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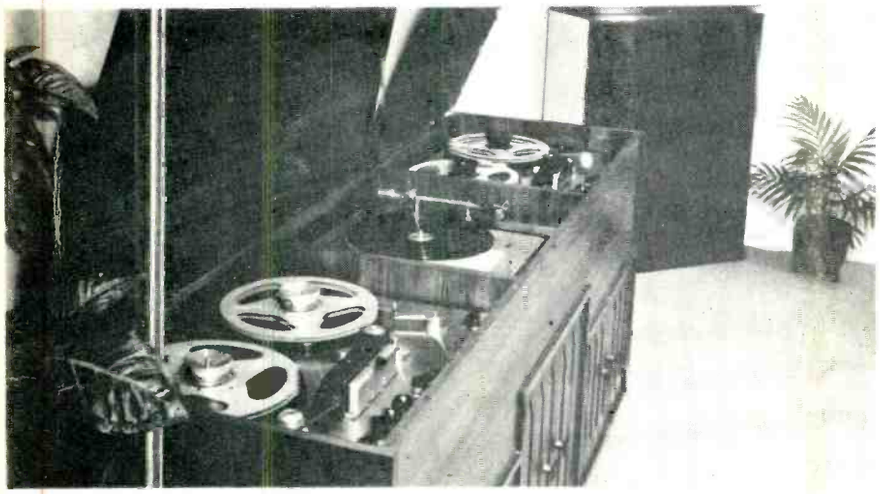
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60¢

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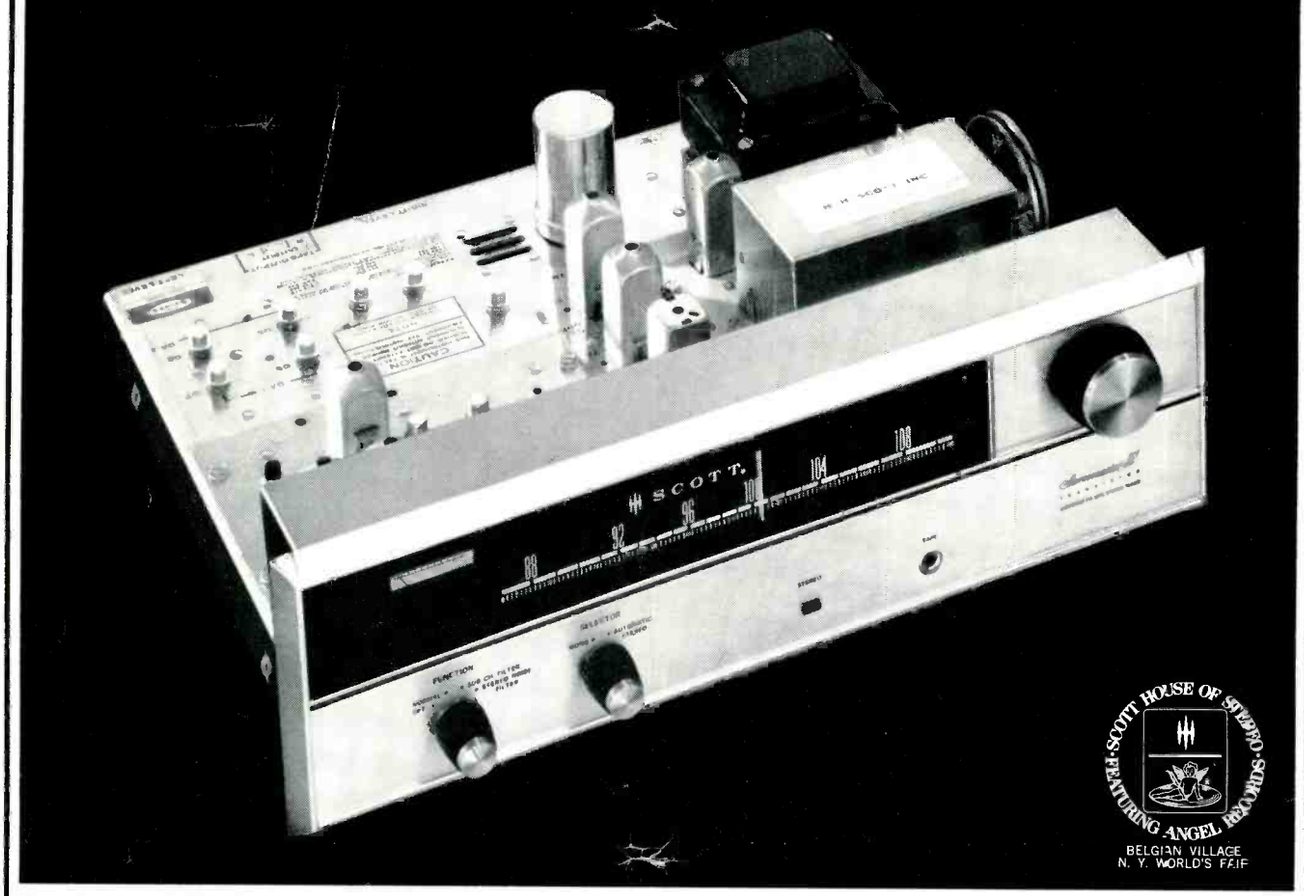




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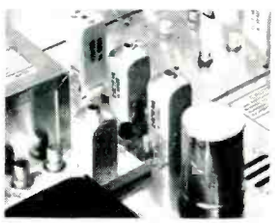


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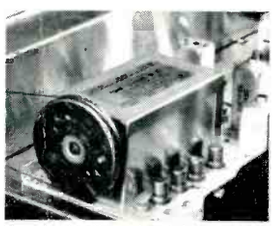
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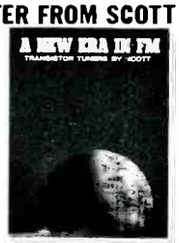
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AUDIO

JULY, 1964 VOL. 48, NO. 7

Successor to RADIO, Est. 1917

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ANNUAL PRODUCT PREVIEW

• Next month AUDIO unveils the "latest greatest" crop of audio equipment, some old, most new. This year's crop pinpoints the emerging trends. Those interested in buying will find the information needed to make an intelligent decision. There will be technical specifications, descriptions, and of course prices.

• This year there is something new: for the first time, we are attempting to list products available for commercial sound applications, as well as for home use. We will be showing speakers, microphones, amplifiers and all the other equipment necessary for commercial sound reinforcement.

• And in addition to all this, of course, we will have our usual AUDIO articles: the next installment of the commercial sound course, and the conclusion of the article "Class-D Amplifiers" by Mr. Stark—plus more that we don't have space to list.

In the August Issue

On the newsstands, at your favorite audio dealer's, or in your own mailbox.

AUDIO CLINIC

Joseph Giovanelli



Send questions to:
Joseph Giovanelli
2819 Newkirk Ave.
Brooklyn 26, N. Y.
Include stamped, self-addressed envelope.

Output Transformer Substitution Problem

Q. I am at present preparing to construct a power amplifier based on the article "High-stability feedback amplifier" by Arnold Kauder, AUDIO, *October, 1962. I have a chance to purchase two push-pull output transformers having the following specifications: primary impedance 6,600 ohms; secondary impedance 500, 250, 125 ohms; primary (d.c.) current rating in each leg 50 ma; frequency response 7–50,000 cps at 25-watts maximum.*

These transformers are fully potted and shielded and available far below manufacturer's list price. I have the following questions about these units:

1. Is there a practical method of matching the output impedance of these transformers to 16-, 8-, or 4-ohm speaker networks at the indicated power rating? (Naturally, I wish to have the least distortion, loss of frequency response, and so on.)

2. I am using two 5881's, in push-pull with 360 volts on the plates, 270 volts on the screens, and 22.5 volts of negative bias on the control grids. No-signal plate current for two tubes is 88 ma. and maximum signal current is 132 ma. Can the above transformers handle this load? Thomas D. Joy, Boston, Massachusetts.

A. The transformers you describe can be used only in conjunction with line-to-voice-coil transformers. The added cost of these line-to-voice-coil transformers may offset the savings obtained by the purchase of the two transformers you described.

The transformers will easily handle the power provided by the amplifier you plan to build. Furthermore, you can match the impedance of the secondaries of these transformers to the impedance of any speaker system with little difficulty. In order to do this, however, you must purchase line-to-voice-coil transformers having the proper primary and secondary impedances. Be sure that *these* transformers can handle the full power of your amplifier and that their frequency response is flat over the audible range at maximum power.

If you use the line-to-voice coil transformers, you may have to adjust the feedback in the amplifier. You must decide whether the feedback should be obtained from the secondary of the output transformer or from the secondary of the line-to-voice-coil transformer. You may not be able to use as much feedback as is called for in the amplifier design. Even if it should happen that you can use the called for amount of feedback, you may have to adjust the values of the components in the feedback loop until proper operating conditions are met.

Monophonic Reproduction with Stereo Cartridges

Q. I have a monophonic system and have been using only one channel of my stereo cartridge. This arrangement sounds just fine to me. I play mostly monophonic discs.

However, I have been told that for best results I should connect both channels together. Is this true? If so, what impedance should be used to load the combined output? The recommended load is 47 k.

Also, what effect does this have on the frequency response if the cartridge is loaded with an impedance which is higher or lower than the recommended value? Arthur L. Stanhope, Shirley Hills, New Jersey.

A. Unless otherwise stated in the instructions accompanying your cartridge, you can parallel the two halves, or channels, and thereby obtain the best possible monophonic sound reproduction. There will be negligible change in the performance of the cartridge. You will not need to alter the preamplifier so that the cartridge will see a different impedance.

If the cartridge is loaded with a resistor lower in value than that recommended by the cartridge manufacturer, the upper treble will be reduced.

If the cartridge is loaded with a resistor higher than that recommended, the treble will be exaggerated and stridant.

It is most important to keep in mind the fact that the proper terminals of the cartridge must be paralleled. If not done correctly, you will cancel all sound created by the lateral motion of the stylus. Monophonic recordings are not playable on a system with the cartridge wired in this way. Only vertically-recorded discs, hill-and-dale recordings, can be played. The terminals must be jumped in such a way that the vertical signal produced by vertical motion of the stylus, is cancelled, and the horizontal, or lateral, signal is allowed to be heard.

By removing the vertical component, tracing distortion will be considerably reduced and surface noise will also be reduced in many instances. Further, if the table has some vertical rumble, this will also be eliminated.

Transistor-versus-Tube Amplifiers

Q. I am now visiting the United States from the Far East. It is my desire to replace some of the stereophonic equipment I now have with equipment of a later design. I had the idea when I came over, to purchase one of the new transistor amplifiers.

I have talked to quite a few equipment distributors and equipment repairmen. In each instance these men cautioned me against the purchase of such equipment.

Would it be asking too much for your comments on this subject and such recom-

(Continued on page 46)

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LETTERS

Home Tape Recording Legal?

SIR:

In the article by Mr. Eric Darmstaedter, "Tape Recorders and the Copyright Law," Mr. Darmstaedter quotes Mr. Stanley Rothenberg to the effect that any home tape recording of music is an infringement of the Copyright Act. If Mr. Rothenberg has been quoted correctly, I believe that he is the only copyright lawyer who believes that home tape recordings of copyrighted music constitute an infringement of the copyright. Section 1 (e) of the Copyright Act provides that a copyright proprietor has the exclusive right to make recordings of music only for the purpose of public performance for profit and for the purposes of printing, reprinting, publishing, copying and vending. (Please note that the word "copying," by virtue of a United States Supreme Court decision, does not include the making of sound recordings.) The usual understanding of this provision is that copyright owners can control recording rights in music only when the recording is done for profit. The above comments, however, apply only to music, since it is clear that the unauthorized tape recording of copyrighted literary or dramatic works would constitute an infringement.

The other legal problems raised by Mr. Darmstaedter on page 69 of AUDIO are also of no concern to home users of tape recorders. Labor agreements are binding only on the parties who sign them, and I know of no case holding that an individual's reproduction of a recording for his own use would constitute unfair competition with the manufacturer of the recording.

DAVID W. MAHER
Kirkland, Ellis, Hodson,
Chaffetz & Masters
Prudential Plaza
Chicago, Illinois 60601

Tax Tape?

SIR:

The article by Eric Darmstaedter touched on a question which has (or should have) pricked the conscience of many tape enthusiasts; namely, the pirating of material from various sound sources, particularly FM radio. There can be no question that this practice gives rise to serious inequities, but is nevertheless ardently pursued because it is enjoyable and economical, and appears to do no immediate harm. Mr. Darmstaedter suggests that the copyright laws should be revised, since they cannot be enforced in private tape recording. However, the inequity would still remain since artists, seldom the most affluent members of society, would not be compensated fully for their work.

I would like to throw out a suggestion, which, while somewhat imperfect, would correct the situation in large measure. If a federal tax were placed on home tape, and the proceeds used as royalties (admittedly distributed under an elaborate formula) to pay artists whose works are broadcast, at least the spirit of the present copyright laws would be maintained. Since tape recordists pursue this practice almost exclusively for pleasure, and most audio tape sold is probably used for unauthorized recording, they should not object to the just compensation for the artist, who derives his livelihood from performances.

MILTON GOTTLIEB
160 Le Beau Pike
Pittsburgh 21, Pa.

Four-Masters and Yachts

SIR:

In the last issue or two of AUDIO, certain pipe organ addicts have taken to pounding the electronic organ in prose when, presumably, they would never deign to pound one in practice. This seems unnecessarily hard usage, and I would like to suggest that a sense of proportion is involved.

To compare these instruments is somewhat akin to comparing a four-masted full-rigged ship with a small well-found yacht. Both have their place and comparisons seem to serve little purpose for they play in separate leagues, as it were. Very few people will attempt to discredit the experience of hearing a centuries old pipe organ in an even older cathedral, for it is admittedly matchless in a man's home and he must reduce both accordingly. To me the electronic organ is not a cheap and nasty version of a pipe job; it is an instrument in its own right which has a performance vastly superior to that of a pipe model of similar size. On this continent families move an average of every two years or so and it is nice not to have to dismantle the house to get the organ out. As for church installations, I do not think the outcome for the congregation will be affected either way; the Almighty may even prefer silence.

I fully agree with Mr. Pike about A.G.O. spacings, short manuals, etc. but of all organ music played today, how much is long-haired stuff (sorry, 'real music')? 10% maybe? Thus are not 25 pedals and a correspondingly smaller console adequate? What is played is simply a matter of taste and to an uncomplicated soul like myself fugues and such like are horrible, tuneless dirges, and "Blacksmith Blues" does far more for me than anything from the estate of Mr. Bach. This, to some people, heretical viewpoint could possibly change with increasing wisdom but that is how it is now and I venture that I am not alone in it.

It will seem a sorry day when the great pipe organs go the way of the sailing ship for both are magnificent concepts, but we might as well face it that this day will eventually arrive. The electronic newcomer occupies far less space, is within financial reach (well, almost!), can respond as fast as human hands can play it, and is entirely adequate for the vast majority of musical requirements. Hence, like sex, it is here to stay awhile and I consider that undue criticism will not much impede its development into something in which even the musical elite can delight.

JOHN PLEWES
R.R. 1
Millgrove, Ontario, Canada

He Wants More

SIR:

I would like to see an article further discussing the pros and cons of the crossover network proposed by Mr. Robert Mitchell in his article in the January issue of AUDIO. Better yet, a discussion and schematic of a working model.

R. J. FORRESTER
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Inglewood 1, Calif.

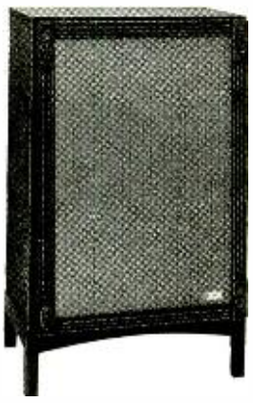
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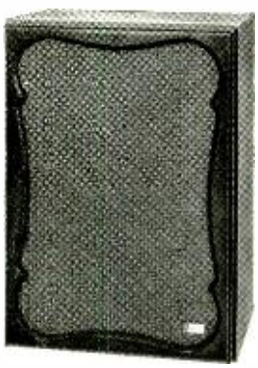
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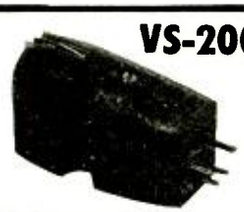
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LIGHT LISTENING

Chester Santon

High Spirits (Original Broadway Cast)
ABC-Paramount ABCS-OC-1

This show recording packs surprises in several important departments. The most refreshing surprise of all is the one that's easiest to detect. For the first time in many months, I've encountered an original cast show on stereo disc with a sound that can be described as wide range, flat in response curve and lacking in distortion. The revelation comes in finding all this on one of the "small" labels that hasn't been too active in bidding for rights to Broadway musicals. One can only assume that ABC-Paramount is content to offer straightforward, high quality sound in this disc because it simply doesn't have the manpower to contact record dealers across the country to find out what the mass market wants in a response curve that'll make a typical phono unit sound "great."

It is a further pleasure to report that ABC's quality sound is not wasted on a humdrum musical. In transferring Noel Coward's hit comedy, "Blithe Spirit," to the musical stage, the producers have crammed top talent into every facet of this attractive package. Even the finest of experienced casts can't get a show off the ground if the music has no appeal. The cast directed by Coward himself is a powerful one yet the strongest point in "High Spirits" is the melody and grace of the songs supplied by Hugh Martin. The composer of *The Trolley Song* and *The Boy Next Door* is just the man to capture the whimsey and romance of this beguiling ghost story. Tammy Grimes plays the part of the former wife whose spirit materializes on stage to break up the hero's second marriage. Although she has some of the best numbers (*Something Tells Me* and the word-tumbling *Faster than Sound*), Miss Grimes cannot prevent Beatrice Lillie from stealing the show as the bungling medium, Madame Arcati, whose seances occasion all the ghostly pandemonium. Miss Lillie's gusto and clarity of attack in *The Bicycle Song*, *Go into your Trance* and *Something is Coming to Tea* make one forget that she was also a favorite comedienne of an earlier generation. On the merits of "High Spirits" alone, the 1963–'64 season cannot be considered a theatrical year lacking in luster.

Funny Girl (Original Broadway Cast)
Capitol VAS 2059

Every now and then a musical comes along that breaks with the usual story pattern. How many shows can you recall whose heroine is an ungainly ugly duckling at the start of the plot and is still in that predicament at the final curtain? "Funny Girl," Barbra Streisand's first starring musical, has just such a story. Many theatergoers of the present generation may find the premise of "Funny Girl" a bit hard to believe because they know so little of the stage career of Fanny Brice, upon whose life story this musical is based. That story receives sympathetic treatment at the hands of producer Ray Stark, who happens to be married to the daughter of Fanny Brice. Since the high powered glamour of a typical stage star was about the last thing the heroine could claim, "Funny Girl" relies heavily on the recreation of Miss Brice's Ziegfeld Follies days for glamorous present-day entertainment. Relying on the youthful appearance of Barbra Streisand in the role of Fanny Brice, the musical's plot sketches in the awkward auditions of a stagestruck teenager and then concentrates on her early Ziegfeld days. The excuse for love songs is the romance leading to Fanny Brice's unsuccessful marriage with the gambler and man-about-town Nick Arnstein, played with authority by Sidney Chaplin. The portrait of "Funny Girl" that emerges in this original cast recording is a mixture of mild, old-fashioned comedy (women performers apparently didn't have to knock themselves out to draw a laugh in those days) and a poignancy rare in a musical these days. In all facets of a demanding role, Barbra Streisand turns in a very workmanlike job. Highlights of her performance are the free-wheeling *Cornet Man*, with its throwback to an early jazz period and *People*, a haunting tune that will keep this show represented in future collections of Broadway's top songs.

Andre Kostelanetz: World-Wide Wonderland
Columbia AKS 1

Andre Kostelanetz: New York Wonderland
Columbia CS 8938

Now that New York City is playing host in Flushing Meadow Park to World's Fair visitors from all over the world, Andre Kostelanetz salutes the event with this special package. Combined here are the tunes most American listeners associate with foreign countries (including those written in Tin Pan Alley) and the tried and true selections of past decades that use Manhattan for a theme. The allusion to the Fair is just about the only modern touch in these albums. These is very little of a topical nature in the music of either disc. This is not to say that the release is lacking in a certain historic importance. No less a dignitary than Robert Moses, president of the 1964–'65 World's Fair, has provided liner notes for the New York album. Persuading Mr. Moses to pause long enough in his perpetual battle with his critics to compile even these brief liner notes probably represented Columbia's greatest effort in turning out these records. The sound on the discs indicates that the recording crew spent very little time fussing with gain in the control room, letting the limiters do most of their work in taking care of the peaks. Whether plowing through *Danube Waves* or the waterfront of New York City, the orchestra enjoys its only freedom in dynamics while playing the quieter pieces in these collections.

Laurindo Almeida: Broadway Solo Guitar
Capitol T 2063

Mono easily takes care of the music making in this no-problem recording of Broadway show tunes. Guitarist Laurindo Almeida has long been an outstanding attraction on the Capitol label with a fine list of recordings running the gamut from classical guitar to jazz arranged for that instrument. In a real change of pace, here he brings his proven talents to a wide variety of Broadway songs, some old, some new. Well aware of the introspective nature of the guitar's quiet voice, Almeida has limited himself to songs of a reflective nature in making up his program. Luckily, the show world has never suffered a shortage of such fare, ranging in time from classics of the musical theatre ("Roberta," "Babes in Arms" and "Jumbo") to recent productions such as "Stop the World," "Funny Girl" and High Spirits." As an unobstrusive source of late evening relaxation, this disc would be hard to beat. AE

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ABOUT MUSIC

Harold Lawrence

Acoustics and Miniature Concert Halls

A large crate arrived last fall at the offices of Bolt, Beranek & Newman, the acoustical consultants in Cambridge, Massachusetts. In it was a 1/10-scale model of a 3000-seat concert hall, complete with stage, balconies, acoustical clouds and seats. The BBN acousticians had been eagerly awaiting the model and were prepared to subject it to a series of tests which, they hoped, would result in further refinements in its acoustical design.

The miniature auditorium was set up on three-foot-high supports in one of BBN's laboratories. Totally enclosed in a plastic bag, it resembled a giant F.O.A. Schwartz doll ready for shipment. Two members of the BBN staff, Russell Johnson and Robert Newman, invited us through a slot in the bag and we snaked our way toward the entrance of the hall. (The bag controls the humidity inside the auditorium, a critical factor in scale acoustical studies.) Johnson pried open the hall at a point parallel to the apron of the stage, and we walked inside.

It gave one an eerie feeling to look out over the rows of seats and terraces; having seen several concert halls in near-completed states, the interior of the model with its unpainted walls, bare stage, single overhead light, and smell of fresh lumber was startlingly realistic (*Fig.* 1). Two objects caught our attention: a B. & K. microphone lying in a row of orchestra seats, and a spark generator on the stage. Suddenly, the back wall of the auditorium started to give way, and there appeared the face of Dr. Leo L. Beranek framed in the doorway like a bespectacled Gulliver. The model, Beranek pointed out, had been constructed on the stage of the Yale University Theatre last year at a cost of nearly $7,000. The architects there had worked on the mechanical and lighting aspects of the hall, making adjustments to improve the physical design, experimenting with lights, and so on. Then they packed it up and delivered it to BBN.

What do the acousticians expect to learn from this model? To some architects and audiomen, the results of such experiments are dubious. It is simple enough to cast scaled-down beams of light across seats and stage area and to check sight lines, but quite another matter to test music in a miniature hall. Is it really possible to predict accurately the acoustical environment of a projected hall based on the ways in which sounds from loudspeakers, spark generators and tone-burst generators behave in a scale model whose inner surfaces differ from those of the full-scale hall? Not completely, say the acousticians, including BBN. But scale models, they claim, can provide us with valuable technical information, clues to the effects of structural alterations on the sound qualities of future building. Especially when the results of the scale model tests are compared to tests in the finished hall.

The use of scale models for sound experimentation has become increasingly popular among acousticians, especially in Europe. Intrigued by the concept of Lilliputian concert halls, newspapers and scientific magazines regularly bring forth auspicious reports on the activities of sound engineers engaged in "scale-downs." On November 24, 1963 the *New York Times* printed a story on a series of experiments conducted by Prof. Friedrich Spandock of the Technological University of Munich, Germany, Professor Spandock, the item stated, had developed "a recently perfected technique [which] promises good acoustical planning in the early design." The technique consists of recording a musical composition in an anechoic chamber. The tape is then played back inside, say, a 1/10-scale model, using an ultrasonic head on the tape recorder and an ultrasonic microphone. The latter relays the high-speed music to a tape recorder operating at ten times the normal speed. The tape finally is heard at normal speed. In this way, the experimenter will supposedly hear what the music will sound like in the completed hall.

