rest of the band. Another healthy contributor is Nat Pierce, who arranged five numbers and serves as second in command. Whether charting a popular ballad or the Basie-styled *That's Where It Is*, his chief concern is that everyone swings constantly. Fancy writing is passed over in favor of imaginative solos from such likely youngsters as Phil Wilson, Billy Hunt, Henry Southall and Frank Hittner. Two side trips include Bob Hammer's stirring visit to the gospel world of Charlie Mingus on *Better Get It In Your Soul*, and Bill Chase puts the tenor sax of Sal Nistico bravely into the hull ring on *El Toro Grande*.

Clare Fischer: **Surging Ahead**
Pacific Jazz Stereo PJ67

Way back when the giants of jazz piano developed original styles and battled into the early morning hours for keyboard supremacy, the term "composer piano" was coined to distinguish certain noncombatants who served behind the firing line. Lacking the solo impact of the big guns, they planned strategy or kept open supply routes to the front. Jazz is undoubtedly much richer because the Duke Ellingtons and Thelonious Monks were unable to outsalvo such rapid-fire experts as Art Tatum and Oscar Peterson. But just as nuclear fission altered the business of war, so has increased recording activity encouraged some pianists to step out of character, and forced the rest to become more versatile. Even Ellington is making daring sorties of late, while Clare Fischer exemplifies the youngsters who at one moment appear studious and reticent only to start toying with dynamite the next.

Before moving on to write for Dizzy Gillespie and other jazz notables, Fischer learned about tactics as accompanist and arranger with the Hi Lo's vocal group. His explosive potential as pianist remained hidden, however, until the release of a trio album called "First Time Out," which amazed listeners and startled the critics. Among the works performed were five Fischer originals, composed in purely pianistic terms and delivered with the striking force of a guided missile. This second trio foray for the same label involves several jazz standards of the sort pianists like to use as proving grounds when seeking to impress their peers.

Even when concentrating on displays of fire power, Fischer remains a composer at heart and tries fresh maneuvers or advanced ideas between bursts. After a breath-taking version of Charlie Parker's agile *Billie's Bounce*, the pace changes to the sultry waltz theme of Larry Adler's *Way Down East*. Two salutes in Ellington's direction prompt the only original of the set, a gospelized tribute to Billy Strayhorn, unless composer credit also be granted for the complete refurbishing of *Davenport Blues*. Bassist Gary Peacock and drummer Gene Stone, who helped at the first launching, serve again just as nobly, until relieved by Ralph Pena and Albert Stinson, or Colin Bailey and Larry Bunker.

Walt Dickerson: **Jazz Impressions of Lawrence of Arabia**
Dauntless Stereo 6313

Because Maurice Jarre wrote a good part of the music to combine with the sounds of filmed events, the score of "Lawrence of Arabia" lends itself admirably to this impressionistic jazz treatment. Instead of being superimposed upon a sound track, the clatter of camel hooves becomes a subtle rhythmic pulse underlying the melodic improvisations of vibist Walt Dickerson. Freed from the necessity of conforming to the action, Dickerson develops themes at length before handing them over to Austin Crowe, the quartet's pianist, for imaginative comment. As arranger, Dickerson also uses his intimate knowledge of Afro-jazz to enlarge upon the original score. The scenic beauties and dramatic events of the film are never ignored, however, even though they are subordinated to the composer's labors for a change. A bowed-bass phrase from Henry Grimes suggests the majesty and ominous size of the desert, while the leader's vibes achieve much the same effect by taking over the electronic tasks assigned the *onde martenot* in the theatre. Percussionist Andrew Cyrille depicts the swift progress of the camel corps or the distant sounds of battle without trampling on his comrades. Stereo and superb engineering enable the plucky little foursome to sweep across the large screen's vast reaches.

Charlie Shavers: **Excitement Unlimited**
Capitol Stereo ST1883

While bright, new trumpeters burst into prominence and then fade away after failing to create a durable style, the Charlie Shavers sound remains as fresh and clean as the day it was minted. Designed along classic lines, it can ride a rocket's nose cone as easily as it traveled the road of sentimental swing with Tommy Dorsey. All that it needs to fit into the jet age are the smart, modern settings which Shavers provides for the octet put into orbit here. Besides introducing five originals, he invents a heat shield for two favorites of his John Kirby Sextet days and relaunches *Undecided* and *Opus 5*. Also built to handle any emergency on land, sea or in the air are fellow astronauts Jerome Richerson, Budd Johnson, Billy Byers, Tommy Byrant, Bruce Martin, George Barnes, and Oliver Jackson. Excitement may be what Shavers is selling, but the lyrical side of his genius gets a chance to shine through on *Tenderly* and *Porgy*. And a bit of old Onyx Club humor turns up during his vocal on *School Days*. The octet takes off from a broad stereo launching pad, and engineer Johnny Cue lets Shavers soar at will.

