AUDIO

AUGUST, 1956

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ENGINEERING MUSIC SOUND REPRODUCTION

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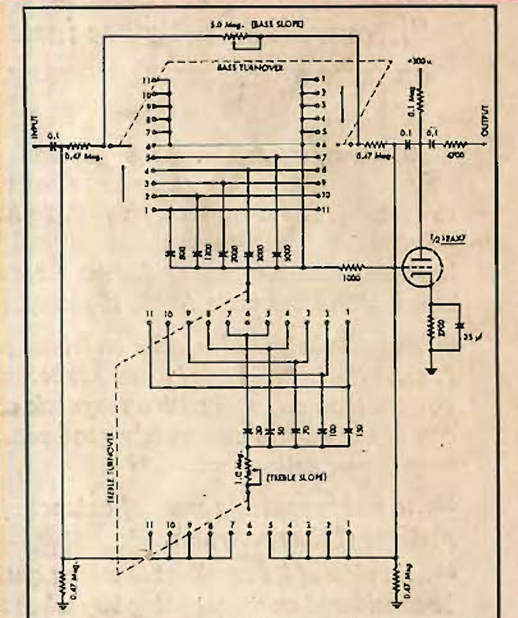

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AUGUST, 1956 VOL. 40, No. 8
Successor to RADIO, Est. 1917.

AUDIO

ENGINEERING MUSIC SOUND REPRODUCTION

CONTENTS

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RADIO MAGAZINES, INC., P. O. Box 629, MINEOLA, N. Y.

JAZZ By... JEAN

JEAN SHEPHERD

A GOOD DEAL of the pleasure of almost anything comes from knowing something about the subject. Whether it be golf, opera, or ecology, there isn't much fun in groping around in the dark and jazz is certainly no exception. For a long while writing on the subject of jazz was pretty much in the polemic class on the one hand or the tract class on the other. The books were mostly written by people who devoted 300 pages to proving that one or the other periods in jazz was the real thing and all others merely a plastic image of the good stuff. It was usually possible within the first ten pages of reading to tell what particular jazz ax the author was about to grind for the next ten chapters or so and the worth of the book was judged only by the critical biases of the individual reader. If you thought the same way as the writer the book was a good one and if he spoke highly of modern sounds while you dug only archaic jazz the volume was a *phonus balonus* to you. The rest of the literature was made up of spotty incomplete "discographies" which followed much the same philosophy of ax grinding as that in compiling lists of "great" recordings. And so it went. At least so it went until a few months back when Grove Press published in America "Jazz: Its Evolution and Essence" by the French critic and musician Andre Hodeir. I am firmly convinced that this volume will prove to be the turning point in jazz critical literature and henceforth anything done in the field will eventually and inevitably be compared with it. Hodeir is obviously a person of rare perception with the ability as well to communicate what he knows and feels. In addition he is exceptionally well qualified to write in the field of jazz since he is a prize winner at the Paris Conservatory in the areas of composition, harmony, and history of music, as well as being a top jazz performer. In short, he knows what he is talking about and knows how to say it.

Hodeir is the current leader among French jazz critics whose work has been more or less the standard of the world for some time now. America produces the jazz musicians but it is unquestionably Europe that has come up with the people who have set the critical standards of writing about jazz. To those of you who have never had the pleasure of reading the works of this school of criticism you can do no better than to begin with this fine volume by Hodeir. If your bookstore doesn't know of its existence, which wouldn't surprise me much, they can order it for you from Grove Press, 795 Broadway, New York 3, at $3.50 per copy which is less than many second rate LP's these days. This is a particularly good buy if you feel constantly called upon to explain your weakness for jazz to those who are wrapped up in "serious" music and can't understand why a man of your obvious intellectual attainments should have such a regrettable blind spot. It will give you plenty of ammo for the next quiet discussion over the gin and tonic. And last but no less important, it is a most interesting book to just read and enjoy.

Recording Practice

For the last few months a new and peculiar trend has developed in the jazz LP market that should be noted both with some wonder and perhaps a bit of alarm. It all goes back to the current methods of studio recording. When a jazz group records it usually runs over the tunes several times before a version is taped that satisfies everyone concerned. However, all the rejected versions and incidental doodling remains on tape and is rarely erased while the session is in progress. A log is kept with the cut number of both the rejected stuff and the ones okayed entered for the records of the recording studio for later reference when masters are dubbed. Most of the rejected stuff is then erased and nothing further happens. At least that is what is supposed to occur and it does in the majority of cases. However, lately some of this same waste material has been appearing on the market under the guise of new stuff by some pretty well known jazz people and they are understandably heated up over the situation. First of all, the material under question was usually rejected for good reasons when it was originally cut. These reasons generally boil down to the fact that it just didn't measure up to the standard of the artist at the time. No artist wants his "fluffed" work to be presented seriously to the public as examples of what he is doing or has done in the past.

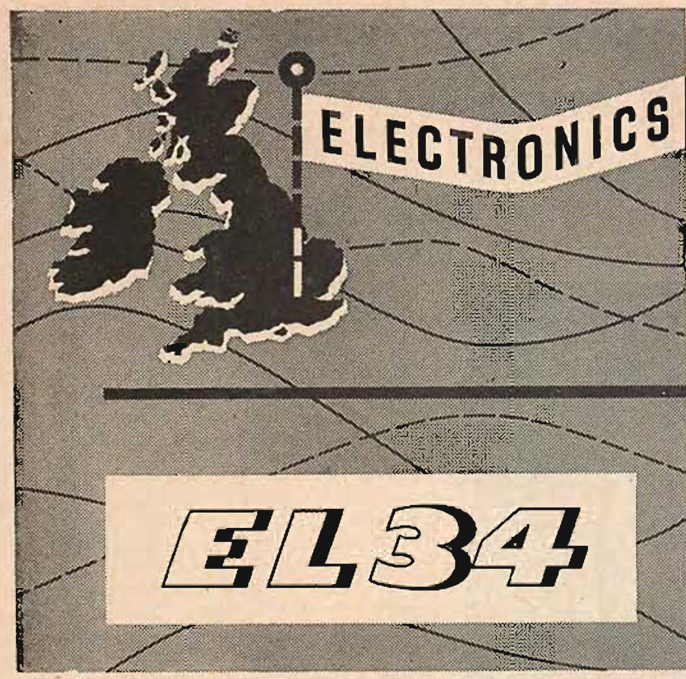
If the contents of many a top novelist's office wastebasket were to be published without explanatory notes there would be an almost universal critical reappraisal of said novelists. The same holds true for any type of artist whether painter, musician, or playwright. Not only that but jazz is a constantly advancing art and what a man did in a studio five or six years ago might not even approach his concepts of the present time. I know one pianist who was recently included in an album presenting the work of four top jazz performers who didn't even remember cutting the tape but only knew from the sound of the material that it was at least five years old and could have been older. Her work of today doesn't even resemble the stuff on the LP and probably never did since it is obvious upon hearing as to why it wasn't previously pressed.

This same artist is right now mulling over the possibility of a law suit but can't convince herself that she would be able to realize much out of it except a lot of trouble. True, many a person believes that all the work of a truly creative mind should be preserved but most artists don't agree with such ideas, knowing the amount of stuff they themselves have tossed out as worthless tries. Then there is the poor old knocked-about customer to consider. He finds himself once again in the familiar position of shelling out first-rate prices for second-rate stuff. This is material actually taken out of the studio waste basket but never labelled as such. It is as though a movie were to be made entirely from the clippings found on the cutting room floor. It might be amusing for the first ten minutes, but it couldn't be taken as a true representation of the film arts. A recent Charlie Parker release was so full of fluffs and muffed cues as to be almost ludicrous but the album notes treated the material as though it were priceless; which it might have been if treated as a joke. I'm sure that if Parker were still on the scene he would have been the first to protest. The nature of jazz is such that a musician must produce a lot of plain old fashioned dross for every small amount of gold created so it is wise to treat the dross as such even though it comes from the horn of a great performer. All is far from gold except at the cash register where it all looks alike. It also is described alike on album covers, but that is an entirely different matter. I don't know what to suggest to remedy this situation unless it be a crackdown by the union or a new clause in recording contracts calling for the immediate destruction of all rejected material.

Jazz Festival

Since this seems to be a time to clean up back odds and ends I feel that a few notes on the just past summer jazz "festival" season won't be too far afield. Try as I might, I just can't take these affairs seriously, neither for the jazz they produce nor for the conditions under which it is heard. Perhaps the connection between the two is closer than most people suspect. That is to say, much of the quality and impact of the music is closely dependent upon the place and time of hearing or playing. It is more than a little disconcerting to hear a blues singer wailing the lyrics to *St. James Infirmary Blues* while the bright sunlight pours down upon the ice-cream-eating crowd mostly dressed in Bermuda shorts and playsuits. Most jazz today is intimate stuff and it is night music at that. Beer just seems to miss at breakfast in much the same way jazz misses at three in the afternoon. The less said about the panel discussions that always accompany these affairs the better. Jazz among all the arts seems to be the field that triggers more talky-talk among college-professor-experts than all the rest combined. It seems all that is required today to make a "panel" is a couple of degrees in anything other than music and a memory for musicians, especially early New Orleans. Oh yes, a crew haircut helps but is not mandatory. There is a constant air of apology about these clambakes as well as a more subtle strain of loud self declamation that rather reminds me of a Salvation Army Lass appearing on the $64,000 Question with "pocket billards" as her question category. She bends over backwards to make herself appear broad and tolerant while at the same time she isn't really sure her topic *is* all right with The Powers. All the while, the boys in the pool room are vaguely and obscenely

(*Continued on page 35*)



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LETTERS

Electrostatic Speakers

SIR:

With reference to the article on Loudspeakers, by Edgar M. Villchur, which appeared in your May issue, I agree with everything the author says (I usually do) until we come to the final paragraph, which contains the following statement:

"The great advantage of the push-pull electrostatic speaker is that the diaphragm is driven uniformly over its surface, and must therefore move without flexing or 'breaking up'."

I am unable to understand how a diaphragm which is clamped at its edges can move without flexing or breaking up, particularly at its resonant frequency. The impression seems to be gaining ground that electrostatic speakers are entirely free from resonance, but they are governed by the laws of nature in exactly the same way as any other vibrating systems. If the response of the electrostatic unit is allowed to go down to the resonant frequency, the position is much worse than with moving-coil speakers because the resonance is not absorbed by the damping factor of the modern amplifier.

I should be extremely obliged to Mr. Villchur if he would explain how the miracle of the clamped diaphragm with equal movement over its entire surface is brought about.

G. A. BRIGGS, Managing Director,
Wharfedale Wireless Works, Ltd.,
Idle-Bradford, Yorkshire, England.

Exchanging Tapes

SIR:

Recently, I sent a letter to the Pan American Union asking if they could tell me how to go about exchanging tape recordings with people in other countries. The Pan American Union gave me your address and told me you would be able to give me the information I desire.

Primarily, I would like to exchange tapes with persons in Spanish-speaking countries because I have studied the language for four years. However, if the expense is not too great, I would like to exchange taped messages with people throughout the world.

Would you please tell me how to obtain the names and addresses of people with whom I might exchange recordings.

JAMES STREATOR,
232 E. Wisconsin Ave.,
Appleton, Wisconsin.

(*World Tape Pals, P.O. Box 9211, Dallas, Texas, should be a good source for names in other countries if this letter doesn't do the trick.* ED.)

FM Broadcasting

SIR:

Thanks for your tip on the suggested 88 to 94 mc reallocation. My card to the FCC goes out in the same mail with this to you. In the L.A. area we have fine programs out of KFAC on 92.3, KNX on 93.1, and KFWB on 94.7 mc.

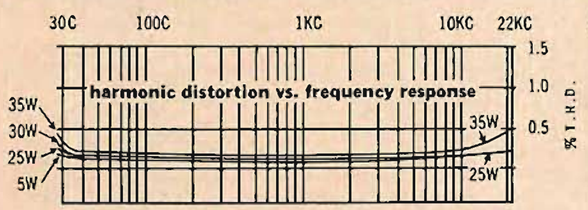
I wish our FM broadcasters were more vocal. We see lots of newspaper space devoted to AM radio and TV program schedules but next to nothing about their FM. The least that could be done would be to list the operating hours, news schedules, and other programs by type of program material. The average FM listener really has to hunt for his programs whereas the AM and TV programs are seen at every turn. Let's publicize our FM! Why keep it a SECRET?

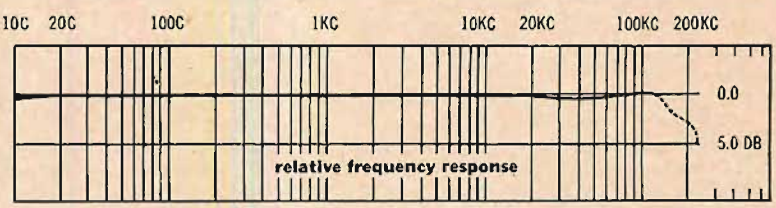
L. E. DOREY,
490 E. 19th St.,
Costa Mesa, Calif.

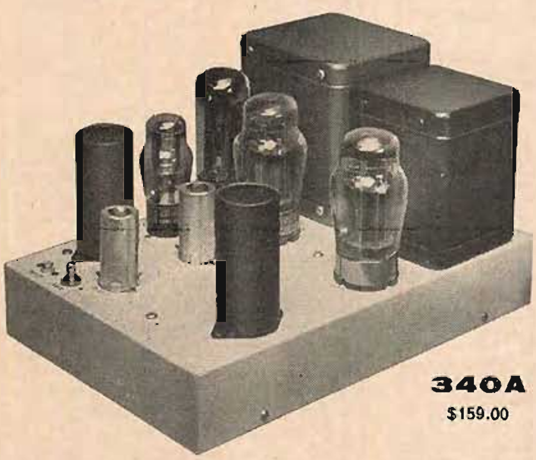
HOW SPECIFIC DO YOU LIKE YOUR SPECS?

Amplifier specifications can be written many ways. In the first column the specifications of the Altec Lansing 340A amplifier are presented in the spectacular manner that has become popular for high fidelity products. Next to these amazing figures are the specifications of the 340A as published and guaranteed by Altec. It's easy to see that the Spectacular bears little resemblance to the complete Engineering Facts; that useless data is given and necessary facts and figures are glossed over or omitted entirely. When you are comparing amplifiers don't be misled by comparing the Spectacular with the Engineering Facts. Both may be true but only the Engineering Facts give a true picture of performance. Altec Lansing specifications are always technically complete, a true engineering report of quality performance.

	340A	
	SPECTACULAR	**ENGINEERING FACTS**
POWER should be expressed in continuous watts (not instant peaks) over a stated frequency range with a specified maximum distortion, otherwise the rating can refer to an overly distorted output level or to a power peak at only one frequency.	100 watts (peak) 50 watts continuous at 2% distortion	35 watts continuous from 30 to 22,000 cycles with less than 0.5% distortion
FREQUENCY RESPONSE should be given at a stated power output since an amplifier's response curve can vary drastically with changing output powers.	within 1 db 5 - 100,000 cps	within 1 db 5 - 100,000 cps 0 to 5 watts output within 0.1 db 30 - 22,000 cps 0 to 35 watts output
DISTORTION varies with frequency and power output (see curve) and should be stated at full power over a specific range, otherwise it may refer to the lowest distortion point in the mid-range.	0.2% at 35 watts	less than 0.5% 30-22,000 cps at 35 watts less than 0.2% 30-22,000 cps at 5 watts
INTERMODULATION should be measured at full power using a low (under 45 cps) test frequency. Use of a higher frequency and a selected lesser power output results in an unrealistically low intermodulation figure.	0.5% at 15 watts 60 cps and 7 kc, 4:1 ratio	1.0% at 35 watts 40 cps and 2 kc, 4:1 ratio







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ABOUT MUSIC

HAROLD LAWRENCE*

Music and Ideology (Part Two)

On January 28, 1936, the editorial pages of *Pravda* were devoted to a sudden and totally unexpected attack on *Lady Macbeth of Mzensk*, an opera that had been enjoying international success for two years. In a masterpiece of musico-political doubletalk, the newspaper accused composer Dmitri Shostakovitch, until then the darling of Soviet music, of the crimes of "Leftist confusion" and "petty-bourgeois formalism." It deplored the opera's injection of sex and exclusion of politics, and described the score in one paragraph as "a game of clever ingenuity," and elsewhere as "coarse, primitive and vulgar."

On the surface, the object of *Pravda's* stinging rebuke was the opera itself. However, it soon became apparent that modern music in general was the larger target, and Shostakovitch the scapegoat. The composer had hardly recovered his wind when *Pravda* pounced upon his ballet *Bright Brook* in a second editorial a week later.

The lion had roared, and the jackals began to close in. Shostakovitch was "tried" by the Union of Soviet Composers and made to apologize, his works were withdrawn from recitals and symphonic concerts, and a host of envious lesser musicians now openly denounced him. It was a short step from *Lady Macbeth* to other "decaying bourgeois music." Within months, such composers as Milhaud, Hindemith, Berg, Bartók, Honegger, Stravinsky, etc., vanished from the repertoire of Russian orchestras.

Pravda's editorials represented no impulsive change in Soviet policy on music. Once again the government had felt obliged to dictate what role its composers were to play in national life, only it hadn't yet made up its mind as to what that role was to be. Since, at the time, Germany's rising military power was becoming a real threat to Russian security, it was therefore essential that a spirit of nationalism be encouraged in all aspects of Soviet life. Musically this meant a greater utilization of folk songs and dances, a more direct melodic approach, an avoidance of daring harmonic and rhythmic devices—in short, "music for the masses."

Once that policy had been formulated, the authorities looked about for some new work that would serve as a guidepost to "erring formalists." They found it in Dzerjinsky's opera *Quiet Flows the Don*, a potpourri of folk song material set in a typically revolutionary frame. Both Stalin and Molotov attended the performance and personally congratulated the composer, who was later awarded the Stalin Prize. This preceded the first *Pravda* editorial by a week—a momentous sequence of events for Russian composers.

Just as the uproar began with Shostakovitch, so did it end (at least for the time being) with the composer of *Lady Macbeth*. On November 21, 1937, on the twentieth anniversary of the October Revolution, his Fifth Symphony was given its première in Leningrad. This time, the critics and *Pravda* lavished superlatives on the new work. Shostakovitch was "rehabilitated" in the eyes of the public and fellow-musicians, and his older compositions, except for *Lady Macbeth* and *Bright Brook*, were again freely included on programs.

Between 1937–1947 the government adopted a more liberal approach to music. There were two main reasons for this: a) it was kept too busy preparing for and fighting in World War II to play watchdog over the arts, and b) Soviet composers were winning friends for Russia all over the Allied world. During this decade, some of that country's most outstanding modern works were composed. From Prokofiev came *Alexander Nevsky*, Symphonies Nos. 5 and 6, Violin Concerto No. 2, Cello Concerto, Violin Sonata in D, and Quartet No. 2; from Shostakovitch, Symphonies Nos. 5 through 9, Quartet, Trio, and Quintet (for this last work Shostakovitch received the Stalin Prize of 100,000 rubles, the largest sum of money ever paid for one piece in the history of music). Miaskovsky composed seven symphonies, and Khatchaturian his three famous concertos.