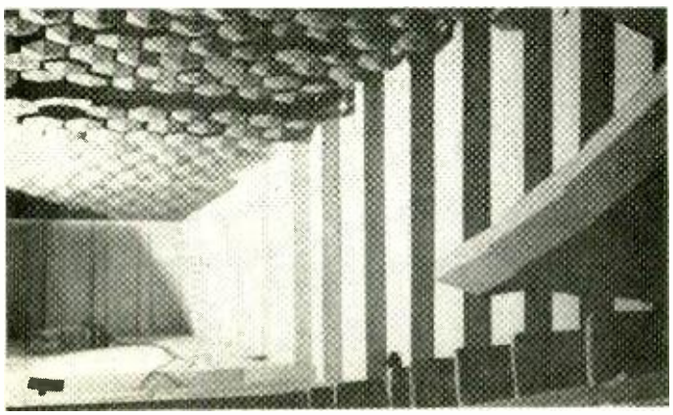


Fig. 1. Scale model of concert hall as viewed from rear of auditorium.

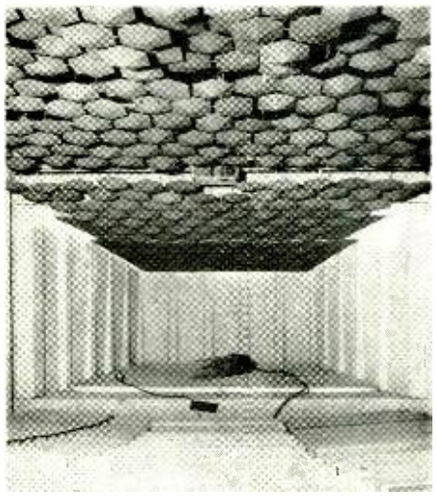


Fig. 2. Another rear view highlighting the acoustical 'clouds'. Note spark generator on stage.

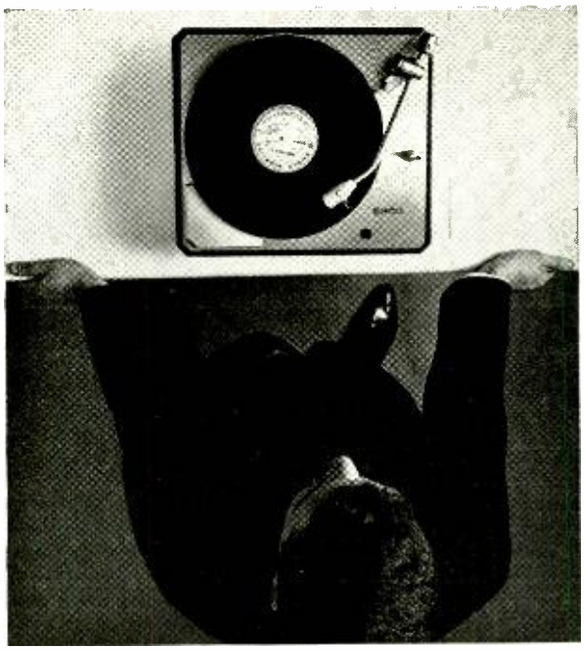
The report goes on to say that "to simulate the effects of the proposed hall, Prof. Spandock matches the absorption capacity of the building materials." Corrugated egg packing cases were used to simulate people, and blind persons evaluated the results of the tests.

"The newspaper reports make it sound too easy and too positive," says Beranek. "The *New York Times* implies that this is a new development in acoustics. Actually, high-speed tapes were used in a 1/10-scale model of the Sidney Opera House in 1959." In addition, Newman remarked, similar news stories on tiny auditoriums have appeared over the past few years. The trouble is that reporters do not seem to follow up these accounts. Specifically, what did these acousticians learn from their tests, and how do their findings compare to the acoustics of the full-scale halls?

BBN and other acousticians look askance at the use of high-speed music in model tests for the following reasons: (1) To reproduce music at ten times the normal speed would necessitate repro-

(*Continued on page 43*)

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You can listen and compare... listen and compare... and listen again... and you'll always come back to the Empire Troubador.

Why? Simple! Because it's the world's most perfect record playback system. Every Empire component was designed and built for maximum performance within the Troubador system... Be it the 398 or the new console model 488.

High Fidelity magazine reported "A precision-engineered product of the highest quality... each component, taken separately, first rate. Taken together, they form one of the finest and handsomest record players available."

Here's how the Empire Troubador achieves that rating. . . . There are only two moving parts in the belt-driven, 3-speed "silent" turntable – the heavy-duty hysteresis-synchronous motor and the turntable platter. Both are individually adjusted to perfect dynamic balance. Complete rumble isolation is provided by the motor suspension, flexible belt drive and the resilient nylon "seat" which supports and cushions the thrust of the main bearing.

Rumble better than –65db. Wow and flutter less than .05%. The American Record Guide (Larry Zide) says: "*I found speed variations – that is, flutter and wow – to be inaudible.*" Don Hambly, Station Manager of KRE AM/FM, Berkeley, Calif. said "*. . . the Empire tables, have all the basic requirements of design and simplicity of operation and maintenance that we have sought.*"

The Empire 980 dynamically balanced playback arm achieves the unique distinction of having rock-like stability and balance in all planes – which allows for perfect tracking at any angle – even upside down.

American Record Guide said "*. . . One of the best available . . . substantial reduction in vertical mass . . . a cartridge of any dimension can be aligned in the head for minimum tracking error . . . calibration is extremely accurate . . . Dyna-lift most useful . . . lateral and vertical friction is exceptionally low . . . exceptionally stable . . . steady even with shaky floors . . .*" And now for the third member of the perfectly integrated record playback system – the 880 P cartridge – Stereophile Magazine reported – "*the Empire 880 P has as high channel separation as any pick up we have encountered . . . needle talk exceedingly low . . . inductive hum pick up well below limit of audibility. The 880 P appears to be one of the most rugged high-performance stereo cartridges we've encountered . . . the best magnetic cartridge we have tested to-date.*" Audio Magazine probably summed it up the best . . . "*truly excellent.*"



The above is only part of the Empire story. From its original concept, the Troubador was designed and built to please the most serious audiophile. Our most recent survey enlightened us to this fact – "*More Empire playback equipment is used by FM/Stereo stations than any other brand.*"

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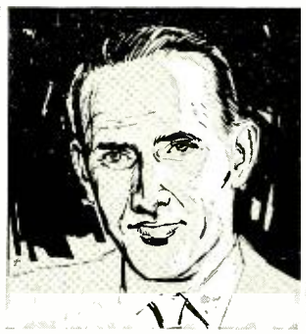
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AUDIO ETC.

Edward Tatnall Canby



For those who don't remember, here is what the audio market looked like to Mr. Canby exactly 10 years ago. This column is a reprint of the July, 1954 AUDIO ETC. Sounds familiar, doesn't it?

THE AUDIO YEAR

AUDIO progress follows more or less the fiscal year, like the theatre and the music seasons. July is between the end of the old season and the beginning of the new and this seems a good time for a look back.

The Season 1953–54 has surely been in many senses THE year of years. This was the period in which, after what already seems a vast period of incubation—a Seven Year Drought—the rains came, the seeds sprouted and like Jack's beanstalk or its U.S. alternative, the fabled cornstalk that hit the sky and produced ears that had to be dragged by tractors and corn grains as big as bushel baskets, Audio joyfully blew up with the biggest bang you've ever heard. A hi-fi bang, too, and no questions asked. (Please read the review of Tchaikowsky's Nuteracker on another page in this connection.)

If this department were exclusively concerned with Sales Expansion and Business Opportunity, I should surely at the present stage be launching a giant carnival of triumph with champagne on the house for all comers. I don't know who has made the profits, but I do know that for every manufactured item launched in any earlier year there must have been ten or twenty or fifty this year. When a business indulges in a hugh expansion there is ordinarily a good reason for it, or people think there is, anyhow. Audio must have looked pretty good to a whale of a lot of enterprising individualists this last year, and I don't see yet the slightest signs of a slowdown. So, taking on my professorial role of Audio Plugger from Way Back, I offer my felicitations to all concerned and my Best Wishes for an ever Bigger and Better Future.

Not Wetblanketism . . .

. . . And having got that off my chest, I continue with somewhat less enthusiasm. It is admittedly a tough job to put aside the all-embracing fact of Expansion for a look at other facets of this year. Maybe it's a waste of time; for who is really going to care what happened as long as business is big and everybody's reasonably happy? Also —I have a certain feeling that any qualification of the present universal joy from this direction may be interpreted as wetblanketism. Don't be a spoil-sport, Canby!

Don't intend to. Every silver lining has a cloud, after all, or it wouldn't be a silver lining. (Well, *that* wasn't so good, but let it pass.) There isn't anything more destructive than destructive criticism, negativism, I am the first to say. There I happily agree with any and all of the publicity departments whose duty is is to paint the Audio sky bright blue and chrome plate the clouds, if any. But unlike some, I take it as occasionally constructive to point out the less-than perfect, if only to give a bit of 3-D perspective. Otherwise how are we to know where we are in the welter of superlatives? Advertising or no, grammatically and practically it is impossible to have something "better" without having something thereby less good. You can't have a High without a Low or a North without a South. So, then, what is the perspective for last season?

Tail-Chasing

First, I'd say this was the Season of Unoriginality. Perhaps a nicer word would be Consolidation. While in the business area Audio has been expanding, in the design and engineering area it has been, so to speak, taking profits. Cashing in on the developmental progress of those dim distant Seven Years of relative silence. Development goes on, of course. Future bombshells are even now forming in the laboratories and test benches, without the slightest doubt. But that is for later. This year we have been exploiting the past, in two major respects.

First in sheer volume; for every amplifier of yesteryear there are a dozen this year. Name any other area of the Audio field (except, perhaps records, which hit the big expansion some time ago) and you will find an almost monotonous multiplication of "sensational new models" which are in fact competitive with others already on the scene. Some areas have burgeoned faster than others, notably the small speaker system field. But the pattern is ever so clear wherever you look this year, if you've been watching stores, catalogues and Fairs. The competitive aspect, indeed, is unabashedly out in front, calculated, intentional and persistent. Nobody's going to let anybody else get away with too big a hunk of the present bonanza.

Ethics in this sort of competition are hard to define and I, for one, am never quite sure when I ought to feel that something is an outright "steal" and when merely a ligitimate and straightforward bid to get in on a good thing. I wouldn't attempt to suggest rules, for there aren't any except the pragmatic ones of success, failure, or prestige, and anybody with sense knows enough to leave a very safe margin between himself and the nearest law. This isn't a matter of law. Yet even so, strictly from my own point of view (of which this column is a reflection) I have frankly often been quite annoyed and even sort of disgusted at the way in which design features, inner and outer, decorative, practical, fundamental, have been systematically "borrowed" in every direction during this last year.

Calculated unoriginality! If one eight-inch enclosure goes over well, such as the original R-J, from 'way back, then everybody gets out a similar box for which he crows lustily and heartily. Not a steal at all, just a Calculated Similarity.

This goes on and on. If among these happy proliferations there appears one model with a certain very good looking decorative metal ring around the speaker grille that attracts both a lot of eyes and a lot of dollars, then quick like a flash everybody has metal rings around their speaker grilles. Different of course, but not *very* different, and the percentage of difference has been rather remarkably consistent this year—as consistant, for example, as the sizes of the numerous eight-inch speaker enclosures themselves: about half of them measure alike within an inch or so each way. Calculated Similarity.

Now don't get me wrong. This, as I say, is the age-old way of the business world. Everybody does it and always has. But don't forget that somebody, somewhere, some time, must stop chasing sombody else's tail around in a circle and strike out for new fields. The guy who does that, alas, isn't always the one who cashes in. But this too is an old business story. Thank the Lord we still have among us those idealistic optimists who *think* they can get somewhere with a new idea—otherwise we'd all end up like the dragonfly, who (I've always been told, will eat his own tail if you feed it to him, until he dies of indigestion. In this Year of Consolidation, tail-chasing is our favorite sport.

Progress, Too

Fortunately, tail chasing has its good points too. I mentioned two aspects of our present consolidation, the first being this rampaging Calculated Similarity, or to put it another way, the phenomenon of mutual bandwagon-climbing. The second aspect is just as clear, but a lot more constructive. Out of this sort of close competition inevitably comes a quiet and steady refining of existing ideas, procedures, equipment, standards. That, during this last year, has been very much to the good.

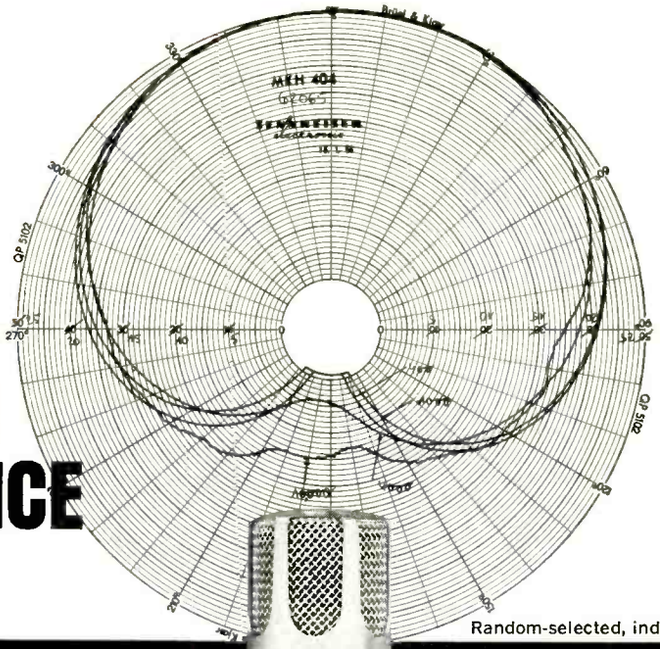
Even though generally speaking there has been little of radically new interest (with some exceptions, notably the new wide range ceramic pickup development, described here in an earlier month) there has been undeniably throughout the true Audio field a gratifying clarification of detail, a simplifying, an upgrading of performance standards.

Amplifiers, for example, have not only multiplied tremendously. Constant revision and experiment has improved everything about the breed from the ease with which they can be mounted in cabinetry and the simplicity of control settings all the way to higher basic tolerances for distortion, hum and so on.

Aside from what I'm sure would be a generally admitted enhancement of performance (I'm not so sure about durability) I'd suggest that the most noticeable amplifier progress has been due just to this sort of ceaseless competitive polishing-up. Physically this year's models have been more adaptable to a greater variety of audio installations, better looking, easier to feel and easier to read. Inputs and outputs and switching are both more versatile and generally simpler as well. (Some of the older models were paragons of utter confusion in their outward facilities!) The marked trend towards fixed-position equalization, to supplement the standard bass and treble controls, is a good one because records during this year have at last begun to approach a resonable uniformity of recording curve and the problem of equalization is bound to get simpler. To separate record equalization from tone control (for taste, room sound, etc.) has always been desirable and that seems to be the trend.

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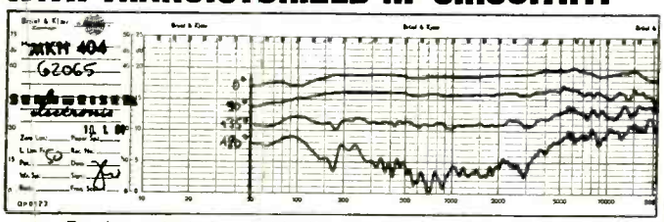
Random-selected, individually drawn cardioid patterns, Type MKH 404

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The cardioid patterns and frequency response curves shown here, taken in the laboratory from a random-selected MKH 404, show the excellent front-to-back rejection ratio at all frequencies and the outstanding uniformity of response at any angle, as well as on axis. In fact, the directional characteristics are exact and independent of frequency. The individually graphed frequency response curve you receive with any MKH 404 will adhere very closely to the one shown here. Response below 40 cps has been tailored to meet practical requirements in most applications.

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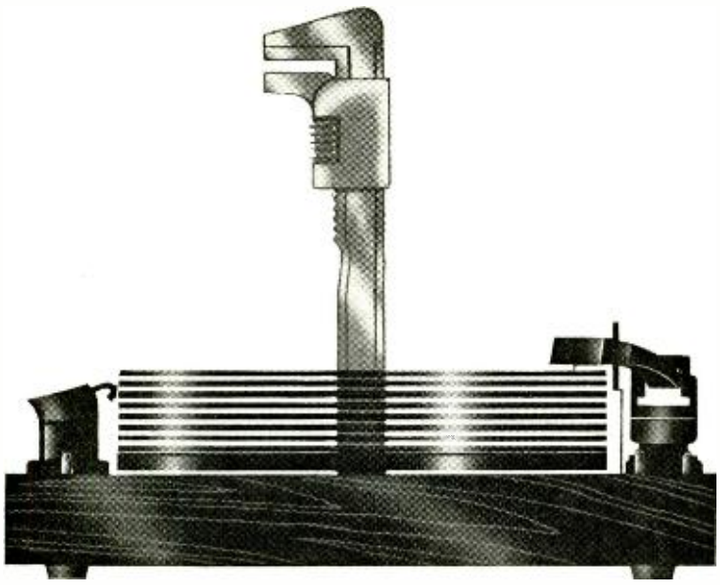
TECHNICAL DATA

Acoustic system	pressure-gradient responsive
Directional characteristic	cardioid
Frequency range	40 to 20,000 cps
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Unweighted noise voltage	25 microvolts (peak-to-peak)
Distortion at 10 microbars	0.35%
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Temperature range	+14° to +158°F (−10° to +70°C)
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The stacking of records varies the stylus angle – increases the load on the motor – creates flutter and wow – wears records – diminishes your listening pleasure. IS IT WORTH ALL THAT JUST TO CHANGE RECORDS?



TD-124 — Recognized as the finest performing transcription turntable, the Thorens TD-124 features 4 speeds, built-in illuminated strobe, flawless sound. Unmatched for mono or stereo reproduction.

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TD-135 — Here is a precision 4-speed transcription turntable with an integrated Thorens tone arm (BTD-12S), for those who prefer a complete, compact unit. Exceeds NAB standards for rumble, wow and flutter. Features 12-inch non-magnetic table, variable speed control, precision mounting. Tone arm has amazingly low tracking error, and is designed for lowest possible inertia and friction. No other integrated unit approaches the professional standards and economy of the TD-135.



TD-224 — If you want highest performance plus convenience, see the amazing Thorens TD-224. There is no other instrument like it in the world. Combines the playback quality of a transcription turntable with the convenience of an automatic record changer. There is never a record stack on the turntable, yet records change automatically. Overcomes all problems of "automatics." TD-224 incorporates the BTD-12S professional tone arm, plus a built-in record cleaner, illuminated strobe, variable speed control. A superb instrument with features never before combined in a single instrument.

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Among the low priced tape recorders, to mention just one more of the many areas in which this constructive consolidation has been seen during the year, you'll note a similar kind of progress. Nothing sensationally new, but in two particular respects the trend is to the good. First, the inherently clumsy mechanism of tape transport has been further simplified, (notably in the loading and unloading of tape) along familiar lines. Who will forget the original Soundmirror or *circa* 1947, a pioneer and grandaddy of millions of younger models but a holy terror in operation, with push-button controls almost guaranteed to go haywire! No reflection on the maker; he was doing wonders for his time, and who could do better, at that stage?

More important, there has been a significant widening of frequency response at all the home tape speeds in many new recorders launched this last year (and there will be more of it in the new season to come) which has basically altered the home tape picture in a vital economic sense. More sound quality, more "fi" for the same tape dollar; or longer tape play with no loss in quality. Next year's tape picture in the home will undoubtedly reflect some radical results of these changes, in the much wider sale of pre-recorded tape, to take advantage of more and better machines now in homes.

The implications of a widening of frequency response were taken up in this space all of four years ago, when the then new Ampex 400 was the first tape recorder and player to do the trick. Owners of back copies of Æ may be interested in looking over the forecasts in those articles in the light of what's now about to happen in the home tape field. (Æ, August and September, 1950.)

Table Hi-Fi and Craft Parts

Enough—for there's no reason to go further in this over-all evaluation of an Audio year. But one major aspect of that year has yet to be considered. It was suggested above when I spoke of the "true Audio field."

What about the overwhelming explosion of "high fidelity" in the commercial one-piece phonograph field—the nationwide publicity that has carried the home table model machine and the semi-pro separate-unit rig together forward in one tornado of happy expansion?

We all know that a number of distraught gentlemen in the Audio profession have been sweating out an impossible task lately, that of defining High Fidelity and related terminology in the light of this year's upheaval. I am very glad I'm not one of them. I have my own problems.

I'm contemplating a book revision, of the tome I wrote a couple of years back, in which page after page of comparison between "the ordinary home phonograph" and "high fidelity equipment" has now been reduced to so much jargon. For is there any home phonograph that doesn't now boast loudly of high fidelity? (If not, then it's Full Fidelity, or other Calculated Similarity.) That once useful term has now gone completely nuts and I doubt if we'll ever be able to bring it back to practical usefulness. I've got to find some other way of talking about equipment and, so help me, I haven't figured it out yet. When I do, we'll have a new edition of my book!

How do I feel about this year's wholesale invasion of "hi-fi" by the big commercial advertisers? I went into that pretty thoroughly last November in the first AUDIO ETC. (Æ, Nov. 1953, p. 34) and nothing has happened to alter the general outlook since, except of course the continued proliferation of dozens of new "hi-fi" machines, Calculated Similarities to compete with the

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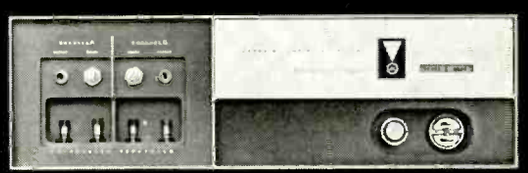
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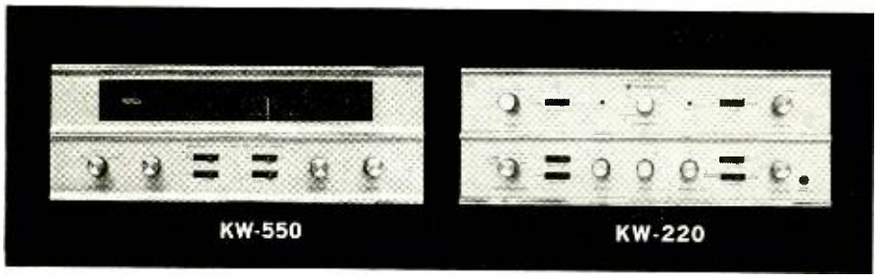
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triumphant Columbia 360 table phonograph which got there first.

Yes, admittedly there has been a general improvement in home phonograph quality, even if we ignore the huge ad claims. It reflects a much belated modernization that has at last brought a measure of wide range response, an improvement in amplifier and tone control design and a gesture, at least, in the direction of speaker enclosure design. Whether *we* call the result High Fidelity is now of singularly little importance—the big ads call it that anyway, and they aren't going to be stopped.

But, granted quite a lot of improvement, even granted that the better new machines might concievably be called hi-fi on a rational basis (rating, as the AES has been considering it, the better systems as super-hi-fi and ultra hi-fi)—even so, I do not think that the home machine has even begun to touch the advantages that still belong to the separate-unit, craft-type of equipment that used to have a monopoly on the term High Fidelity. In spite of all this year's publicity-enforced excitement, I honestly do not feel that things have changed much—except linquistically.

I am as much in favor of separate-unit craft audio equipment, for the home, as I ever was and I have no intention of changing my point of view when it comes to going over my book. The values in equipment bought "audiophile net" through audio outlets. are, I insist, as good relative to the "ordinary phonograph" as they ever were before the Great Tidal Wave of Hi-Fi this year. The differences, tone quality for tone quality, dollar for dollar, are still very much the same. If "ordinary home phonographs" are improved, which I do not deny, then so, in proportion, are the separate units of this season as well.

And this I will continue to assert however loudly the hi-fi ads may scream. I'll say it no matter how many famous conductors and musicians give ecstatic testimonials for table hi-fi, nor how many beaming movie stars emote for 4-D sound in the home. I will keep suggesting to people who ask what to buy that the acquire a good audio catalogue and pick out parts, just as I have been suggesting these seven last years.

If You Can't be Bothered . . .

What about the hi-fi phonograph, then? Well, it has its good place. There never was a time, these last seven years, when I didn't regularly run into people who just couldn't be bothered with fancy equipment and, moreover, who really didn't care very much about the possible tonal difference. I long ago learned to bow gracefully to this point of view. Some of my most musical friends have it. I have personally bought, in past years, several unmentionable table portables with three-inch speakers for friends who were entirely delighted, though the sound of the things made me wince. People are like that. They were seven years ago and they are still. Only now they buy "high fidelity" machines, and love 'em.

Now, you can get a ducky little home machine that in point of fact will actually reproduce a 10,000-cps tone, though the distortion in the upper regions may or not be worse than the blissful high-end silence of yesteryear. Now, this same machine will reproduce an audible bass of remarkably low pitch, though the attendant boominess may or may not add to your musical enjoyment. Now, instead of one cramped speaker pointing outward you may have three, or a brace of them pointing in various directions—which, quite seriously, is one of the more positive improvements to be found in

(*Continued on page 37*)

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THREE MAGAZINES SELECT TOP HI-FI SYSTEMS

Popular Science (September 1963) selected hi-fi components for the best possible stereo system without frills.

Turntable: AR two-speed ($78)

Speakers: AR-3's ($225 each in oiled walnut)



The AR turntable — less than ½ the cost of other arm-turntable systems over which it was chosen.

Bravo! (Fall 1963) selected hi-fi components for the best possible stereo system.