Amanda Ambrose: **Recorded Live!**
RCA Victor Stereo LSP2696

When an unknown makes a recording debut before an audience in a night club, there must be a good reasou. This young singer has the backing of Harry Belafonte and Miriam Makeba, who presented her to the crowd at the Village Gate in Greenwich Village, but the main factor behind the public launching seems to be that she is too live and kicking for studio confines. Discovered working in Chicago clubs, Amanda Ambrose is built along the same lines as Nina Simone and, in true Windy City tradition, cast in a larger mold than the Philadelphia lass. Already the mother of five children, she sings in vigorous and uninhibited fashion and thumps out her own rollicking piano accompaniments.

Her gospel stylings recall the enthusiasm of a country revival meeting as well as the urbanized soul currently in vogue, and the two congregations are brought together on a glorious *This Little Light Of Mine*. For city sophisticates, there are clever renditions of *This Can't Be Love* and *Bessie Mae Mucho*. For country cousins, there are eloquently humorous versions of *Tennessee Waltz* and *When Irish Eyes Are Smiling*. And she captures the jazz audience with *A Foggy Day* and *Come Rain Or Come Shine*. Osie Johuson, Bill Salter, Sam Brown and Auchee Lee make up the supporting quartet, and engineer Bill Simpson manages to keep everyone walking a straight two-channel path.

BOSSA NOVA ROUNDUP

Stan Getz/Luiz Bonfa: **Jazz Samba Encore!**
Verve C293 (4-track UST)

If none of the songs appears to be fated for the popular success of *Desafinado*, this second round between Stan Getz and the jazz samba is in many respects more rewarding than the first. Acting as seconds in his corner this time out are guitarists Luiz Bonfa and Antonio Carlos Jobim, two experienced advisors on the gentlemanly art of rhythmic endeavor. Also lending encouragement from ringside is Maria Toledo, who writes lyrics to Bonfa's songs and engages in an enchanted sort of vocalese. Just about the only member of her sex to know bossa nova from the inside, she tosses numerous helpful ideas in the tenor saxists's direction. Getz has developed a great defense by now, blocking any Brazilian trickery by thrusting forth one of this country's half-forgotten popular songs like any other seasoned bossa novaist. In fact, the round is won through two songs devised in just this manner. Detecting the number of disguised melodies thrown about in the heat of battle is a test of the true aficionado. Four-track stereo tape does full justice to Getz's beautiful tone, and the listener gains a choice seat between unamplified guitars at ringside.

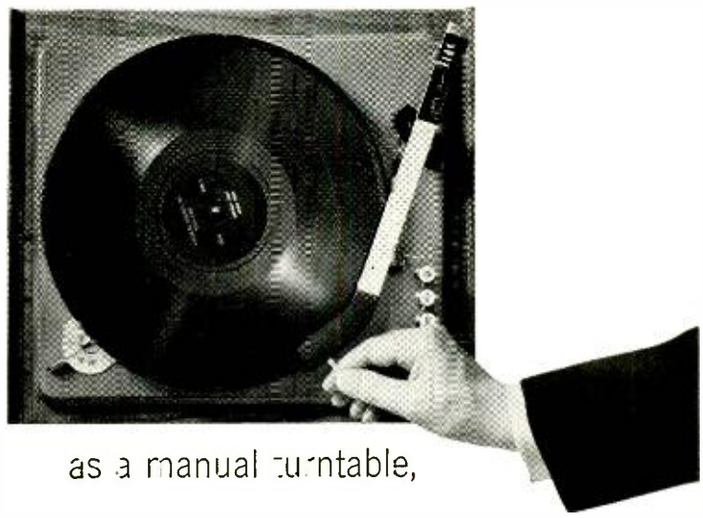
Charlie Rouse: **Bossa Nova Bacchanal**
Blue Note Stereo ST84119

As Thelonious Monk has yet to give bossa nova a stamp of approval, Charlie Rouse must make his bow in the direction of Brazil from someplace besides his regular post in the pianist's quartet. The tenor saxist also defers to his boss by relying on two Spanish concert guitars instead of hiring a piano substitute, but his playing becomes much freer and more relaxed when not under constant surveillance from the master. Rouse does follow the example of one of his peers, however, and prepares for bacchanalian goings on further south, as Sonny Rollins did on a recent recording, by lingering briefly among the calypso islands of the Caribbean. From Haiti comes a song once recorded by Harry Belafonte, *Merci Bon Dieu*, and Leighla Whipper contributes the lively *Back To The Tropics* and *In Martinique*. Percussionists Willie Bobo, Potato Valdez and Garvin Masseaux also are right at home here, but later everyone enjoys dancing through the streets on Luiz Bonfa's *Samba de Orfeu*. Rouse's original, *Un Dia*, unites the two highly rhythmic cultures, and stereo harnesses choice teamwork from guitarists Kenny Burrell and Lord Westbrook.