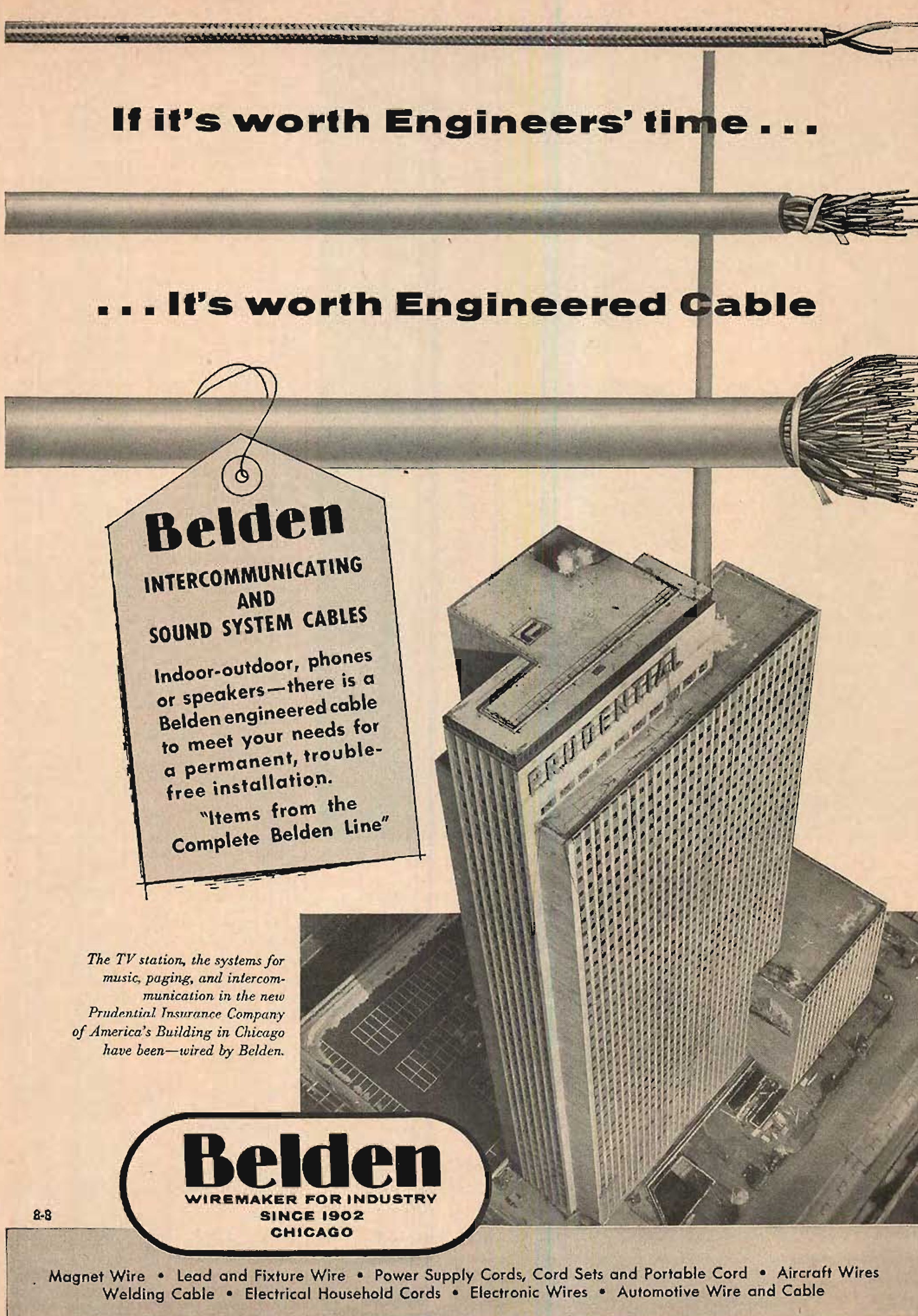
In February 1947, the leading composers in Russia were Prokofiev, Shostakovitch, Miaskovsky and Khatchaturian. A year later, it would have been difficult to find their works performed anywhere in Moscow. What had happened? Soviet musical policy had simply made a complete about-face. It had taken three decades to do it, but there it was. The fiery revolutionaries who had once rejected all pre-1917 music as decadent now were condemning with equal fervor all truly contemporary music. In both cases, the same ideological arguments were brought to bear.

It all began shortly after the thirtieth anniversary of the Revolution. Stalin, Zhdanov, and a hallful of party officials attended a "closed" première of a new opera by a young Georgian composer named Muradeli. The performance was a fiasco. A few weeks later, a special session was called of the Central Committee of the Communist Party to look into the state of Russian music. Never before had the country's celebrated musical figures been subjected to such a barrage of criticism. At one stroke, Chairman Andrei Zhdanov and his henchmen declared all the works of the Big Four, and their followers, worthless.

"Bourgeois formalism" was the principal charge levelled at the defendants. To understand the meaning of the term, let's examine each word by itself.

"Bourgeois" implies a divorce between the Soviet composer and the masses, brought about by the former's snobbish theory that the public needs time to comprehend modern music. This conception, concluded the Central Committee, leads to a "thoroughly individualist" approach in which the composer feels that he is not creating for today but for posterity. As a result, ideological overtones are conspicuously absent from his works, despite the devious manoeuvre of providing them with patriotic titles. Another sympton of bourgeois writing is the "renunciation of classical tradition," which, according to

* *26 W. Ninth Street, New York 11, N.Y.*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Zhdanov, is merely an additional form of escape from reality.

"Proof" of these accusations was introduced at the hearings. Modern Soviet works are admired in the West not by the working people but by "reactionaries . . . bandits and imperialists," while in Russia, letters from workers in factories and on collective farms pour into *Pravda, Izvestia* and other newspapers criticizing these same works: "Why is it that," wrote one proletarian, "when I listen on the radio to the Piatnitzky Choir of Song and Dance, or to bits of Tchaikovsky's *Eugen Onegin*, I really enjoy myself and when I listen to all that modern stuff of Shostakovitch and Prokofiev, I don't?"

The word "formalism" concerns itself mostly with technique. Any piece of music that contains elements of so-called decadent Western "innovations," is likely to be regarded as formalist. Intricate rhythmic changes, polytonality, dissonance of any sort, and other "stunts and contortions" were frowned upon. "Give me a tune I can whistle," could have been the slogan of the monitors of Soviet musical culture.

How then did the Central Committee explain away the enormous prestige of the Big Four in Russian musical life? "Sycophantic, boot-licking critics" built them up before the public, while at the Moscow Conservatory, and other leading music schools, "we see nothing but little Shostakovitches and little Prokofievs."

Few composers at the meetings came to the defense of their beleaguered colleagues. But there were counterattacks on a limited scale. In reply to the charge of modernity, Knipper stated that "musical language, like literary language, develops. We cannot speak today with the language of Borodin and Tchaikovsky." Shaporin came up with a term to answer "bourgeois formalism." It was "epigonism," or blind imitation of classic masters. The final outcome had already been decided before the meetings had begun, however, and on February 10, 1948, the Decree was issued.

As for the Big Four, Shostakovitch and Khatchaturian apologized, Prokofiev sent the Committee a not-so-contrite message, and Miaskovsky, who was then sixty-eight, did not respond at all to the summons. Disillusioned and sick at heart, the old composer died in Moscow two years later.

Two months after the conference, the ban on performances of the Big Four was gradually lifted. The effects of this latest official bombshell, however, were far-reaching. Prokofiev's attempt to please the authorities by writing an opera about a legless Soviet pilot failed. Although Shostakovitch had better luck with *Song of the Forests*, his works were nevertheless carefully scrutinized by the government. Prokofiev finally hit upon the right formula with his *Pravda*-praised last symphony. After the New York première, Virgil Thomson sadly reported in the Herald Tribune that "it bears a striking resemblance to what the party leaders say they want. . . . It is sticky and sweet and, in its lighter moments, just plain silly. Were it not so signed, I should not believe that Prokofiev wrote it."

Through works like *Song of the Forests* and the Symphony No. 7, the heavy hand of government censorship is all too evident. Until 1948, composers could more or less write around 'bureaucriticism'. In the late Thirties, Prokofiev once said, "They always attack compositions they cannot understand. If we were to take them seriously we would stop writing music." Events tragically disproved Prokofiev's optimistic remark. It now remains to be seen whether the new leadership will repudiate Stalin's theory of music by decree.

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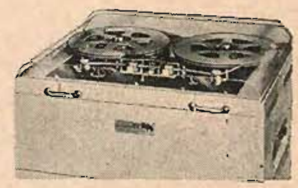

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EDITOR'S REPORT

FALL PREVIEW

NEXT MONTH'S ISSUE will carry a preview of the new items to be on view at the New York High Fidelity Show September 27–30 at the New York Trade Show Building. We were fortunate in being able to attend some of the exhibits, just closed this past week, of the National Association of Music Merchants. We have always enjoyed the fall audio shows, but the NAMM show was held in both the Hotel New Yorker and the Trade Show Building so we could compare the two locations. We say unequivocally that the new building is far superior to the hotel as the site of an audio show, not the least of the reasons being the air conditioning. This shouldn't be so important during the last week of September, but the presence of, say, 3000 people at once is certain to raise the temperature somewhat, so the air conditioning may well be a blessing. The lighting is better, being fluorescent throughout, and the acoustics are certainly as good, if not better. On the whole, we look forward to a highly successful four-day show—the first one staged by the Institute of High Fidelity Manufacturers in New York City. During the past week it became necessary to open up the sixth floor of the Trade Show Building for exhibit space, since all could not be accommodated on the 3rd, 4th, and 5th floors which were originally scheduled for the show.

The NAMM show gave us an opportunity of seeing some of the new items to be exhibited to the public for the first time at the NYHFS. With this slight foretaste of what we may expect, let it be said that no one need feel that "everything has been shown before, so why go this year." Just a hint—one item in the electro-mechanical field is a knockout—be sure and see it.

16-2/3 RPM AGAIN

Some months ago we had occasion to comment on the possibility of having another speed for records—that comment being engendered by the Highway Hi-Fi that had been shown by one group of automobiles. Let us pass on a few additional remarks just to clarify the still-possible fourth speed.

Recalling the specifications for Highway Hi-Fi, you will notice that the stylus force required for proper reproduction is of the order of two *repeat two* grams. And furthermore, the stylus tip radius must be one-half mil.

What does this mean with respect to home use of the fourth speed? To be sure, some record playing equipment will rotate at the new speed. And at least one manufacturer (whose advertisement happens to face this page) has available a pickup with a 1-mil stylus and a ½-mil stylus so as to take advantage of many current LP records which are cut with a V groove, and attendant improved reproduction in the higher frequency range. And it may track satisfactorily at two grams. But we are willing to bet that the average record-playing equipment will not work at two grams *reliably*—certainly not with a minimum of intermodulation distortion.

Aside from the small catalog of Highway Hi-Fi records, we know of no other sources of music on the new speed. Talking Books are available, of course, and if that source of program material is what is desired, the fourth speed is a necessity. Our only aim is to discourage delay on the part of potential purchasers of turntables while they wait for a fourth speed to make its appearance. In other words, we do not feel that the source material for the 16⅔-rpm phonos is likely to be abundant for a long time to come, even though the equipment may be available.

Then, too, all of AUDIO's readers are quality conscious. And if there is still any doubt, we suggest that they refresh their memories of reproduction at the higher speeds by comparing a modern and undeniably high-quality LP with a 78-rpm microgroove record. Same difference like AM and FM. In the meantime, if you need a good turntable, make sure that your requirement for the fourth speed is so important that you can afford to wait.

Changes and improvements come along, but not all changes are improvements. Remember the horse that died on the day his owner finally got his diet switched to 100% sawdust.

GREMLIN DEPARTMENT

Much as we hate to admit it, we had that old trouble again in the May issue. On page 26, four resistors (R_{28}, R_{29}, R_{30}, and R_{31}) were shown in the schematic as 500 ohms whereas in the parts list (page 76) they were shown as 50,000 ohms; similarly, R_{44} was shown as 22 ohms on the schematic and as 22,000 ohms in the parts list.

Just for the record, the lower values are correct in both instances—500 ohms for the four grid stoppers in the regulated power supply, and 22 ohms for the current limiting resistor in the bias supply. Please change the figures in the parts list on page 76.

Actually, there are in the vicinity of 50,000 words in an average issue of AUDIO—if we got every one of them right we would be awfully lucky. But we do try.

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Half a record

yet that may be all your present system reproduces!

Recent improvements in high-fidelity recording have captured the full tonal color of every instrument in the orchestra . . . every subtle shading from the brilliance of the violins to the deep roll of the kettle-drums is impressed on discs made with the latest recording techniques. Yet this dazzling other-world of sound may be *beyond the capacity* of your present high-fi equipment . . . in terms of sound reproduction, *you may be buying only half a record!*

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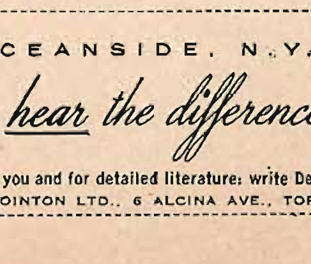

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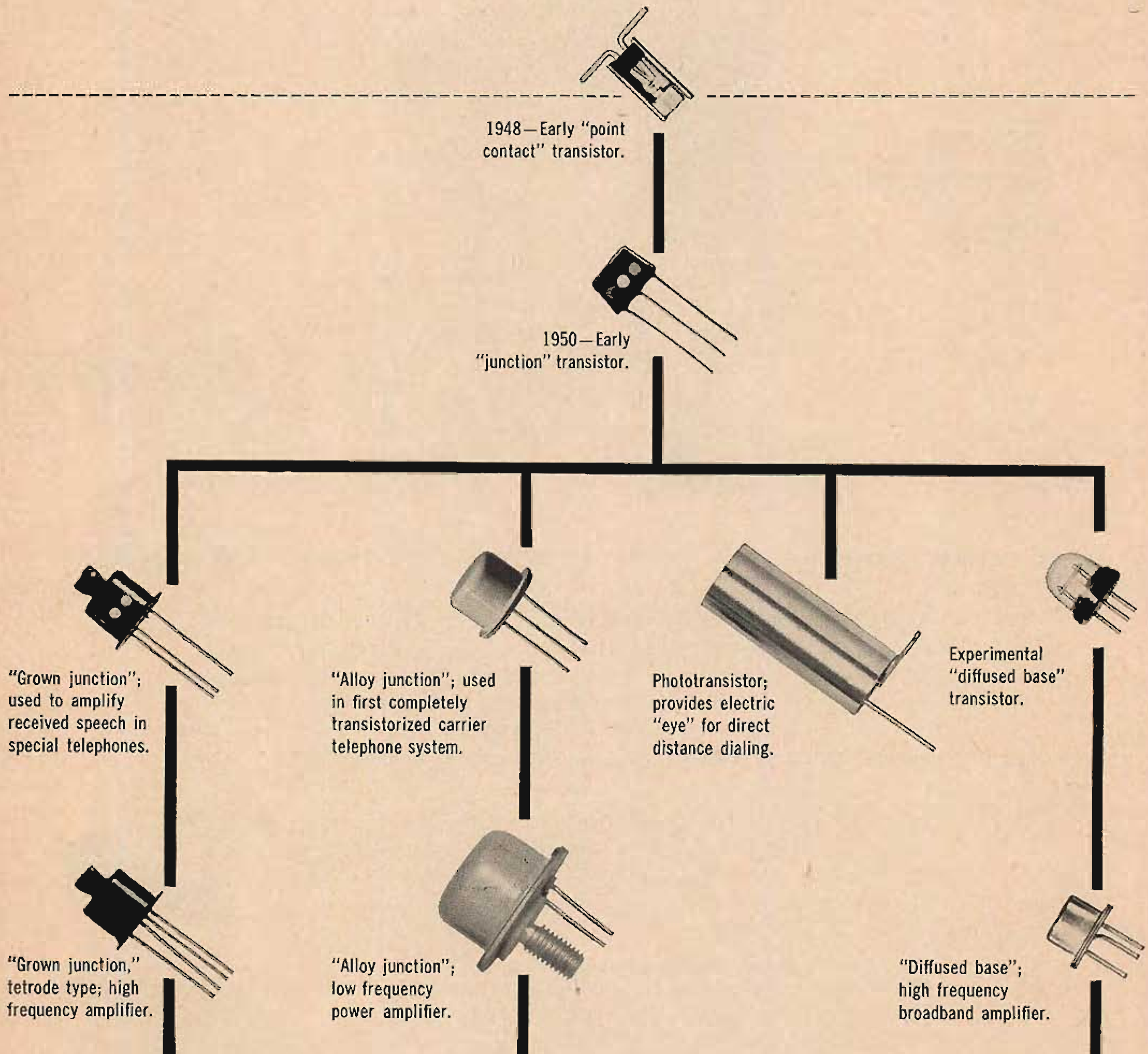

In 1948 Bell scientists announced their invention of the transistor—a tiny device able to amplify signals a hundred thousand times using a small fraction of the power of an electron tube.

From this original "point contact" transistor has grown a distinguished family of immense usefulness to electronics. Some of its leading members are shown here, in approximate actual size, with their scientific type names.

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Baffles Unbaffled

E. J. JORDAN*

Part 1. The author presents a thorough discussion of the design, construction, and performance of the various methods of mounting loudspeakers, ranging from the flat baffle to the most elaborate enclosures.

JUDGING FROM the number and nature of queries that have been received regarding loudspeaker enclosures, it has been realized that a great deal of confusion and misconception exists. This is not surprising when one considers the presentation of much of the information on this subject. We have, on the one hand, the highly technical discourses coupled with the advanced mathematical treatment that is necessary for the basic understanding of acoustics, and, on the other, empirical and often inaccurate information which, being more readily absorbed by the reader, receives wide publication and when one asks "what type of enclosure shall I use?" one is immediately confronted with a diversity of answers governed often by personal prejudice and sales talk.

An attempt is being made in this paper to clarify this position. In due course, all the principal types of enclosure will be discussed, leading finally to the description of new developments

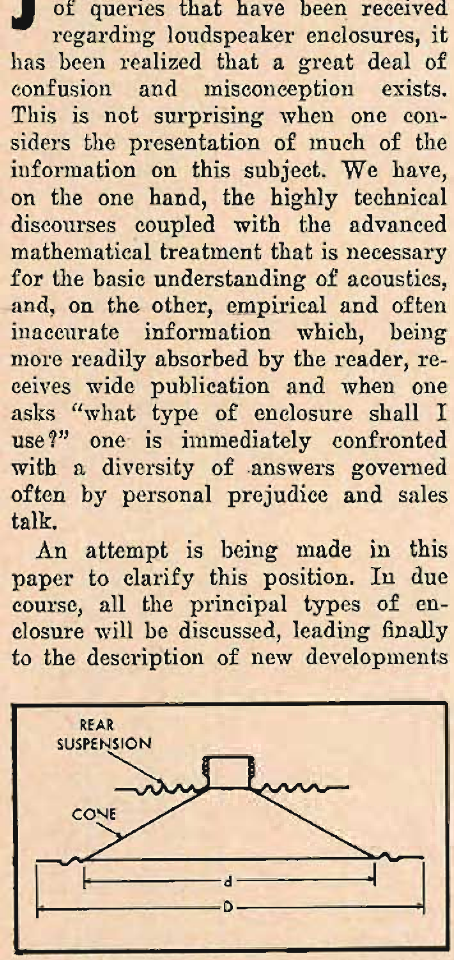

Fig. 1. Typical loudspeaker cross section. D = speaker diameter; d = piston diameter of cone; $\pi d^2/4$ = piston area.

that have been made. The aim throughout is to provide a good fundamental outline of the principles involved in each type of enclosure and to discuss fully their merits and demerits, these being demonstrated, where possible, by impedance curves, and to include the necessary formula and guidance for the home constructor to enable him to determine readily which type of enclosure is most suited to his particular requirements, and to design and build such an enclosure.

* *Goodmans Industries, Ltd., Axiom Works, Wembley, Middx., England.*

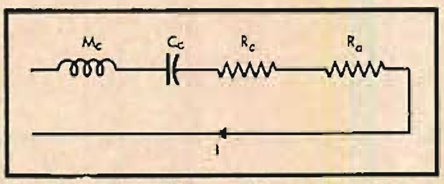

Fig. 2. Loudspeaker analogy. R_c = friction loss in cone; M_c = mass of cone; C_c = compliance of suspension; R_a = radiation resistance.

So that we may form a foundation for future discussion, the following elementary facts are set out.

A loudspeaker cone, when reproducing those frequencies where the wavelength is large compared to the cone diameter, behaves approximately as a rigid diaphragm of area πr^2 where r is the radius of the cone base. (*Fig.* 1). This is known as the piston area of the cone. If the cone is vibrating in free air each surface of the cone will cause alternate compressions and rarefactions in the adjacent air layers which will in turn be radiated as sound waves. Where the distances between surfaces is short compared with a wave length, the air compressed on one surface will flow into the rarefaction occurring simultaneously on the other, and the total radiated sound energy will be negligible. A loudspeaker cone under these conditions can be regarded from some points of view as analogous to an electrical circuit which takes its simplest form as in *Fig.* 2.