Turntable: AR two-speed ($78)

Speakers: AR-3's ($225 each in oiled walnut)



AR-3 loudspeakers — less than ⅓ the cost of other speakers over which they were chosen.

GQ GENTLEMEN'S QUARTERLY (Summer 1963) selected hi-fi components for the best possible stereo system.

Turntable: AR one-speed* ($75)

Speakers: Brand X ($770 each. AR-3's were chosen for a lower cost system.)

Eight independent experts were involved in making up these recommendations.** You can make your own judgments at the AR Music Room, on the West Balcony of Grand Central Terminal, where the AR turntable and AR speakers are on permanent demonstration. No sales are made at this showroom.



The Popular Science survey also recommended Roy Allison's **High Fidelity Systems — A User's Guide** (AR Library Vol. 1, $1). This book may be purchased at many AR dealers', or you may order it directly with the coupon below.

*2-speed model was not yet available.

**The Bravo and GQ choices were not influenced by speaker size; the Popular Science panel limited its choice to speakers in the compact class because of the practical difficulties of placing large speakers in the home.

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge, Massachusetts 02141

☐ Please send me Allison's **High Fidelity Systems—A User's Guide.** I enclose $1 in cash or check only, and/or

☐ Please send me free literature on AR products, plus the complete lists of components chosen by each magazine.

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EDITOR'S REVIEW

TICKY-TACKY WIRES

A little while ago we heard a recording by a prominent folk singer, wherein the legend of the ticky-tacky boxes was unfolded. A feature of these boxes, as told in the song, is that they are variously colored, yet all the same. Those of you who have heard this song know the significance of these words. Anyhow, what brought them to mind was a suggestion (somewhat tongue in cheek) by an AUDIO reader that a standard color code for audio cables be adopted. This reader even provided a rather extensive suggested code (23 colors).

Of course, the idea is not new and it does recur from time to time as an "original" and thoughtful suggestion. However, the enthusiasm and sincerity which permeates most of these suggestions somehow seems to obscure the purpose; they seem to have forgotten that the reason for a standard color code is to be able to tell, merely by looking at the cable, that it is the left phono cable, or the right tuner cable or whatever else it may be. Unfortunately, the possibilities are so numerous that we end up with dozens of colored wires. We would probably need a color chart to interpret the mess. We think it would be just as easy, in fact far easier, to tape a flag to each cable with its function neatly written out. Possibly some kind-hearted (or far-sighted) cable manufacturer could supply adhesive tape with the various routings already printed on it, or he might make cable available with the legend printed right on the cable. This would eliminate the necessity of translating a color into a routing.

Thus, we propose ticky-tacky wires all the same (with labels).

NO NAME, NO SOUND

The past year has seen the emergence, and flowering, of a crop of speakers without names. By that we mean without a clearly identifiable brand name. The main distinguishing characteristics of these speakers is that they have been "part of a system." Another main characteristic has been that they are uniformly poor in quality.

Apparently, in order to achieve an attractive package price on a group of standard equipment, some retailers have completed the "package" with a speaker system whose main virtue is low price; a new form of discounting.

Unfortunately, all they have succeeded in discounting is the sound of the rest of the system. Certainly, a several hundred dollar tuner-amplifier is not going to sound its best with a several dollar speaker system. In fact, that may be the understatement of the year.

The strange part about this entire area is that the retailer seems to be making close to his normal profit with this scheme (we took several of these systems and totaled the so-called "normal prices" with the addition of an amount for what we thought those speaker systems were worth). We conclude from this that the retailer feels he cannot sell the equipment as individual components but must offer packages in order to induce sales. True or not, he is inadvertently pushing the concept which the component industry has fought for years: the concept of a packaged system at a price. In effect, a console approach.

Strangely enough, the console manufacturer is on much stronger footing in this area. His system was engineered as a system, but what the audio retailer is selling is a system he selected arbitrarily. Heretical as this may sound, it is entirely conceivable that the console manufacturer would produce a better quality system under these circumstances. Mind you, we're not talking about the individual pieces but rather the over-all system. In effect, these audio retailers are becoming console retailers with an audio veneer.

Coming back to those no-name no-sound speakers, the point we wish to make about them is not that they are bad because they are inexpensive, but rather that they are not an engineered speaker system. We all know that a loudspeaker system is a contrary and difficult beast at best and requires careful engineering and manufacturing. These no-name wonders have obviously been spared the normal agony of birth that most speaker systems must endure. Instead, they have transferred the agony to the listener.

BY JOVE, I THINK WE'VE GOT IT!

Whatever happened to the dedicated perfectionist who would go to extraordinary lengths to achieve 1/100 of 1 per cent improvement.

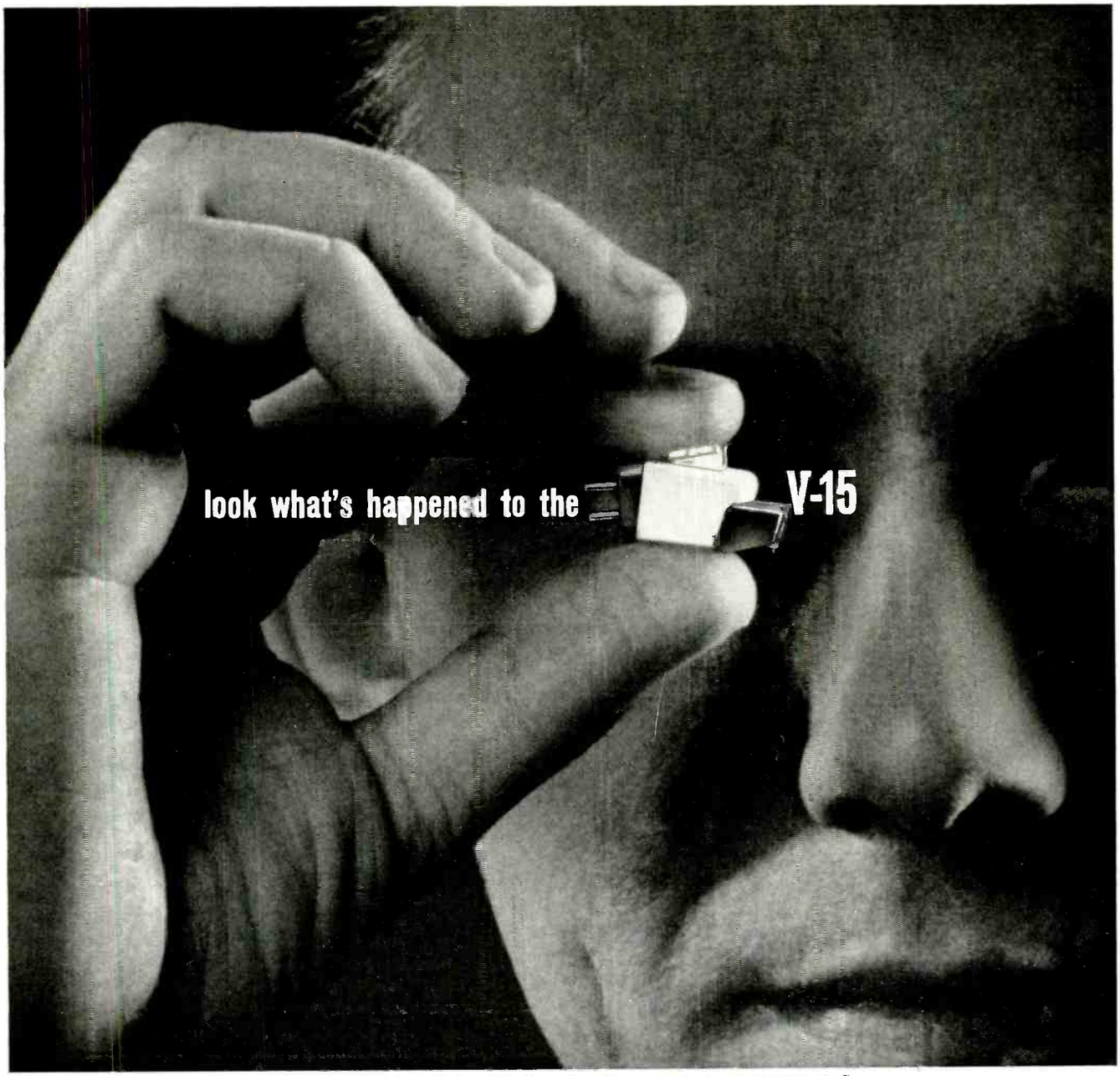
This question popped into our mind immediately we viewed the cartoon shown below. On reflection, it seemed to us that this breed is vanishing, alas. We can all remember the time when a high percentage of audiofans were compulsive improvers of the breed. Now, by jove, I think they've had it! We'd venture that most audiofans today are content to select their equipment rather than design and build it. There is nothing wrong with this. However, it is sad in a way to leave all the creative audio to the professionals who gather their living that way. Where will that unconventional idea come from? You know the idea that I'm talking about; the one that will reduce amplifiers to the size of thimbles, or convert walls to loudspeakers, or get an hour's worth of recording on a quarter-sized record. Not from the professionals, certainly. How can they? They're engaged in finding practical and saleable solutions. After all, revolutionary and visionary ideas don't pay the payroll.

Are we wrong? Are there still a few of the hearty breed left who have the courage to actually build those "far out" attempts at perfection? Let's hear from you. Send us drawings, photographs, plans or what have you of your brainchild. We'd like other audiofans to see what you've done. Perhaps the creative spark will be transmitted to the very person who can reduce an amplifier to the size of a thimble, and so on.



By Jove, I think we've got it!

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FOR THOSE WHO CAN HEAR THE DIFFERENCE

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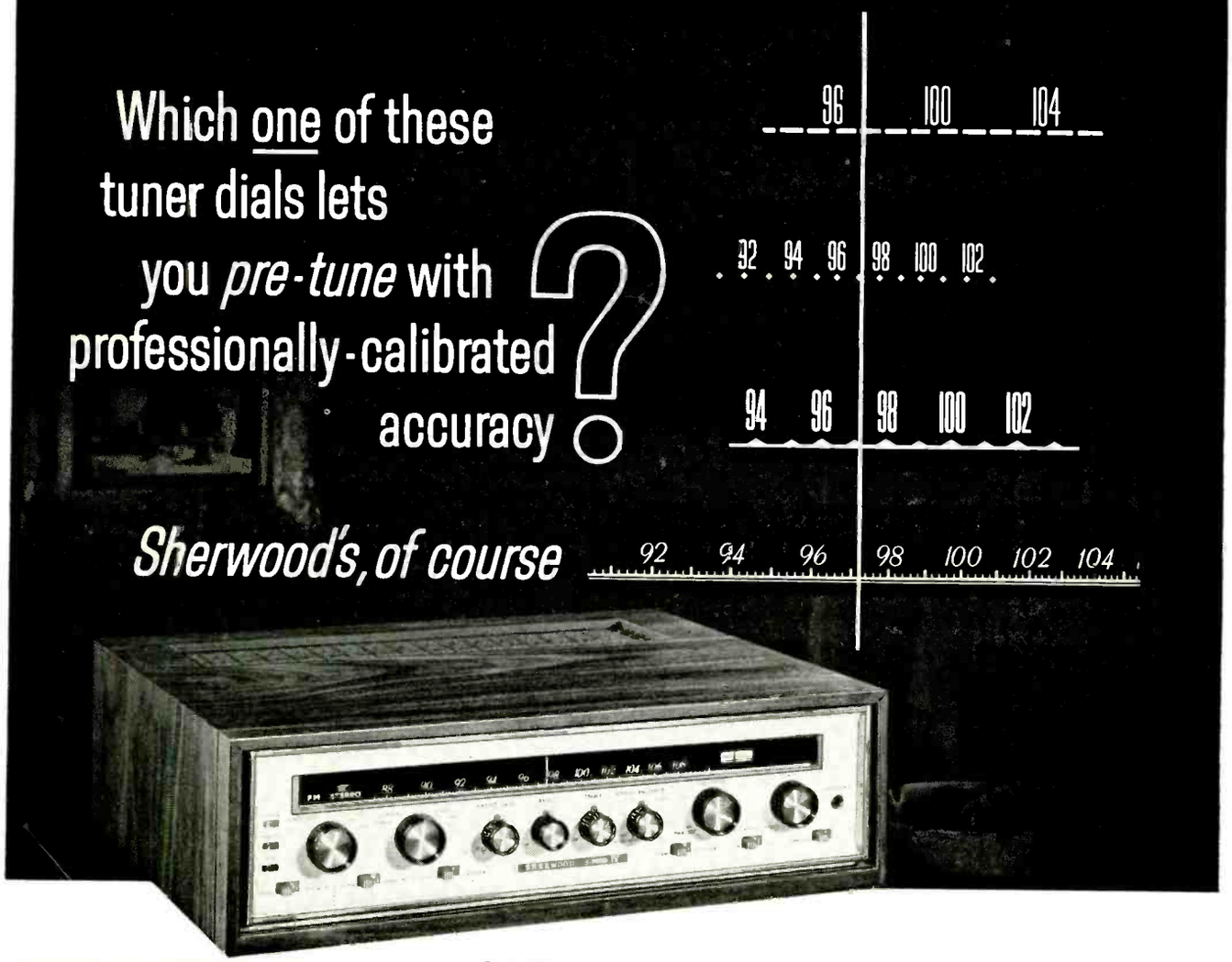
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Which one of these tuner dials lets you *pre-tune* with professionally-calibrated accuracy?

Sherwood's, of course



Sherwood's new S-8000IV FM stereo tuner/amplifier, $329.50.
Genuine Walnut cabinet optional at $29.50.

Only Sherwood precisely graduates its FM tuning dial every 200 kilocycles —the minimum spacing between FM station channels. If, for example, the FM broadcast of your choice is being transmitted at 97.3mc., you can visually pre-tune the Sherwood tuner dial to receive it with professionally-calibrated accuracy. Final zeroing-in of the FM station's carrier is merely a matter of referring to Sherwood's D'Arsonval Zero meter.

Precision tuning is but one of many superlative engineering reasons for buying Sherwood's new S-8000IV FM stereo tuner/amplifier. Others include ☐ 80-watts of stereo music power ☐ 1.8μv. IHF sensitivity ☐ 2.4db. FM capture effect ☐ only 1/3% distortion at 100% modulation ☐ new "powered" center channel for a mono speaker—ideal for extension speakers ☐ stereo headphone jack and separate speaker disabling switch.

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- *Time-Saver Shopping Guide*—detailed comparative specifications on components offered by major manufacturers.
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Tuner Alignment for Quality FM Reception

ARTHUR L. BOYNTON

Tuner alignment is not necessarily as difficult as most people would think. And the equipment need not be too elaborate either.

MANY PEOPLE HAVE NOTED, with much distress, that the procedures for aligning FM tuners, provided by the manufacturer, have often been unnecessarily complicated and misleading. They would have the technician remove parts temporarily, connect the generator output (through a capacitor) to various parts of the i.f. strip, and even use an unmodulated r.f. signal, which in most cases leaves one with a tuner i.f. bandpass which may look like *Fig.* 2 or 9.

Poor tuner performance, made even worse by stereo, impelled me to express my findings concerning proper tuner alignment so that those who wish to have a tuner capable of 'state of the art' reception may have it without spending several months figuring out the necessary procedure.

The minimum equipment needed for FM tuner alignment is: (1) an FM-RF generator capable of sweeping in both directions, i.e., defeatable blanking; (2) an AM generator capable of external modulation; (3) an audio generator capable of delivering 100 kc; (4) a VTVM; and (5) a crystal-controlled calibrator capable of controlling marker frequencies to within 0.1 per cent accuracy.

I.F. Alignment

Setup: (See *Figs.* 1 and 3.) The FM generator sweep is connected to the 'scope horizontal amplifier so that sweep sync and phase adjustments will function, thereby causing the 'scope horizontal to follow the generator frequency deviation.

If there is an age buss in the tuner, connect the probe to the r.f.-filtered section, point A in *Fig.* 4, *not* the audio-filtered section. In most cases, a 1:1 probe has proved satisfactory. If the tuner has an i.f. diode detector (AM) built in, this test point may be used instead (see *Fig.* 5, point B). However, do not attempt to use your own detector probe, as experience has shown that some tuners resent even this minor intrusion. There are also a number of tuners on the market that have individual grid-biasing networks instead of an age buss. Connect the 10:1 probe to the point marked C in *Fig.* 6. Using a 1:1 probe will almost invariably load the circuit, reshaping the curve, and perhaps causing oscillation.

At this point, it should be added that the more accepted way of checking the i.f. response of a ratio-detector circuit, is to remove the detector's stabilization capacitor and connect the 'scope lead to the hot end. Unfortunately, the limiter(s) are between the i.f.'s and the probe. For any normal strength signal, the limiter(s) will limit, making the most sloppy i.f. alignment appear to be flat topped.



Fig. 1. Typical equipment setup. Equipment (left to right): Shasta audio generator, Hickok AM-RF generator, RCA general purpose scope, Simpson AM-FM-RF generator. Tuner shown is Harman - Kardon Citation-IIIX. Author shown. (Test equipment courtesy Cal Poly College, San Luis Obispo, California.)

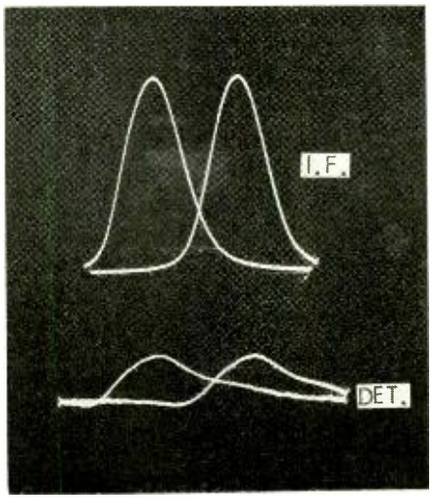


Fig. 2. Inexpensive tuner aligned by using unmodulated r.f. signal, phase offset. (50 kc per division).

If the generator signal is reduced sufficiently so that the limiter(s) does not limit, the i.f. response curve will appear. Obviously, this is a signal too weak to be living-room listenable. Conditions of bias and signal amplitude are not the same, and they *must* be duplicated in order to achieve optimum performance.

The generators can usually be coupled to the tuner by moving the mixer tube shield so that it is not grounded and connecting the generators to it and grounding to some convenient point on the chassis. If this causes the tuner to oscillate, replace the tube shield and stuff a few turns of insulated wire into the shield on top of the tube. Connect the hot generator leads to one end of the loop. You will need quite a bit of signal to make this technique work, but it is much better than loading the mixer circuit by making a connection to the grid or plate.

Tune the generator for a response curve around 9 to 12 mc. The correct response is the one that does *not* move when the tuner dial is turned. If local stations are interfering, try retuning the tuner, or remove the r.f. amplifier. If the

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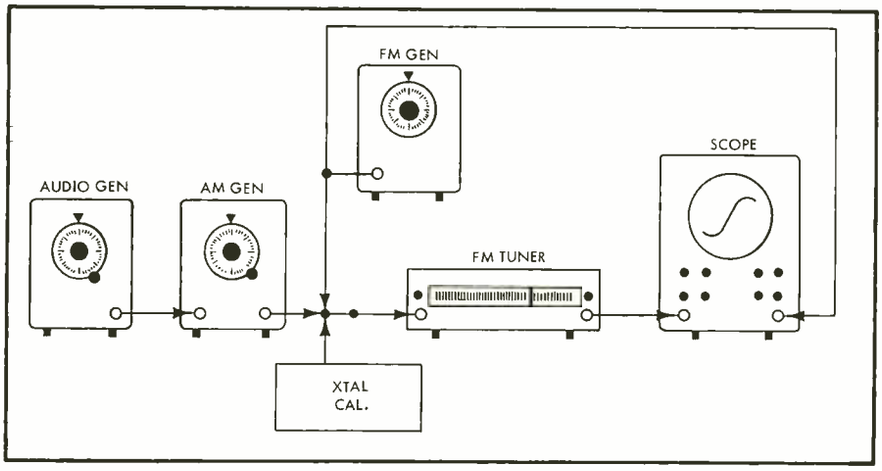


Fig. 3. Block diagram of typical setup.

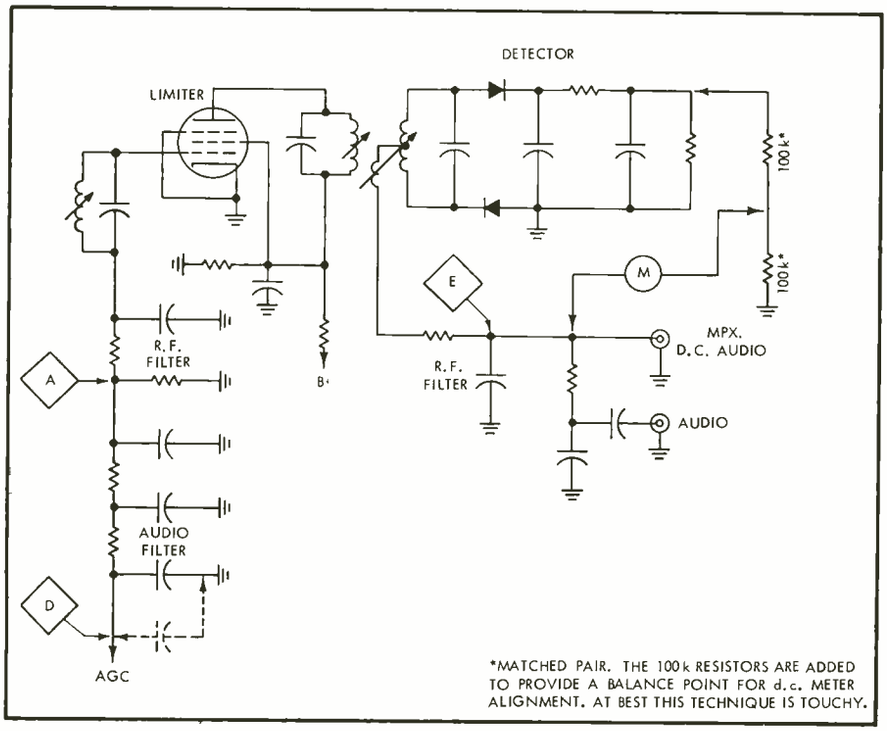


Fig. 4. Typical limiter-detector schematic showing filters of agc buss and audio, r.f., d.c., and a.c. detector outputs of a ratio detector circuit.

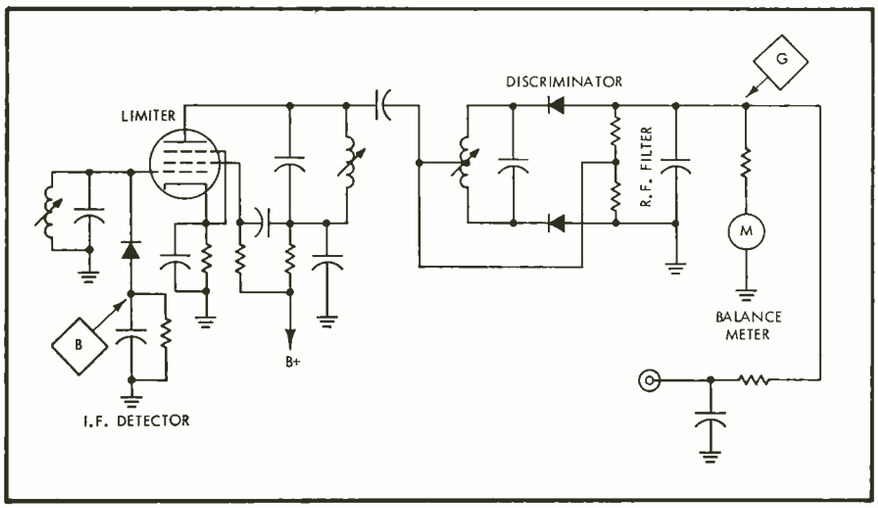


Fig. 5. Typical limiter-discriminator with an i.f. detector. At balance the meter will read zero volts.

r.f. amplifier is part of the mixer or oscillator, try to reduce the interference by placing a short across the antenna terminals.

Tune the AM generator around 10.7 mc to get the marker to appear. Care must be used so as not to suppress the response, by having either too large an AM or FM signal. A little adjustment of the r.f. levels will be necessary. Now turn on the audio generator and modulate the AM generator at 100 kc. This will produce the 100 kc submarkers. In order to have clear markers, the frequency response of the 'scope vertical amplifier should be limited to about 1 kc. Usually the r.f. filter, either age or grid-bias, will take care of this problem. If the markers are much too broad, however, a small capacitor connected across the 'scope terminals (50 pf for a 5-meg load; to 500 pf for a 500-k load) will solve the problem.

Calibrate the 'scope for some convenient width to measure 100 kc, with the sweep width representing about 600 kc.

With the calibration complete, turn off the submarkers. Note which way the AM generator marker must be moved to get to 10.7 mc, then adjust all the i.f.'s to move the response to 10.7 mc. The 10.7 mc marker should be accurate to within 0.1 per cent (i.e., 10 kc).

Determine whether having the bottom cover near the tuner makes any difference in the i.f. response. If so, connect wires to the test points (i.f. and d.c. detector) and bring out through the closest bottom plate adjustment holes, and mount the plate.