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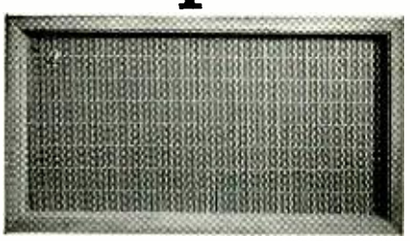
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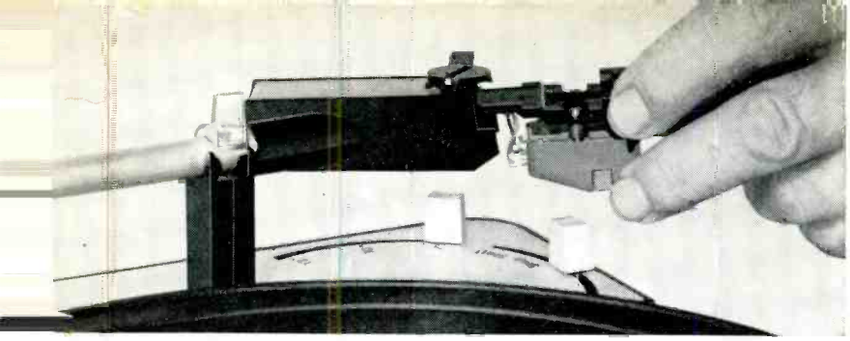
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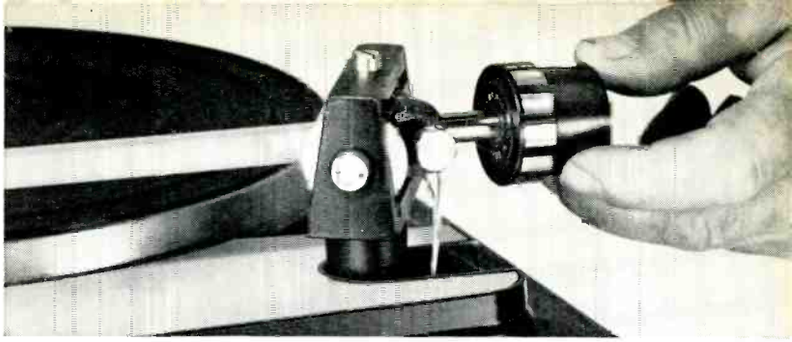
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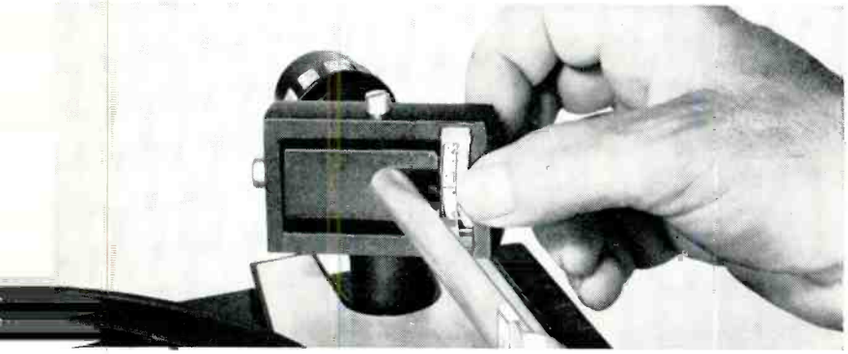
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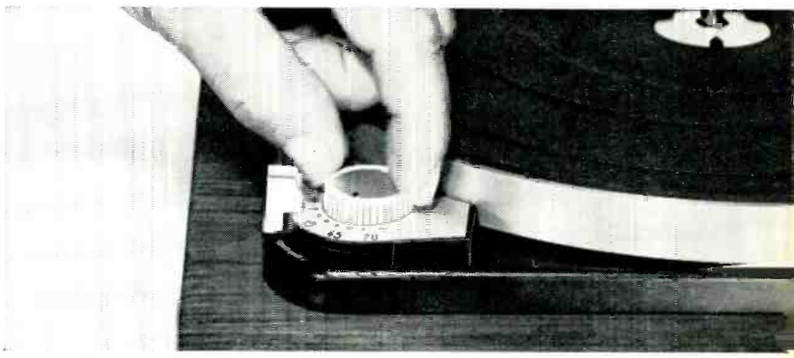
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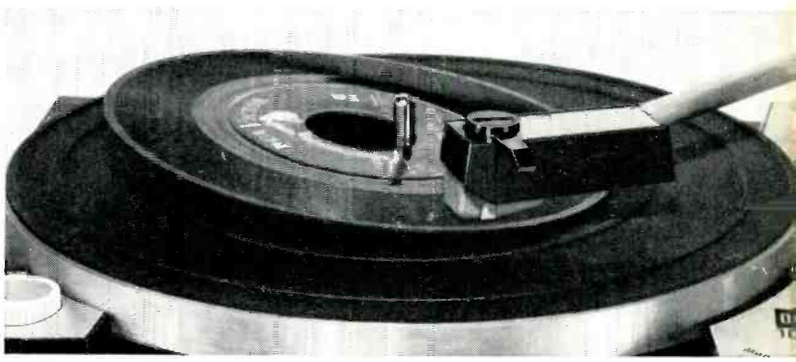
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