This is a series resonant circuit where the current in the circuit is analogous to the cone velocity, and the power developed in R_a is analogous to the radiated sound power—and it will be seen that for a given value of R_a this will reach its maximum at the resonance of M_c and C_c, i.e. the bass resonance of the loudspeaker where the Impedance $Z = R_c + R_a + j\left(W\ M_c - \frac{1}{W\ C_c}\right)$ simplifies to $Z = R_c + R_a$ and the current rises to a high value limited only by these resistances. Below this frequency the reaction of C_c rises rapidly and the current through R_a falls correspondingly. If the loudspeaker is unbaffled it takes very little energy just to push air from the front to the back and vice versa, and we say that R_a is low. Consequently the radiated power is low, although at resonance the velocity and amplitude of the cone will be very high. (*Fig.* 4).

It will be seen throughout this paper that velocity characteristics are indicated by voice-coil impedance curves. This is for convenience and is justified if the base of the velocity scale is represented by a line drawn at that impedance presented by the voice coil if the voice coil were clamped. This is shown by the following:—

Z_t = Total impedance of voice coil
Z_m = Motional impedance
Z_c = Clamped impedance of voice coil (d.c. resistance at low frequencies)
v = Velocity

Now $Z_m \approx v$

$Z_m = Z_t - Z_c$

$Z_t - Z_c \approx v$

At the frequencies we are considering

$Z_c \doteq$ d.c. resistance $= 12$

$Z_t - 12 \approx v$

Then $v = 0$ if we draw the velocity base line at $Z_t = 12$

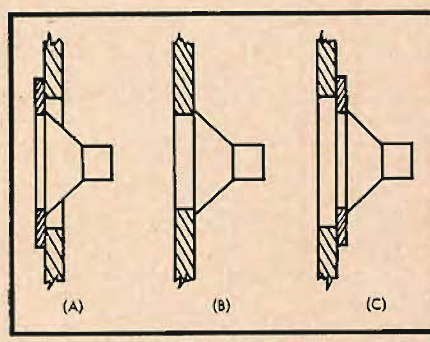

Fig. 3. Common methods of mounting loudspeakers in a wall.

The velocity curve is therefore an indication of the radiation from the cone. It is not necessarily an indication of the total radiation from the combined cabinet and loudspeaker system, but is nevertheless very useful in determining the action of an enclosure and in this respect is more useful than pressure response curve, since these vary greatly with microphone position. It is for these reasons that velocity curves have been used throughout.

We have seen that to secure good radiation at the low frequencies, the radiation from the rear of the cone must be prevented from cancelling that from the front, and we shall discuss the various means of doing this.

The Flat Baffle

This is the simplest method of loudspeaker mounting. Ideally the dimensions of the baffle should be infinite, but a very close approximation to this is achieved by mounting the loudspeaker in a wall, e.g. the partition wall between two rooms. This method is used quite frequently and the following points should be borne in mind: (1) It is rather important to mount the loudspeaker on a sub-baffle as shown at (A) in *Fig.* 3. The sub-baffle should be of substantial wood or chipboard ¾ to 1 in. thick. With the loudspeaker mounted as in (B) or (C) it will be seen that an air column is set up in front of the cone, the length of which is equal to the thickness of the wall. This air column will have a natural resonant frequency. If for example the wall is 2½ in. thick then this frequency will be approximately 968.4 cps. As a general rule the thickness of the baffle should not exceed one-tenth of the diameter of the opening, unless it is bevelled.

(2) The position on the wall also calls for some consideration. It is preferable to mount the speaker near a corner since this increases the air loading on the cone and improves the bass radiation. The reason for this will be

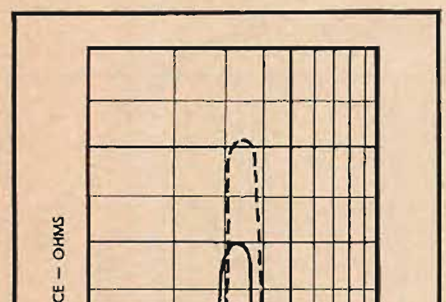

Fig. 4. Voice-coil impedance of loudspeaker in free air (dotted curve) and mounted in wall (solid curve).

seen later. The height of the speaker above the floor is largely a matter of personal taste with regard to the high-frequency distribution; e.g. if the speaker is placed near the floor there may be excessive absorption of the high frequencies due to furniture, carpets, and so on, although the low frequencies will have the advantage of, effectively, a corner position. It is usually preferred to have the speaker at ear level when one is seated in the normal position. Often it is better to sit slightly off axis, especially when listening to orchestral music, since the inevitable beaming of the high frequencies, however slight, cause one to be unduly aware of the point source

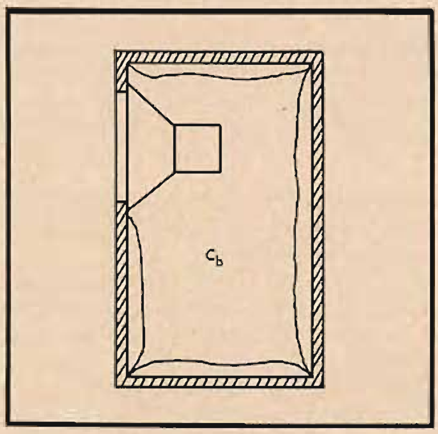

Fig. 5. Cross section of closed box.

which may spoil the realism of the reproduction.

It will be appreciated that much of the foregoing will apply to all forms of speaker mounting.

Small Flat Baffles

Often wall mounting is not possible and relatively small rigid baffles are used. In general, the back-to-front cancellation occurring with an unbaffled speaker occurs also with a small baffle except at a lower frequency.

Considering firstly a circular baffle with the speaker mounted centrally, then the minimum radius r required to maintain the radiation down to a given frequency f is given by :–

$$r = \frac{\sqrt{3}\lambda}{2\pi} \text{ or } r = \frac{311}{f} \text{ ft.}$$

Where λ = wavelength at frequency f.

There is no point in making f lower than the bass resonance of the loudspeaker since, as we have seen, below this frequency the radiation falls rapidly due to the increase in the stiffness reactance (*Fig.* 2). The use of a circular baffle, however, is not recommended since the path length from front to back of the loudspeaker is the same in all directions and standing waves

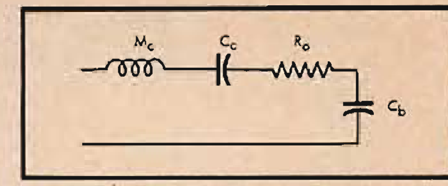

Fig. 6. Analogy of the closed box mounting.

will be set up causing a series of peaks and troughs in the loudspeaker frequency response. The preferred shape of a small baffle is an irregular one, e.g. a square with the loudspeaker mounted off-center, in which case the minimum dimensions should be determined as for the circular baffle where r = the distance from the centre of the speaker to the nearest edge. More usual, however, is the rectangular or square baffle, and the minimum dimensions here are given by :–

$$l = \frac{\lambda}{2} \text{ or } \frac{565}{f} \text{ ft.}$$

where l = the length of the smallest side of the rectangle or the side of the square.

If, for example, we have a loudspeaker with a bass resonance at 60 cps and we require to mount the speaker on a square baffle, the optimum length of the side is given by $l = \frac{565}{60}$ or *9.42* ft. Such baffles must be rigid and if made of wood this should be of thickness not less than one tenth of the baffle hole diameter.

The analogous electrical circuit for a loudspeaker mounted on an infinite or finite baffle of optimum size is similar to that shown for a loudspeaker in free air (*Fig.* 2) except that the baffle produces a large increase in R_a and a small increase in L_a. We should therefore expect to find a corresponding decrease in the cone velocity and the resonant frequency. This is shown in *Fig.* 4.

It is sometimes not realized that small loudspeakers acting as treble units should be mounted on a baffle large enough to ensure full radiation down to about half the crossover frequencies. This is necessary since the crossover does not occur sharply, but there is some over-lap.

If, for example, the crossover is at a 1,000 cps, then the baffle size for the treble unit should be $\frac{565 \times 2 \times 12}{1000} = 13.6$ in. square. If the baffle is rectangular, this should be its smaller dimension.

Considering again the low frequencies from the point of view of the commercial set manufacturer, the optimum baffle size is very often far too large even when frequencies as high as 100 cps are the lower limit and a flat baffle of any size or shape has little aesthetic

SPEAKER	BASS RESONANCE — CPS					
	Off Baffle	1 cu. ft.	2 cu. ft.	3 cu ft	4 cu. ft	5 cu. ft.
15"	25	105	65	77	70	65
12"	35	116	65	75	70	65
12"	55	120	55	85	78	72
10"	52	105	62	74	70	68
9"	25	116	77	65*		
8"	75	108	92	85	80	78

* The "Q" of this resonance become too low to measure beyond here

Fig. 7. Typical resonant frequencies of various sizes of loudspeakers in closed boxes with volumes from 1 to 5 cu. ft.

appeal, so the baffle takes the form of an open backed cabinet.

The limiting frequency in this case may be calculated using the formula for circular baffles where r is the distance from the center of the loudspeaker cone to the nearest point on the rear boundary of the enclosure; the sides and top forming part of the baffle.

A cabinet of this nature, however, has an air column resonance, the frequency of which approximates to

$$f_1 = \frac{6780}{l + .85R} \text{ cps}$$

where l = depth of cabinet

$$R = \sqrt{\frac{A}{\pi}}$$

A = area of open back

when all dimensions are expressed in inches. The above expression will be discussed more fully in a section devoted to tuned pipes.

In addition to f_1 there will be a number of harmonically related resonances f_2, f_3, f_4, etc. where $f_n = nf_1$, n being any whole number. These resonances give rise to the unnatural booming quality that is characteristic of many commercial receivers. Often this introduces an artificial bass which compensates for the fall in true bass due to the insufficient baffle area.

To achieve this, the bass resonance of the loudspeaker must be carefully chosen. It is usually undesirable to have this higher than the frequency given by the above expression. Maximum bass accentuation will be had when the resonance frequency of the cone is equal to f_1. If, however, this is excessively boomy, a speaker having a lower cone resonant frequency should be used. This will also have the advantage of extending the bass range. Where the cabinet contains the auxiliary radio apparatus the formula given for f_1 will not be accurate, but may still be used as a guide. If the cabinet is very small (e.g. extension loudspeaker cabinets, etc.) f_1 may be of the order of 400 to 500 cps. In this case, it has been found that the most pleasant results are to be had by the use of a speaker with a cone resonance between 70 and 90 cps.

The True Infinite Baffle has the advantage of providing full radiation down to the cone resonance of the loudspeaker without the introduction of other resonances above this frequency, and is therefore suitable for high-quality reproduction.

Small Flat Baffles are suitable for use with high-quality loudspeakers only if the dimensions are large enough to fully justify the speaker. The term "small" is used in the relative sense, and it will be found most speakers would require a baffle that was very large in order to provide good radiation down to their resonant frequency of the cone.

Open Backed Cabinets are usually very convenient, but have very little to recommend them from the acoustic point of view. The inherent resonances make them unsuitable for use with high-quality speaker systems.

The Corner Position

We have said earlier that it was preferable to mount the loudspeaker near a corner of the room. This is universally true for all methods of loudspeaker

MATERIAL	DENSITY gms/cu. cm.
Concrete	2.6
Brick	1.8
Dry Sand	1.5
Chipboard	0.81
Oak	0.72
Plywood	0.67
Mahogany	0.67
Pine	0.45

Fig. 8. Densities of materials used in construction of speaker enclosures.

mounting, since at low frequencies the bass radiation will be increased in a manner readily appreciated if we consider firstly a small source of sound in an open space.

The radiation from this source will be of equal intensity at a given distance in all directions, i.e. spherical. If now a large flat wall is placed near the sound source then the total radiation will be concentrated into a hemisphere and its intensity will then be doubled. Similarly if a second wall is placed near the sound source at right angles to the first the total radiation will be concentrated into one quarter of a sphere, then its intensity is four times greater. Again a third wall at right angles to the other two will increase the intensity eight times.

A loudspeaker standing in the corner of the room may at medium low frequencies be regarded as similar to the second case, and approaching the third case as the frequency falls to a point where the wavelength is much greater than the height of the speaker above the floor.

The Closed Box

One method of preventing back to front cancellation is, of course, to enclose the rear of diaphragm completely, thus achieving what is effectively an infinite baffle (*Fig.* 5). The enclosed volume of air, however, may be regarded as an elastic cushion which, when the loudspeaker cone is displaced inwards, is under compression, and when the cone is displaced outwards, is in rarefaction. In either case the enclosed air will attempt to return to its normal state, and in so doing will apply a stiffness force to any movement of the cone from its position of rest.

We have seen in *Fig.* 2 that the bass characteristics of a loudspeaker are determined largely by its frequency of resonance which, in turn, is governed by the mass of the cone and the stiffness of the suspension (M_c and C_c). We now see that the enclosed volume of air adds a further stiffness which is shown as an additional series capacitance C_b in the analogous circuit (*Fig.* 6). The effect of this, of course, is to raise the resonant frequency.

Since the value of C_b varies with the volume of the box, the larger the box, the more extended will be the bass response for a given value of cone resonance. Alternatively, for a given bass extension, the lower the cone resonance, the smaller will be the box required.

It is difficult to give a formula showing this last relationship since it is not sufficient to know only the cone resonance, but the corresponding values to M_c and C_c must also be known, and usually they are not. However, the table of *Fig.* 7 is offered as a guide.

When constructing enclosures of this and other types which will be described subsequently, two important points must be borne in mind:–

(1) At frequencies whose wavelength is comparable to the internal dimensions of the enclosure, reflections between inside faces will occur which will be additive at some frequencies and cancelling at others, thus causing irregularities in the response. It is therefore necessary

(*Continued on page 40*)

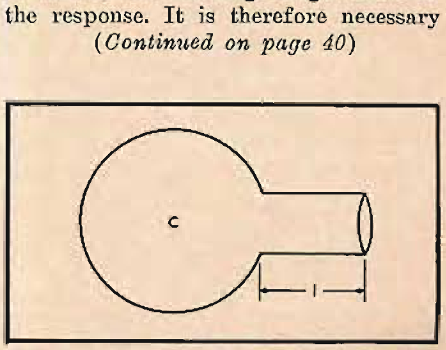

Fig. 9. Diagram of a Helmholtz Resonator.

A Feedback Tone Control Circuit

The author gives two examples of wide-range, switch-type tone controls using frequency-sensitive negative feedback, also calculations and methods of approach for designing variations on the basic circuit.

HAMILTON BARHYDT*

TONE CONTROL CIRCUITS have long been a weak point in the design of audio preamplifier and control circuits because of the distortion they introduce. Now that power amplifiers are being built with 20 db or more feedback, reducing intermodulation distortion to less than 1 per cent at normal volume levels, it is quite possible for the major part of the distortion in the amplifier system to come from the earlier stages. The results of intermodulation distortion measurements on voltage amplifiers[1] indicate that all voltage amplifiers with outputs above 0.5 volt need inverse feedback to keep intermodulation distortion well below 1 per cent.

The usual tone control involves a variable attenuator with a loss of about 20 db, or 10 times, for flat frequency response, in order to be able to give up to 20 db of boost. The audio signal is amplified to a large value and then reduced about 10 times in the tone control. To accomplish this without introducing excessive amounts of distortion, the designer must use a feedback driver involving additional tubes or operate the entire circuit at a low signal level, increasing the relative hum and noise level.

A much neater solution is to use a feedback amplifier with varying amounts of feedback to give the tone-control effect. The extra gain, rather than being thrown away in an attenuator, is used to provide distortion-reducing feedback. Degenerative tone controls have been used in this country for many years, but have never gained great popularity since the circuits require an inductance for the bass tone control. Recently Baxandall in England introduced another type of feedback tone control using no inductances.[2] Barber has described this circuit in AUDIO ENGINEERING.[3]

The feedback tone control circuit as published by Baxandall and Barber, although a great improvement over previous circuits, still has several disadvantages. First the preceding circuit must have a very low output impedance in order to obtain maximum bass and treble boost from the tone-control circuit. This required Barber to use an extra tube, a cathode follower, to drive his version of the tone control. The maximum treble boost available at 15,000 cps with this circuit is reduced more than 1 db if the output impedance of the preceding circuit exceeds 6500 ohms, more than 4 db if this impedance exceeds 20,000 ohms.

Second, there is as much as 2 db of overshoot in the bass tone-control curves. Baxandall shows this effect in his article. For the benefit of those who do not have easy access to *Wireless World* this effect is illustrated in *Fig.* 1, showing some experimental bass tone-control curves made with a circuit like that described in Barber's article. The overshoot is caused by the presence of two capacitors in the bass tone-control network. Eliminating one of the capacitors eliminates the overshoot.

The author's third objection is to the form of the tone-control frequency curves. This is an admittedly controversial point, since any given set of tone-control curves is a compromise. In fact, Baxandall and Barber stated that one of the advantages of their tone control was the shape of the curves. A recent article by Villchur discusses this problem very ably.[4] The author agrees with Barber that the primary purpose of the tone control is to adjust the over-all tonal balance of the complete audio reproduction system. However, he differs in belief on how this might best be accomplished. For the purpose of considering over-all tonal balance the author likes to split the audio spectrum into three parts: the middle range from 200 cps to 4000 cps, the bass region from 200 cps on down, and the treble region from 4000 cps up. A tone control is used to vary the amplification of the bass and treble regions in respect to the middle range. This is best done by a tone control with fixed crossover frequencies near 200 cps and 4000 cps. (By crossover frequency the author does not mean the technical turnover frequency, but rather a less

* *114 Summit Avenue, Ithaca, N. Y.*

[1] W. B. Bernard, "Distortion in voltage amplifiers," AUDIO ENGINEERING, Feb. 1953, p. 28.

[2] P. J. Baxandall, "Negative feedback tone control," *Wireless World*, Oct. 1952, p. 402.

[3] B. T. Barber, "Flexible tone control circuit," AUDIO ENGINEERING, Sept. 1953, p. 29.

[4] E. M. Villchur, "The selection of tone control parameters," AUDIO ENGINEERING, March 1953, p. 22.

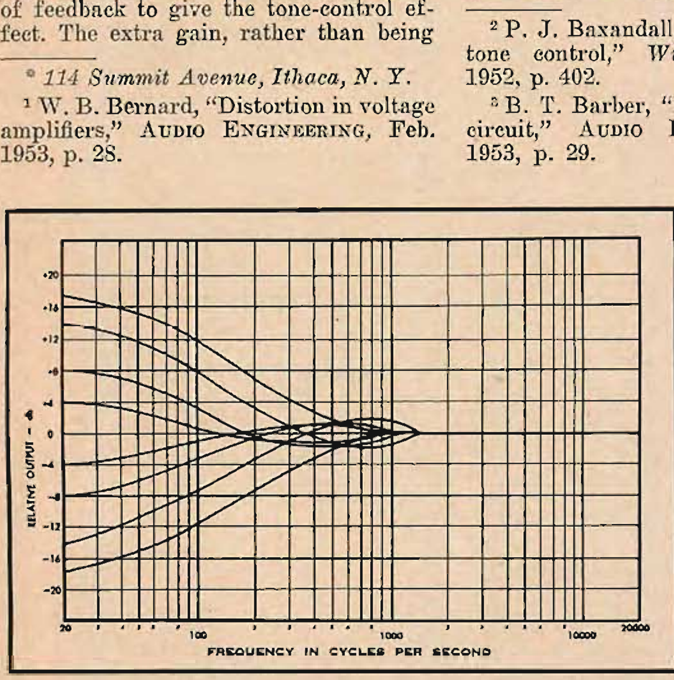

Fig. 1. These curves, taken from a Baxandall tone control, show the overshoot obtained with continuous controls.