If blanking has been used up to now, turn it off! Due to a change of gain of the i.f.'s while the FM generator frequency is within the passband of the receiver, a slope will result which can be mistaken for improper i.f. response. A frequency sweep in the opposite direction will show a similar slope in the opposite direction of a properly aligned i.f. strip. (See *Fig.* 7.) If the tuner in question has age, this sloping effect can be reduced by connecting a large capacitor from the audio filtered portion of the age buss to ground. A capacitor value of 20 μf or larger, rated at 10 volts or higher, will do the job. This is point D on *Fig.* 4.

With the help of the AM generator, position the FM center frequency so that the 10.7 mc. marker will be in the center of the 'scope. Again check for sweep width calibration. Now turn off the markers, so as to prevent distortion of the i.f. response. If the phase is offset, your picture will probably look something like *Fig.* 8. It is a matter of taste as to which presentation is used, i.e., offset or inline. It is important only that both sweeps are there, and that you know where 10.7 mc is located.

Increase the FM generator output until the tuning indicator indicates.

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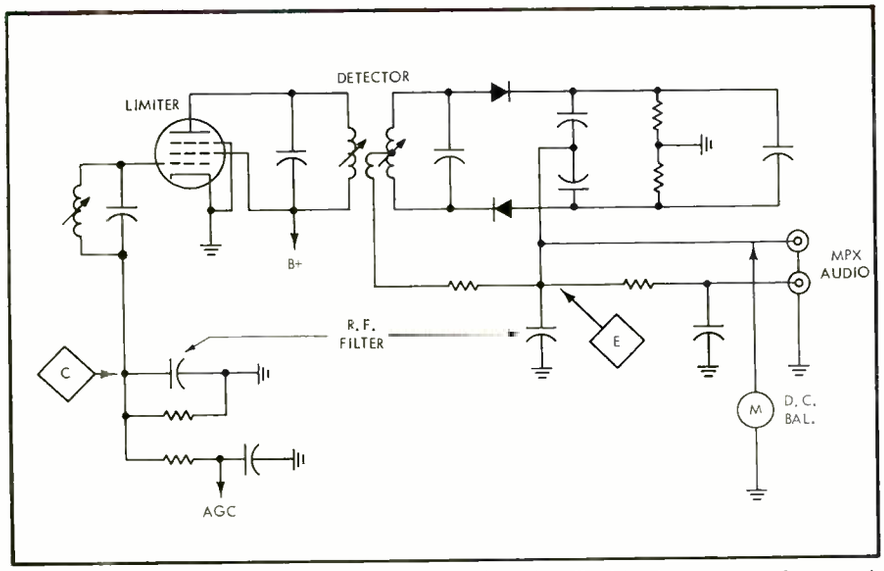


Fig. 6. Typical limiter-detector with individual bias in all i.f.'s. Agc goes to front end.

There is no point in aligning a tuner for optimum response with an extremely weak signal representing a station so weak so as *not* to be living room listenable. Also the i.f. gain will change with an increase in the received signal resulting in a different response. So make the i.f. response correct in the range of usable signals! (See *Fig.* 8.)

Rock each adjustment to make sure that the response of each adjustment affects each side of the curve equally. You should now have an approximation to a flat top response as in (B) of *Fig.* 9. Don't spend too much time trying to make the response *absolutely* straight or balanced. The injection of the 10.7-mc signal around the mixer tube does not result in the best tuner performance. All that is wanted in this step is reasonable flatness for about 200 kc *centered* at 10.7 mc.

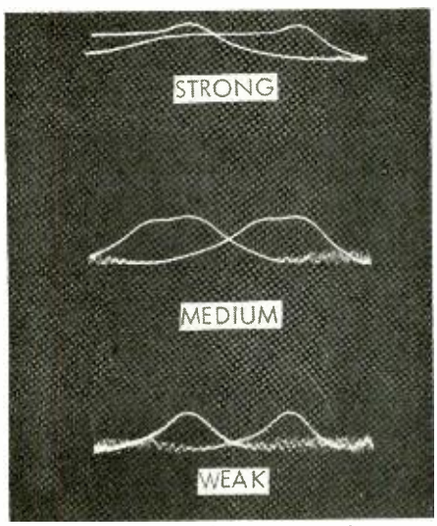


Fig. 8. Improper i.f. response of strong, medium, and weak signals. (100 kc per division).

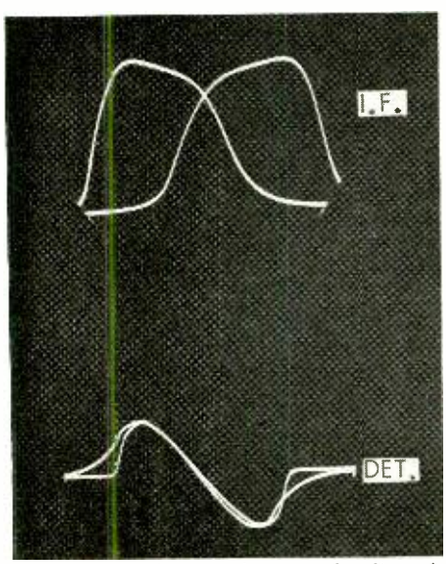


Fig. 7. Bandpass of properly-aligned tuner. (50 kc per division for upper trace, 70 kc for lower.) Note mirror symmetry of upper sweep demonstrating change of gain of i.f.'s.

Now connect the 'scope to the tuner audio, preferably the multiplex jack. Adjust the detector circuitry for maximum height of swing, as well as a balanced swing. (See *Figs.* 7 and 10.)

Remove the coil from around the mixer tube and replace the tube shield. Reinsert the r.f. amplifier tube. Change the FM generator to an unused broadcast frequency in the FM band, and connect the generator output to the antenna terminals. The 'scope is connected to the i.f. section as before. Recheck the 'scope calibration so that the distances between the 100 kc markers are known. Now you are ready for the final i.f. adjustments.

Due to stereo broadcasting, it is desirable to have as flat a top as possible and some little bit of adjusting might be required to achieve a flat portion at least 150-kc wide, and preferably 200-kc wide. Don't drastically detune one of the i.f.'s just so you can get a flat response with the remaining adjustments. *Figure* 9 shows the curve just before complete detuning of one i.f. adjustment. When detuned a little farther, the response is apparently gone but the little devil will provide the tuner with extra image response as well as poorer sensitivity. If your curve has a sag in the middle, the response of the tuner is too wide and must be made narrower. You may be forced to compromise between this sag and wide bandwidth. The absolute minimum bandwidth for top quality stereophonic reception is 228 kc.

Detector Alignment

If the tuner doesn't have a center-of-channel meter, a d.c. VTVM can be used with detectors of the type shown in *Fig.* 5 or 6, but not with the type shown in *Fig.* 4, unless the VTVM is powered through an isolation transformer. Connect the meter to the r.f.-filtered d.c., audio output of the detector, point E in *Figs.* 4 and 6, or point G in *Fig.* 5; and the other end to the balance point of the diode output. In *Fig.* 5 and 6, it is ground. In *Fig.* 4, it is the junction of the two 100-k resistors. The FM generator is not changed. However, you may want to widen the sweep so as to see the detector curve better. The top and bottom of the detector transformer are first adjusted for maximum amplitude on the 'scope, then the top (secondary) is adjusted for zero voltage on the meter (balance) while the bottom (primary) is adjusted for the straightest possible line (linearity). (See *Fig.* 10.) In some cases, the frequency upswing will bow one way while the downswing will bow the other way. All you can do is adjust for maximum symmetry, making the bows balance around the desired imagi-

(Continued on page 34)

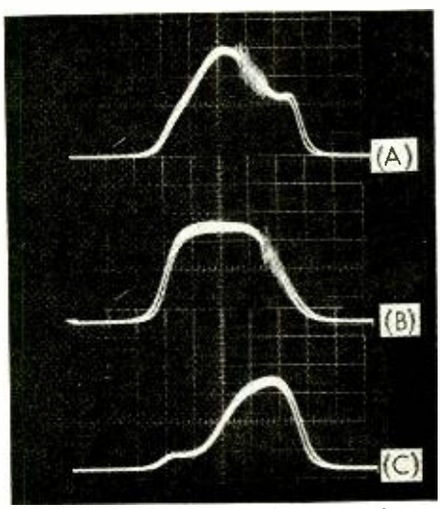


Fig. 9. Effect of partial detuning of one i.f. adjustment. Marker is interference. In (A), note slight bend on left revealing response associated with the pronounced knee on right. (B) is normal adjustment. (C) is same adjustment turned in opposite direction. (100 kc per division.)

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A New Triode Amplifier

Reliable performance, ruggedness, and low distortion characterize this latest version of the triode amplifier—a good construction project for those interested in performance rather than labels.

ROBERT M. VOSS AND ROBERT ELLIS

THE ENTHUSIASTIC RECEPTION given our two earlier triode amplifiers (using, respectively, 6BX7's and KT88's as output tubes), has prompted us to be on the lookout for new tubes which would allow still further refinements in the art of triode amplifier design.

This latest effort uses as output tubes Genalex KT77's, tubes which are fairly unsung in the United States, and have not yet, to the best of our knowledge, been used in any domestic commercial circuits. This tube is very much smaller than its big brother, the KT88, has the same 7AC basing, and is capable of similar feats.

We have rated this amplifier at a conservative 20 watts, but it is built on a chassis little bigger than the original 10-watt 6BX7 amplifier. The KT88, operated at maximum ratings in push-pull triode, requires an input of 80 watts to the output stage in order to deliver 27 watts of audio. The KT77's, in this circuit, deliver over 20 watts for an input of 55 watts. Of more importance than the difference in efficiency is the fact that whereas the KT88's function at plate voltages on the order of 500 volts, requiring either special high-voltage or series-connected electrolytics in the power supply, KT77's are designed to operate at plate voltages some 50 volts less, thereby allowing the use of conventional filtering elements. The two types of tubes share the desirable characteristic of drawing almost constant plate current, regardless of output level, but the KT77's require considerably less grid driving voltage than the KT88's.

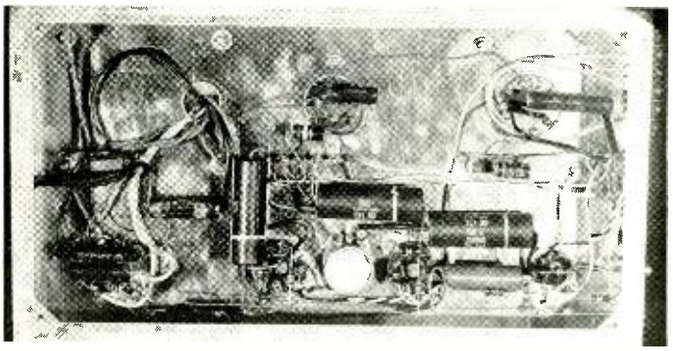


Fig. 2. Under-chassis view of the amplifier.

Because of all these characteristics, we have been able to simplify both the power supply and the amplifier circuit (see *Fig.* 1). The choke in the power supply has been eliminated, although plenty of RC filtering remains. For the power transformer we have chosen the inexpensive Triad "100" series, with excellent results. The output transformer, however, is not the place to economize, and, once again, we have chosen a husky, well rated component, this time the hermetically sealed Triad HSM-84.

The KT77 requires a comparatively small grid signal; because of this we have abandoned our previously-used pseudo-520 circuit, and have employed instead a simple floating paraphase inverter feeding the output stage directly. This means a saving of one tube and a handful of resistors and capacitors. More important, operating parameters are less dependent upon individual component values, and 10 per cent resistors have been used almost exclusively with no ill effect. The one disadvantage to this circuit is its comparatively low gain, even with the KT77's, but more about that later.

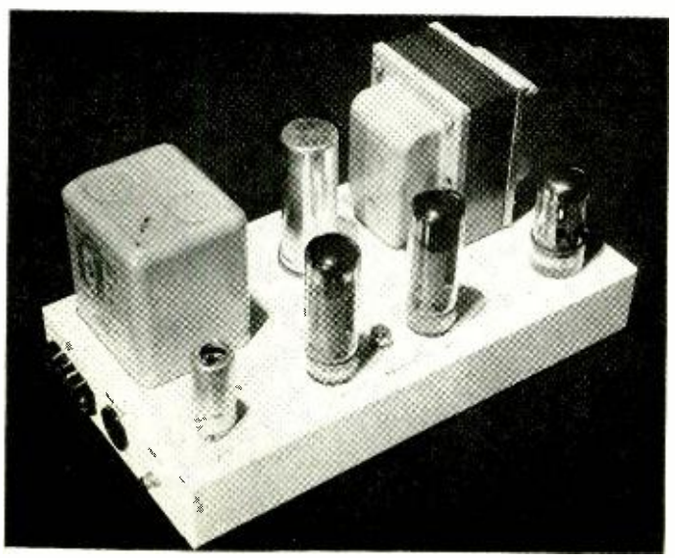


Fig. 1. Top view of new triode amplifier.

The Circuit

The input signal enters the upper half of the phase inverter, the lower half being fed from the tap on R_8. Traditionally, this circuit uses two resistors, the upper being slightly smaller than the lower. Rather than search for something as exotic as, say, a 273k resistor, we have used a balance control which, being variable, can be adjusted both for equal output voltages and to compensate for unbalanced output tubes (undesirable, see below). Capacitor C_2 looks larger than it need be; preliminary testing with 0.05 μf here produced severe distortion in the low-frequency region, which was caused by the inverter going out of balance because of the rising reactance of the smaller capacitor. We have concluded that, with this circuit, C_2 must be large enough to keep things under control to well below the bandpass of the amplifier.

The output and screen-suppressor resistors are values recommended by Genalex. The cathode bias resistor is somewhat smaller than recommended by Genalex for 450 volts on the plate, but plate dissipation is, at 27.5 watts per tube, within the design maximum value of 28 watts, and well below the absolute maximum of 35 watts. (Values are total plate and screen.)

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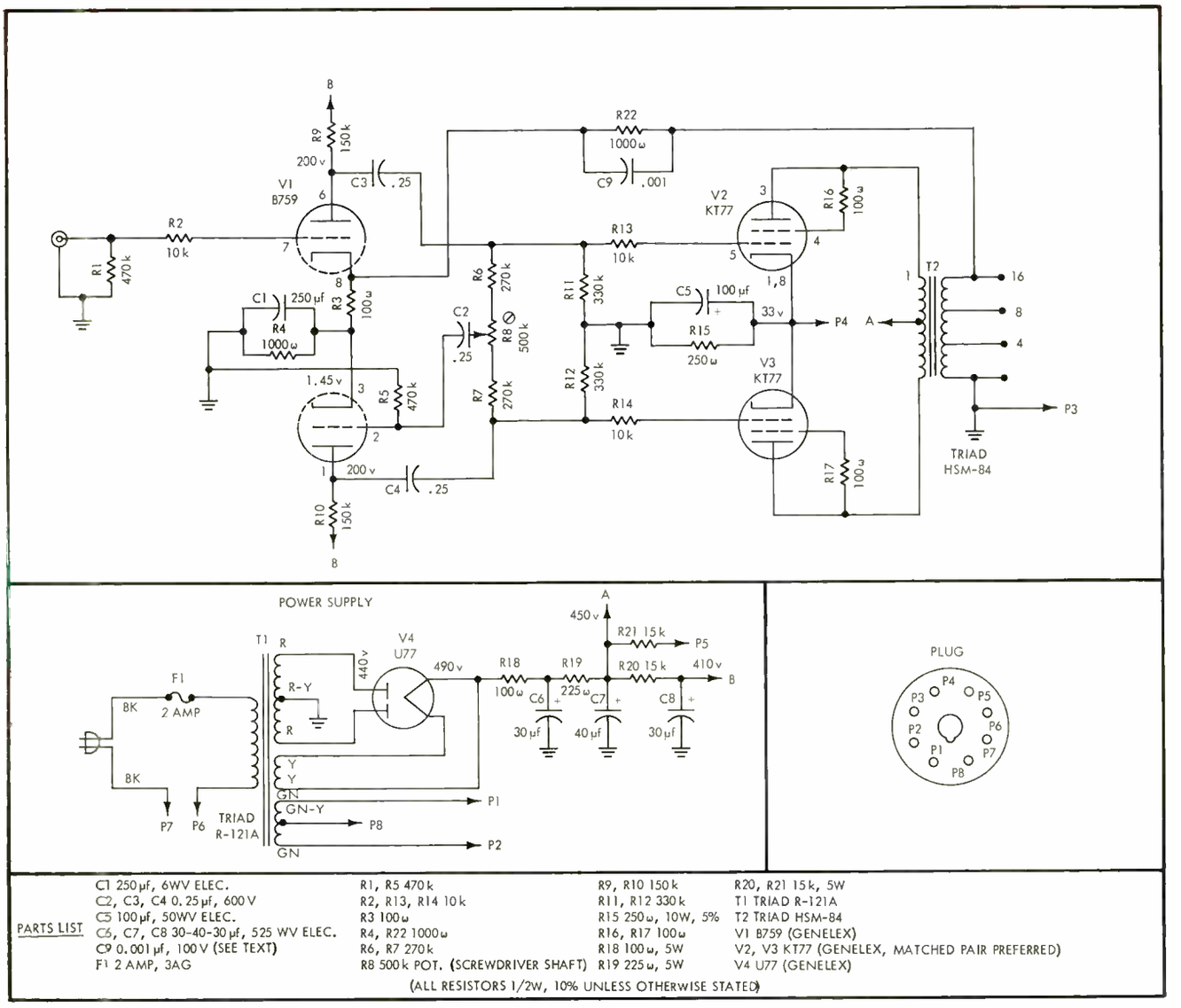


Fig. 3. Schematic of amplifier, including a socket for powering an unpowered preamplifier.

The power supply uses simple RC filtering all the way through, with no increase in hum, instability or distortion. The electrolytic we used (Cornell-Dubilier UPI 1D1992) is actually meant as a replacement for a Dyna amplifier; the 40 µf section is made up of two paralleled 20's. A power takeoff for a preamp is included; it will provide about 300 volts at 10 ma as well as filament. If no preamp is used (as is most likely the case; we realize that a power takeoff is an anachronism, but we have an un-powered preamp of which we are very fond) make up a jumper plug, shorting pins 6 to 7 and 4 to 8. Or, perhaps, leave out the socket and make the connections inside, using a switch for the a.c. if you like. The connection from 4 to 8 puts a positive bias on the heater center-tap, which is somewhat more effective in reducing hum than grounding. Actually though, hum is completely inaudible under any conditions, even floating filaments.

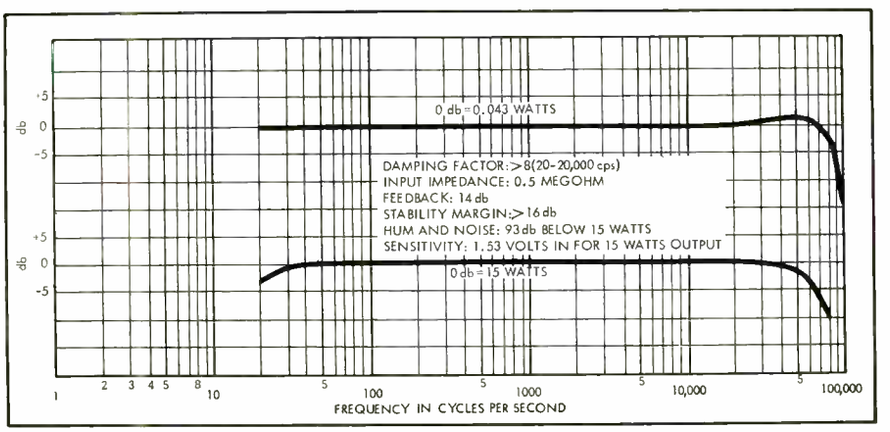


Fig. 4. Frequency response.

Performance

The frequency response is shown in *Fig.* 2. It is dead flat throughout the audible range at all levels. The slight hump around 50 kc may be eliminated completely by a careful trimming of C_9; the optimum value lies around 0.0013 µf.

Figure 3 is the power-versus-frequency curve. The amplifier puts out over 20 watts continuous over most of the range before clipping; music power rating would be on the order of 25 watts. Of great importance is the nature of the clipping—this amplifier, when properly balanced, will clip perfectly symmetrically, and, even at the bottom end, will

(*Continued on page 35*)

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Class-D For Efficiency

PETER A. STARK

A summary of the operation and theory of Class-D audio amplifiers using switching techniques, with design information and several working circuits

IN THREE PARTS—PART TWO

Schmidt Trigger

And so, as promised earlier, we come to the Schmidt trigger circuit. This is a circuit which has many interesting applications. It is essentially a circuit with two states; its output has one of two values, depending on whether the input voltage is above or below a definite 'trip' level.

As shown in *Fig.* 10, the long-tailed pair circuit given earlier could easily be said to be just a variation of the Schmidt trigger where the value of R_3 is zero and where the audio input signal is applied to the base of Q_2 instead of the base of Q_1. But the difference between the two circuits is more basic, since the Schmidt trigger has a positive feedback path which speeds up switching.

The two input signals are applied to the base of Q_1 through resistors R_1 and R_2. Suppose that both input signals are positive, so that transistor Q_1 is biased off. The collector voltage of Q_1 is therefore approximately −12 volts, and current through R_4 biases Q_2 on. When Q_2 is on, the emitter current flows through R_5 and makes the emitter voltages of Q_1 and Q_2 approximately −2 volts. This makes the Q_1 base-emitter voltage even higher, so that transistor Q_1 is driven even further into cutoff. As long as the circuit is in this state, the output voltage is near −2 volts, since Q_2 is saturated.

But now supose that the base voltage of Q_1 starts to go negative. Nothing happens until this voltage reaches −2 volts, at which time the base becomes slightly more negative than the emitter (which is at −2 volts). When the input voltage rises somewhat more, Q_1 starts to conduct. As this happens, the collector voltage of Q_1 falls, and the forward bias on Q_2 falls. Q_2 therefore starts to conduct less and eventually comes out of saturation. Its emitter current then decreases, with the result that the emitter voltage, developed across R_5, also decreases. This makes the base of Q_1 even more negative with respect to the emitter, and the process continues until Q_1 is on and Q_2 is off. This regenerative action results in a very rapid switching action.

The trick to the circuit is that R_7 is smaller than R_3, so that the current through Q_2 at saturation is larger than the current through Q_1 at saturation. When Q_1 is on, therefore, the emitter voltage is lower than it was when Q_2 was on; in fact, it is now only about 1.6 volts. In order for the circuit to switch back to the state where Q_1 is off and Q_2 is on, the input now has to go to almost −1.6 volts before the circuit switches again. The trip-on voltage is therefore −2 volts, and the trip-off voltage is −1.6 (actually, the trip voltages are about .2 more negative, because there exists a base-emitter voltage drop of about this value in the transistor; the trip voltages are therefore about −2.2 volts and −1.8 volts or so). The difference between the trip-on and trip-off voltages can be made smaller by making R_3 smaller, with the limitation that it must be greater than R_7. For example, if R_3 were 1.1k instead of 1.2k, the trip-off voltage would be about −2.0 volts instead of −1.8 volts. But making R_3 too small makes it too dependent on component tolerances, since just a slight error in the values of R_3 and R_7 may make R_3 smaller than R_7, rather than larger. Moreover, if R_3 and R_7 are too close to each other in values, the regenerative action of the circuit decreases and the response time of the circuit becomes longer.

It's interesting to note that the difference between the trip-on and trip-off voltages results in hysteresis; *Fig.* 11(A) shows this quite nicely. The horizontal axis is the instantaneous input voltage into the circuit; the vertical axis is the output voltage from the collector of Q_2. As the input varies, the output switches between the two states, represented by the horizontal lines at the upper right and the lower left. Since the trip-on and trip-off voltages are not equal, however, the curve takes different paths depending on whether the circuit is switching on or off.

Figure 11(B) shows the modulated

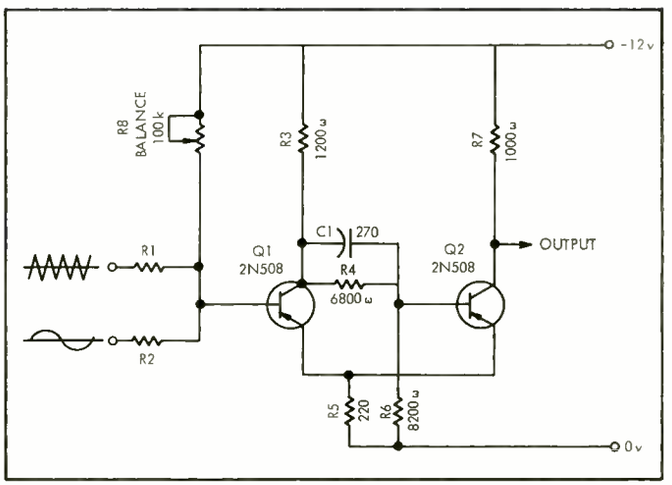


Fig. 10. Basic Schmidt-trigger circuit.

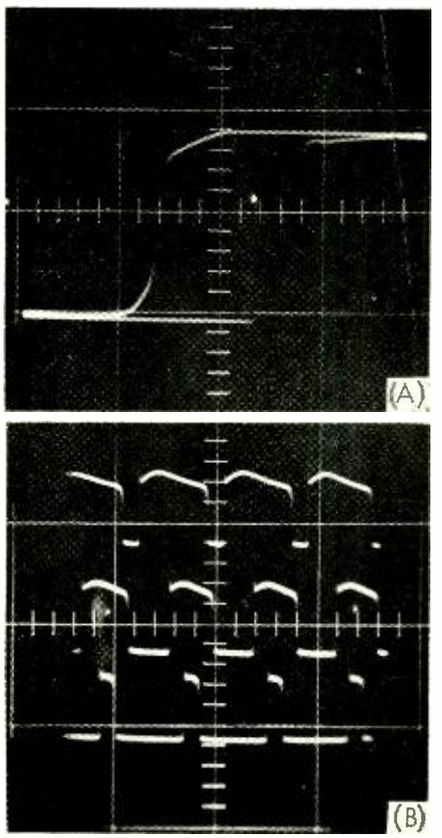


Fig. 11. Schmidt-trigger output waveforms.

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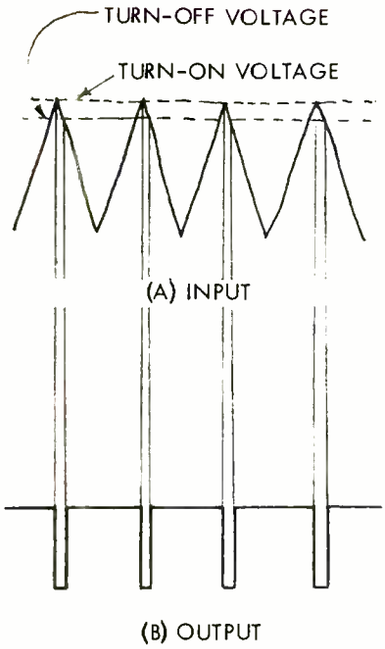


Fig. 12. Maximum modulation with a Schmidt-trigger modulator.

pulse output of the Schmidt trigger, at three values of input signal. The center curve is the symmetrical unmodulated output; the upper and lower curves are the approximate limits of modulation in both directions.

Unlike the two previous modulators, the Schmidt trigger modulator works on the difference in voltages between the audio and triangular wave inputs, rather than the sum. As we noted earlier, the circuit switches back and forth at certain defined values of input voltage. The circuit is biased with R_8 so that the normal input voltage to Q_1 is about halfway between the trip-on and trip-off voltages. When no audio signal is applied, the triangular input voltage increases and decreases the input voltage above and below the trip points, so that the circuit switches back and forth. When a positive input audio voltage is supplied, the triangular input voltage must go more negative before it switches; the trip-on and trip-off levels are therefore both shifted toward the negative side of the triangular wave. The same happens when the input audio signal is negative, except that now the trip levels are shifted toward the positive side of the triangular wave.

But there is a catch in all of this, and that is caused by the fact that the trip-on and trip-off voltages are not equal. As in the previous modulators, there is a limit to the maximum modulation obtainable. In this case, this limit is due to the hysteresis, and can be seen in *Fig.* 12.

Suppose that the input waveform is shifted by the input audio signal to the point where one of the trip voltages is exactly at the tip of the triangular wave, as shown in (A) of the figure. If the triangular wave is shifted any lower, it will never reach the trip-on voltage, and the circuit will never trip on (resulting in a fantastic amount of distortion, as we shall see later). This is therefore the maximum offset possible. But since the other trip voltage is different, this means that a small interval of time will elapse before the triangular wave shifts back to the other trip point. This interval of time, which could be called a delay time, represents the shortest pulse length that the circuit will handle, and limits the modulation.

Note further that the modulation limit in this as well as the other modulators described earlier depends also on the waveshape of the triangular wave. So far we have been considering ideal triangular waves with sharp corners. In reality we may sometimes find that the triangular wave is not quite so perfect. One such typical case is the simplest type of triangular wave generator, shown in *Fig.* 13. It is a Unijunction transistor circuit which generates a somewhat unsymmetrical triangular wave at approximately 70 kc with only four parts. It acts as a simple RC oscillator, where C_1 charges through R_1. When the voltage on C_1 exceeds the firing voltage of the Unijunction transistor, the transistor fires and discharges the capacitor. The process then repeats. At lower frequencies, this circuit would generate a sawtooth since the charge time would be much longer than the discharge time, but at 70 kc or so the waveshape approximates a triangular wave, as shown in *Fig.* 14, although one side of the wave is somewhat steeper than the other. This results in a combination of single-edge and double-edge modulation, but the circuit is useful for small circuits and for experimentation. But it has the drawback that the peaks are not really sharp, but instead curve rather gently. This is especially evident in the lower trace of *Fig.* 14, in which one cycle is expanded to show more detail. Referring back to *Fig.* 12, we see that if we use the Schmidt trigger with such a waveshape, we get even less modulation because the curved part of the wave is almost useless.

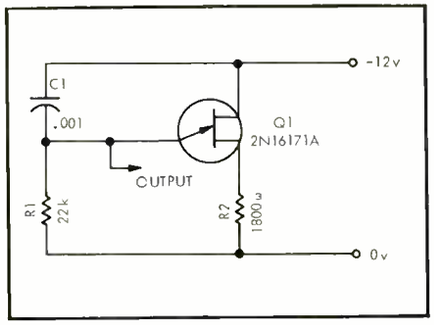


Fig. 13. The simplest triangular wave generator using a unijunction transistor.

For more exact applications we therefore need a more linear sawtooth generator. Many such units have been described in the literature on pulse circuits, but perhaps the easiest are either the relaxation oscillator (which tends to provide sawtooth waves more readily than triangular waves), and the integrator circuit which modifies a square wave.

The latter one is of more interest, because it has been used in an existing amplifier circuit with a rather neat twist. It works like this:

Suppose we apply a square-wave signal to an integrator circuit (low-pass filter) as shown in *Fig.* 15. Each time the applied input voltage changes value, the capacitor will try to charge to the new value. How long it takes the capacitor to charge to the value depends on the time constant, equal to the product of resistance times capacitance (RC). The time constant is equal to the time it takes the voltage across the capacitor to change by 63 per cent. For example, suppose that at a given instant the capacitor is discharged, and a pulse of 100 volts is applied to the input of the integrator. The voltage on the capacitor at the end of the time constant will therefore be 63 volts. All of this is rather elementary, but what we're leading up to is the fact that the voltage across the capacitor can be expressed mathematically in terms of exponentials. To be specific, if the voltage across the capacitor at the beginning is zero, the time constant is RC, and a voltage V_0 is applied to the integrator at a time $t = 0$, then the voltage V across the capacitor at any time, t, greater than zero can be expressed as

$$V = V_0(1 - e^{-t/RC}).$$

We can check this equation very quickly, by noting that at the beginning $t = 0$, so that $e^{-0} = 1$. We then have

$$V = V_0(1 - 1) = V_0(0) = 0.$$

At $t = RC$, the time constant, we have

$$V = V_0(1 - e^{-RC/RC}) = V_0(1 - e^{-1}) = V_0\left(1 - \frac{1}{e}\right)$$

$$= V_0\left(1 - \frac{1}{2.72}\right) = V_0(1 - 0.37) = V_0(0.63).$$

And finally, at very large values of t, $e^{-t/RC}$ becomes very small, so that (approximately)

$$V = V_0(1 - 0) = V_0.$$

Much the same occurs when the voltage across the capacitor at the beginning ($t = 0$) is V_0 and an input of 0 volts is applied. The capacitor then discharges, and its voltage can be expressed as

$$V = V_0(e^{-t/RC}).$$

In either case, the voltage does not vary at a constant rate with time, but instead varies at a rate determined by the

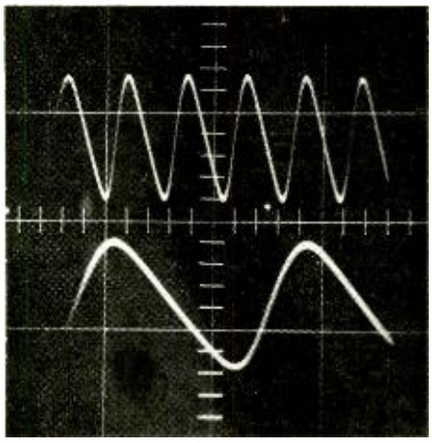


Fig. 14. Output of unijunction transistor oscillator of Fig. 13, at two sweep rates.

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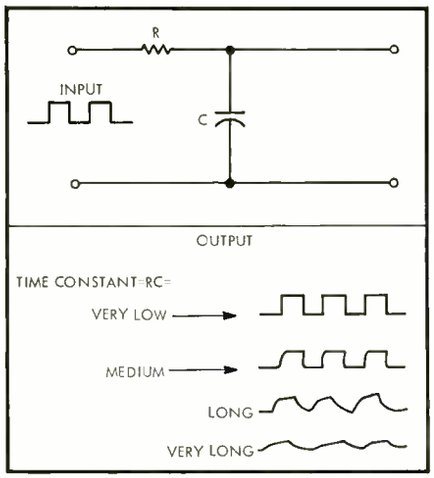


Fig. 15. Effects of time constant on output of an integrator circuit.

exponential term $e^{-t/RC}$. This is the reason why some of the output waveshapes shown in *Fig.* 15 have rounded edges.

But if the voltage does not vary at a constant rate with time, then the output is far from a triangular wave, which is what we would like to have, since the triangular wave has straight rising and falling slopes. How can we straighten the output from the integrator enough? This happens to be quite simple; we merely make the time constant of the circuit very long, so that the circuit travels only over a small portion of its charge or discharge exponential curve, and this small portion will be *almost* straight. This is mathematically justified, since the exponential function e^x can be approximated by what is called a Taylor's series of the form

$$e^x = 1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \frac{x^4}{24} + \cdots$$

If we let $x = -t/RC$, then we have

$$e^{-t/RC} = 1 - t/RC + \frac{t^2}{2(RC)^2} - \frac{t^3}{6(RC)^6} + \cdots$$

When t is much smaller than the product RC, then t/RC is very small. But $t^2/(RC)^2$ is very much smaller, and $t^3/(RC)^3$ is much smaller yet, and so on. And so, when t is very small some of the terms in the above equation become so small that they can be omitted from the equation without changing the total value of the equation by more than a few percent. And so we may approximate $e^{-t/RC}$ by

$$e^{-t/RC} = 1 - t/RC,$$

which changes linearly with time. This can be seen in *Fig.* 15 for the case where the time constant is very long, with the result that the output of the circuit is very close to a triangular wave. The difficulty is that the triangular wave has a very low amplitude because the voltage across the capacitor doesn't have time to change by very much, but this can easily be fixed just by amplifying the output.

The next question is therefore how to produce the square wave input to feed into the integrator. Of the variety of circuits available for the job, one of the best is the astable multivibrator shown in *Fig.* 16. In this circuit transistors Q_1 and Q_2 alternately turn on and off and the output from either collector is a square wave. The circuit works like this:

Suppose transistor Q_1 is on and Q_2 is off, but that the circuit is about to switch over to the other state. If Q_1 is on, then its base is slightly negative. Similarly, since Q_2 is off, its collector is almost at -12 volts. Capacitor C_2 is therefore charged to approximately 12 volts, with its left end more positive than the right. Suppose that the circuit switches at this time. Q_2 therefore turns on, and its collector voltage drops to almost zero volts (for simplicity, let's assume that it drops to exactly zero). The left end of C_2 is therefore about 12 volts more positive. This voltage is applied to the base of Q_1, and keeps Q_1 turned off.

But note resistor R_3. Its lower end is at $+12$ volts, and its uper end is at -12 volts. A current will go through the resistor, and will discharge the capacitor. The discharge time is dependent on the time constant R_3C_2. Capacitor C_2 will discharge until the voltage at the bottom end of R_3, and therefore the base of Q_1, become slightly negative, at which time transistor Q_1 starts to conduct and the circuit flips state. At this point capacitor C_1 and resistor R_2 take over and perform the same functions as C_2 and R_3 did before. If $C_1 = C_2$ and $R_2 = R_3$, then the circuit will stay the same time in either state, and the output is symmetrical. Or, for that matter, if the two time constants are equal, that is if $C_1R_2 = C_2R_3$, then the output will also be symmetrical.

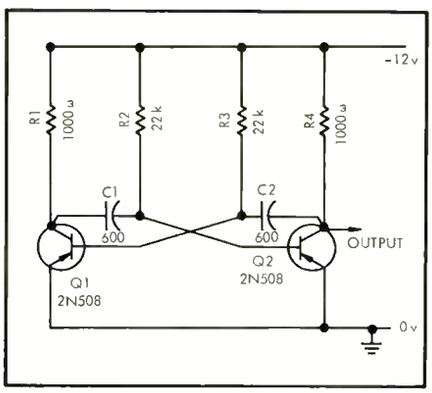


Fig. 16. Astable multivibrator square-wave generator.

So far we have shown that the values of C_1 and R_2 determine the length of time that Q_2 is off, and the values of C_2 and R_3 determine the length of time that Q_1 is off. Let's see if we can determine mathematically how long each of the transistors is off for given values of R and C.

Let the circuit of *Fig.* 17 represent one of the RC networks in *Fig.* 16, say, C_2 and R_3. As we mentioned earlier the voltage across C_2 is $+12$ volts at the time that Q_1 just turns off and Q_2 just turns on. Since the negative end of C_2 is at about zero volts (the collector voltage of Q_2 is about zero), we show the negative end of C in *Fig.* 17 grounded. The positive end of C is at $+12$ volts, and is connected to the resistor R, just as the positive end of C_2 is connected to R_3 in *Fig.* 16. The other end of R in *Fig.* 17 is connected to -12 volts, just like the other end of R_3 in *Fig.* 16.

Now let the -12 volt input voltage be called V_{in}, and let the initial voltage of $+12$ volts across the capacitor be called V_c. Then let the output voltage of the network (across capacitor C) be called V_{out}. Now at the beginning, that is, at $t = 0$, the output voltage is equal to the initial capacitor voltage: $V_{out} = V_c$. A long time later, after the circuit has stabilized and the capacitor has finished discharging, the output voltage will be the same as the input: $V_{out} = V_{in}$. Between these times the capacitor will discharge with an exponential waveshape like that shown in the curve of *Fig.* 17.

Notice the similarity between the dashed and the solid curves; the dashed curve is the same shape as the solid curve, except that it is 12 volts higher up. Several paragraphs earlier we have shown that the discharge curve can be expressed by an equation of the form

$$V = V_o(e^{-t/RC}),$$

where V_o would be $+24$ volts. Since V_{in} is negative (this is a pnp circuit), this can be expressed as $V_o = (V_c - V_{in}) = 24$, and the equation for the dashed curve becomes

$$V = (V_c - V_{in})e^{-t/RC}.$$

Now note that the solid curve is the same, except that it is 12 volts lower. We can therefore get V_{out} by subtracting 12 volts, which is the same as adding -12 volts. We can therefore get the equation for the solid curve by adding V_{in} to the dashed curve. The resulting equation is

$$V_{out} = (V_c - V_{in})e^{-t/RC} + V_{in}.$$

Though the above equation is correct, we have gotten it by rather simplified

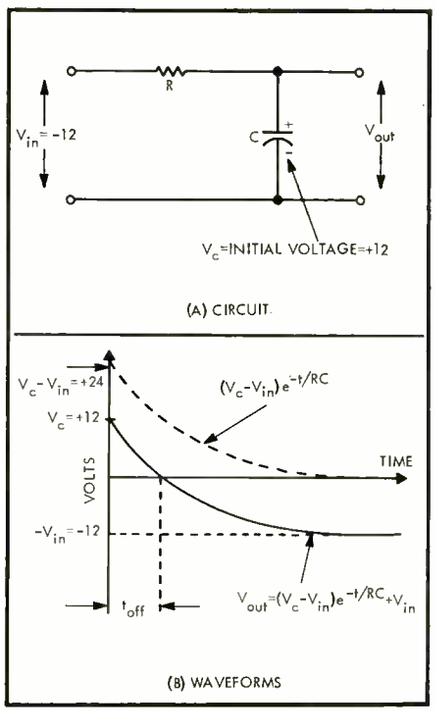


Fig. 17. Calculation of t_{off} for the astable multivibrator.

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reasoning; the mathematically rigorous derivation can be found in any electronics text, so we won't belabor the point further.

But note one thing at this point: this is the equation which would govern the behavior of the *RC* circuit in *Fig.* 17, whereas the actual *RC* circuit is connected into the circuit of *Fig.* 16. And we never permit the voltage across the capacitor to swing through the entire range from +12 to −12 volts. It so happens that as soon as the voltage drops to about zero, the base voltage of transistor Q_1 becomes zero. At this point the base starts becoming negative, and the transistor turns on. Now the other *RC* network assumes control. The off time of transistor Q_1 is therefore equal to the time that the voltage across capacitor C_2 takes to go from +12 volts to zero. This is the t_{off} interval marked off in (B) of *Fig.* 17. Since at this point $V_{out} = 0$, we can solve the preceding equation to find the value of t when $V_{out} = 0$.

$$V_{out} = 0 = (V_c - V_{in})e^{-t/RC} + V_{in}$$

$$\frac{-V_{in}}{(V_c - V_{in})} = e^{-t/RC} = \frac{V_{in}}{(V_{in} - V_c)}$$

$$e^{-t/RC} = \frac{1}{e^{-t/RC}} = \frac{(V_{in} - V_c)}{V_{in}}$$

$$t/RC = \ln\left(\frac{V_{in} - V_c}{V_{in}}\right)$$

or $$t = t_{off} = RC \ln\left(\frac{V_{in} - V_c}{V_{in}}\right)$$

where "ln" is the symbol for a natural logarithm. Let's now apply the above equation to the circuit of *Fig.* 16, where R is 22k ohms, and where C is 600 pf. The value of V_c is +12 volts and V_{in} is −12 volts. The value of t_{off} is therefore

$$t_{off} = (2.2 \times 10^4)(6 \times 10^{-10}) \ln\left(\frac{-12 - 12}{-12}\right)$$

$$= (13.2 \times 10^{-6}) \ln (2).$$

Looking up the natural log of 2 shows that it equals about 0.7, so that

$$t_{off} = 0.7 \times 13.2 \times 10^{-6}$$

$$= 9.2 \times 10^{-6} \text{ seconds} =$$

9.2 microseconds.

If the circuit is symmetrical, then each transistor will be turned off for approximately 9.2 microseconds, so that the total time for one cycle is about 18.4 microseconds. The frequency of operation is therefore

$$\frac{1}{18.4 \times 10^{-6}} = 55 \text{ kilocycles.}$$

The circuit can therefore very nicely provide a square wave output of about 55 kc, which we can then convert into a triangular wave by means of an integrator. We can then modulate the triangular wave by one of the modulators shown earlier and get the required length-modulated pulses.

But wait! We can get length-modulated pulses out of the multivibrator directly. Suppose we modify the circuit as shown in *Fig.* 18. This circuit operates the same as the circuit in *Fig.* 16, except that resistors R_2 and R_3 are connected to the −12 volt line through the secondary of transformer T_1. If no audio input is applied, no voltage exists across the secondary of T_1, and the circuit provides symmetrical square wave outputs as before.

But suppose that an audio input is applied and causes the voltage at terminal 1 to decrease to −10 volts, and the voltage at terminal 3 to increase to −14 volts. This unbalances the two sides of the multivibrator. Capacitor C_1 will take longer to discharge, whereas C_2 will take less. Applying the same equations as before, we see that for the network composed of C_1 and R_2, t_{off} is found to be

$$t_{off} = (13.2 \times 10^{-6}) \ln\left(\frac{-10 - 12}{-10}\right)$$

$$= (13.2 \times 10^{-6}) \ln (2.2).$$

Since the natural log of 2.2 is 0.79, (looked up in a table of natural logarithms[13]),

$$t_{off} = 10.4 \times 10^{-6} \text{ seconds} =$$

10.4 microseconds.

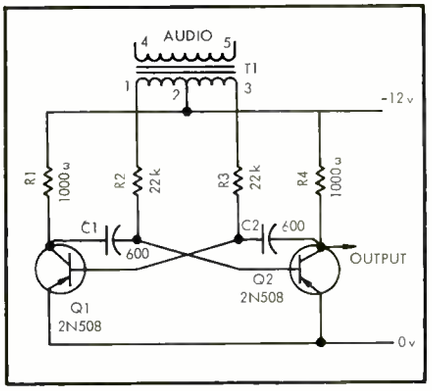


Fig. 18. Astable multivibrator generator and modulator.

On the other hand, t_{off} for the network composed of R_3 and C_2 is

$$t_{off} = (13.2 \times 10^{-6}) \ln\left(\frac{-14 - 12}{-14}\right)$$

$$= (13.2 \times 10^{-6}) \ln (1.86).$$

$$t = 8.2 \times 10^{-6} \text{ seconds} =$$

8.2 microseconds.

The total time required for one cycle is 10.4 + 8.2 = 18.6 microseconds, which is a slight change from the 18.4 microseconds we had earlier.

Unfortunately there is a slight catch in the circuit: it requires an extremely large audio signal, and the frequency changes with the audio signal.

To illustrate these effects, let's double the input voltage to the audio transformer so that the difference between terminals 1 and 3 is now 8 volts instead of 4 volts. Terminal 1 is therefore at −8 volts and terminal 3 is at −16 volts. Recalculating the t_{off} times as before, we get 12.1 microseconds for C_1 and R_2, and we get 7.4 microseconds for C_2 and R_3. The total time is now 19.5 microseconds, indicating that the oscillator frequency has dropped to about 51 kc.

Once more, let's double the input voltage again, so that the voltage at terminal 1 is −4 volts and the voltage at terminal 3 is −20 volts. Then t_{off} for C_1 and R_2 is 18.3 microseconds, and t_{off} for C_2 and R_3 is 6.2 microseconds. The total time for one cycle is 24.5 microseconds, so that the frequency is now 41 kc.

Well, the next question is, just how much audio voltage do we need to provide 100 per cent modulation of the square wave? (At 100 per cent modulation one of the t_{off} times will be zero, and the other t_{off} time will be equal to the complete period.) Denoting this mathematically, and letting two t_{off} times be called t_{off1} and t_{off2}, we mean that

$$m = \frac{t_{off1}}{t_{off1} + t_{off2}} = 1,$$

which occurs only when t_{off2} is zero (we have coined a new quantity m, which we might call 'duty factor'—the fraction of the time that the circuit is in one of the two states.)

Let's calculate the frequency and the duty factor m for a variety of input voltages (voltages between terminals 1 and 3 of transformer T_1):

Input (volts)	Frequency (kc)	Duty factor	Modulation (%)
0	55	0.5	0
4	54	0.56	12
8	51	0.62	24
12	47	0.68	36
16	41	0.74	48
20	32	0.81	62
24	zero	1.00	100

There are several interesting effects pointed out in the above table. For one thing we get not only pulse-length modulation, but also frequency modulation of sorts (remember that for negative input voltages the duty factor decreases from 0.5 down to 0, and the modulation goes up to 100 per cent in the opposite direction.) We might therefore expect to get not only the sidebands which belong to the length-modulated signal, but also sidebands which belong to the frequency modulation. These latter sidebands may go quite far down in frequency below the repetition frequency of the square wave.

The second interesting thing is the decrease of the frequency in one jump down to zero. This is rather unique, because this means that the voltage at terminal 1 of transformer 1 has decreased down to 0 volts. This merely means that the voltage across the capacitor, which follows the exponential curve, never really quite discharges completely to zero—the multivibrator never flips back.

Finally, the audio input required is approximately in the range from −24 volts to +24 volts (to get duty factors from 0 up to 1.0). This is fairly easy to get from a transformer, but hard to get from a transformerless circuit because it means that a power supply of at least 50 volts is required; this pretty much eliminates batteries as a power source.

The maximum modulation is also somewhat limited by the theoretical consideration that we don't want the operating frequency to decrease below about 50 kc, to prevent unwanted low frequency sidebands from interfering with the audio. Since the frequency goes down to zero at full modulation, we must limit modulation in some way. If the maximum desirable frequency, required to keep circuit

(*Continued on page 45*)

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A Basic Course in Commercial Sound

Norman H. Crowhurst

Chapter IV

Phasing

In certain situations, phasing of speakers is unimportant, but most often it is at least noticeable in its effect and sometimes it assumes serious importance. In any system where the acoustic waves generated by individual speakers should be "parallel," (speakers in same plane) their phasing is extremely important (refer back to *Fig.* 3–1). Whether the sound comes from overhead or in front of the audience, reversal of phase of any one speaker will result in a serious "hole" in coverage.

Where the intensity from the reversed speaker is equal to that from others in the system, the combined effect is a transverse wave movement that gives the impression that the local speakers are not working at all, and all the listener thinks he hears is confused sound from more distant speakers. This will be the complaint usually received under these circumstances, so receipt of this complaint at any time should be checked (a) by verifying that the speakers in question are connected and working, and (b) that their phasing is correct.

But in many places, such as long halls, successive rather than parallel reinforcement is needed, even if the acoustics are not poor enough to necessitate the use of a delay system (refer to *Fig.* 3–8). How about phase now? There is no clear-cut answer. In such a system it is difficult to avoid at least small "dead spots" where hearing is difficult, because sound from two speakers at different distances, almost inevitably causes some confusion of sound.