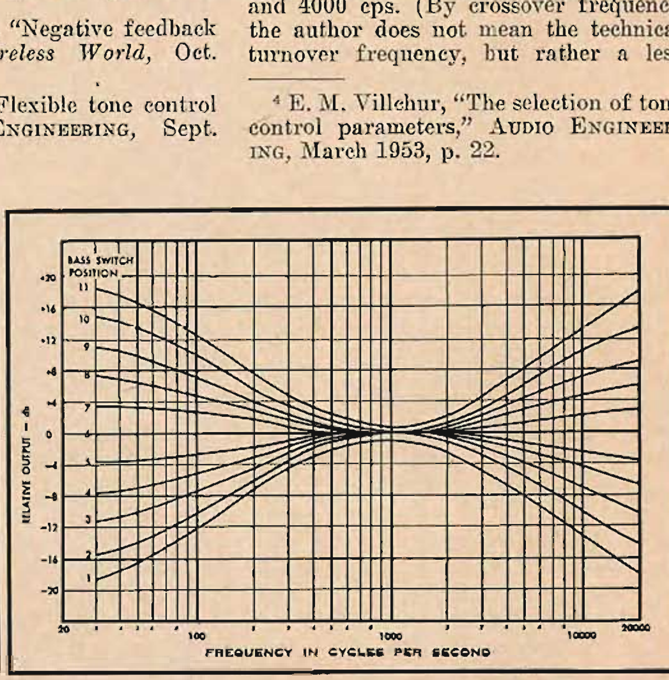

Fig. 2. Curves illustrate the wide range of slope control obtainable with the circuit of Fig. 2. The turnover frequencies are fixed.

well defined frequency where the relative effect of the tone control curve becomes large.) In the circuit shown by Baxandall and Barber, on the other hand, the shape of the response curve is held more or less constant and the crossover frequency is varied.

Use Of Switches

A tone control free of overshoot and interaction between the treble and bass controls can be built conveniently only with switches rather than potentiometers. The simple form of the expression giving the frequency response of the feedback-type tone control allows almost any desired set of tone control curves to be built up easily if switches are used. Furthermore, the switch type of tone control is convenient since it can be quickly reset to the same positions. The user will quickly associate certain positions of the tone-control switches with the various conditions of audio reproduction that he normally encounters with his equipment and consequently will find the switches a great aid. The author finds that an average of two or three db variation between the switch positions is just about right to give slight but noticeable changes of tone quality. A switch-type feedback tone-control circuit is shown in *Fig.* 3 and its frequency response curves in *Fig.* 2. Maximum boost is obtained in position 11 of both treble and bass switches, while maximum attenuation is obtained in position 1. Position 6 gives flat frequency response and the gain of the circuit is unity. *Figure* 4 is an equalizer with variable turnovers and continuous slope controls.

In order to understand better the operation of the feedback tone-control circuit it is of interest to derive the analytical expression for the gain. In *Fig.* 5 is shown an equivalent circuit for the tone control. M is the gain of the amplifier tube including the loading effect of the tone-control network. Z_1 and Z_2 may be complex impedances (some combination of resistors and capacitors). From the equivalent circuit diagram one can write the three equations

$$E_I - E_O = (Z_1 + Z_2) \times I,$$
$$E_G = E_I - Z_1 \times I,$$
$$E_O = -M \times E_G.$$

Solving these equations simultaneously gives

$$Gain = \left|\frac{E_O}{E_I}\right| = \frac{|Z_2|}{|Z_1|} \times \left|\frac{1}{1 + \frac{Z_1 + Z_2}{M \times Z_1}}\right|.$$

If $Z_1 + Z_2/M \times Z_1$ is much smaller than unity, then to good approximation

$$Gain = \frac{Z_2}{Z_1}.$$

For the feedback control circuit herein described this approximation is always good if M is greater than 40, as it is for a 12AX7 triode. The gain of the tone control is then the ratio of two independent impedances Z_1 and Z_2. Variations in the gain M of the amplifier tube do not affect the frequency response so long as M remains greater than 40.

When M is large, E_G is effectively zero, and the amplifier tube grid is effectively at ground potential. Thus the amplifier tube grid is a "virtual ground." An easy way to see that this is so is to assume E_G to be zero, as it must be if the amplifier tube grid is indeed a "virtual ground," and then work out what the gain must be. Referring again to *Fig.* 5, for E_G equal to zero then $E_I = Z_1 \times I$ and $E_O = Z_2 \times I$. Therefore

$$Gain = \left|\frac{E_O}{E_I}\right| = \left|\frac{Z_2 \times I}{Z_1 \times I}\right| = \left|\frac{Z_2}{Z_1}\right|.$$

This is the same result that was obtained in the preceding paragraph; so the amplifier tube grid must be a "virtual ground" as stated. Then, since this grid acts like a ground point, examination of *Fig.* 5 shows that the load the tone control places on whatever circuit precedes it is Z_1, and the load on the amplifier tube plate circuit is Z_2.

The voltage gain of a 12AX7 triode, as shown in *Fig.* 3, is about 50, or 34 db. Since the maximum boost available from the tone control is about 10 times, or 20 db, the net inverse feedback in this circuit is always greater than 5 times, or 14 db. Thus, if this circuit is operated at the 1-volt signal level, the intermodulation distortion is 0.2 per cent or less. (Actually in the case of treble droop the amplification of the tube is less than 50 due to loading of the plate circuit by the tone-control network; however the inverse feedback is still greater than 14 db since the over-all gain of the tone-control circuit is less than unity.)

Since the output impedance of the tube shown in *Fig.* 3 is less than 40,000 ohms without feedback, the output impedance with feedback always greater than 14 db is always less than 1/5 of 40,000 ohms or 8,000 ohms.

A 4700-ohm resistor R_4 has been added in series with the output to reduce the effect of the phase shift which might otherwise be added to the feedback voltage due to heavy capacitive loading if a shielded output cable is used. Such loading could cause high-frequency oscillations if R_4 were not included.

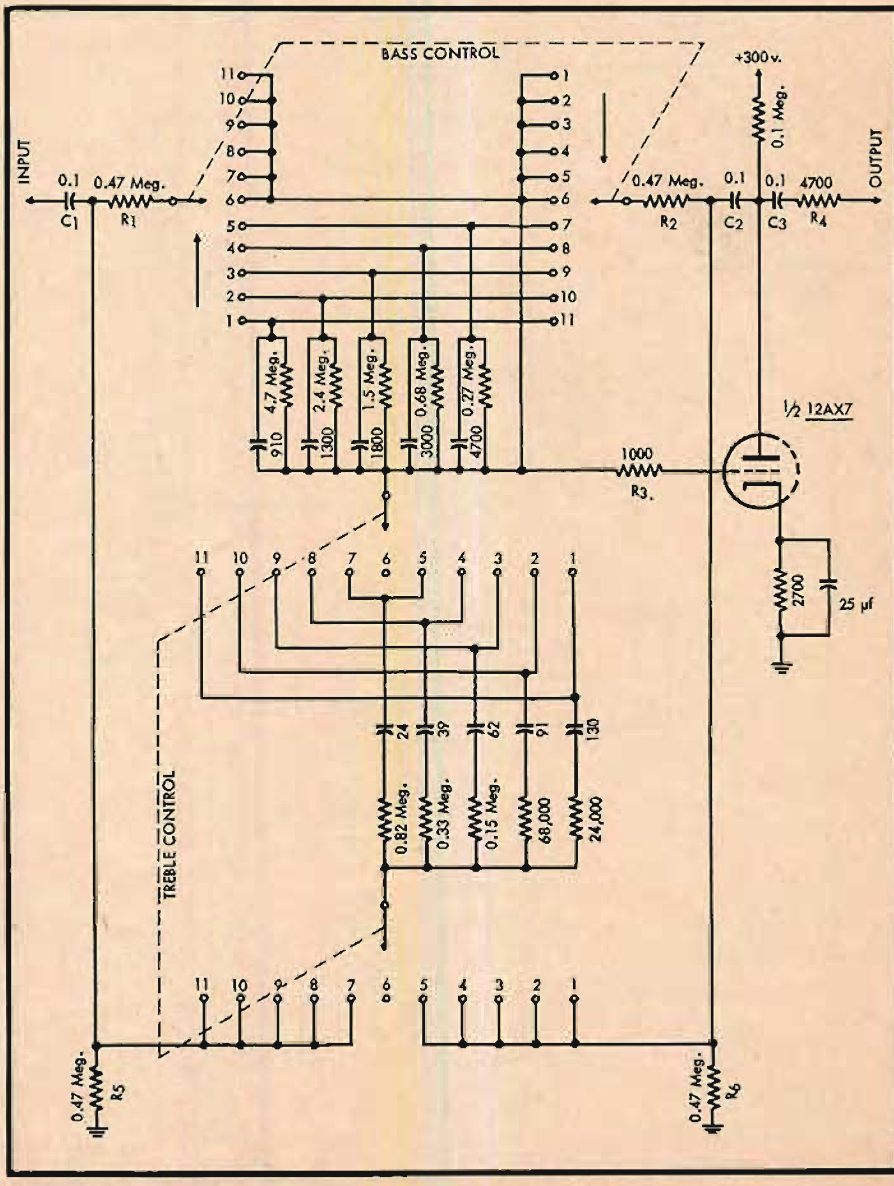

Fig. 3. The author's tone control. The switches allow optimum component-value selection for each condition and give good resettability.

This makes the total output impedance about 13,000 ohms. Loading the output with up to 400 μμf of capacitance reduces the output at 15,000 cps only 1 db when the tone control is set for maximum treble boost, and much less for other positions of the tone control. Thus, this tone-control circuit can also be used as a low-impedance output stage for an audio preamplifier unit, eliminating the need for an extra cathode-follower tube. (It should be pointed out that even though loading down the output like this does not greatly effect the frequency response of the circuit, it does reduce the amount of feedback somewhat, and this may increase the distortion level of the circuit. This also applies to the cathode follower and any other circuit which obtains its low impedance by negative feedback.)

Examination of *Fig.* 5 shows that the output impedance of the circuit preceding the tone control must be added to Z_1 when determining the gain of the circuit. In order for the preceding stage to have a negligible effect on gain its output impedance must be much smaller than Z_1. This is why the output impedance of the preceding circuit must be kept below 6500 ohms for the Baxandall circuit so that there is less than 1 db loss at 15,000 cps in the maximum available treble boost. Although preceding the tone control with a circuit whose output impedance is somewhat greater than these limiting values will reduce the maximum amounts of boost available, it will not affect the other characteristics of the circuit. If it is desired to precede the tone control with a circuit whose output impedance is somewhat greater, in the case of the switch-type tone control it is possible to compensate the treble-boost circuit to give the correct response, using the design technique to be described later.

If one compares the circuit in *Fig.* 3 with the Baxandall circuit, he will find that the fixed resistors R_1 and R_2 in the tone-control network are 470,000 ohms rather than 100,000 ohms, and that there is no 470,000-ohm resistor between the bass and treble controls. This change was

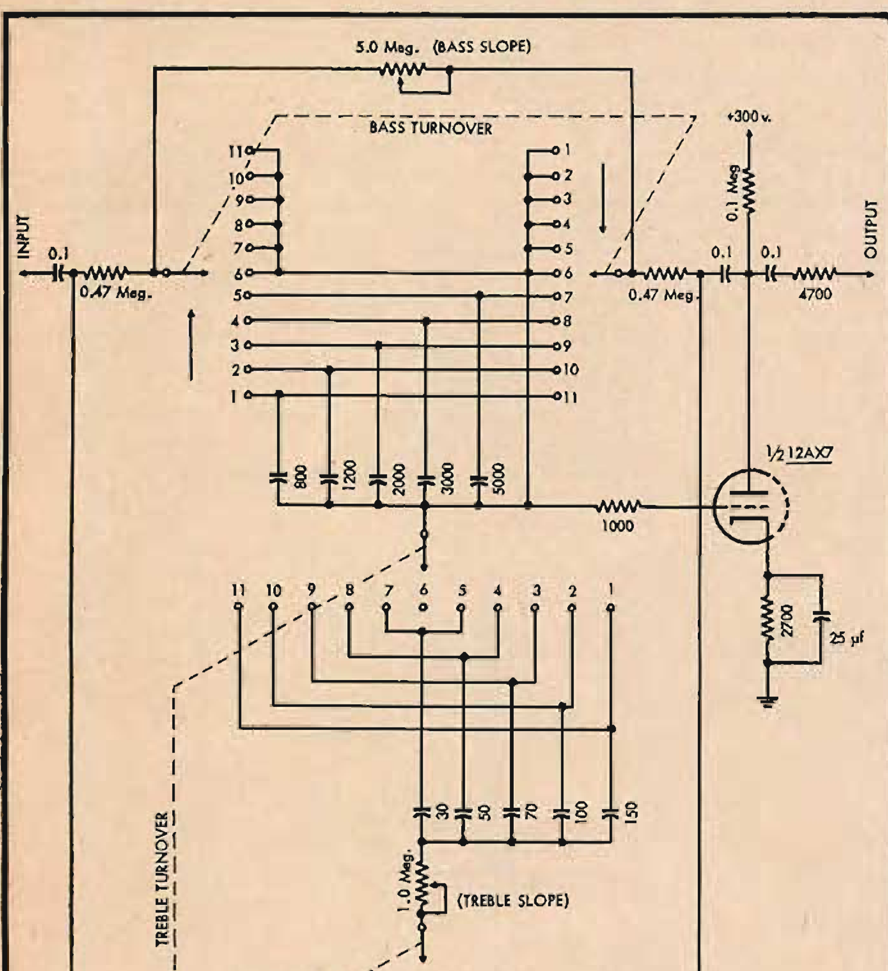

Fig. 4. This form of the tone control gives choice of turnover frequencies as well as control of the bass and treble slopes.

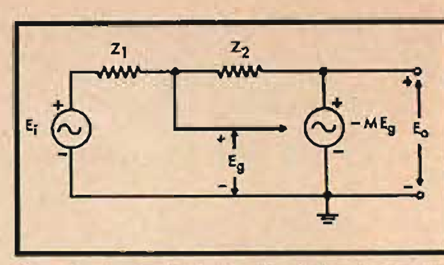

Fig. 5. Equivalent circuit of the tone control.

made to increase the impedance of the tone control and hence reduce the limitations on the output impedance of the preceding circuit. For the circuit in *Fig.* 3 the maximum treble boost available at 15,000 cps is reduced by 1 db when the output impedance of the preceding stage becomes as high as 16,000 ohms and 4 db for 66,000 ohms. These impedances are approximately 3 times larger than the impedances for the Baxandall circuit. Although they are still low, it is now feasible to precede the circuit with a low-output-impedance voltage amplifier rather than a cathode follower. This could be done for the switch-type tone control without increasing the maximum impedance at the grid of the tone-control amplifier tube beyond 1 megohm because of the elimination of the 1-megohm bass-control potentiometer. The 470,000-ohm resistor in the Baxandall circuit is used to increase the impedance of the tone control at treble frequencies, but this is no longer needed in the switch-type unit. Even without any isolation between the treble and bass networks there is no interaction causing variation away from the predicted frequency response curves in any situation that would be normally encountered.

The choice of vacuum tube for the feedback tone-control circuit is not very critical. The pentodes 5879 and 6SJ7 give about the same gain without feedback as a 12AX7 triode in the circuits described. A high-*gm* pentode such as a 6AU6 will give much more gain before feedback, allowing more feedback to be used in the circuit. Any triode having a gain somewhat more than 10 can be used with only slight lessening of the maximum amount of boost available, although the amount of feedback will be less, with a consequent increase in distortion and output impedance. In the case of high-*gm* pentodes and triodes with low plate resistance, the magnitudes of the impedances in the tone-control network can be reduced, allowing long leads between the controls and the tube without affecting the performance of the circuit; but this requires a correspondingly lower output impedance in the preceding stage. Using pentodes will reduce the Miller effect which might otherwise adversely effect the treble-boost curves of some of the possible variations of the circuit. The Miller effect, however does not bother the circuit in *Fig.* 3 or the Baxandall circuit.

Variations

The switch-type feedback tone control is capable of many variations. It is en-

(*Continued on page 44*)

Simplitronics:

Understanding the r's in Transistors

HAROLD REED*

A simple explanation for the experimenter of the r parameters of transistors

THE EXPERIMENTER and electronic technician will be working with transistors more and more. Many will be unacquainted with such things as the science of solid-state physics and quantum mechanics used in the study of semiconductors.

Although it is desirable, for a thorough understanding of transistor theory, to make a study of these principles, it is not at all a prerequisite to do so in order to experiment intelligently with and design and develop transistor circuits.

However, there are basic transistor parameters that should be understood by the transistor experimenter and technician, and he should become as familiar with them as he is with fundamental vacuum-tube parameters. Among others, important in transistor circuitry are the r parameters, the subject for discussion in this article.

Before discussing the simple equations involved we should consider some of the conventions employed in transistor work. It is usual practice to represent parameters of the transistor itself with small letters, while capital letters are used to indicate parameters external to the transistor. Thus, r_c refers to the collector resistance whereas the external load across the transistor, (collector output), may be shown as RL. Similarly, in the case of voltages, v_c would indicate the collector to base voltage and V_c the collector supply voltage. Further, it will be found that the small letter r may be immediately followed by two numbers. The reason for this will become clear when the reader recalls the simple Ohm's law equation which states that, $R = E/I$, and studies the transistor circuit for the grounded-base configuration given in *Fig.* 1 together with the following data. The circuit is used for small signal and d. c. parameter testing.

Suppose we first consider the term r_{11}. In this case the voltage between terminal 1 and ground of *Fig.* 1 is measured with the high-impedance voltmeter. The current flow through terminal 1 is measured with the milliammeter or microammeter. Thus, r_{11} denotes the resistance obtained by measuring the voltage across terminal 1 to ground and the current through terminal 1. Similarly, r_{12} indicates the resistance found by measuring the voltage across terminal 1 to ground and the current flow through terminal 2. In each case the first numeral after the r refers to the voltage and the second numeral refers to the current reading. Referring again to r_{11}, this implies that $r = v_1/i_1$; that is, the ratio of the voltage across terminal 1 to ground and the current through terminal 1. This equation is equivalent to the Ohm's law equation, $R = E/I$. Similarly, r_{12}, means that $r = v_1/i_2$, which is the ratio of the voltage across terminal 1 to ground and the current flow through terminal 2. The voltage and current terms of these equations are sometimes written as v_e, v_c, i_e, i_c, corresponding to voltage and current readings as taken at emitter or collector terminals of the transistor. The reason for this will be understood when it is realized that terminal 1 connects to the emitter and terminal 2 goes to the collector in the diagram shown.

Parameters r_e, r_b, r_c and r_m are known as emitter resistance, base resistance, collector resistance and mutual resistance, respectively.

The important r parameters are as follows: $r_{11} = v_1/i_1$, $r_{12} = v_1/i_2$, $r_{21} = v_2/i_1$, $r_{22} = v_2/i_2$. With the grounded base transistor circuit we may write as follows: $r_{11} = v_e/i_e$, $r_{12} = v_e/i_c$, $r_{21} = v_c/i_e$, $r_{22} = v_c/i_c$. r_{11} is the input resistance, r_{22} the output resistance, r_{12} the feedback resistance and r_{21} the forward resistance. Also $r_{11} = r_e + r_b$, $r_{12} = r_b$, $r_{21} = r_m + r_b$ and $r_{22} = r_c + r_b$. It can be seen then that $r_e = r_{11} - r_{12}$, $r_c = r_{22} - r_{12}$, $r_m = r_{21} - r_{12}$. The parameter r_m is known as the mutual resistance since a transistor network, like the electron tube, is an active network. An active network results in amplification between its input and output terminals. This active property is shown in transistor-network diagrams as a generator and designated r_{mic}. The reader may compare this with the equivalent radio tube expression μE_g.

As with electron tubes, dynamic or static measurements can be made. *Fig.* 2 presents the circuit connections for statically testing for the r parameters.

(*Continued on page 42*)

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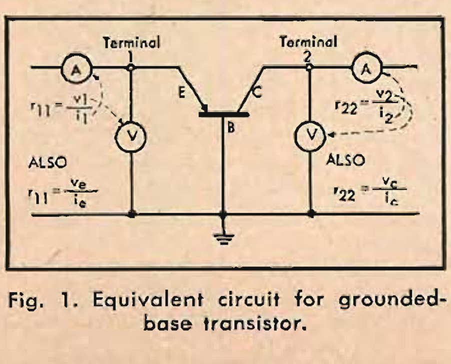

Fig. 1. Equivalent circuit for grounded-base transistor.