Often reversal of phase of one of such a pair, compared to the other, will make the "transition zone" smoother. The required phase may be "in" or "out" in the electrical sense. The only way to find which is best is to try each of them and explore the transition zone quite thoroughly. Changing phase will almost invariably move the transition zone at which most difficulty in hearing intelligibly is experienced, so don't just check at the listening position while phase is reversed. Choose the connection that gives best over-all listening throughout the whole transition area from where the sound appears to come exclusively from one unit, to where it appears to come exclusively from the other.

One connection may shift the "difficult" spot into an aisle, or somewhere else not occupied by audience for one reason or another. In such cases, this is the obvious choice of phasing. In making checks use voice intelligibility tests, because these are the most critical. Also use different voices (either live or recorded) because the frequency range in which important intelligibility components lie can affect the apparent result.

When setting up an installation, such as a large hall, where both parallel and successive waves occur, one must work successively. First connect only the first group and check for correctness of phasing. Then connect only the second group and so on, checking each group for phasing within the group, separately from other groups. Next check for the best phasing between successive groups, first and second, then with both these connected find the best phase for the third group, and so on, until the entire system is connected.

Determining Phasing

Nowadays, most speaker manufacturers make matters convenient by marking one binding post of the speaker for phasing purposes, so that when a positive voltage is connected to the marked post (usually a red dot), and a negative voltage to the other one, the diaphragm moves forward. Where wiring is identified in polarity, by black/red, red/white or black/white insulation coloring, this does make the ensuring of correct electrical phasing simple. If all speakers are connected in parallel to the amplifier, it's a simple matter of connecting all marked posts to one color of wire and all unmarked posts to the other color. Of course, maintaining correct color continuity through-out the system is essential.

In systems where the entire acoustic field is parallel wave, it is safe and quick to connect up on this basis. If one speaker should happen to be wrongly phased (which is quit unlikely,

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but nevertheless possible), it will be easy to spot, because it will produce "dead spots" surrounding itself on each side, where it meets the sound field from its neighbors; in some instances the speaker itself will seem dead too.

Between any pair of speakers intended to produce parallel wave development, phasing can be checked by listening critically at a point equidistant from both. Moving a little to the left should make the sound appear to come from the left speaker, while moving to the right should make it appear to come from the right speaker. In between, there should be a point where the sound seems to shift from one to the other, remaining quite definitely in front of the listener. Wrong phasing destroys this continuity.

Where successive wave development is used, and phasing proves necessary, connect the system successively and check at each point, as described earlier, before proceeding to the next. This care is time well spent, because you can waste a lot of time trying all the permutations and combinations of phase changes, with all speakers connected, and still finish up missing the correct one!

Relative Power

Another factor that controls effective coverage is the relative power fed to different units in a system. In a parallel-wave system, if each unit feeds a virtually identical audience area, each should receive the same audio power, as well as being connected in the same electrical phase.

But if areas fed are unequal in such a system, or the building being served lacks symmetry in one way or another, different power distribution may be needed. The system still uses parallel wave distribution so phasing is maintained electrically correct, but the power to the units serving the larger areas is stepped

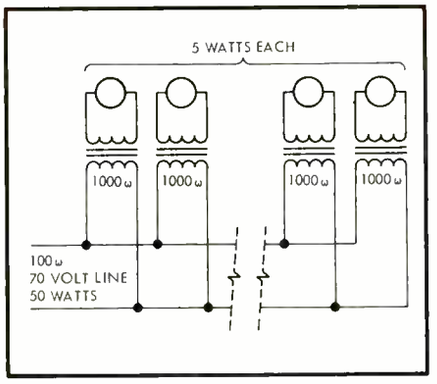


Fig. 4-1. Constant-voltage line setup to deliver 5 watts to each of 10 speakers from a 50-watt amplifier.

up relative to those serving smaller areas.

Where successive wave distribution is used, the relative power fed to successive units also affects the phasing which will seem best, because it moves the zone where confusion is likely to occur. In such cases, the relative power can probably be decided by simple arithmetical comparison of areas served—twice the area, twice the power. This will simplify the phasing procedure, because only one "variable"—the phasing—has to be checked experimentally. But sometimes the calculated relative power will be found incorrect when the job is complete, because some factor was either not considered, or was incorrectly assessed.

For example, it may be that, as well as having to serve a larger area, one speaker also "loses" sound because its area is not enclosed in the same way as adjoining areas are. This will call for a greater proportion of power than mere increase in service area will. After making such a step up in power to correct a weak spot, you will need to recheck phasing, if successive wave distribution is involved.

Electrical Feed

So far, we have discussed phasing and variation of electrical power purely from the viewpoint of the acoustic effect —the over-all result on the effective coverage of the system. We have not gone into any details about how to get the right amount of power in the right place.

In the early days, the big question was whether to use series or parallel feed, with mixtures of series/parallel sometimes serving a useful purpose. Where numbers of speakers are used, the disadvantage of parallel feed is that impedance gets very low, and consequent line losses become a considerable portion of the available output—the system gets quite inefficient.

The argument against series feed is that speakers "work best" with parallel feed. The usual reason given is that they get better amplifier damping. A group of speakers all in parallel results in each speaker being directly connected to the low amplifier output impedance as damping. The same group all in series results in each speaker having all the others connected as series damping, so the amplifier cannot damp each individual speaker unit at all.

Meanwhile, there is a better system available, that avoids both problems: constant-voltage lines. In high fidelity and kindred audio applications, the reference is to impedance matching. If multiple units are used, the connection must be that the total load is correct in impedance for the amplifier. Constant-voltage lines involve a change in concept.

The system is regarded as analogous to a power distribution system, where the lines carry constant voltage, and the power taken by any appliance connected is controlled by the impedance of the appliance. So, in speaker systems, the relative power controlled by the impedance presented by the speaker, through its constant-voltage line-matching transformer.

Matching and Distribution

Any system of connecting a number of speakers to an am-

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plifier has to serve two purposes: (a) deliver the full available output of the amplifier, in correct proportions, to the individual units of the system, and (b) do so efficiently. The "correct proportions" is a matter of distribution; the obtaining of full available output, efficiently, is a matter of matching, and impedance.

Series-Parallel

To get things in perspective, it may be well to answer that series-versus-parallel question first. Suppose we have to feed ten 16-ohm units: in parallel, these result in a combined impedance of 1.6 ohms. If the wiring has a resistance of 1 ohm (half ohm in each leg—which is small for a big system) almost 40 per cent of the available power will be used to warm the wire. Such small audio power will not appreciably heat the wire, of course, but it is a serious waste, because it means that only 60 per cent of power produced by amplifiers whose cost is so much per watt, can reach the speakers.

So let's consider them in series: the total impedance is 160 ohms, of which 1 ohm is less than 1 per cent; more than 99 per cent of the available power reaches the speakers. But what about this damping question? For high fidelity purposes, damping can be important; we are dealing with commercial sound. In installations where voice reinforcement is the only function of the system, transient distortion would probably be unnoticed.

However, the fact that individual units are fed virtually constant current, rather than constant voltage, means that serious frequency coloration can occur, as well as the less noticeable effect on transients. While this is a more valid argument, the fallacy in it comes in the implied assumption that only the speaker whose response we are considering (just one—not all of them together) has an impedance characteristic—all the others are resistances! Actually, all the speakers have impedance characteristics, which can mutually affect one another. This could aggravate the situation or minimize it, in different circumstances.

If all the units are of the same type, then their impedance characteristics will be reasonably similar, so 10 of them in parallel will result in substantially identical impedance characteristic, of one tenth the value, while in series it will have ten times the value. Matched equivalently to the amplifier (with nominal output impedances of 1.6 ohms or 160 ohms, respectively) the frequency response will be identical: neither will be fully constant voltage or constant current, and each method of connection will receive substantially the same frequency coloration.

Only if individual units have radically different impedance characteristics, so one unit has a high value at a frequency where the others have low values, or vice versa, will coloration *at an individual unit* appear. The overall energy fed into the area may be less colored than with identical units, but the color *differences* between units will get exaggerated, with possible unpleasant effects in parts of the audience area.

So, for performance purposes, we have a relatively simple answer: if the units are all the same type, series is as good as parallel, and the circuit is much more efficient; if the units are different, parallel will avoid possible frequency coloration. But there are other factors.

One of these is safety. Any individual unit may develop an open circuit or may develop a short circuit. In speakers, open circuits are the more common fault. In parallel connection, a short circuit would kill the whole line, while an open circuit kills only the defective unit. In series connection, an open circuit kills the whole line, while a short circuit only kills the defective unit. Thus, as opens are more common, the parallel connection has a slight edge from the safety factor viewpoint.

Another factor is matching: we have to match the amplifier. Does this have an impedance tap of 1.6 ohms, or 160 ohms? Likely not. So we must get a matching transformer to produce the required match, one way or the other. The alternative is to juggle series/parallel combinations, in an endeavor to get a combined impedance for which the amplifier does provide an output.

But whatever combinations we consider, in however large quantities of speaker units, the steps from one arrangement to another always seems rather drastic and it's a headache to find a combination to give the over-all power distribution required and come fairly close to an impedance the amplifier happens to provide. Wiring it may get even more involved than drawing a diagram on paper and then if you want to change it for any reason. . .

Examples in books may make it look easy, because they were picked to make the figuring look simple. A very "lucky" coincidence! But the case you're likely to meet is never that simple! Which fact led to the adoption of the constant-voltage line technique.

Constant-Voltage Lines

This hinges around a design voltage, rather than a design impedance. The European standard is 100 volts, while the American is 70 volts (100 volts peak for a sinusoidal signal of maximum power). First maybe we should clarify what is meant by constant voltage. It does *not* mean that the line carries an audio voltage that is always 70

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or 100, as the case may be. In quiet signal spots, there is no voltage on the line at all.

What it does mean is that the available, or peak signal voltage, is regarded as a constant figure, at which value various currents, or wattages, may be drawn, for the determination of *relative* power throughout the system. Thus if ten 5-watt speakers are connected to a 50-watt amplifier, correct matching will be achieved (if the same "constant voltage" design figure is used throughout) and each unit will receive one tenth of the total power.

Although, for convenience in application, amplifiers, speakers and matching transformers are given a voltage and wattage rating, rather than stating their operating impedance, they are still designed on an impedance basis. It will help clear the mystery of how constant voltage lines work, if we make the conversions for a few cases. Although we do not *need* to make these conversions in figuring out an installation, it will help us understand what we are doing.

The convenient formula is that $PR = E^2$, which for 70-volt lines is approximately 5000. Dividing watts into 5000 gives impedance in ohms, or vice versa. To deliver 50 watts at 70 volts, the output impedance of the amplifier must be designed as 5000/50 = 100 ohms. Each speaker must present an impedance to the line of 5000/5 = 1000 ohms (*Fig.* 4–1). If the unit voice-coil impedance is 16 ohms, the line transformer impedance ratio is 1000:16. Connecting ten 1000-ohm impedances in parallel results in a load of 100 ohms, so matching is preserved, merely by making sure that the power ratings add up.

Suppose that, instead of ten speakers all taking the same power, we have eight, of which six are to take 5 watts and two will take 10 watts. Total power is still 50 watts. The 5-watt units still present an impedance of 1000 ohms, while the 10-watt units present an impedance of 500 ohms each. These values are taken care of by the speaker line transformers. Six 1000-ohm impedances in parallel produce 1000/6, or 166⅔ ohms, while two 500-ohm impedances produce 250 ohms. Combining these in parallel gives 100 ohms, just the same as for ten identical units, or any other grouping that adds up to the correct total power.

Mismatch

Using constant-voltage lines often with multiple tap line transformers so that the rating of a speaker can be changed on the spot to obtain correct distribution with a simple adjustment, simplifies the matching and distribution problem considerably, but still it is a miracle if everythings works out exactly right, according to the convenient examples we just used.

More likely we shall want to use ratings that enable us to put twice as much power in some units as in others, or some detail like that, and when we add up the total power rating for the speakers it will come to either more or less than the power rating from available amplifier sizes. So what do—or can—we do?

Logically, we would say that it's all right to load up to, but not exceeding the maximum rated power of the amplifier. So if our total speaker ratings add up to 55 watts, and amplifiers come in 50- or 75-watt ratings, we should use a 75-watt amplifier.

This is a "safe" way to view matters, but may be unduly extravagant of power sometimes. If this arrangement is used, the 75-watt amplifier will never use more than 55 watts of its available power. Feedback will hold its output down, approximately, to a constant peak voltage, so that 55 watts is the maximum power it will give *into this load.*

Suppose we did connect 55-watt's worth of speakers to a 50-watt amplifier, what would happen? In theory, an amplifier delivers just so much *current* at its peak voltage and then quits, because saturation of the output stage is reached. Following this theory (which is close to practical results) voltage will be cut to 50/55, or 10/11 of the value at correctly matched maximum, resulting in reduction of power to about 45 watts, into speakers with a total rating of 55 watts.

Question—Chapter IV

With the mismatch just described, it may be possible to "get by." With bigger mismatches, the loss could be serious. Connecting 100 watt's worth of speakers to a 50-watt amplifier will result in only 25 watts being actually delivered. This is serious: the actual power is cut to a quarter of the calculated power, although the amplifier, properly matched, could deliver as much as a half, which may be enough. So what can be done?

Would you (1) raise the constant voltage at the output by using a set-up transformer of 1:1.4; or (2) 1:2; or would you (3) drop the voltage by a step-down of 1.4:1; or (4) 2:1?

Answer—Chapter IV

The third answer was the correct choice, which can be verified on either an impedance or voltage/power basis (*Fig.* 4–2). A total load of 100 watts of speakers rated for 70-volt line will present an impedance of 5000/100 = 50 ohms. The amplifier's load should be 100 ohms. A 1.4:1 step-down will match the 50-ohm load to the 100-ohm amplifier output.

(*Continued on page 45*)

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extremely effective performance they provide. The ratio detector is the famil-

lems, the signal source should be continuously (and easily) variable throughout its frequency range. Those of us who have used this kind of oscillator to sweep a range while displaying the output on a scope know how quickly difficulties can be uncovered Another useful attribute for transistor circuits is the ability to provide a balanced signal.

The B & W Model 210 is an R-C oscillator which provides all the features mentioned above plus a few others. From the photograph we can see the just-under-5-in. calibrated dial which makes it a snap to read frequencies accurately. In addition, a small friction knob permits fine control. The 210 provides signals from 10 cps to 100,000 cps in four ranges. It also provides a variable output up to 10 volts, or 150 milliwatts into a 600-ohm load.

The oscillator of the Model 210 is a two-stage (6AU6 and half a 6CG7) resistance-coupled amplifier with positive feedback to cause oscillation. Negative feedback is used to reduce distortion and to stabilize the output. Tuning is accomplished by means of a variable capacitor and the range is established by switching resistors, both in the positive feedback loop. An incandescent lamp (resistance increases with current) is used as an unbypassed cathode resistor for the 6AU6 so that the negative feedback is automatically increased, thus tending to stabilize the oscillator output.

The output of the oscillator goes to the driver, the other half of the 6CG7, which drives a 6CL6 pentode. This pentode then supplies one of the two output transformers. One transformer is used in the range from 10 cps to 10,000 cps and the other from 10,000 cps up to 100,000 cps. Negative feedback is provided from the output transformer to the cathode of the driver.

Frequency response of the B & W 210 was within 0.75 db over the entire range into 600 ohms. At a 10 volt output the distortion was 0.24 per cent from 50 cps to 20,000 cps. Also, at a 10 volt output in the range from 10 cps to 50 cps and from 20,000 cps to 100,000 cps, the maximum distortion was 0.41 per cent. The hum and noise at 10 volts out was –69 db.

Altogether, this is a very fine instrument in the less than $200 category and well worth the attention of the serious audio worker or lab.

G-16

RCA RIBBON MICROPHONE, MODEL SK-46

RCA has been making ribbon microphones for many, many years now. In fact, most of us probably grew up with sound transmitted by RCA ribbon microphones. We don't mean to imply by this that ribbon microphones provide "old"

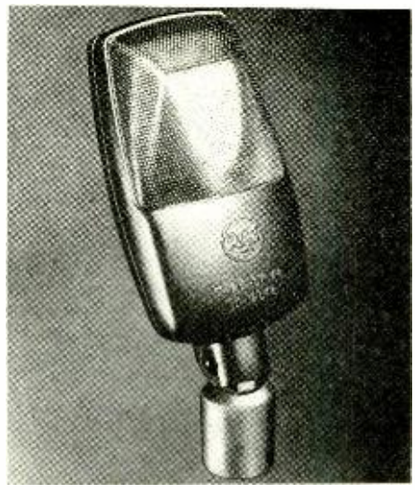


Fig. 3. RCA ribbon microphone, Model SK-46

sound, but rather that RCA is a very experienced maker of this form of microphone.

The SK-46 was designed for use in reinforcement and broadcasting applications. Over the years, ribbon microphones have proved very effective in this type of application because of their "figure-eight" pickup pattern. This characteristic eliminates or severely reduces pickup of unwanted sounds from the sides of the microphone.

The RCA SK-46 comes in a handsome,

(*Continued on page 47*)

FM RECEPTION

(*from page 21*)

nary straight line, while making sure that the d.c. voltage is balanced, zero. The zero spot on the 'scope should occur at the center of the i.f. bandpass. (See *Figs.* 7 and 10.)

Recheck the i.f. response and retouch, then recheck the detector.

Watch the i.f. response while changing the amplitude of the FM generator. Readjust the 'scope sensitivity so as to maintain a constant-amplitude presentation. Observe the way in which the i.f. response changes. The adjustments should be such that the slope is no greater in one direction for a weak signal (tuning indicator shows presence of signal) than it is in the other direction for a strong signal. *Figure* 8 shows improper response to weak and strong signals, but checks o.k. for a medium strength one.

If your FM generator is capable of being modulated from an external source without exceeding 0.1 per cent distortion and noise, a slightly more accurate method of detector alignment can be employed. Modulate the FM generator with 400 cycles and allow about ± 50–75 kc deviation. Connect the tuner audio output through a 400-cycle filter (schematic available from H. H. Scott, 111 Powdermill Road, Maynard, Mass.) to a millivolt a.c. VTVM. Tune the filter for the greatest null at 400 cycles, then adjust the bottom slug of the detector for a minimum reading on the VTVM. Keep in mind that the detector must be d.c. balanced as before. Experience has

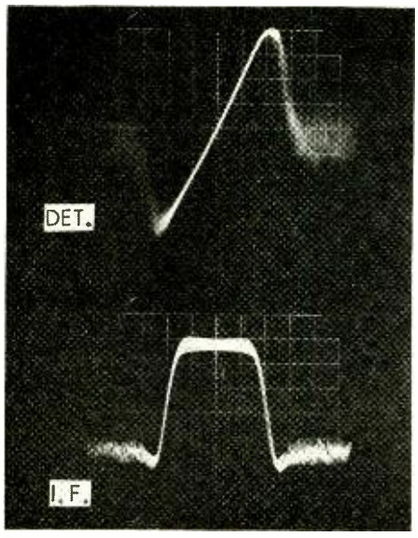


Fig. 10. Superimposed sweeps. Here the two sweeps can be observed easily for balance. (100 kc per division.)

shown the author that if the previous detector adjustments are properly done, only a very slight readjustment of the primary will be necessary for achieving minimum distortion, and the improvement in distortion is only about 4 per cent. Example: 1 per cent distortion reduced to 0.96 per cent is an improvement of 4 per cent.

As a quick check for AM rejection, turn off the FM generator and turn on the AM generator. Switch out the filter. Modulate the AM generator with 400 cycles and listen to the tuner output (at regular broadcasting volume). There should be no audible 400-cycle tone. Sometimes a compromise must be made between maximum rejection, a straight detection line, and a balanced output; although a properly designed detector will "maximise" all these items at the same adjustment.

Since these techniques have been put into practice, results have been excellent. This alignment procedure has proven to be the most straightforward and effective way of adjusting any tuner for its optimum performance. Once the i.f. and detector sections have been aligned, the oscillator can be made to track and the r.f. sections peaked and you are well on your way to quality FM reception whether the tuner is mono or stereo. Æ

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AMPLIFIER

(*from page 23*)

make almost perfect square waves out of sine waves before any notching appears. It shows no sign of instability, even when driving an open circuit, or a purely capacitive load. Harmonic distortion at 10 watts is below 0.5 per cent, 20 to 15,000 cps. Transient response, indicated by square wave passage, is excellent.

The damping factor is greater than 8 throughout the entire audible range. This is just about right for most speakers; acoustic suspension systems may require a bit of bass boost. About 14 db of feedback is used. More will not improve the listening quality to any degree; however if you have gain to spare (this is a limiting consideration here; the amplifier, as is, requires close to 2 volts for 20 watts output) try increasing the size of R_3. In our tests we went to the limit here (R_3 open) and detected no oscillation, although we measured more than 30 db of negative feedback. Do not try to increase the amount of feedback by decreasing the size of R_{22}; this controls the operating point of the phase inverter, and changing it will create all sorts of new problems.

A note about the output tubes: The British, in general, seem to use separate bias resistors in the output stage, a practice which American audio design does not usually follow. We think that if one uses matched tubes, separate resistors accomplish nothing, and, in addition to requiring separate, large bypass electrolytics, are actually disadvantageous if they are less than perfectly matched. However, since we do use a common resistor, it is most necessary that matched tubes be used, preferably factory matched, since factory matching includes transconductance as well as emission.

Although we prefer the luxury of separate amplifiers for each channel, it is very likely that some will desire a stereo version of this circuit. For them we would recommend an R-25A power transformer and two U77's in a push-pull arrangement in the common power supply. This would run somewhat cooler, at least as far as the power transformer is concerned, than the monophonic version.

How does it sound? As far as we can tell, the amplifier described here has as complete an absence of any sound of its own as any we have heard. Of course it is rated at only 20 watts, which limits its use to other than, say, filling an auditorium. For normal use, however, we think it is the best balance of sound, size, and price we have yet encountered.

We feel a good measure of our success can be attributed to the willing assistance of the Triad Transformer Corp. and British Industries Corp. Æ

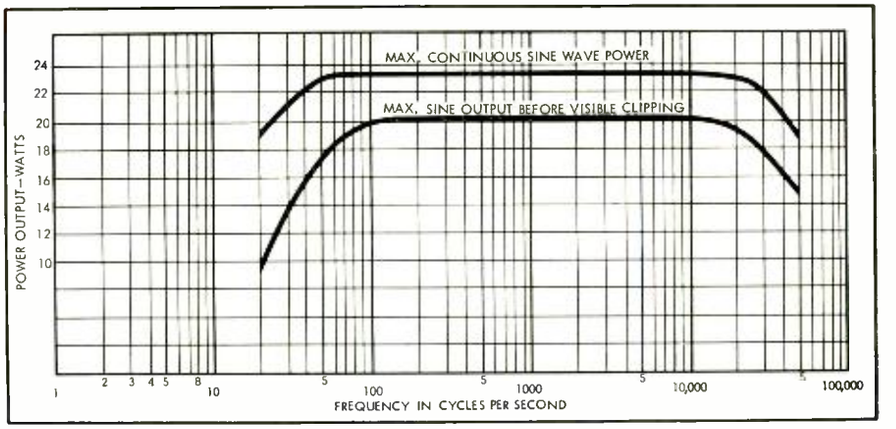


Fig. 5. Power-versus-frequency curve.

for the critical recordist...
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It's shock-mounted! It's a dynamic! It's a cardioid! And it's only $29.95
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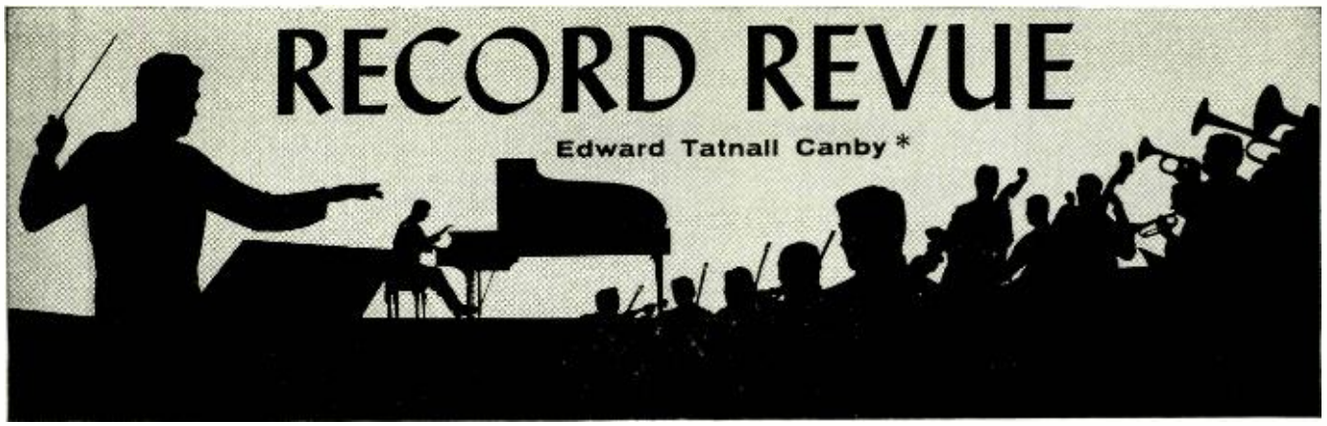


For complete specifications, write Desk R-7A, LTV/University, 9500 West Reno, Oklahoma City, Oklahoma.

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HAIL COLUMBIA

Songs of Ned Rorem. Sung by Charles Bressler, Phyllis Curtin, Gianna d'Angelo, Donald Gramm, Regina Sarfaty; the composer at the piano.
Columbia MS 6561 stereo

Here is an interesting use of the recorded medium to its own best advantage, the first of its sort I can remember. Congrats to Columbia for advancing the versatility of our medium still another notch—artistically, this time, rather than on the technical side.

The composer of these two-dozen-odd songs, Ned Rorem, plays accompaniment to a series of top-notch vocal performers, collectively a team of stars. The unifying factor of the recording is not in the artists, not in the musical form, but in the composer, both in his music and in his actual presence. The variety is in the songs—and in the singers. It's a fine idea, given good performers. For nothing is tougher to project than a long series of short songs, one after another. And Rorem's songs in particular need this heightening of contrast; for his music is gentle, rather unassuming, never violently contrasted.

The trick, you see, is that this arrangement is practicable only on records. It would be utterly out of place in a "live" concert, or for that matter, on TV!

For with sight added, the succession of important artists, one after the other, would be hopelessly disruptive. Imagine it—each making his "entrance," to applause, each with his exit, too, complete with bows and still more applause. It could be managed, maybe, but not easily. The music would not be well served.

But *in the unique recording situation* the scheme works to perfection. No clapping, no bows, no distraction. All music. It is an effective plan and should be used more often.

Are we at last beginning to learn that recorded music has its own virtues, its own requirements? Are we beginning to realize that "the best seat in the concert hall" belongs to the concert hall—not in the living room? I guess maybe we are. Columbia is, anyhow.

MONSTERS

Liszt: A Faust Symphony; Les Préludes. Charles Bressler, tenor; Choral Art Society; N. Y. Philharmonic, Bernstein.
Columbia M2S 699 stereo

No doubt about it, old Liszt is making a big comeback. To put it differently, we are coming around to *him,* rapidly.

To be sure, he still sounds out with the high-Romantic fireworks, the (now) corny dramatics, the overblown climaxes and the heart-searching melodies that still sound dated as all get-out. But that aspect is audibly receding, as we move further away from the Romantic period. What is emerging (and was not even noticed by our predecessors) is the meat of Liszt's music, the extraordinary harmonic and melodic modernism—the near-atonality of it, the painful tensions expressed in twisted chromatic chords, in melodies made of distorted intervals, diminished, augmented, tortured into writhing shapes.

I hadn't heard the huge three-section "Faust Symphony" in a long time; it is surely a great work. Bernstein's performance is a curious one, if typical of him. No hurry-up, no austerity, no modern streamlining; in his Romantic performance time is once again let out to its fullest extent and the music, recording or no, expands to enormous length. That's good. And it is wonderful to discover, at last, that tape and disc are now quiet enough so we can take the long silences, the pregnant, almost-inaudible whisps of meaningful melody, without losing the dramatic sense—minus that old mechanical grind-grind-grind and pop-sputter-crackle that could kill the delicate moods so quickly! Here we can really relax, and let Liszt go slower and slower, right down to near-mud, without a qualm.

But Bernstein's Liszt curiously lacks one vital feature—inner tension. Instead of the built-in harmonic and melodic intensity, we get a kind of rhapsodic, Hebraic sort of emotion, sincere gusty, sighing, dramatic but somehow astonishingly slack. The music, indeed, comes near to falling apart. It never does, because B. is too good a conductor for that.

But Toscanini would have torn this music to shreds for sheer tension, in half the time at double speed. Fritz Reiner would have made in crackle with enormous voltages. Bernstein makes it weep, dance, sing and shout, yet in a *very* relaxed fashion. Not really right—but enjoyable just the same.

I like the new big, close-up stereo sound. Its wonderfully helpful to Liszt, especially in those moments of quietude where each instrument is spotlighted, underscored in its stereo presence.

Mahler: Symphony No. 8 ("Symphony of a Thousand"). Soloists, combined Univ. of Utah Choruses, Utah Symphony Orch., Abravanel.
Vanguard VSD 71120/21 (2) stereo

This is a tour de force of recording, both musically and technically, a daring project for any "small company" and a triumph when it actually succeeded. None of the big labels has tackled the whole of this gigantic symphony in stereo. And you won't find better Mahler anywhere in terms of disciplined, expressive performance, in spite of the size of the forces involved.

Take a huge chorus, 250 singers. Add a second chorus, just as big, one on each side of a vast stage. Add still a third, hundreds of children. Add a double complement of solo voices—eight of them. Warm up an immense organ, the famous instrument in the Mormon Tabernacle. To all of these, assembled in the finest acoustic situation in the U.S. (of this size, anyhow), add a symphony orchestra beefed up to half again as large as normal, 150 players. There you have it! Almost a thousand people.

In the "live" concert form this king of big symphonies has a profound impact—if the performers can manage to keep together. Vast sonic climaxes, sweeping up for minutes. Impressive near-silences, long-drawn-out; for silence was Mahler's greatest dramatic asset. Fabulous orchestral and vocal colors, plus a maximum of directional play between the numerous spaced groups of performers—soloists, three huge choirs, the widely-distributed orchestra. But what a monster to record!

Vanguard's success is the adding-up of a series of nice technical calculations. First, to capture this enormous musical scene with maximum presence, a multi-mike stereo technique. Sixteen of them. Some will disapprove, but I say the decision was right. For in spite of theoretical cancellations and what-not, only this technique can provide the musical balance that rounds out each group, preserves the fine hall acoustics and yet projects the detail work without sonic confusion. No grand blur here! No other technique could deliver so much of the musical sense to the home loudspeaker.

But beyond the miking there is the vital matter of dynamic range. And Vanguard has made a deliberate maximum effort to extend it via the *low-level* end. That's the proper way to make the loud parts louder. Clean electronics, good cutting and plastic and so on, of course. Also, a new "revolutionary" tape, presumably 3M's new silver-gray 200-series, as hailed last year in "Audio ETC." It adds precious extra hiss-free dbs of quiet at the low end of the volume range.

Then, in the disc transfer, a Vanguard exploits its advantage cleverly. With clean cutting and low rumble on very quiet plastic, the overall disc level is held deliberately low, relying on higher-than-normal amplifier gain to bring out the big climaxes. It works like a charm.

In the softer musical passages you'll think something has gone wrong with your amplifier, so quiet is the background. The tiniest, faintest sounds, the ultra-low rumble of a distant bass drum, come through clearly. (That is, if you have a good table and adequate speakers.) When the loud passages finally come along (nothing's in a hurry here!) they'll knock you over.

So—move back the living room furniture, spread out your stereo speakers to ten or fifteen feet apart, whomp up the volume to near-maximum and try this huge sound for size. As the ads say, you'll agree . . . etc.

Schubert: Sonata in B Flat; Sonata in A Minor. Fou Ts'ong, pianist.
Westminster WST 17038 stereo

Schubert: Sonata in B Flat. Geza Anda, piano.
Deutsche Grammophon 138 880 stereo

Two fine readings of the greatest of the big Schubert piano sonatas, the posthumous B Flat, the work nearest in spirit to the great C Major symphony. The two performances are utterly different.

Fou Ts'ong is a young Chinese, out of Peking, educated in the East but in the Western tradition. He moved from Shanghai to Warsaw to finish his piano study and he has come out of this strange background one of the finest and most understanding of the new pianists, an impeccable Schubert player who hears the all-important harmonic subtleties in this music as some of the great older pianists from Schubert's own neighborhood do not. Mr. Fou's performance is of the younger generation, that is, held back, underplayed, some-

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what gentle and delicate. But his sense of the large shape of the enormous Schubert piece is so secure that he carries it straight through effortlessly—where many a pianist flounders and gets lost.

Geza Anda is not old but of an older generation. He is Hungarian and his Schubert is big, lusty, thunderous, Romantic in the old style with a great deal of heavy pedalling, constant rubato (expressive irregularities of rhythm) and much attention to dramatic detail. He reminds us here of the much older Wilhelm Backaus—perhaps the styling is deliberate, for I don't remember Anda playing this way in his earlier recordings. He does well with this fusty style but his pedal is sometimes too blurring and the large shape of the music is often lost in the attentions of the moment. Fou Ts'ong is much less impressive on first hearing but has the longer, larger view in spite of his youth.

DG gives Anda's piano a big, fat recording, just right. Fou Ts'ong, similarly, gets a lighter, thinner piano sound, also suitable.

R. Strauss: Don Quixote (1897). Phila. Orch.

Columbia MS 6515 stereo

"Don Quixote," in all its length and leisure! First time I studied this marathon piece about the nutty knight was via a set of "LP" records, 1933 or so, from RCA Victor. (I think Strauss himself did the conducting.) Several discs; for the early long-play records were *very* long and *very* so-so in quality, but grew shorter and better-sounding until at the end they ran no more than eight or ten minutes a side, mostly on the outside third of the space.

I note that Columbia's version takes just under 42 minutes—that's a lot of Strauss, and it seems even longer in spite of Ormandy's best. There are lovely moments, plenty of them. But in between, the thing moves at a positively worm-like pace—never did a score with so much move so slowly! It was not a streamlined age and no use at all trying to speed things up.

The thing to do with this serviceable stereo version of the music is to set it going, then settle yourself to a nice, quiet and rewarding task. Like, say, paying bills. By the time you're done, so is the music done and everybody's happy. It sounds good that way, and I really mean it.

AUDIO ETC.

(*from page 14*)

the new machines. Sound should be spread out, sound-source masked, and the much-vaunted and wholly mis-named "3-D" speaker technique is good, without qualification.

But all in all, 3-D stereosonic, magic miracle hi-fi and all the rest, the "ordinary home machine" still fills the same old bill, and fills it very well, better than ever before. Let's allow it the hi-fi title—that battle is lost, and its going to be called hi-fi, amazing, astounding, the Last Word in Ultra-Concert-Hall-Realism, the phonograph that is Too Great to be Called a Phonograph and all the rest, whatever we may say or think, and that is that. The advertising battle for hi-fi is lost—but we still have, in separate-unit equipment, the advantages we have had right along, waiting to be promoted.

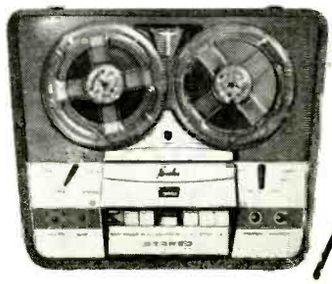
And so, with the beginning of another Audio Year, with sensations in magnetic tape recorders and players and lots more in the offing, let's get on and through the era of tail-chasing. I'm looking forward with enthusiasm to some real developments this coming year, brand new, original, and not even faintly similar to somebody else's good idea.



"My tapes have to meet the broadcast standards of the leading FM stations around the country, whose other taped programs are normally recorded and played back on professional broadcast-studio consoles. My Norelco '401' gives me tapes that not only meet or exceed these standards, but on playback on the '401' I defy any listener to tell the difference between my live broadcasts and my taped ones!

"As to reliability, my Norelco has been on the firing line five nights a week, month after month, year after year, and has required less maintenance than any other recorder I've ever used. It handles tape more gently, too: it doesn't break tape, it doesn't spill tape, it doesn't stretch tape—not even the half-mil stuff I'm forced to use to get an hour's broadcast on a 7" reel.

"Although the '401' was designed for the operating convenience and for the pocketbook of the home user, in my book it has proved itself as a thoroughly professional instrument."



The Norelco Continental '401': *100% transistorized • 4-speed • 4-track stereo/mono, record/playback • completely self-contained with dual preamps, dual power amplifiers, two wide-range stereo-matched speakers and stereo dynamic microphone. (Two broadcast quality microphones can be used with simple adapter.)*

At your hi-fi dealer's—or write to Dept. A-7, North American Philips Company, Inc., High Fidelity Products Division, 100 East 42nd Street, New York, N. Y. 10017

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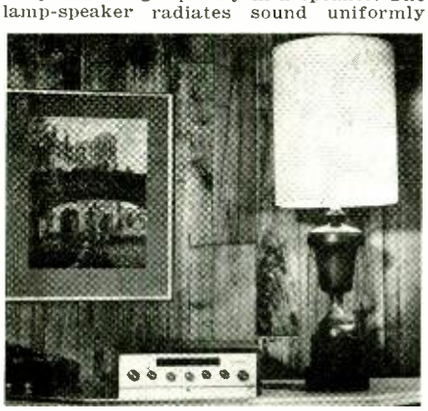
NEW PRODUCTS

● **Transistorized Impedance Tester.** With the aid of the Sennheiser Electronic Model ZP-2 impedance tester, it is possible to determine impedance in circuits of various types. The ZP-2 produces a negligible loading effect on components under test. For this reason it lends itself to precise measurements of sensitive components, such as microphones, tape heads, and audio-frequency transformers with high-permeability cores. Rapid measurements of resistances, capacitances and inductances are greatly facilitated, due to the large meter scale and switching method. The instrument measures with three test frequencies: 250 cps, 1000 cps, or 4000 cps.



With the ZP-2, impedances of from 1 ohm to 1 megohm can be determined over 12 overlapping ranges for optimal measuring accuracy. The unit is fully transistorized and weighs 5½ lb. It contains an R-C generator to produce the measuring signal, and a circuit which amplifies the current drawn by the component under test, driving the meter movement. The power supply is a standard 9-volt battery. Provision has also been made for internal monitoring of battery voltage. Available through Sennheiser Electronic Corporation, 25 West 43rd St., New York 36, N. Y. **G-1**

● **Table-Lamp Speaker.** A high fidelity speaker which radiates sound from the lamp-shade and base of a normal-looking table lamp has just been introduced by Acoustica Associates, Inc. The new "Omnisonic" lamp-speaker combines the dual functions of an attractive decorator-styled lamp and a high quality hi-fi speaker. The lamp-speaker radiates sound uniformly



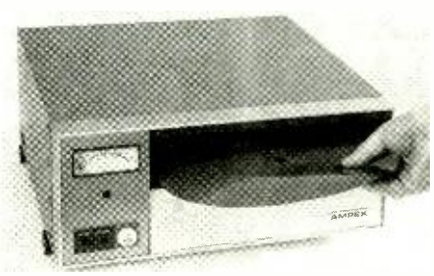
from the entire surface of the lamp-shade in a 360-degree pattern throughout the listening area. No different in appearance from a fine table lamp, the unique Omnisonic system consists of a cylindrical electrostatic loudspeaker in the form of a translucent lamp-shade and a special woofer speaker in the lamp base. The electrostatic speaker, including the fabric shade cover, is less than ¼-inch thick. The lamp-speaker's frequency range is from below 40 cps to well over 25,000 cps. The lamps come in a variety of decorator designs. A classic hand-turned wooden Grecian-urn shape with matching grained base is priced at $229.50 complete. Another Omnisonic lamp-speaker, costing $209.50, features a cylindrical base covered with genuine leather in a wide selection of decorator colors. While designed to be energized by Acoustica's new all-transistorized FM-AM/FM-Stereo receiver-amplifier, the Omnisonic lamp-speaker may be used singly and in pairs as a stereo system, or as an auxiliary unit to supplement an existing hi-fi system. The Omnisonic speakers can also be used with electronic organs. Acoustic Associates, Inc. 5331 W. 104 St., Los Angeles, Calif. **G-2**

● **Record Brush.** The Staticmaster record brush provides a convenient means for removing accumulated dust, lint and other foreign particle containments. It contains a sealed foil source of radioactive Polonium securely mounted under a protective metal grill. The Polonium source emits alpha radiation which is non-penetrating



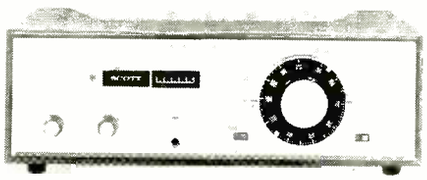
and therefore harmless externally. When alpha rays collide with air molecules they create a dense concentration of ionized air. The ionized air provides a conductive path to bleed away surplus ions from statically charged materials (records). Katonah Sales, 65 College Ave., Rochester, N. Y. 14607. **G-3**

● **Spot Recorder.** A new approach to radio spot announcement recording, involving a new concept in magnetic recording, has been introduced by Ampex Corporation. An engineering prototype, it is a new type of solid-state magnetic recorder/reproducer which makes use of a magnetic disc instead of tape reels for recording and reproducing sound. The disc is inserted in a slot in the front of the recorder, which automatically centers and cues it for recording or playback. The record/reproduce



head is mounted on a carrier which moves across the rotating disc from the outer edge toward the center in a straight line. Playing time of the magnetic disc is three minutes and maximum cue time 5 seconds. Tape discs can be produced at low cost and duplicated in quantity quickly without loss of fidelity, in contrast with the present common practice of transferring conventional disc recordings to tape cartridges. Ampex Corporation, 401 Broadway, Redwood City, Calif. **G-4**

● **Stereo Tuner.** H. H. Scott, Inc., has introduced the Model 350C FM-stereo tuner, an improved version of their 350 series. Completely restyled, the Scott 350C incorporates the following features: Time-switching multiplex circuitry; improved sensitivity; "sonic monitor" which signals when stereo is on the air; and precision illuminated tuning meter for easy, accurate tuning. Additional features include: silver-plated front end; wide-band detector; switchable agc; and cascode rf stage. Usable sensitivity is 2.2 microvolts,



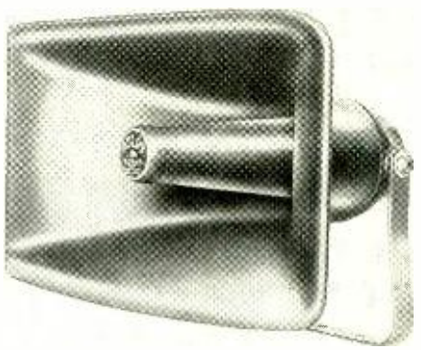
signal-to-noise ratio is 60 db, harmonic distortion is 0.8%, drift, 0.02%. Capture ratio is 6 db, selectivity 35 db, spurious response rejection, 80 db. Separation is 30 db. Dimensions, in accessory case, are: 15½" wide by 5¼" high by 13¼" deep. The 350C is $224.95. H. H. Scott, Inc., Dept. P, 111 Powdermill Rd., Maynard, Mass. **G-5**

● **Stereo Headset.** Individual volume control for each stereo channel has been incorporated into each ear-piece of a new stereo headset manufactured by Telex. With the new headset, designated the ST-20, the audiofan eliminates the necessity of a separate headphone control center. Remote control of stereo balance and volume is accomplished by adjustment of



the control knobs on each ear cup. The ST-20 can be plugged into the headphone jack of the stereo system. Volume controls are self-contained in the headset. Soft foam rubber cushions of deep cavity design exclude room noise and assure comfort. Response is 16 to 15,000 cps, 4–16 ohms. Price is $29.15 complete with 8-ft. cord and plug. Telex/Acoustic Products, Minneapolis, Minn. **G-6**

● **Public Address Loudspeaker.** An increase in the continuous power rating of model CJ-44 Cobra-Jector reproducer to 40 watt (60-watts equalized response) is announced by Atlas Sound. The CJ-44 is an all purpose wide angle projector complete with power driver. The horn is of



all-weather Fiberglas construction. Impedance is 16 ohms, response 115–12,000 cps. Dispersion 120 deg. × 60 deg., bell opening 23" × 13", over-all length 19". Atlas Sound, Division of American Trading and Production Corporation, 1419–51 39 St., Brooklyn, N. Y. **G-7**

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Herman Burstein
280 Twin Lake E., Wantagh, N. Y.

Differences Between Branded Tapes

Q. Most people are under the impression that all recording tape is the same. I first began to take note of this when I used some 6-year old tape to copy a phono record. I always A-B my tapes while recording, and noticed that this tape did not meet the A-B test. I got out some new tape, and using the same record I again made the A-B test. This time there was no difference between the record and the tape copy. I have since found that different brand tapes produce a difference in quality of reproduction. I would appreciate your remarks on the subject.

A. Your observations appear correct. Some time ago I compared the high-frequency response of four well-known brands of comparable tape. The differences were fairly minor, about 2 or 3 db at 20,000 cycles at 7.5 ips. With a cheap, unbranded tape obtained at a camera store, there was a pronounced loss of highs. A sixth tape of excellent reputation but made a number of years ago also produced substantial treble loss. On the other hand, the same company's present-day tape compares with its competitors.

There is much more to the matter than frequency response alone. For one thing, there is the question of the amount of distortion at a given recording level. For another, there is the matter of output level, which involves the signal-to-noise ratio. There are further considerations such as smoothness of the oxide, homogeneity of the oxide (absence of dropouts), immunity to flaking, lubrication, resistance to embrittlement, dimensional accuracy, resistance to cupping or curling, and so on. As a general statement, I believe that premium tapes at premium prices are worthwhile, not only for the things you hear (better frequency response, lower distortion, higher output level) but also for what you don't hear (greater smoothness. better lubricatoin, and other things that spare the tape heads).

Mysterious Garbling

Q. Recently I was recording on my stereo tape machine. Although the signal monitored (before reaching the record head) was continually clear and normal, it was later found on playback that after several minutes of good recording the left channel became somewhat garbled and severely reduced in strength. In fact, several sections became so diminished in volume as to be barely audible. This unusual effect was noted when recording music with sudden volume changes and great transients, for example percussive pieces. Subsequent recording with the same tape but different source material proved successful. Sometime later the same thing happened to me when using a different tape machine. If possible, please assist me in diagnosing this problem.

A. The only explanation that occurs to me is that an extremely high incoming signal may have caused blocking of the tape amplifier for a brief period. That is, the signal may have caused a tube grid to go so negative as to cut off the tube until this negative charge could leak off. Perhaps more careful attention to recording level may help you avoid this problem in the future.

Stray Field Erasure?

Q. When I play some of my several-year-old tapes, the treble seems to be weak. I wonder if stray electromagnetic fields can be gradually erasing my tapes. Of course, such fields are everywhere, especially in my neighborhood. with a 50 kw. AM transmitter less than half a mile away. Every metal object in my house must have some voltage induced in it. All the house wiring has external fields because the wiring is not in conduits or BX. The furnace ducts must have strong fields around them by now. What can I use to shield my tapes?

A. I doubt if the radio transmitter or other fields are erasing your tapes. I think it more likely that the tapes of several years ago were not of as good quality as today's tapes, including treble performance. This could account for your impression of weakened treble. Also, I suspect that you were using a different tape machine for recording the tapes than you are now using; differences in equalization and in azimuth alignment could account for treble loss.

If you want storage cans to shield your tapes, I suggest that you write to Perfection Mica Co., Magnetic Shield Division, 1322 N. Elston Avenue, Chicago, Illinois.

Dropouts

Q. I recently got a quarter-track tape recorder and find that dropouts occasionally occur. They seem to be random in term of occurrence, amplitude, and duration. They occur only during playback of a home recorded tape, and not during playback of a professionally recorded tape. I'd appreciate any helpful hints.

A. Have you been using top-quality tape? Have you carefully cleaned the tape heads prior to recording? Have you observed whether the dropouts occur at reduced recording levels? It may be that excessive input signal is causing blocking, as discussed in answer to the question about "Mysterious Garbling."

Bulk-Erased Head

Q. After subjecting the heads of my tape machine to the field of a bulk eraser, I have gotten recordings that are too bright and have extreme background tape hiss. Experimenting with the bias current setting has done nothing to improve this situation. How great is the possibility of head damage by this strong magnetic field? How can I correct my problem?

A. It appears that you have strongly magnetized your tape heads, which accounts for the elevated hiss. Possibly you have also done internal damage to the record head by dislocating its windings, which could account for the increase in brightness. However, I understand that the chance of such damage is rather small. Try demagnetizing the heads with a regular head demagnetizer. If this doesn't work, because the heads are too strongly magnetized, you might try using your bulk eraser. Bring the eraser near the heads and withdraw it gradually while moving it in a small circle. Do not shut off the eraser until you are several feet away from the heads.

Floating Ground

Q. My tape recorder employs a "floating ground," which is defeated when one grounds the negative side of the output to chassis. I cannot tell that this affects the performance of the recorder, but it raises the question as to why would the manufacturer employ this circuit when the user has to defeat it in order to use it as portable equipment. If it makes no difference, why was the ground not made internally, eliminating the need for an external ground cable?

A. The floating ground appears to be for the protection of the user and of the transistors in the tape amplifiers of your machine. Sometimes equipment that isn't isolated from the house line, such as an a.c.-d.c. radio, is connected to the tape recorder and, depending on the polarity of the line plug, this may place the line voltage on the tape recorder chassis, with consequent danger to the operator and to the transistors.

Playback Equalization

Q. In playback, with equalization set for 7.5 ips, there seems to be just the slightest bass boost and loss of treble. When set at 3.75 ips, there is entirely too much treble and tape hiss. What is the reason?

A. The excess of treble and tape hiss when playing back at 3.75 ips may be due to improper playback equalization. Excess treble may also be due in part to overmuch treble boost in recording. These are matters for a competent technician to correct.