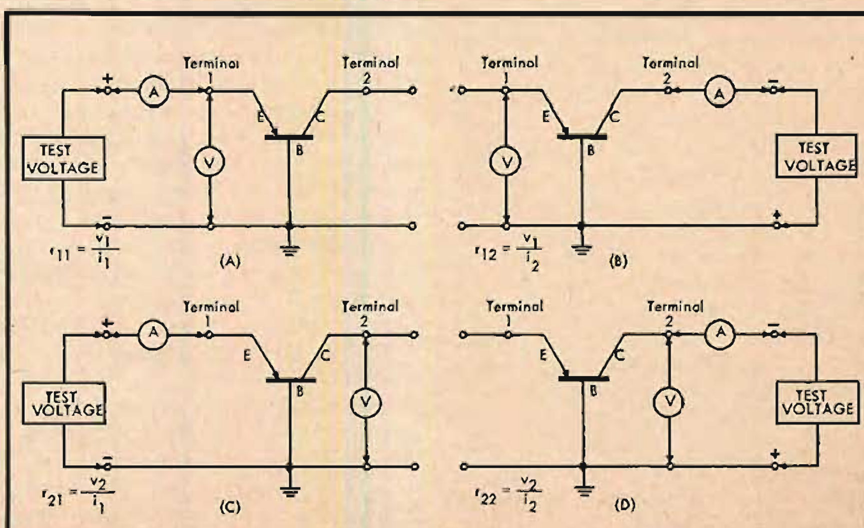

Fig. 2. Circuit connections for making static tests on a transistor.

Speaker Enclosures

EDGAR M. VILLCHUR*

A discussion of indirect radiator systems—the horn and the resonant enclosure —and how they help to couple a speaker to the air at bass frequencies.

Sound—Chapter 10, Part 2

We have seen that in direct-radiator speaker systems the function of the enclosure may be thought of as a negative one—that of separating front and back waves (except in the case of the acoustic suspension cabinet, which must also supply elastic restoring force to the speaker). In resonant and horn systems, however, the enclosure, in addition to serving as a baffle, plays a definite positive role in the radiation of bass frequencies.

Resonant Enclosures

It will be recalled that a Helmholtz resonator is that type of acoustical resonator in which an enclosed body of air, with an opening to the outside, vibrates as a mass-elasticity system—the cavity of air supplying the elasticity, and the air in the port providing the (acoustic) mass. The confined air is compressed and expanded uniformly, so that the device pulsates as a single unit rather than in sections, and it does not create overtones like those of an organ pipe. The sound produced by blowing across the mouth of an empty jug illustrates the pure fundamental output of the Helmholtz resonator, as compared to the rich harmonic spectrum of air column resonances.

Suppose we were to mount a speaker so that the cone faced into such a Helmholtz resonator, and the sound emerging into the listening room came from the resonator's port. The speaker would thus be radiating through the Helmholtz resonator rather than directly, and would of course be strongly influenced by the characteristics of the resonator.

This does not quite describe the design of the bass-reflex enclosure, but it is close. In the bass-reflex system only the rear of the speaker faces the room (speaking acoustically) through the Helmholtz resonator, and the front of the cone continues to act as a direct radiator. Furthermore the rear sound path, through the cabinet, becomes ineffective at the mid and high frequencies, where the front of the cone takes over and acts in the same way as in a purely direct-radiator system. The bass-reflex speaker system is illustrated in *Fig. 10—4*.

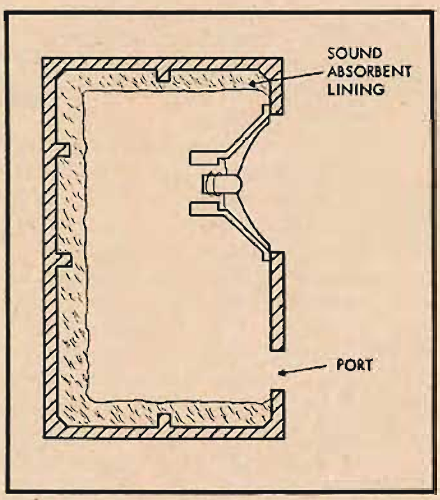

Fig. 10—4. Bass-reflex enclosure.

One might be led to believe that the cabinet resonator would "speak" almost continuously at its own natural frequency whenever it received energy from the speaker in this frequency region, adding an artificial, boomy quality to the music. This is, unfortunately, precisely what happens with improperly adjusted bass-reflex systems, and evidently the number of improperly adjusted systems has been great enough to create undeserved criticism of the bass-reflex enclosure itself. A correctly designed bass-reflex enclosure, adjusted to the particular speaker used, is capable of producing clean, wide-range bass, and of extending the capabilities of the speaker used, particularly from the point of view of decreasing bass harmonic distortion.

The bass-reflex system is a combination, or *mesh*, of two resonant systems, the mechanical moving system of the speaker and the acoustical Helmholtz resonator. A detailed analysis of the behavior of resonant systems in mesh is not in order here, but the conclusion may be stated, that the performance of the combination has qualities of its own. Specifically, when the resonant frequencies of the two systems are the same the single resonant peak is replaced by two smaller peaks, above and below the original resonant frequency, and when the proper amount of damping is applied, the smaller peaks may be "ironed out."

Thus when the Helmholtz resonator of the bass-reflex enclosure is tuned to the same resonant frequency as the speaker, and when the port is properly damped, instead of boomy, one-note low-frequency reproduction we may expect uniform, extended bass. Most important, the resonator increases the efficiency with which energy is coupled from the speaker to the air at low frequencies, and a given bass power can be radiated from the speaker (through the Helmholtz resonator) with smaller cone excursions. Since the non-linearity of speaker suspensions, as we have seen, is the major source of harmonic distortion, the decreased requirement for voice-coil excursion may radically reduce bass harmonic distortion.

Let us again resort to analogies for the purpose of gaining an intuitive grasp of the physical working of the device we are investigating. When we blow across the mouth of an empty jug, or into an ocarina, we increase the efficiency of coupling energy from our breath to the air of the room. We can produce a relatively low-pitched sound of respectable volume; it would probably be impossible to produce such a sound directly, by whistling, without the aid of the Helmholtz resonator. Of course in these examples the influence of the acoustical resonator is predominant; in the case of the bass-reflex enclosure the acoustical resonator is tamed and made a servant rather than a master.

Although the acoustical resonator of the bass-reflex cabinet is anti-resonant to the speaker and out of phase with it, sound radiated from the port is in phase. Sound from the back of the speaker cone is opposite in phase to sound from the front (compressions occur at the same time that the air in front is being rarefied and vice-versa) and when the rear sound has its phase reversed by the cabinet it emerges in support of the direct radiations of the speaker.

Another analogy may be helpful in illustrating the working of the bass-reflex system. Suspend a weight on a

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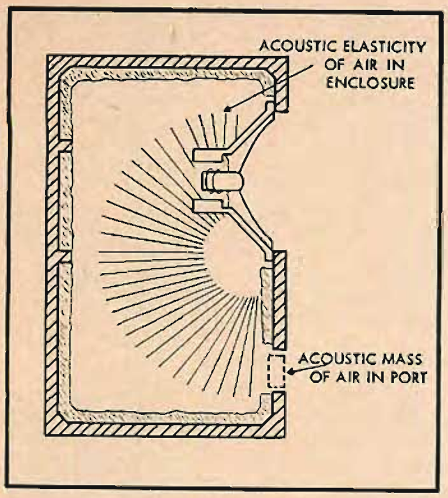

Fig. 10—5. Illustration of mass-elasticity system of bass-reflex Helmholtz resonator, and how it is coupled to the rear of the speaker cone.

long rubber band and, holding on to the free end of the band, move your hand up and down. It will be seen that at one frequency of vibration (the resonant frequency of the system) the weight will move the farthest. Two things may be noted; first, that at resonance the motion of the weight and of the hand applying the force are more or less in opposite directions—out of phase—and second, that at resonance the load imposed by weight is greatest—one feels the greatest resistance. The hand doing the work represents the moving speaker cone; the weight represents the acoustical mass of the air in the enclosure's port; and the rubber band, communicating energy to the weight, represents the enclosed air of the cabinet. The reversal of phase, and the anti-resonance of the acoustical system (which pulls or pushes *against* the force of the speaker) is thus illustrated. *Figure* 10—5 shows this mechanical analogy of weight and spring in place in the actual reflex cabinet.

An improperly adjusted bass-reflex enclosure not only loses the advantages listed here, but introduces peaked characteristics of its own which create very unnatural, if loud, bass reproduction. Such a system is actually improved by stopping up the port opening. Methods of tuning and damping bass reflex enclosures to the particular speaker being housed involve changing the size of the port opening and stretching cloth across the opening for damping. Procedures using test instruments are described in the literature.[1] A rough method, which may nevertheless be successful if the port size is approximately right, is to stretch layers of a loose-weave cloth like burlap across the opening in progressive layers, until the bass sound is most natural, neither boomy nor thin. Good program material to use for such an adjustment is organ music with a dominant pedal line, or orchestral music in which repeated use of the bass drum is made.

[1] E. M. Villchur, "Handbook of Sound Reproduction," Chap. 11, AUDIO ENGINEERING, May, 1953.

Other Resonant Enclosure Systems

Other resonant enclosures are, for the most part, variations on the theme discussed above. The acoustical resonator may be an air column rather than of the Helmholtz type, as in the acoustical labyrinth and the "air coupler." Here there is an additional problem, of suppressing the harmonics of the column. The RJ, Kelton, and Baruch-Lang enclosures are examples of the application of the damped Helmholtz resonator to enclosures of small size.

Horns

The basic purpose of a horn is to increase the coupling between a vibrating source of sound and the surrounding air. The horn is an ancient acoustical device, and loud blasts of sound, for military or other applications, could be produced thousands of years ago by persons who forced their lips to vibrate against the mouthpiece of a horn.

It is evident that, for a given vibratory excursion, the larger the radiating diaphragm the more air will be moved and the greater the sound energy that will be radiated. But large diaphragms are inconvenient and heavy. By using a flared transmission channel (a horn) the *effective* radiating area of a source of sound can be increased to that of the mouth, or large end.

Let us divide the air of a horn into imaginary successive layers, infinitesimally thin, each one a tiny bit greater in diameter than the last. (See *Fig.* 10—6) When we stimulate the small diameter layer at the throat of the horn with sound we will progressively engage each of the succeeding layers of air. Because of the gradual change of diameter (the "impedance discontinuity" between each successive layer is negligibly small) we will find that the source of sound at the throat engages all of the air in the horn. We can think of the horn having an imaginary, massless diaphragm at the mouth, of much larger diameter than our real diaphragm, which is controlled by the latter. This "virtual" diaphragm is no less effective for being imaginary—the molecules of air are vibrating back and forth just as if a diaphragm the size of the horn's mouth were actually there.

There may appear to be an unreal quality about the action of a horn, in that it seems to get something for nothing, making a soft sound into a loud one. A horn is purely a passive device, and does not inject additional energy into the system. But the reason that a horn is able to increase so dramatically the radiation of sound from a given source (by factors of 10 or more) is that most sources of sound have only a very poor "bite" of the surrounding air, and do not succeed in changing much of their mechanical energy into acoustical energy. The horn allows the mechanical power capabilities of the source of sound to be tapped much more efficiently. In the case of a horn-loaded loudspeaker neither the efficiency nor the power capability of the speaker itself is changed, but the transfer of mechanical to acoustical energy (the mechanico-acoustic efficiency of the system) is greatly increased. The extra acoustical power drawn from the system was there, unused, all the time.

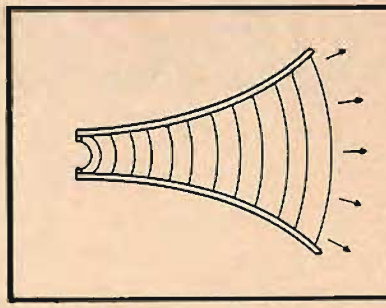

Fig. 10—6. Increase of effective radiating area of a small diaphragm at the throat of a horn to that of the mouth.

The use of the horn in the development of sound reproducing equipment is illustrated in *Fig.* 10—7. The earlier horns were necessities, as the small diaphragms could not move far enough to produce anything like the required volume of sound. The modern bass horn illustrated in *D* is not a necessity, but is used to increase the efficiency of the speaker and to reduce the excursion requirements of the speaker mechanism.

Horns have their special problems, too. There are two characteristics of horns as transmitters of sound energy that are especially significant; the cut-off frequency, and the formation of standing wave resonances due to reflections from the mouth, as in an open-ended organ pipe.

Below a certain frequency, determined by the rate of flare, the horn ceases to act as an efficient sound coupler. To keep the cut-off frequency low, the rate of flare of the horn must be very gradual. This characteristic is independent of the actual length of the horn, but if we want a large mouth the slow flare must be continued over a long distance. And it is important that the mouth be large, for reasons other than those relating to efficiency. Unless the

(*Continued on page 34*)

AUDIOCLINIC ? ?

JOSEPH GIOVANELLI

Hot Stylus Recording

Q. *I have heard much discussion and seen quite a few references on album jackets about hot stylus recording. What is it and why is it used? Elbert Aaront, Dallas, Texas.*

A. Heated stylus recording is little different from the usual methods of making instantaneous disc recordings on lacquer. As always, the sapphire needle is placed on the surface and is caused to spiral by means of a feedscrew. The vibrations imparted to the needle by the cutting head assembly cause the undulation in the groove walls which, when played back, are translated into electrical impulses by the pickup, later to be translated into acoustical power by the loudspeaker or headphones. In the heated stylus method, the sapphire tip is wound with resistance wire whose terminals are fed by a source of voltage. This causes the resistance wire to heat up, similar to the action of a heating element in a toaster or flatiron. This, in turn, causes the sapphire tip to be heated. A variable resistance and an ammeter are placed in series with one side of the resistance so as to indicate the proper adjustment for the equipment to the correct amount of heat. The heated tip is able to cut the lacquer material far more easily than the cold sapphire tip, meaning that the head weight can be greatly reduced for a given amount of groove depth. This means that much longer cutting time may be had from a single stylus than would otherwise be the case. Since the needle can travel through the lacquer more easily, it becomes possible to reduce the surface noise or increase the signal-to-noise ratio by as much as 20 db, depending upon the condition of the stylus tip, the amount of heat used, the condition of the blank, and so on. Since the head is lighter, this frees the needle to move more easily from side to side, which means that less driving power is needed, especially at the high end of the spectrum. It also means that the frequency range can be increased. However, the chip or waste material etched out of the surface of the disc to form the grooves is highly inflammable and the heat of the stylus may easily be sufficient to cause it to burst into flame. Thus, a suction system is needed to remove the chip from the record surface as quickly as it is created. In commercial installations, suction was used even before hot stylus recording. For anyone who wants to try it at home, suction is most important. The brush or other "chip chaser" must not be used.

Class A, B, C

Q. *What are class A, B and C amplifiers and what are their advantages and disadvantages? John J. Haner, Galesburg, Ill.*

A. First, it must be clearly in mind that a vacuum tube operates on what we call a grid voltage-plate current characteristic curve. Starting from the center of this curve, the more negative the grid voltage, the less the plate current, and the change in grid voltage causes the change in plate current to be directly proportional to it. As we approach the lower end of the curve, we see that the grid voltage must be decreased much more to obtain a given decrease in plate current; the linearity of the curve is gone. Finally, we reach a point where the grid voltage is such that there is no more plate current flowing. This is known as the cut-off point. Going back again to the center of the curve, we can increase the grid voltage for quite a while and the plate current will increase in direct relation to the increase in grid voltage. Finally, we reach a point where the grid itself draws current, and here again the linearity of the curve disappears. Further increases of grid voltage cause increases in plate current, but not in direct proportion to the changes in grid voltage which cause them. We eventually reach a point where the cathode is incapable of emitting any more electrons, and further increases in grid voltage can cause no further change in plate current. This is the saturation point.

A class A amplifier is one in which the static operating grid-bias voltage is adjusted to fall in the center of the curve. The swing in grid voltage should be held to such a value that it never enters those portions of the curve wherein nonlinear operation is observed. With this arrangement, either single-ended or push-pull arrangements may be used. This type of amplifier has relatively low distortion products, but is the least efficient of the three classes of amplifiers under discussion here. This lack of efficiency stems from two factors: 1) With no plate current change, that is, under static operating conditions, the tubes draw a fairly large amount of plate current, and, 2) very little useful "work" if, indeed, any at all, is being done. Also, the power output from this type of amplifier is not as high as can be obtained from the same tubes with the same plate voltages but under class B or C conditions. This is because the grid voltage swing must be confined to the linear portion of the curve, as previously noted.

A class B amplifier is operated in such a way that its static bias is set at cut-off. This type of amplifier cannot be used for audio work without being connected in a push-pull arrangement for, as can be seen, only the positive half of each cycle will be reproduced in a single-ended class B amplifier. In the push-pull arrangement, one tube works while the other is cut off. The grid voltage swing is adjusted so that at the extreme positive point of swing the tube just begins to draw grid current. It is easy to see that there is more distortion in this type of amplifier, since each tube works on the nonlinear portions of the curve, both above and below the center. This distortion can be greatly minimized by the proper use of feedback circuits. It will also be obvious that the efficiency will be greatly increased over the class A amplifier since, when there is no signal there is little or no plate current flowing. While the efficiency of a class A amplifier may run somewhere in the neighborhood of 30 per cent, a class B amplifier's efficiency may be in the order of 60 per cent. Much greater power output can be had, too, helping to improve the efficiency, since the grid of the tube may be permitted to swing through almost the entire length of the curve. It should go without saying that biases between those of class A and B may be used, with good efficiency and low distortion. These are commonly known as class AB amplifiers, as they are neither class A nor class B.

The class C amplifier is biased to a value of about twice cut-off. This type of amplifier cannot be used in audio work. It finds wide application in radio transmitters, however, and in these circuits the efficiency is very high, perhaps 80 per cent.

Instantaneous Starts

Q. *While listening to broadcast stations, I have often noted with some amazement the promptness with which the recording follows its introduction by the announcer or another record. I've tried to do this at home and have found that the lead grooves are just too long for the music to start that quickly. Are the records used by broadcast stations made with short lead grooves? Louis Heid, Corning, N. Y.*

A. The records used by broadcasters are very likely pressed from the same masters from which those in your own collection were pressed. The studio engineer uses a simple but effective trick to accomplish this. There are various systems but they are essentially the same in result and general method. The output from the pickup's preamplifier is so arranged as to be channeled into one of two amplifiers, the first of which ultimately feeds the transmitter, the second of which feeds a loudspeaker or headset. While the announcer is introducing the record, or perhaps while the preceding disc is playing, the turntable in question is switched into the second amplifier, known as the audition or monitor amplifier. The engineer starts the table and places the arm on the record just as you do. He waits until he hears the first note of program material and then quickly stops the disc with his hand, leaving the table rotating under the now held disc. He rotates the disc in a counterclockwise direction for between a quarter and a half turn, depending on the rotational speed of the recording. This of course means that there is a half turn of blank groove during whose rotation the disc can come up to speed. This prevents the music from "wowing" in. The engineer's next step is to make sure that the volume control governing the output from that particular amplifier is turned down; then he throws a key which switches the preamplifier's output into the program amplifier. At just the right moment, he releases the disc and a fraction of a second later turns up the volume control. If the record has been properly cued, for that's what this whole process is called, the disc will not "wow" in and there will not be a long delay between the time the announcer introduces the selection and the time you, the listener, hear the first note.

Infinite Baffles

Q. *What is an infinite baffle? Lincoln Roberts, Dixon, Missouri.*

A. Before discussing what this is, it might be well to review the need for a baffle. A loudspeaker mounted in free air operates in the following manner when the cone is making an outward excursion: The air directly in front of the cone is being pushed together to form a compressional wave; at the same time, the rear of the cone is attempting to recede from the air pushing against it, forming a partial

(*Continued on page 46*)

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Equipment Report

Marantz 40/20-watt Power Amplifier—Marantz Audio Consolette—Rek-O-Kut Models 120 and 160 Transcription Arms—National New Criterion AM and FM Tuner

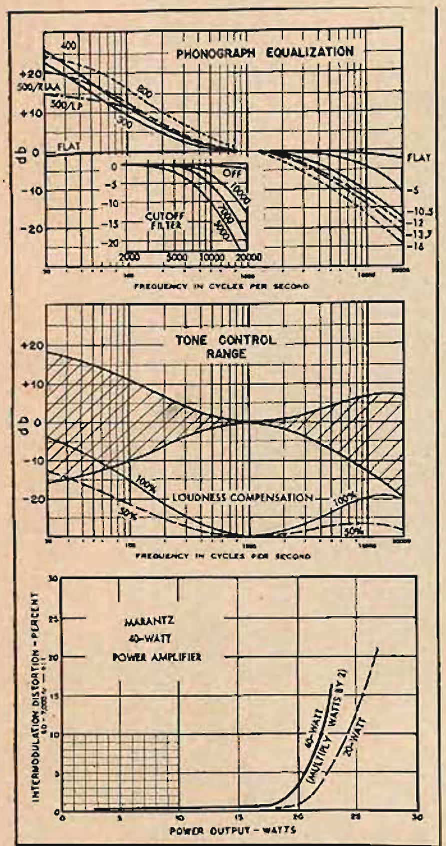


Fig. 1. Performance curves for the Marantz amplifier and Audio Consolette.