Recording Amp

Q. I want to make a small power amplifier to carry with me on tape recording sessions. It can be either conventional tube design or transistor. I can't find a complete diagram of an amplifier that will do, and I'm not a good enough engineer yet to design one. Can you help me with this project?

A. My recommendation is that you purchase one of the small combination amplifiers (preamp plus power amplifier) available in kit-form from several companies. You can write to these companies for schematics, and build therefrom. However, unless you have an extremely well-stocked "junk box," you will find it much less expensive to buy the kit than to obtain the components in some other manner. Æ

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NEW LITERATURE

● **Index to Record Reviews.** The Polart 1963 "Index to Record Reviews" is an index which shows where and when a particular recording, disc or tape, was reviewed in 1963. Monitoring such publications as Atlantic Monthly, AUDIO, Harpers, and an even dozen more, the index makes it easy to find the most recent review of your favorite composer. In addition to a composer listing, there are listings of artists in the Collections and Pop and Jazz sections. Subjects and shows are listed under Miscellaneous and Shows. All categories are repeated in the Tape section. Price is $1.50. Polart, 20115 Goulburn Ave., Detroit 5, Mich. **G-8**

● **Tape Transport Booklet.** The differences between reel-to-reel tape recording transports and continuous loop transports are detailed in a technical bulletin prepared by 3M Company, makers of "Scotch" brand magnetic recording tapes. The bulletin describes a continuous loop tape cartridge and discusses tension and friction. It indicates that the much greater friction developed in the slack loop, versus conventional reel-to-reel operation, dictates that tapes for continuous loop applications be constructed for two purposes. One purpose is to withstand excessive friction by using an oxide coating construction with maximum resistance to ruboff. The other is to counteract potential friction by using a special external dry lubrication on the tape. The bulletin outlines magnetic coatings and lubricant coatings, along with space factor considerations and tape speed versus frequency response. Copies of "Sound Talk" bulletin No. 40 are available free from the 3M Company, Dept. Z4-111, 2501 Hudson Road, St. Paul 19, Minnesota. **G-9**

● **Guide to Solid-State Technology.** "What is a transistor?" "Do transistors deteriorate with age?" "What makes transistors sound so special?" "What makes one transistor amplifier sound better than another?" These frequently-asked questions about the use of transistors in high fidelity design are answered in "A Practical Guide to Solid State Technology"—a new 4-page brochure now available from Harman-Kardon, Inc., Plainview, Long Island, New York. The brochure is handsomely illustrated with photographs of the Harman-Kardon Citation A solid-state preamplifier and the Citation B solid-state power amplifier. **G-10**

● **Sound and Vibration Spectrum Brochure.** A new 8-page brochure describing swept band graphic sound and vibration spectrum analysis is being offered by the Singer Company, Metrics Division. The brochure describes in detail a basic Panoramic LP-1aZ Spectrum Analyzer and the five SY-Analysis Systems for the 5 cps to 22 kc range. These low-cost instruments provide rapid "quick look" as well as detailed high resolution measurements. Modular design permits the user to select only those functions which he immediately requires, and to build added capability later. Packaging and factory integrated systems are also described. Included are equipments for resolution to 2 cps, chart recording, as well as CRT displays, electronic switching for dual displays, and triangular wave generation for high-selectivity filter response plotting. Many illustrations are included on a wide variety of spectrum analysis showing the potential use of these instruments. The Singer Co., Metrics Division, Bridgeport, Conn. **G-11**

● **New Tung-Sol Catalog.** New modular assemblies for low-current silicon rectifier stacks are described in a new catalog published by Tung-Sol Electric Inc. Detailed specifications are given in the catalog for single-phase center tap assemblies, single-phase bridge assemblies and three-phase bridge assemblies in the current range from 3 to 75 amperes. The 12-page catalog shows a photograph of a typical single-phase bridge modular assembly and includes six outline drawings giving mechanical dimensions for each type of modular assembly. Data given on the stack assemblies includes a selection chart broken down by output current, voltage aad PRV rating of the silicon rectifiers used in the three assemblies described. A graph is included for each stack family which shows output current as a function of ambient temperature. Free copies of the catalog on low-current silicon rectifier stacks are available from Tung-Sol Electric Inc., One Summer Avenue, Newark 4, N. J. **G-12**

COVER INSTALLATION

The several views on the cover show the system of John W. Allen, Jr. of Albuquerque, New Mexico, which he recently completed after approximately four years of effort. The console cabinet is made of hand rubbed American black walnut, which was designed and built by the author. The cabinet houses the following equipment: Ampex Model 300-2½-track stereo recorder-reproducer; Ampex Model 300-2½-track and ¼-track reproducer (special); Audio Empire Model 398 turntable system; Scott Model LC-21 stereo preamplifier; Scott Model LT-110 FM multiplex tuner; 3 McIntosh 30-watt amplifiers for the right, left, and center channels.

Also, included is a signal patch panel shown in the center section of the cabinet, to which all components are connected for convenient test set-ups and changing the mode of component operation. Microphone input jacks are also located on this panel. A second panel located adjacent to the Ampex electronics in the right-hand section of the cabinet handles only high-level signals, i.e., power amplifier outputs and the system's a.c. power control. An output selector switch routes the power amplifiers' output to the main speaker system or remote speakers located throughout the house. Test jacks are included with switched amplifier load resistors for performing amplifier tests without removal from the cabinet. Headphone jacks and a special attenuator, used only for performing speaker A-B tests are also found on this panel. The a.c. power control consists of a main power switch, two high-low speed "Whisper" fan switches and two a.c. convenience outlets.

All component mounting boards in the cabinet can be easily removed for installation of newer components as might be desired in the future. The cabinet is mounted on six large casters which are recessed out of view under the cabinet base. The casters allow the cabinet to roll away from the wall easily for rear access to the equipment. The power amplifiers, which are not visible in the photographs, are located in the left hand section of the cabinet.

The complete system also includes two Klipschorn speakers located in the room corners about 18-feet apart. The center-channel speaker is a Klipsch Model CW driven by the third McIntosh 30-watt amplifier. A Klipsch Model H speaker is remotely powered by the center-channel amplifier and is located in a den. The system is completed by an Ampex Model 6022 recorder and Electro-Voice 655C microphones used for recording outside the home. The photographs were taken by Richard Berg, a friend of Mr. Allen.

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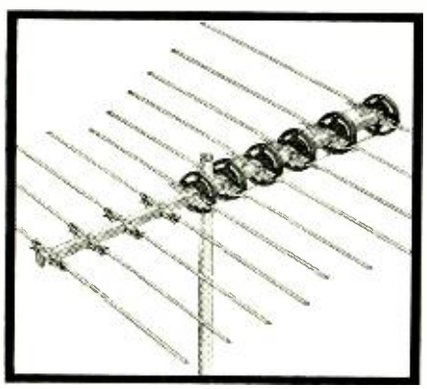
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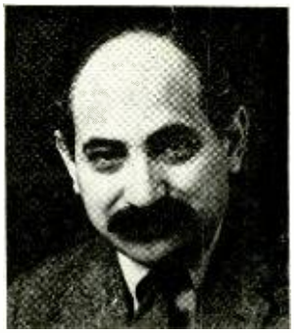
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CIRCLE 49

JAZZ and all that

Bertram Stanleigh



The Swingle Singers: Going Baroque
Philips Stereo PHS 600-126

When a record has the outstanding success that accompanied the Swingle Singers' "Bach's Greatest Hits," a sequel is to be anticipated. Here it is, and it is certainly no disappointment. This time Handel's "Harmonious Blacksmith Air & Variations" and the Fugue from Vivaldi's "L'Estro Armonico," as well as the works of two of Bach's sons, are represented. But the lion's share of the program is still made up of works by Johann Sebastian, and the gem of the collection is the *Largo* from his "F Minor Keyboard Concerto" sung as a blues scat solo by Christianne Legrand, sister of the well known French arranger/conductor, Michel Legrand. The variety of selections and the exquisite arrangements and performances make this collection every bit as worthwhile as the original set. But one wonders whether a continuing series of jazzed up bits from the classics will manage to retain the same fascination. Isn't this the time for this group to come forward with something a bit more original? After all, there is certainly nothing novel in swinging Bach. Ward Swingle has effectively demonstrated his talents as an arranger and conductor, and the group has proven itself the most capable, accurate and musical of jazz vocal ensembles. Now all that is necessary is some new ideas equal to their talents.

Rod Levitt: The Dynamic Sound Patterns of the Rod Levitt Orchestra
Riverside Mono 471

Harmonic and instrumental color, rather than patterns in dynamics, are of particular interest on this fascinating set of octet arrangements composed by trombonist, Rod Levitt. Writing for an able group of studio musicians who have formed themselves into a rehearsal unit to play for their own satisfaction, Levitt is fortunate to have at his disposal three reed men who can perform with style on a total of eight woodwinds. And much of the charm of his music is to be found in the sensitive manner in which he has chosen each instrumental voice. This is smooth sophisticated writing by a former member of the Dizzy Gillespie band who currently functions as a member of a theater orchestra and a performer at studio sessions. The group, with Levitt on trombone, includes Rolf Ericson, trumpet, Buzz Renn, alto and clarinet, George Marge, tenor, clarinet, piccolo and English horn, Gene Allen, baritone and bass clarinet, Sy Johnson, piano, John Beal, bass, and Ronnie Bedford, drums.

The Smothers Brothers: It Must Have Been Something I Said
Mercury Stereo SR 60904

Last March I had some harsh words for an RCA Victor live recording made at The Ice House in Pasadena. The present platter made at the same location is ample demonstration that first class engineering can work wonders in controlling unwanted extraneous noise during an on location session. In spite of the sound of audience participation and the coughs and background noises that cannot be avoided under such conditions, this recording is never obscured by extraneous sounds, and its bright, crisp presence is never lost as performers stray from their proper positions. Credit in part is certainly due Mercury for its fine engineering, but the major praise for this achievement must go to the Smothers Brothers, themselves. The sure control that they exercise over their audience, and their knowing way of working with microphones, is at the core of the technical success of this disc. But no amount of technical excellence is of any use unless the performances are of interest. These are. The fifth long playing platter by these lunatic folk singers find them as well stocked as ever with freshly irreverent material. Two of the most mirth provoking numbers are by Shel Silverstein. *Slithery Dee* and *Civil War Song*. Further nonsense is dispensed on such subjects as the *Population Explosion, Hiawatha* and a purported new dance craze called *The Shrimp*. The very best is saved for the end of side 2 as the brothers carry on an extended argument as to whether *Carnival* from "Black Orpheus" is a Spanish or a Jewish folk song.

Joe Henderson: Our Thing
Blue Note Mono 4152

Heard most recently on trumpeter Kenny Dorham's *Una Mas*, tenor saxophonist Joe Henderson returns to wax as leader of a disc of his own with the able assistance of Dorham. As before, the team works beautifully together. Both men seem to anticipate each other's ideas and the result is intense, vigorous playing filled with meaning. A hard driving rhythm section composed of Peter La Roca, drums, and Eddie Khan, bass, ably assist in maintaining the headlong pace of this recording. Only Andrew Hill, on piano, seems to require a more leisurely tempo for full expression. However, he manages to get his ideas across without in any way impeding the general proceedings.

Toots Thielmans: The Whistler and His Guitar
ABC-Paramount Mono ABC 482

Electric guitarist Toots Thielmans is probably best known for his six-year association with the George Shearing Quintet. More recently he has developed an audience for his unison whistling and guitar playing, and a healthy segment of that audience will no doubt be pleased with his straightforward solo performances on this new release which includes his recent hit single, *Bluesette*. For this reviewer, the overall effect is just a bit too straightforward. Thielmans plucks and whistles his way through a dozen tunes in a detached, impersonal manner. Dick Hyman, on electric organ, contributes a syrupy background that is often too loud and is constantly fraught with cliches. *Bluesette,* recorded in Sweden with a nameless organist, is more constricted in sound, but it offers the most agreeable music making on this platter.

The Banjo Barons: It's A Folk, Folk, Folk, Folk World
Columbia Stereo CS 8935

Good Sound and passable banjo playing are marred by vulgar arrangements that combine three banjos with bass, drums, honkeytonk piano and (shudder) electric organ. The results run the gamut from tasteless and insipid to embarrassing and tawdry. Clearly this is an attempt to cash in on a type of disc that some of the folk labels have pioneered with success, but this heavy handed unimaginative imitation is not likely to offer any serious competition. The buyer who doesn't mind the performances is bound to feel gypped when he discovers that the total time of the two sides adds up to twenty-seven minutes.

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ABOUT MUSIC

(*from page 8*)

ducing a frequency spectrum in the area of 100,000 cps. Audio engineers know how difficult it is to reproduce complicated orchestral sound patterns at normal speed. Limitations of the equipment used place the upper frequency limit at 3,000 cps in the model tests. (2) The loudspeaker is one of the weakest chains in the sound reproduction system. To expect it to perform smoothly in the ultrasonic range is like having it grow arms and legs. Have you ever heard a tape recording that had been launched into outer space and brought back to earth again, aurally speaking?

Even if ultrasonic music recording could be done successfully, we would still be faced with a crude aural yardstick. For, as acousticians know, one of the characteristics of good sound design is perfect balance of instrumental timbres. In his experiments, Prof. Spandock is said to have recorded chamber music in an anechoic chamber. But what does this tell us about the performance of symphonic music in the same hall? Let us assume that the professor used dead recordings of orchestral music as well. How were these recordings made? What microphones were utilized and how were they deployed? What kinds of loudspeakers relayed the speeded-up recording to the corrugated audience?

The idea of recording a symphony orchestra in an anechoic chamber is ludicrous, but if one is to go through with it, one should record each instrument on a separate channel and assign its part to a separate loudspeaker which should be pointed in a direction comparable to that of the actual instrument. For example, angle the French horns back and to one side, place the cellos (if located on the right of the podium) to the left and turned slightly upwards, etc.

The acousticians at BBN stop far short of blind listeners and Mickey Mouse orchestras; their objectives are more realistic. Using a spark impulse generator (and in some cases a directional sound source such as a small electrostatic speaker), an ultrasonic microphone, an oscilloscope, and a graphic level recorder, they are out to determine the reverberation period of the hall, the degree of attenuation of sound passing at grazing incidence over the seating area, the distribution of energy due to absorptive and reflective surfaces, the existence of such acoustical problems as "picket fence trouble," and especially the ratio of early to reflective sound. The latter parameter has turned out to be an extremely important one according to recent studies, and the results of the tests on the model will be compared with tests taken in several well-known and liked concert halls.

After the model has been put through the paces at the sound laboratories of BBN, the architect may have a great deal of useful information available to aid him. George C. Izenour, the architect of this project, has designed a multipurpose auditorium that will serve as a 3000-seat concert hall and opera house, and an 1800-seat drama theatre and recital hall. An articulated, power-operated cable-hung ceiling and pivoting wall system will reduce the volume and capacity of the hall, transforming the larger hall into a smaller hall. From the ceiling will hang densely-packed convex clouds to aid diffusion of sound (*Fig. 2*). To convert the concert hall into a recital hall the clouds will be lowered, side walls in the rear will be closed off, the concert shell walls and ceiling will be struck and flown, and banks of seats will be tracked on to provide close-up seats. In terms of mechanization, the auditorium may well be the most sophisticated in the world. Estimated costs for the building total $6,000,000; machinery costs will add $600,000. Trouble-laden Philharmonic Hall in Lincoln Center cost $17,000,000 to construct.

It will be interesting to see how BBN's intensive tests on the scale model will correspond with tests at the finished hall. Æ

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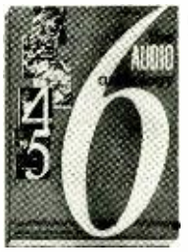
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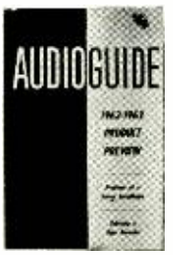
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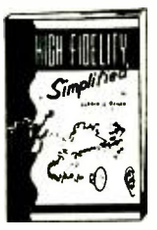
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COMMERCIAL SOUND

(*from page 31*)

Viewed on the alternative basis, the step-down will make the amplifier deliver a modified "constant voltage" of 50, instead of 70. This will halve the actual power delivered to the speakers, as compared with their 70-volt ratings. Matching will automatically be preserved, both at the amplifier and at the speakers.

Now, before the next installment arrives, it sometimes happens that a transformer to do just the job required is not available, and getting a special one wound is a virtual impossibility. So give some thought to how you would approach finding a unit that will do the job successfully, although not specifically designed for it.

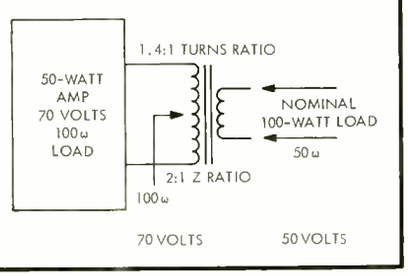


Fig. 4-2. Using a step-down transformer to improve the power (and impedance) matching.

CLASS D

(*from page 27*)

losses to a minimum, is 75 kc, then the maximum change in frequency with modulation is from 75 to 50 kc, or about 33 per cent. As we can see from the above table, this means that we must limit modulation at some 50 or 60 per cent. The interesting point is that here we are limited by theoretical considerations, whereas low modulation of the previous circuits was due to inefficient circuitry.

The big question is which system of modulation is better, and this one is hard to answer. The modulation methods based on a triangular wave modular have one big advantage, and that is that the output has a constant frequency. This becomes very important in a stereo amplifier where compact construction would almost surely lead to interference between two different high-frequency signals, resulting in beat signals which are audible. Being able to synchronize the frequencies in the two channels by using the same oscillator for both is a tremendous advantage. The astable multivibrator modulator, on the other hand, has radically different overload characteristics. Overmodulation results in clipping, usually in the driver circuitry to the modulator. This kind of distortion is much easier to take, since it happens gradually and consists of harmonics which, in small amounts, are masked by the harmonics in the music.

A triangular wave modulator, on the other hand, sort of "runs off the triangle" when it distorts. For example, look at *Fig.* 12 and imagine what happens when the audio input is such that the Schmidt trip-on voltage is above the highest peaks of the triangular wave. The trigger circuit therefore never trips on and nothing happens until the audio drops below this maximum level. In the case of a low-frequency audio wave, several dozen triangular wave cycles may go by before this happens, and all during this time the amplifier is completely dead, capacitors start to discharge, transistors come out of saturation and begin to heat up, and things are never quite the same again. The amplifier emits a

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CIRCLE 51

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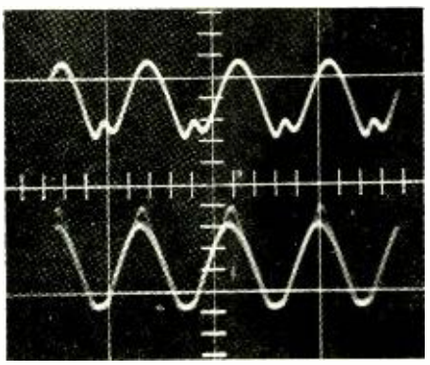


Fig. 19. Typical distorted output from a triangular wave modulator.

loud thump, screeching, or any of a number of other horrid sounds.

This effect is shown in *Fig.* 19, which shows a distorted 1 kc output signal from the amplifier. The upper trace shows what happens to the output when the amplifier misses a few cycles. The lower trace shows what happens when the circuit is just on the verge of missing. Sometimes it misses and sometimes it doesn't, resulting in several superimposed waves and a loud screech from the speaker. The distortion may occur on either peak of the output depending on where the signal overloads the modulator. The only way to eliminate this serious distortion is to limit the signal before the modulator.

And so, after this somewhat long look at modulators, let's finally take a quick look at output stages and then proceed on to some working circuits.

To Be Concluded

AUDIOCLINIC

(*from page 2*)

mendations as you may wish to give as to the merits of each? R. C. Brown.

A. Transistor equipment can sound very good indeed. Such equipment has the advantage of operating with less heat and of consuming less power from the a.c. supply line than a tube-type amplifier having the same output power. Output transistors, however, are often subject to failure because of accidentally shorted speaker terminals. Similar shorts would not cause output tubes in a tube amplifier to fail. (*Providing it used an output transformer.* Ed.) This possibility would not be serious to a resident of this country where replacement transistors are quite easily obtained. I question how easily you will be able to obtain transistors in your own country. If you buy a transistor amplifier, it would be wise for you to take spare parts along with you, especially the output transistors. It would also be a good idea to take along some of the larger electrolytic capacitors used in the equipment. It is possible that these capacitors will be hard to find in your local radio shop.

Some people do not like transistor equipment because, they believe, they are not uniform from one amplifier to another even though the model numbers are identical. They point out that transistors vary rather widely.

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CIRCLE 54

I find this problem, however, is gradually decreasing in importance, especially because the differences which do occur are smoothed out by the application of large amounts of feedback.

Equipment containing transistors is often capable of wider frequency response than equipment with tubes. Many people believe that this extended frequency range contributes little, if anything, to the performance of the equipment.

Tubes and their associated parts are often easier to obtain and cheaper than their opposite numbers in transistor equipment. This may be the most important factor to consider in your particular case.

Æ

Industry Notes . . .

● **E-V Promotional Program.** A program, claimed by Electro-Voice marketing officials as being the most ambitious promotional effort in the past several years, will introduce E-V's new portable outdoor/indoor high fidelity speaker unit, the "Sonocaster." The program, as announced to E-V sales representatives, will utilize colorful, informative merchandising aids, special promotional pricing, and national consumer and trade advertising. Planned for all levels of distribution, the "Sonocaster" sales promotion package includes animated point-of-purchase displays, colorful wall banners, window streamers, four-color outdoor-high-fidelity brochures, two-color catalog/data sheets, copy for radio spots, a merchandising guide, ad mats, and national advertising with dealer listings. The merchandising program has been planned with two goals as prime objectives: short-term, to introduce the "Sonocaster" and establish immediate nationwide distribution; the second goal to provide sales tools to keep "Sonocasters" moving off dealers' shelves.

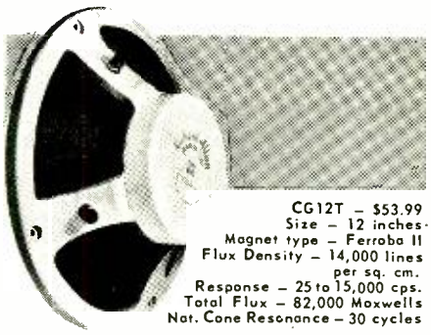
● **Stanton Elected IHF President.** Walter O. Stanton, President of Pickering & Co., Inc., has been elected President of the **Institute of High Fidelity, Inc.** for a term of two years. Mr. Stanton, well-known figure in the component high-fidelity industry, holds many patents and is a past president of the Audio Engineering Society and a member of the Young Presidents Organization. **Saul B. Marantz** was elected Treasurer of the Institute. Mr. Marantz is President of Marantz Company, Division of Superscope, Inc. Directors elected include **Ben Arons** (Fisher Radio Corp.), **R. T. Bozak** (The R. T. Bozak Mfg. Co.), **Saul B. Marantz, Raymond V. Pepe** (James B. Lansing Sound, Inc.), and **Victor Pomper** (H. H. Scott, Inc.). The Institute of High Fidelity, Inc. is now actively planning three consumer shows this year; it is also exhibiting at the New York World's Fair Better Living Center.

● **Norman Joins Fisher. Avery Fisher,** President of Fisher Radio Corporation, has just announced the appointment of **Harry E. Norman** as Regional Sales Manager. Mr. Norman will be associated with the New York office of Fisher Radio Corporation. Before joining Fisher, Mr. Norman was National Sales Manager for the Rockbar Corporation from 1959 to the present.

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CIRCLE 47

EQUIPMENT PROFILE

(*from page 31*)

compact case and is finished in gray (RCA calls it TV gray) with a chrome-plated screen. It is mounted on an adjustable swivel which conveniently holds the microphone at any angle up to 85 degrees.

The output impedance of the SK-46 is 200 ohms or 15,000 ohms. The latter impedance is achieved by changing a tap on the transformer which matches the output of the ribbon element. The output of the microphone is balanced and the cable shield is grounded to the case. The effective output level of the 1000 cps is –58 dbm at the low-impedance setting. At the high-impedance setting it is –60 db below 1 volt.

The response at a distance of 6-in. from the microphone is within 2 db from 50 cps to 5000 cps. Above 5000 cps it rolls off so that it is 15-db down at 10,000 cps. The SK-46 is supplied with 25 ft. of two conductor-shielded cable. It lists for less than $50.

The RCA SK-46 is a rugged ribbon microphone whose modest cost makes it a good prospect for sound reinforcement and broadcasting applications. G-17

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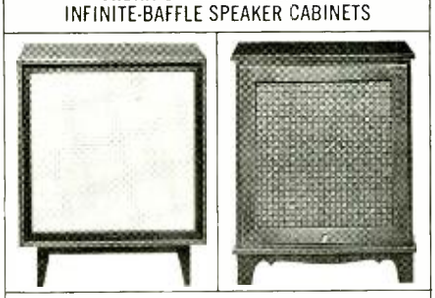
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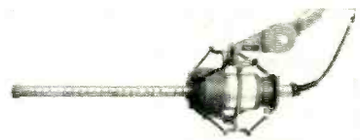
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