If the average audiofan were to start building a preamplifier-control unit exactly to suit his fondest dreams as to performance, absence of hum and noise, flexibility of control, and over-all appearance, it is quite likely that he would come quite close to duplicating the Marantz Audio Consolette—if he had the necessary experience, ability, and perseverance. And that is just about what Saul Marantz did, and over many months he worked out the design. The result was sufficiently "commercial" to warrant putting the unit on the market. The performance curves in *Fig.* 1 show why.

And with a successful Audio Consolette on the market, it was only logical that a power amplifier of equivalent performance should be developed to round out the line. The amplifier is shown in *Fig.* 2 and the Consolette in *Fig.* 3.

The amplifier has several unique features. In the first place, it may be used as a 20-watt triode amplifier or as a 40-watt Ultra-Linear unit, the choice being made simply by throwing a switch. The output tubes are 6CA7/EL34, working at a plate voltage of 465 and with fixed bias. An illuminated meter on the chassis permits correct adjustment of bias, d.c. balance of the plate currents in the output stage, and a.c. balance of the entire amplifier. A switch on the panel above the meter has four positions—NORMAL, BIAS, D.C. BAL, and A.C. BAL. Separate controls are provided for adjustment of each of the three parameters. To prevent leaving the switch in any of the test positions, the output is shorted except in the NORMAL position.

The input to the amplifier is unusual in that there is a built-in high-pass filter that serves to eliminate practically anything below about 10 cps, thus reducing the damaging effect of low-frequency signals which are sometimes present because of faulty record player or pickup arm—or even in the records themselves, such as once-per-revolution bumps which can ruin reproduction (to say nothing of the loudspeaker) when followed by a high-powered amplifier. Additional jacks provide for a lower level input (6 db) and for eliminating the filter where it is not needed. The filter will not affect the audible frequency response of the amplifier, however, even if left in at all times.

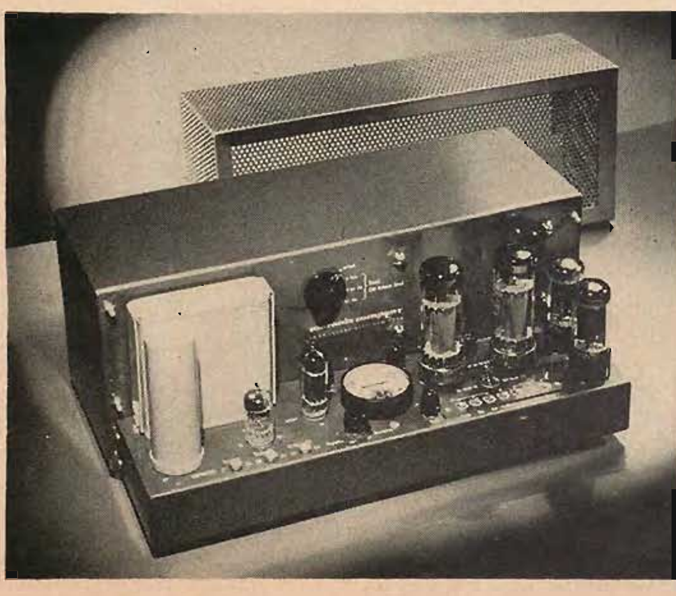
The gain of the amplifier is practically unchanged when switched from the 20-watt condition to the 40-watt mode. In the PRE-AMP input, a 1-watt output is obtained from an input of 0.3 volts for 40 watts and 0.315 volts in the 20-watt position. The other two jacks have the same input-voltage requirement for a 1000-cps signal—0.104 volts for the high-power setting, and 0.109 for the low-power setting. Measured hum output was .0004 volts across 16 ohms which is 80 db below 1 watt, or 96 db below maximum output as usually stated in specifications.

In the 40-watt setting, IM distortion is below 1 per cent up to 35 watts, just barely over 2 per cent at 40 watts; at the 20-watt setting, the distortion remains below 1 per cent at 19 watts, reaching 2 per cent at 21 watts. Distortion is below 0.2 per cent at one tenth the rated output.

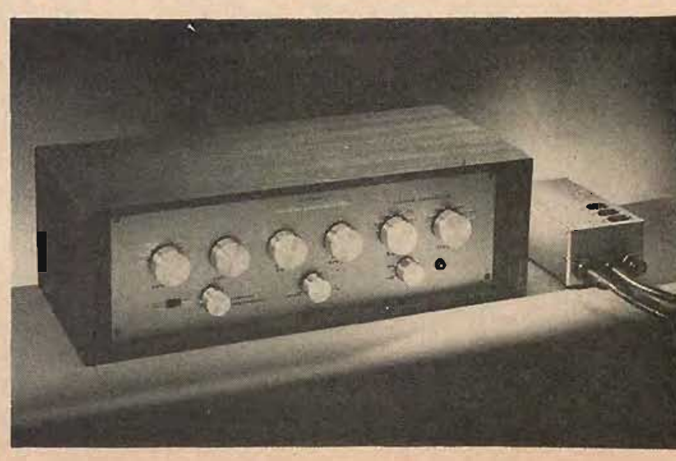
A wide variation in damping is available—there are three separate returns for the variable-damping action, together with a control which adjusts the damping to suit the requirements. Listening tests show a minimum of effect with high-quality speaker; with those not properly housed or with resonant peaks, the variable-damping feature assumes greater importance.

The Audio Consolette

As would be expected, the preamplifier curves in the Consolette are among the most we have encountered. Tone controls provide relatively conventional response, but the loudness compensator is unique in that it is continuously variable yet separate from the volume control. The curves in the center section of *Fig.* 1 show the response at 50 per cent rotation and at full on, with any intermediate degree being available. The cutoff filter has four positions—FLAT, 10 KC, 7 KC, and 5 KC—with the curves shown in the insert in the upper section of



The two Marantz units—Fig. 2 (left) the 40-watt power amplifier with the perforated grille cover removed to show the meter and test switch as well as the adjustable controls. Fig. 3 (below) The Audio Consolette in its wood housing.



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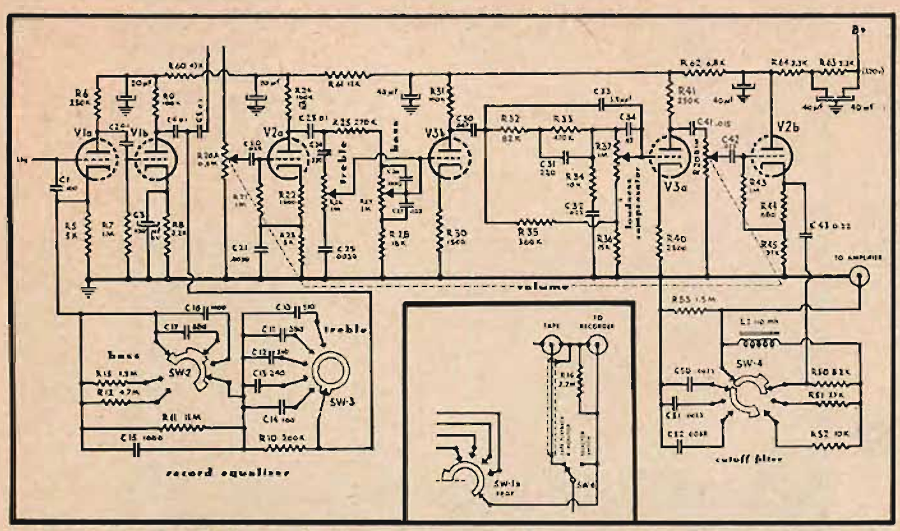

Fig. 4. Schematic of the Audio Consolette, with input switching eliminated to reduce size. The insert shows the switching for tape recorder feed and monitor output.

Fig. 1. The schematic of *Fig.* 4 omits the input switching to save space, but there are three low-level inputs (microphone, low-level phono, and medium-level phono), and four high-level inputs (tuner, TV, extra, and tape). The tape input is controlled by a slide switch which connects the output of the tape recorder to the high-level input so that it may be used to monitor while making recordings on a three-head machine, as well as for playbacks from the more common two-head machines. The selector switch thus controls the feed to the tape recorder at all times, and also to the remainder of the amplifier when the slide switch is in the right position (in the insert of *Fig.* 4) for monitoring what is being fed to the recorder, while if the switch is in the left position the remainder of the amplifier is connected to the tape recorder output for monitoring off the tape.

The Consolette is powered by a separate supply, shown at the right in *Fig.* 3, which furnishes 320 volts for the plate circuits and 18.9 volts for the three heaters in a series-parallel arrangement, as well as for the pilot light. Both supplies are heavily filtered, the high voltage with 200 µf of capacitance and the heater supply with 1300 µf. With the volume control in the maximum position, the hum (and noise) in the output is less than 0.1 millivolts. In the microphone and phono positions, hum is less than 0.5 mv at normal settings of the volume control, or more than 66 db below 1 volt output.

The phono preamplifier is equipped with two separate controls—one for the bass and one for the treble. When using microphone, both controls are normally set at FLAT. Any desired combination of low- and high-frequency equalization may be used, providing all the flexibility that should ever be required. The dual volume control prevents overloading of the first stage of the tone-control stages, while reducing hum and noise in the intermediate stages by the section just preceding the cathode-follower output stage.

Signal levels required to produce a 1-volt output are as follows: tuner, TV, extra, and tape, .056 volts; microphone and low-level phono, 1.25 millivolts; medium-level phono, 2.3 mv. The signal supplied to the tape recorder is the same as that of the high-level input sources, and it is 45 times the input from the phono pickup or microphone.

From these performance curves and data, it is seen that the Audio Consolette and the Power Amplifier are both of exceptionally high quality, which is carried out in the appearance of the units from the outside. Internally, they show every evidence of careful design and workmanship. The wiring is neat and efficient, cabled where possible. Parts placement is such as to minimize the length of connecting leads,

(*Continued on page 33*)

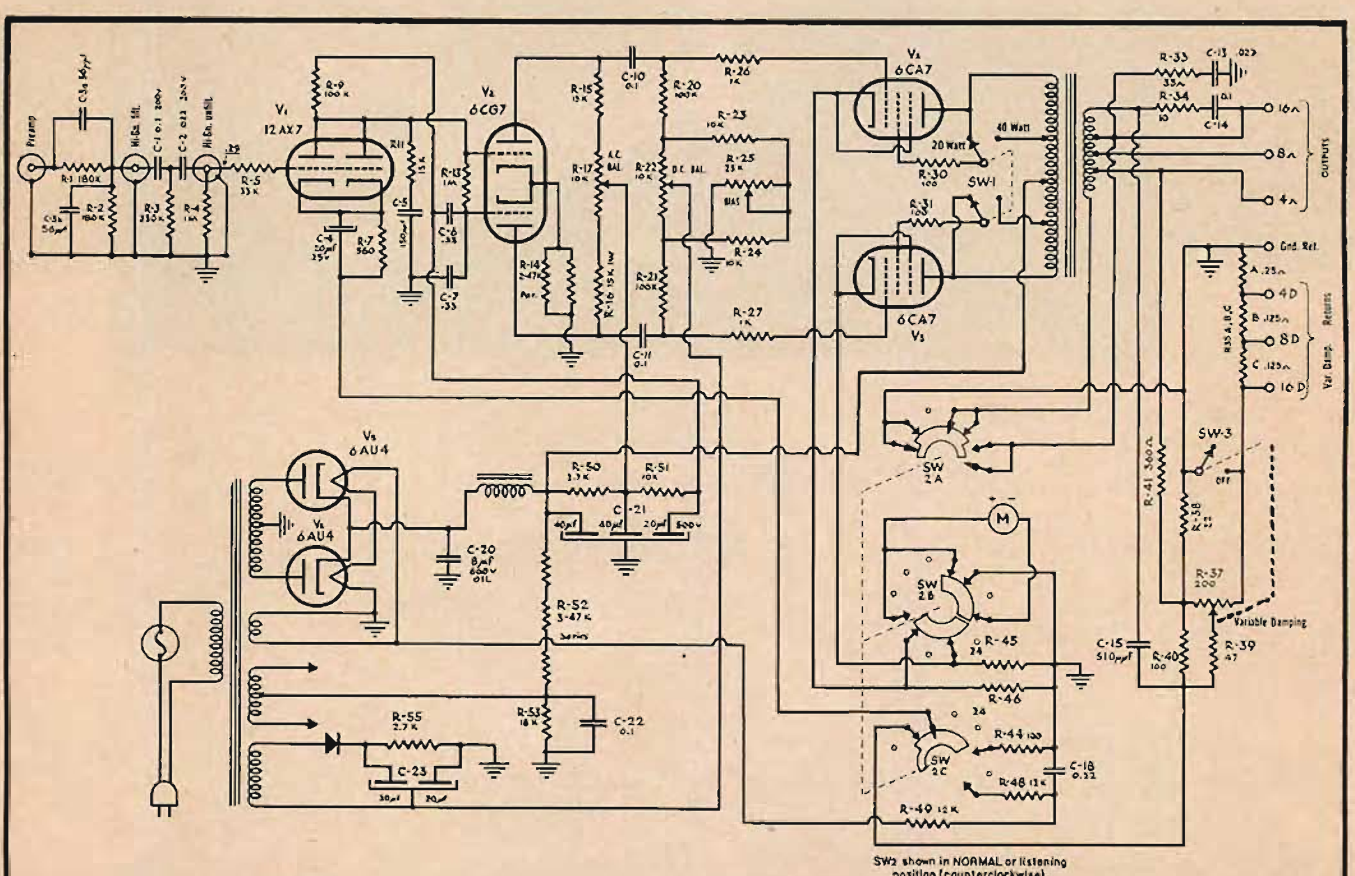

Fig. 5. Schematic of the Power Amplifier. The switch in the plate circuit of the output stage adjusts for maximum outputs of 40 or 20 watts, yet without changing gain.

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RECORD REVUE

EDWARD TATNALL CANBY*

2. ROMANTIC

Brahms: Viola Sonatas Opus 120, #1 and #2. Paul Doktor, viola, Nadia Reisenberg, pf.

Westminster WN 18114

Brahms: Cello Sonatas #1, Op. 38; #2, Op. 99. Pierre Fournier, cello, Wilhelm Backhaus, pf.

London LL-1264 (12")

Two marvelous pairs of the best in Brahms, both more than usually well played. In the viola sonatas (same as the two clarinet sonatas) Doktor knows his style, does an excellent job if occasionally a bit timidly when more outspoken expression could be used; Nadia Reisenberg's piano gives him an energetic and strong support that is always musical if not entirely subtle. Those who know the music in its clarinet form will find the viola coloration, in this, Brahms' own alternative, particularly interesting.

The cello sonatas are highly contrasted, the first a vigorous, youthful work of the most disarming and straight-forward Romantic lyricism, the second, twenty years later, far more complex but even more masterful in its use of the difficult cello-piano combination. The Backhaus piano is a pillar of tremendous strength here—and these piano parts are incredibly sumptuous and rich. Fournier is somewhat more restrained though equally musical, and this is entirely proper; too much cello can spoil these works only too easily but weakness in the piano playing is fatal.

The viola sonatas are smoothly recorded and well balanced, in a rather close acoustic, the cello sonatas have more liveness, the piano a bit in the background but with plenty of strength and clarity.

Brahms: Horn Trio, Op. 40. Arthur Grumiaux, vl., Gregory Tucker, pf., James Staglione, horn.

Boston B-209

The names aren't the biggest, but this is by all odds the finest recording of this work I've heard and, for that matter, the most intensely played of any of these Brahms works. The horn trio is one of the most endearing of all Brahms' early and lyric pieces, full of the sort of heartfelt and youthful melody that also fills the earlier cello sonata (preceding) and the somewhat later German Requiem (following). An impassioned playing, in all three instruments, and Arthur Grumiaux' violin comes through particularly well. The horn solo has just the right mellow, German quality, without vibrato (as in French style) and full of atmosphere. A splendid, big recorded sound too, only the piano being a bit off, on the thin side. (Maybe it was the piano itself.)

Brahms: German Requiem, Op. 45. St. Hedwig's Cathedral Choir, Berlin Motet Choir, Maria Stader, sopr., Otto Wiener, bar., Berlin Philh., Fritz Lehmann.

Decca DX 136 (2)

Another splendid "Requiem," yet quite unlike the recent and also excellent version from Frankfurt, on Capitol records. (Both are German-made recordings.) This is a grand, cathedral-style performance, encased in a vast liveness, the chorus evidently very large and at some distance, the orchestra also at cathedral distance. But there is no sluggishness, even though the opening and closing movements are taken very slowly. The fugues and faster parts move with grace and ease, the singing and playing is highly accurate and remarkably sharp and clear. Both solos are excellent in their relatively short sharings of the music with the chorus and orchestra.

The old Vienna recording (Columbia) is notable for the throaty wobbles of its chorus. These singers, in Berlin, sing with as clear and vibrato-free tone as a boys' choir. Entrances are far better disciplined and more enthusiastic by far than the Vienna group's, and indeed the entire performance, in spite of the massive sound and grandiose surroundings, is full of life.

However, the Requiem is a highly personal Romantic work and can stand a good deal more intimate inspection, at closer range, than is possible in this Berlin cathedral, which suggests the impersonality of a Catholic Mass. Before you acquire this, listen if you can to the Capitol version (PBR 8300) which brings the chorus into a more compelling close range. While not as grand in the big moments, it has much to offer in natural and unaffected singing and playing.

Wagner: Flying Dutchman Overture; Good Friday Spell (Parsifal); Prelude and Love-Death (Tristan); Forest Murmurs (Siegfried). Detroit Symphony, Paul Paray.

Mercury MG 50044

Gone are the days of the Stokowski Symphonic Synthesis and the slithery and hot-breathed brand of Wagner that Stoky, and others in his hey-day, used to bring us! Wagner items are few and far between today, and they are usually, as in this case, rather startlingly unlike the familiar playings of years back.

This bouncy little Frenchman, as I've noted before, can do the damndest things to Wagner and other German Romantics, such as you cannot anticipate ahead of time. Yet he's always musical and I find that everything he does is musically interesting if sometimes odd enough to make one gasp.

All is lightness of texture here, the violent sections positively electric, the lyric parts of an almost perfumed serenity more of Saint-Saëns and Fauré than of Wagner. The Flying Dutchman gets off to a start that will propel you clean out of your seat. Tristan and Isolde love and die in a most colorful manner. The birdies in Siegfried's forest somehow remind me of cuckoos popping out of a cuckoo clock. And Parsifal, the tired late-Wagner of some performances, regains a large measure of youthful vigor. Unique!

The Mercury "living presence" has the usual vast and solid bottom, plus a close-up, spaceless sound that is not very good for Wagner—too dead and lacking in acoustic atmosphere. But the details—with oboes, trumpets and so on practically floating in front of your face—are wonderfully clear.

All in all, of you're an old Wagner hand, you'll leave this disc with a slightly dazed feeling, not sure whether you hate it or love it. But never forget that Wagner's original audience was even more fatefully stunned, when the music was new and fresh, the impact unpredictable.

Grieg: Lyric Suite Op. 54; Norwegian Dances Op. 35; Wedding Day at Troldhaugen Op. 65, #6; Houlberg Suite Op. 40. Bamberg Symphony, van Remoortel.

Vox PL 9840

Grieg: Lyric Pieces, Books 3 and 4. Manahem Pressler, piano.

M-G-M E3197

(See also Books 1 and 2, E3196)

Composers come and go, wax and wane, and Grieg is on the way to becoming old fashioned and, eventually, unintelligible. In the wrong hands—and there are plenty now—he seems no more than banal, over-sentimental.

But fine performers of Grieg there are still —and in their hands he still is an impressive, if small scale composer, impressive for his utter honesty, his lyric gift, his piquant harmonies and gentle folk touches. Here are two performances that should convince almost any modern ear.

Pressler's piano has already been hailed as unusually sensitive and understanding in other types of music. His Grieg goes straight to the heart, simply and without pretence. Really an experience to hear him, and he's young—not an old veteran Romanticist by any means.

Van Remoortel is also young and of a mixed background, Belgian with training in Italy. But he makes these old orchestral scores glow with genuine sentiment. They still sound a bit *passé*, but at least they are played with honesty and real musical emotion, without apologies. You're likely to love 'em.

Both recordings are well miked, the piano full toned, the orchestra sounding huge and fat in a golden liveness.

Beethoven: Piano Sonatas #17 ("Tempest"), #23 ("Appassionata"), #26 ("Les Adieux"). Istvan Nadas.

Period SPL 729

Beethoven: Sonatas #14 ("Moonlight"),

#8 ("Pathétique"), #21 ("Waldstein"). Istvan Nadas.

Period SPL 726

These follow a first disc (Period SPL 718) with two late sonatas, #29 and #30, which I didn't get to hear. Nadas' fairly recent debut in the U.S. was highly successful and marked him as a pianist with plenty of technique and a good, strong personality.

These are certainly interesting interpretations though they may well make oldtimers sit up in some amazement. Nadas is a young modern. His Beethoven is clearly not out of the old tradition of Beethoven playing, he has not borrowed from the Schnables and the Hesses and the Kempfs. It's as though he had come to these piano scores by himself, had only the printed notes to go on. And that, may I remind you, isn't much if you've heard the music.

Fabulous technique, strong personality, honesty, yes. Nadas' Beethoven is curiously open; the inner wheels are all out in the light, turning as smoothly as a well-greased transmission. Nadas plays with a sort of glorified harpsichord technique, using very little pedal and almost none of the grand blurring that has long been traditional—after a century of pianistic attempts to get out the long lines and big shapes of Beethoven's works that lie half buried behind the mass of detail.

Nadas nurtures that detail work and it purrs—but, to my mind, clearly at the expense of the big lines. You'll tap your feet to Nadas, but you won't be lifted up. His beat is all within the measure, the long phrases are merely draped upon the detail work, and so lost.

Nevertheless, this music is played, so to speak, from a strong position, and one can always learn new things from a strong pianist, even if the old things aren't quite the same. And the piano recording, always good at Period, is superb.

Reger: Clarinet Quintet (1916). Georges Coutelen, cl., Winterthur Str. Quartet.

Concert Hall CHS 1244

Well . . . if you like Reger. . . . That's the expected comment on this music, but I've given it a try, at Concert Hall's indirect behest in the notes on the jacket, and I must admit, it ain't bad.

Still pretty thick and gooey, a post-Romantic chromaticism that likes its Ninth chords too much. But the inherently spare and at the same time atmospheric medium of clarinet and strings does well by Reger—he can't get as thick and gooey here as he does with a full orchestra. Result is that his naturally melodic sense is enhanced, rhythms cut cleanly, and listening is good. If you know the Brahms Clarinet Quintet, you'll understand how this work takes off, a quarter century later, out of the middle movements of that work, Brahms' only impressionist piece.

The music is often heard in Europe, it seems, and this performance is comfortable and familiar-sounding, as though the players did know it well.

3. THE MADRIGAL

The English Madrigal School, vol. 2. The Deller Consort.

Vanguard-Bach Guild BG 554

(See also vol. 1, BG 553)

Content-wise, the special feature of this second volume of Alfred Deller's madrigal offerings is the inclusion of a good many works from the period of the pre-Elizabethan music, the middle 1500's—to give depth and background to more familiar late madrigals by Wilbye and Weelkes. Of Elizabeth's own day, towards the turn of the century. The earlier works are unexpectedly lovely—or, I should say, not unexpectedly. It's about time, as the notes here point out, that we stop thinking of the English madrigal as a law unto itself, isolated from both earlier English music and contemporary music on the continent.

It's an almost belligerent habit of madrigal lovers to isolate the English product as though it were in a class strictly by itself, the same sort of semi-snobbery that likes to think Gilbert and Sullivan has no relation to the outside world of non-British music! All liberal-minded madrigalists, therefore, are urged to listen to the present collection, which is sung in a spritely, tasteful manner, the voices pitched high, the wobbles not too great, the words nicely clear. Only criticism: the ensemble is not entirely smooth, with a good deal of nervous energy. At a distance, on stage, even in a private home, this would be fine; but at close mike distance it leads to a good deal of near-overloading and consequent tendency to blast, here and there, in the more excited moments.

I haven't seen Volume 1, but assume it is similarly presented.

Madrigals of Gesualdo, Vol. 1. Singers of Ferrara, Robert Craft. Notes by Aldous Huxley.

Sunset LP 600

The Italian madrigal, long pretty much unknown among English madrigal enthusiasts, is beginning to emerge as the tremendous musical force it is. Gesualdo, at the time of Palestrina and Monteverdi, was the extreme radical of the day—but not as radical as was once believed, if by radical one means slightly crazy. Gesualdo's sensuous death-madrigals use extraordinary chromatics, weird harmonic progressions based on untempered free vocal pitch; he wrote passages that have long suggested Wagner to interested commentators. But the music makes extraordinarily good sense, once understood and sung, as I have reason to know. It is neither arbitrary nor "crazy," nor is it remotely unsingable—far from it.

The Singers of Ferrara hail from the U.S. West Coast—it was Gesnaldo who came from Ferrara and the singers' collective title honors him. This enterprise is significantly of the present day. Under the benevolent patronage of an interested Huxley and Stravinsky, conducted by Stravinsky's oft-time exponent, Craft, this group also includes, typically, an element of contemporary jazz and screen writing in its personnel; Gesualdo is extra-curricular fun for such musicians.

The sound is also characteristic of the new movement. Perfectly blended professional voices, as exactly alike as so many graded peas, a string quartet precision, a tonal blend, for harmony, that is positively orchestral in spite of vibrato. And the singing? Ah—there's the rub! It is, as you might expect, positively instrumental, and with a remarkable lack of interest in the very wellspring of these madrigals, the text, the word-shapes and word-phrases!

A matter of opinion, possibly, though I don't myself think so; the internal evidence of the music is much too strong in favor of the words. These singers sing metrically, with a steady and Stravinskian beat, in very nearly strict time, measuring out all the pauses quite literally, treating weak and strong syllables more or less alike. Beautifully done, but purely instrumental. Lovely, but wrong.

Moreover, they sing with such precision and accuracy that the pitch inevitably, is tempered. That is, it sounds much as it would if played on the piano with the piano's tempered tuning. The wonderfully subtle contrasts of violently unlike harmonics are thus partially lost, or weakened.

Nevertheless, a remarkable recording if only for its incredible vocal precision and, of course, the music itself, which gets through in essence. A must for all madrigal singers.

Lament for April 15 and Other Modern Madrigals. The Randolph Singers.

Composers Recordings CRI 102

A good idea, this, and it should by rights make a fine complement to the madrigal collections above, and in fact there are many nuggets of gold or, if you wish, much protein, to be dug out of the presentation. But even though one of my own minor works is included, I can't wax overly enthusiastic.

Most of the works aren't madrigals properly, but that is unimportant. Many are of a highly humorous cast, and this is of more interest, because it points up the uncomfortable fact that modern singing technique simply cannot cope naturally with the English language, nor can most composers of today.

The Randolph Singers go to great lengths to project the information, humorous or otherwise, that is conveyed here; but the conventionally exaggerated diction of the professional singer defeats them at every turn, makes the humor seem childish and highly forced, even gets in the way of the sense. Rolled r sounds, fancy vowels, and a wobbly tone are inheritances from the continental vocal past that simply do not suit our own colloquial language today, even when well composed into music.

There's nothing wrong with our speech for music, as a million and one popular and folk singers can tell you. It *can* be rendered into music intelligibly, with the greatest of ease. But not in the continental manner.

Most of the works here were composed for and/or dedicated to the Randolph Singers and have been featured on their programs. The composers are Avery Claflin, Charles Mills, Halsey Stevens, Daniel Pinkham, Ulysses Kay, Kurt List, Judith Dvorkin, Carter Harman, plus yrs. tly., an interesting and varied list.

Hindemith: Symphony "Mathis Der Maler" (1934); Symphonic Dances (1937). Berlin Philharmonic, Hindemith.

Decca DL 9818

Mathis de Maler is now a familiar classic; here is Hindemith's own performance of his work, echoing that which he made in the early Thirties, reissued after the war on Capitol LP but now again defunct. With it is another of those vast and heavy sypmhonic works that followed Mathis, not one of which seems to have gained the audience of the earlier piece.

Hindemith is a puzzle. Does he write "just the same old ideas all over again"? Didn't Mozart? Is his music heavy-handed? It sounds out powerfully from the orchestra. Academic? Yes, but deftly and skillfully, the massive works put together like any racing car. Very knowing craftsmanship, any way you look at it.

And yet a work like this, the Symphonic Dances, seems to ask for condemnation. It is insufferably heavy, noisy, thick, long, it does seem to say what Mathis did but more turgidly. There's not a shred of evidence for this, but I feel it just the same. Don't ask me why.

One thing is clear: Hindemith is plenty hard on the recording engineers. Most of this music is nicely encompassed in the Berlin recording, but the too-long Symphonic Dances get out of control a good while before the end and the last loud quarter-inch of inner groove will probably throw the average changer pickup for a loop. Mine wouldn't track it at all and when it did the sound—Hindemith saves his biggest blasts for the end—was unpleasantly distorted.

Hindemith: Four Sonatas (Trumpet, Clarinet, Bassoon and Viola). Harry Sevenstern, trumpet, Jos D'hont, clarinet, Arnold Swillens, bassoon, Francis Tursi, viola; Henri Duval, Jose Echaniz, pianists.

Concert Hall CHS 1250

The Hindemith puzzle continues here. These are outstanding examples, recent and early, of his celebrated "music for use"—music for a practical purpose rather than as art for its own sake—and there can be no argument left as to the validity of the idea. These *are* useful works, as every soloist on these instruments knows.

Are they good works? Well . . . same story. The same sort of ideas and expression, over and over again; and yet when you look closer, they really aren't the same at all, and each piece is wholly consistent in its own inner architecture, each is logically built upon its own thematic ideas, no two alike.

Three of these I did not know; they all "sounded the same," as usual. But the fourth, the Clarinet Sonata, I knew quite well from some years back though I had not heard it since. Immediately, in this recording, this one struck me as, at last, *real* music, and far more interesting than the other works! I ate it up. But was it simply because I knew it? I'm afraid so.

That's the way it is with this man. He annoys you no end at first. But he grows on you when you get to know him. And he's had a vast influence on contemporary music the world over. Come to think of it, old Bach was sometimes like that, too. He, too, is always himself, dogmatically, uncompromisingly, whether you like it or not. But is Hindemith another Bach? Maybe, yet I still doubt it.

Bartok: Second Suite for Orchestra, Op. 4 (1907). Minneapolis Symphony, Dorati.

Mercury MG 50098

Here's both a super-hi-fi record and an interesting musical experience, the one aspect neatly dovetailed with the other. As we've already found out, Bartok's orchestra is superb for recording because, being modern but straight out of the Romantic tradition, it requires exactly what recording can best give—modern, close-up, soloistic clarity of detail immersed in a big Romantic liveness.

This early work of Bartok is an exception to the general rule that his earlier music tends to be long, turgid, indigestible for today's ears. Perhaps because it is a suite, this piece is shorter, and it comes through with great clarity and transparency in the orchestra. As the notes note, there are many suprising suggestions here of the much later Concerto for Orchestra—almost forty years later. And, intriguingly, right along with the Bartokian suggestions there is plenty of that then-reigning old modernist, Richard Strauss. Most interesting mixture.

The Dorati performance is an exception, too, for my ear; other Dorati recordings in this series have seemed to me to be hard and unmusical, even including the Concerto for Orchestra itself. But somehow, this piece has been given a passionate and on the whole, very musical playing with but a trace, here and there, of the tell-tale pounding hardpan that characterizes his playing in other recordings. A first rate job, then, and particularly welcome to those who already know the popular Concerto for Orchestra. (See discussion of the RCA-Reiner recording of the Concerto, AUDIO, June 1956).

EQUIPMENT REPORT

(from page 28)

and high-quality parts are used throughout, one example being in the choice of Ohmite (Allen Bradley) variable controls in every instance. Deposited carbon resistors are used in every plate-load position and for unbypassed cathode resistors. Critical values of both capacitors and resistors are maintained by the use of 2 per cent tolerance components. Both of these units may truly be called "deluxe."

B-20

REK-O-KUT MODELS 120 AND 160 TRANSCRIPTION ARMS

Because of the high precision required in the construction of a high-quality transcription turntable, it would be expected that if any manufacturer of such a turntable were to turn to the making of an arm it would most likely be of similar precision. The Rek-O-Kut arms are no exception to this assumption.

plastic tubing to prevent scratching of the arm finish.

As near as we could determine, the arm resonance with even the lightest of pickups is below 15 cps, and is even low in amplitude, although this is a difficult characteristic to measure. It is most easily done with a sweep frequency record cut at 78 rpm and extending down to, say, 25 cps. When turned at 33⅓ rpm, the lowest frequency is just under eleven cps, which is almost below the range of most practical measuring instruments. However, no other resonances that could be attributed to the arm were found throughout the entire audio spectrum.

The striking appearance of the Rek-O-Kut arms lends a definite professional tone to any good turntable, with the brushed chrome matching the aluminum usually employed for the turntable platter. Such features as the ball on the lifting handle contribute to ease of operation since there

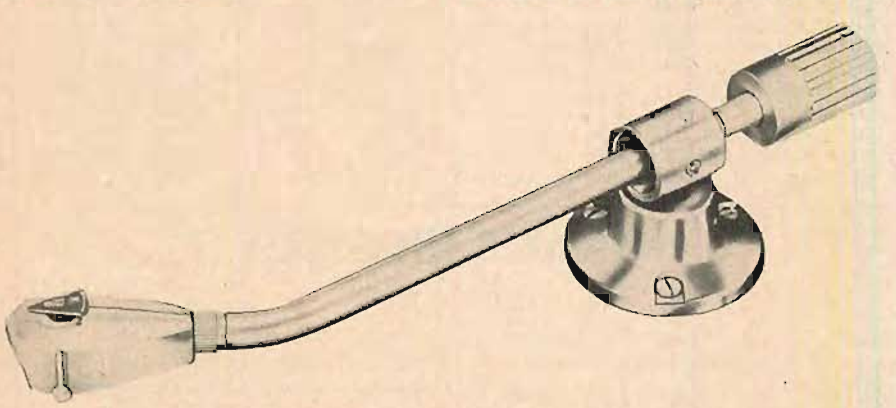


Fig. 6. The Rek-O-Kut transcription pickup arm.

Model 160, for 16-in. turntables, and Model 120 for 12-in. turntables are similar in every particular except length. The 12-in. model is the one we had under observation, and it is designed to mount with its center 8-3/16 in. from the turntable center. Both models are finished in satin chrome. All other information pertains to the 12-in. unit specifically.

The cartridge shell is of die-cast construction, with a convenient lifting handle. The front is cut out to provide for turnover cartridges and to facilitate seeing the stylus. A snap-out plug on top accommodates cartridges of the G.E. type. The head plugs onto the end of the arm and is held firmly in place by a locking ring, electrical contact being made through silver-plated spring-loaded pins in the head. Two ball bearings provide smooth operation of the vertical axis, while adjustable hardened needle bearings engage projections on the side of the tube for the horizontal bearings. The arm is counterweighted by an adjustable balancing weight which is rotated one and a quarter turns for each gram of needle force required after once bringing the arm to a balance with the pickup mounted. The counterweight is spring-loaded so there is no chance of rattle or play, and so the weight will not change adjustment with normal handling.

Clearance for the center shaft is had by a ¾-in. hole on the motor board, and the height of the arm may be adjusted from 1¾ to 2¾ in. The arm rest is similarly adjustable, the arm being gripped with two springs which are covered with a

is little likelihood of one's finger slipping off the handle and allowing the pickup to drop to the record with attendant damage. A locating pin on the head ensures the pickup being parallel to the record at all times, and the open front of the shell is a distinct advantage when cueing records to specific grooves, as is often required in accurate programming.

The 120 arm will mount on the base plate of the Rondine B-12 and B-12 Deluxe turntables, bosses being provided on the plate casting to accommodate the mounting standard. Height adjustments are locked in place with Allen set screws on both arm and rest. Either arm will be found to dress up an installation, and performance and handling are all that could be desired.

B-21

NATIONAL NEW CRITERION AM and FM TUNER

Normally tuners are listed as "AM-FM" but this would not be quite accurate with the Criterion model, for it is in effect two separate tuners, one for AM and one for FM. They just happen to be mounted on the same chassis and powered from a single supply. Thus the tuner may be used for binaural or stereo broadcasts where one channel is transmitted on AM and the other on FM. In addition, there is an output from the FM circuit which precedes the de-emphasis network, thus permitting use of the receiver for multiplex FM transmissions. This same output may be used to actuate control circuits which shut off the output when such control signals are transmitted by the station, as is the case with Storecast and some other broadcast music services. *Figure* 7 shows the tuner with the Horizon 5 preamplifier installed; if the tuner is to be used with amplifiers having tone and other controls, a brushed and anodized aluminum cover plate replaces the preamp.

While the original model of the Criterion tuner was reported in the EQUIPMENT REPORT of September, 1954, several improvements have been made since the first models were introduced. These have been made mainly in the limiter and detector circuits of the FM section, and they appear to have smoothed out the performance somewhat. At the same time, the Mutamatic circuit (which squelches the output in the absence of usable signal) works much more smoothly and with practically no noise as the signal cuts off and returns. Using the type of ratio detector described as "wide band" since it covers a band some 2 megacycles wide, the selectivity is controlled mainly by the i.f. amplifier circuits, of which there are eight in the FM section. The two cascaded 6BN6 limiters provide exceptionally effective limiting action, and stations appear out of a silent background fully tuned in; as you turn the tuning knob further, the stations just disappear into the silent background. The audio quality is very good, and not dependent on extremely accurate tuning—the station is either in or it is out and there is no need to fish for the middle one of the three peaks to get the best sound.

Even on AM, quality is above average

Fig. 7 National New Criterion AM and FM tuner.

because of the wideband i.f. amplifier, permitting relatively flat response up to 8000 cps. The arrangement of the tuner is such that one may use one section for recording while listening simultaneously to the other section. While joint use of the i.f. amplifier by both AM and FM signals is not uncommon when only one of the signals is passing through the amplifier at any time, this is the first tuner we have seen which used one i. f. amplifier for both AM and FM simultaneously.

Rather larger than most tuners, the National New Criterion is of unusual appearance, more professional than "decorative" in the usual sense. In appearance it is quite functional, and its performance leaves little to be desired, for it is very sensitive, quite flexible, and shows no tendency to drift under any average condition of operation. **B-22**

SPEAKER ENCLOSURES

(*from page 23*)

mouth is large enough (the absolute size required is related to how low the frequencies to be reproduced are) the mouth reflections and standing wave resonances become great.

A slow flare and a large mouth add up to a very large structure. If we put numbers into these general relationships we will find that, for a horn conveying fairly uniform bass down to low frequencies, we will have a piece of furniture that we cannot use in a living room, let alone get through the door. This problem was first met by the Klipschorn, which folded the horn path back onto itself and then, being placed in a corner, used the walls of the room as an extension of the flared paths.

Combination of Different Enclosure Types

We have discussed three basic types of speaker enclosure. There are also enclosure designs which utilize more than one of these three systems simultaneously. Horns which load the rear of a speaker diaphragm, for example, may be effective over only the lower part of the frequency spectrum, and direct-radiation may take over at the higher frequencies. Another design that has made its appearance is a bass-reflex enclosure whose port or ports are horn-loaded by a short path between cabinet and corner walls (see *Fig.* 10—8).

Both horns and resonant type enclosures decrease the burden placed on the

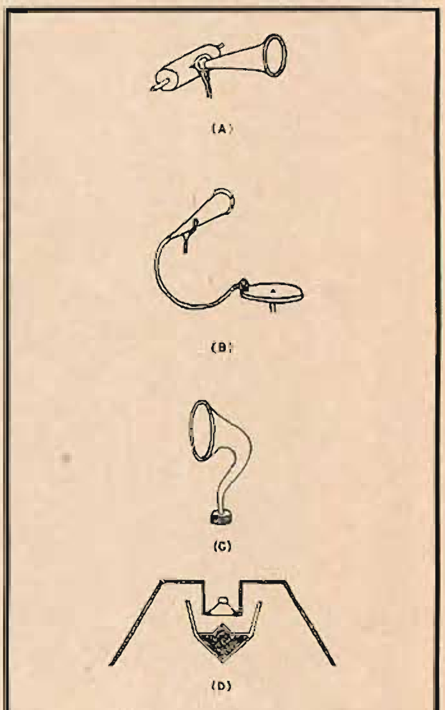


Fig. 10—7. Use of the horn as an acoustical coupler over the last seventy-five years (A) rigidly attached to phono pickup (Edison); (B) attached by flexible tubing (Berliner); (C) curved to conserve space; and (D) folded bass horn with direct-radiator type driver.

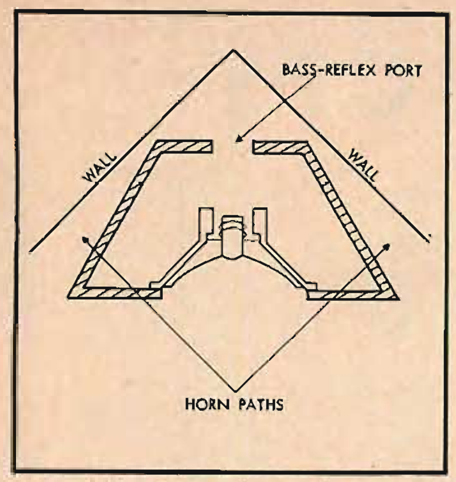


Fig. 10—8. Corner bass-reflex system with horn-loaded ports.

speaker compared to direct-radiator baffle systems, particularly from the point of view of the voice-coil excursion required at low frequencies. They also bring with them their own resonances, which must be strictly tamed for high-quality reproduction.

Jazz by Jean

(*from page 4*)

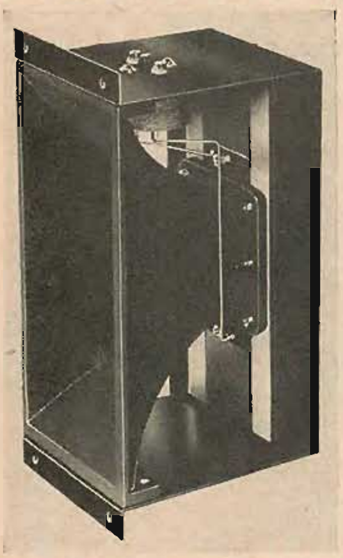
amused at her performance in much the same manner as working musicians leer among themselves over the guff handed out by the college-prof-experts. Either you feel it or you don't.

To be perfectly honest, most musicians don't take these things seriously but merely look upon them as prestige items that will mean a few extra jobs when the pickings get lean around Christmas time. They are a lot of fun when viewed simply as a pleasant outing or as a sociological phenomenon since many interesting specimens of good old *homo* show up at these affairs. It is also interesting to note how tightly the promoter jazz-type musician has clamped onto these blowouts. There are a couple of these guys around who don't rate among actual working musicians but who seem to be the subject of endless glowing slick magazine pieces directed at the unknowing, and who always seems to be where the cash is heaviest and the knowledge the least. In fact, I'm going to do a paragraph or two in the near future about these characters since they are a study in themselves. They could be called professional jazz *men* as opposed to jazz *performers.* The product they sell is phony atmosphere rather than music and they come complete with prop bottle, open shirt collar, and "musician talk" and have carefully schooled themselves to be "amusing" at parties thrown by elderly wealthy patrons of *le jazz hot* who don't know Brubeck from Bolden but think it's modern and democratic to dig jazz. These guys bear about the same relationship to genuine jazz players as Nick Altrock, the baseball clown, bore to real ball players. They both had a small talent long ago but have made a career of clowning in the uniform and burlesquing their betters. The promoter and the locust will always be with us.

Since the summer months are the leanest as far as new releases are concerned, I have decided to stack everything up for next month and review all the new discs in a batch rather than piecemeal. The harvest season is almost upon us and the trees are heavy with fruit so let us hope that the stuff will be as tasty as it is sure to be plentiful.

NEW PRODUCTS

• **Ribbon Tweeter.** The Kelly ribbon tweeter represents a new British approach toward the ultimate in high-frequency response. In operation, the ribbon diaphragm is air-coupled to a specially designed catenoidal horn which gives high coupling efficiency at frequencies between 3000 and 20,000 cps, and attenuates considerably all frequencies below 1000 cps. The diaphragm consists of a ribbon of duralumin foil 0.0003 in. thick operating in an intense magnetic field. The alternating voice current flowing through the foil generates a magnetic field which interacts with the permanent field, the resulting magnetic force being applied uniformly over the entire ribbon. The entire moving system vibrates in phase and with equal



force, resulting in remarkably smooth response with freedom from resonance. The Kelly tweeter has a power capacity of better than 10 watts and input impedance is 15 ohms. Distributed in the United States by Ercona Corporation, Electronic Division, 551 Fifth Ave., New York, 17, N. Y. **B-1**

• **Sherwood FM-AM Tuner.** Many professional features are incorporated in the new Model S-2000 FM-AM tuner recently introduced by Sherwood Electronics Laboratories, Inc., 2802 W. Cullom Ave., Chicago 18, Ill. Remarkably high FM sensi-

tivity of 1.2 microvolts for 20 db quieting is accomplished by using the new 6BS8 input tube along with a specially designed balanced input transformer. Distortion is held to a minimum due to advanced circuitry which includes both AGC and AFC. The AM section offers a choice of 16- or 5-kc bandwidth, with a 10-kc whistle filter in the circuit at all times. Exceptionally compact, the S-2000 measures only 14 x 10½ x 4 ins. The tuner is available in a variety of attractively styled cabinets to match the Sherwood S-1000 20-watt amplifier. **B-2**

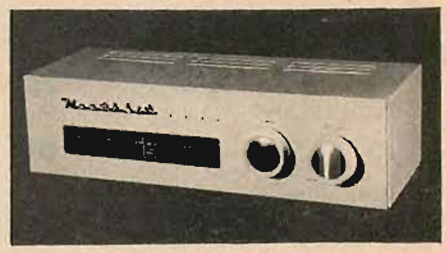
• **Premiere Corner Speaker System.** Speakers designed especially for the theater, coupled to a newly designed corner horn enclosure, assure the user a superb quality of sound from the new Premiere speaker system. To provide exceptionally clean bass, the Premiere employs a dual-throat folded corner horn with an internal volume of more than 9 cu. ft. and a path length of 12 ft. Drivers consist of a rugged 15-in. unit possessing a very high flux density for clean transients in the region of 30 to 800 cps, and a heavy-duty compression-type unit for handling the frequency range from 800 to 22,000 cps. The latter is coupled to a large, extremely rigid sectoral horn. Crossover at 800 cps

is accomplished by a 12-db constant-resistance parallel-type network using air-core coils and oil-filled capacitors for lowest possible distortion. Power rating of the Premiere is 35 watts. Enclosures are 39"h x 33"w x 28"d, and are custom built from genuine walnut, mahogany and korina woods. Descriptive sheets are available upon request. United Speaker Systems, 58 Schuyler St., Belleville 9, N. J. **B-3**

• **Altec Lansing Microphone.** The new Model 680A dynamic microphone, recently announced by Altec Lansing, introduces the unique "acoustic gate" principle to provide high-quality broadcast perform-

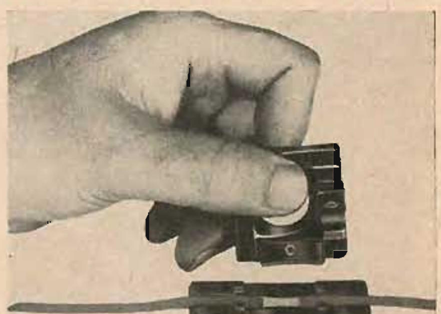
ance throughout an extended frequency range. A peripheral sound entrance channel 2 mils in width, the acoustic gate provides an acoustical resistance loading virtually independent of frequency to the front of the diaphragm, thereby eliminating high-frequency peaks and extending the smooth frequency response over an exceptionally wide range. Altec Lansing Corporation, Dept. AE-6, 9356 Santa Monica Blvd., Beverly Hills, Calif. **B-4**

• **Heathkit AM Tuner Kit.** Incorporating a number of features not usually found in an AM circuit, the new Heathkit Model BC-1 is designed especially for use in high-fidelity music systems. It provides broad bandwidth, while still maintaining good-sensitivity and selectivity. A special voltage doubler detector employing crystal diodes is used to assure low distortion even at high modulation levels. Audio response of the BC-1 is within ±1 db from 20 to 20,000 cps. Tuning range is 550 to 1600 kc. I-f bandwidth is 20 kc. Other fea-



tures include a 10-kc whistle filter, 6 db signal-to-noise ratio at 2.5 microvolts input, and pre-aligned r.f. and i.f. coils. The unit is self-powered and matches other Heathkit models in physical appearance and dimensions. The Heath Company, Benton Harbor, Mich. **B-5**

• **Tape Splicer.** Designed for semi-professional and amateur use, the new Gibson Girl Model SP-4 tape splicer miter cuts and trims the splice without the use of scissors or razor blades. It consists of a



tape guide which is provided with pressure-sensitive adhesive for attachment to any recorder, and a hand-held splicer which has two different cutting actions. One side of the splicer makes a diagonal cut in the tape, while the other side trims the tape to the familiar gibson-girl shape. Robins Industries Corp., 214–26 41st Ave., Bayside 61, N. Y. **B-6**

• **Audio Test Instrument.** Known as the Donner Model 21 Wave Analyzer, this instrument is intended primarily for testing the performance of high-fidelity, juke-box, and other music-system amplifiers. Although built to a high standard of precision, the unit is priced well within the reach of sound service specialists. It accurately measures amplitude and frequency over a range of 30 to 50,000 cps. In addition to making frequency runs, the Model 21 is also useful in the measurement of intermodulation and harmonic distortion. Full-scale deflection of the meter, which is calibrated in both percentage and db, can be obtained with input signals ranging from 160 microvolts to 500 volts rms. Easily carried by hand, the instrument incorporates design and cir-

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❶ Heathkit FM TUNER KIT

Features brand new circuit and physical design. Matches WA-P2 Preamplifier. Modern tube line-up provides better than 10 uv. sensitivity for 20 db of quieting. Built-in power supply.

Incorporates automatic gain control—highly stabilized oscillator—illuminated tuning dial—pre-aligned IF and ratio transformers and front end tuning unit. Uses 6BQ7A Cascode RF stage, 6U8 oscillator—mixer, two 6CB6 IF amplifiers, 6AL5 ratio detector, 6C4 audio amplifier, and 6X4 rectifier. Shpg. Wt. 7 Lbs.

MODEL FM-3 **$24.50**

❷ Heathkit 25-Watt HIGH FIDELITY AMPLIFIER KIT

Features a new-design Peerless output transformer and KT66 output tubes. Frequency response within ±1 db from 5 cps to 160 Kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20-20,000 cps. IM distortion only 1% at 20 watts. 4, 8, or 16 ohms output. Hum and noise, 99 db below rated output. Uses 2-12AU7's, 2-KT66's and 5R4GY. Attractive physical appearance harmonizes with WA-P2 Preamplifier. Kit combinations:

W-5M AMPLIFIER KIT: Consists of main amplifier and power supply, all on one chassis. Shpg. Wt. 31 Lbs. Express only. **$59.75**

W-5 COMBINATION AMPLIFIER KIT: Consists of W-5M amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. wt. 38 Lbs. Express only. **$79.50**

❸ Heathkit HIGH FIDELITY PREAMPLIFIER KIT

Designed specifically for use with the Williamson Type Amplifiers, the WA-P2 features 5 separate switch-selected input channels, each with its own input control—full record equalization with turnover and rolloff controls—separate bass and treble tone controls—and many other desirable features. Frequency response is within ±1 db from 25 to 30,000 cps. Beautiful satin-gold finish. Power requirements from the Heathkit Williamson Type Amplifier. Shpg. Wt. 7 Lbs.

MODEL WA-P2 **$19.75**

❹ Heathkit Williamson Type HIGH FIDELITY AMPLIFIER KIT

This amplifier employs the famous Acrosound TO-300 "Ultra Linear" output transformer, and has a frequency response within ±1 db from 6 cps to 150 Kc at 1 watt. Harmonic distortion only 1% at 21 watts. IM distortion at 20-watts only 1.3%. Power output 20 watts. 4, 8, or 16 ohms output. Hum and noise, 88 db below 20 watts. Uses 2-6SN7's, 2-5881's and 5V4G. Kit combinations:

W-3M AMPLIFIER KIT: Consists of main amplifier and power supply for separate chassis construction. Shpg. Wt. 29 lbs. Express only. **$49.75**

W-3 COMBINATION AMPLIFIER KIT: Consists of W-3M amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. Wt. 37 lbs. Express only. **$69.50**

❺ Heathkit Williamson Type HIGH FIDELITY AMPLIFIER KIT

This is the lowest price Williamson type amplifier ever offered in kit form, and yet it retains all the usual Williamson features. Employs Chicago output transformer. Frequency response, within ±1 db from 10 cps to 100 Kc at 1 watt. Harmonic distortion only 1.5% at 20 watts. IM distortion at rated output 2.7%. Power output 20 watts. 4, 8, or 16 ohms output. Hum and noise, 95 db below 20 watts, uses 2-6SN7's, 2-5881's, and 5V4G. An exceptional dollar value by any standard. Kit combinations:

W-4AM AMPLIFIER KIT: Consists of main amplifier and power supply for single chassis construction. Shpg. Wt. 28 lbs. Express only. **$39.75**

W-4A COMBINATION AMPLIFIER KIT: Consists of W-4AM amplifier kit *plus* Heathkit Model WA-P2 Preamplifier kit. Shpg. Wt. 35 lbs. Express only. **$59.50**

❻ Heathkit 20-Watt HIGH FIDELITY AMPLIFIER KIT

This model represents the least expensive route to high fidelity performance. Frequency response is ±1 db from 20-20,000 cps. Features full 20 watt output using push-pull 6L6's and has separate bass and treble tone controls. Preamplifier and main amplifier on same chassis. Four switch-selected inputs, and separate bass and treble tone controls provided. Employs miniature tube types for low hum and noise. Excellent for home or PA applications. Shpg. Wt. 23 Lbs.

MODEL A-9B **$35.50**

The World's Finest Electronic Equipment in Kit Form

New Heathkits are easy to build..

Heathkit construction manuals are full of big, clear pictorial diagrams that show the placement of each lead and part in the circuit. In addition, the step-by-step procedure describes each phase of the construction very carefully, and supplies all the information you need to assemble the kit properly. Includes information on resistor color-codes, tips on soldering, and information on the tools you need. Even a beginner can build high quality Heathkits and enjoy their wonderful performance.

HEATH COMPANY

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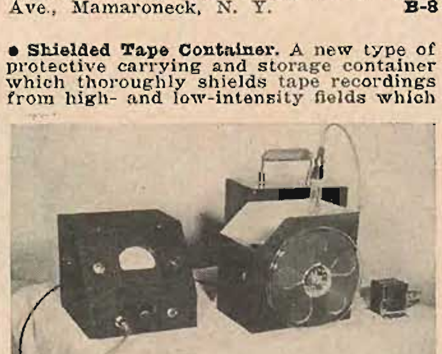
cuit innovations which provide functions heretofore available only in units considerably larger and heavier. Donner Scientific Company, 2829 Seventh St., Berkeley Calif. **B-7**

• **Four-Speed Collaro Changer.** Identical in quality and performance with its 3-speed predecessor, the new Collaro Model RC-456 record changer includes an operating speed of 16-2/3 rpm. Among the first quality changers to be provided with

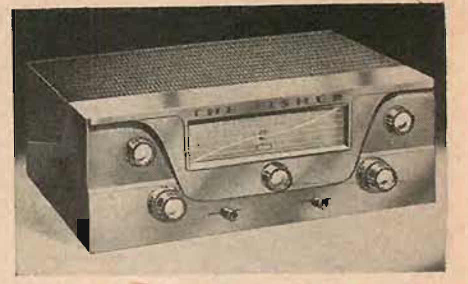
the new speed, the RC-456 retains such features of the earlier model as automatic intermix and automatic idler disengagement. British-made, the Collaro is distributed in this country by the Collaro Division of Rockbar Corporation, 650 Halstead Ave., Mamaroneck, N. Y. **B-8**

• **Shielded Tape Container.** A new type of protective carrying and storage container which thoroughly shields tape recordings from high- and low-intensity fields which



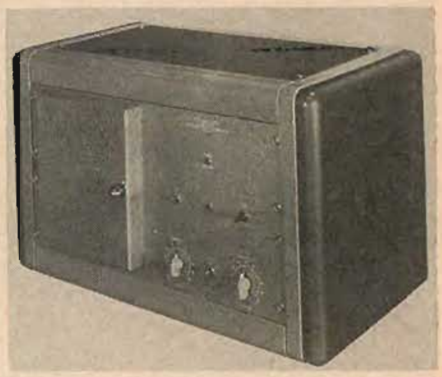
might cause accidental erasure has recently been introduced by Magnetic Shield Division, Perfection Mica Company, 20 N. Wacker Drive, Chicago 6, Ill. Double metal construction consists of two layers of specially prepared magnetic shielding materials known as Fernetic, which attenuates high intensities, and Co-Netic, which attenuates low intensities. The container is available in a variety of sizes and shapes to fit any desired application. **B-9**

• **Fisher Master Control Amplifier.** This new Fisher Model CA-40 amplifier provides on a single compact chassis an advanced preamplifier with controls, as well as a 25-watt power amplifier which affords full output with less than 1.0 per cent distortion. Six inputs are provided, also six equalization positions for records, and direct tape-head playback. The Fisher "Tonescope" provides a graphic indication of tone control settings. Also provided is a four-position loudness contour control, and rumble and noise filters. Frequency response of the amplifier is stated to be



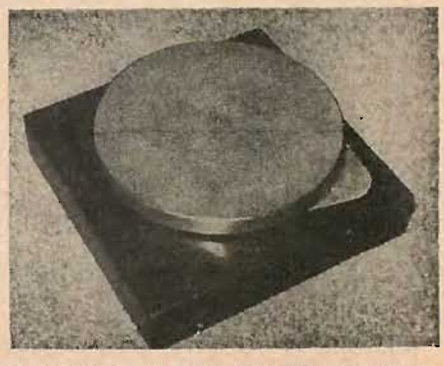
within 0.5 db from 10 to 90,000 cps, with noise level down 90 db at full output. Separate bass and treble controls provide 15 db boost or cut. In addition to 4-, 8- and 16-ohm speaker outputs, the CA-40 is equipped with a cathode-follower output for a tape recorder. All low-level tubes are fed with d.c. filament voltage. Complete in an attractive two-tone cabinet, the CA-40 is ideally suited for table-top or shelf installation. Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y. **B-10**

• **Continuous-Loop Tape Recorder.** A unique concept in tape drive systems is found in the Magneloop, a continuous-loop tape recorder-reproducer with continuously variable speeds. Stepless control of speed is afforded from 1⅞ to 15 ips with a frequency response of 50 to 15,000 cps at the higher speed. Continuously variable automatic equalization and amplitude com-



pensation is also provided. The new Magneloop is designed to record and playback any message, musical program, or sound effect up to 60 minutes in length. Unusual recording and playback possibilities are created because speed control over an 8-to-1 ratio is now built into a single unit. The Magneloop is available in single-, dual-, and triple-channel models. Complete technical specifications may be obtained by writing to Amplifier Corp. of America, 398 Broadway, New York 13, N. Y. **B-11**

• **Components Turntable.** Similar in design and construction to the well-known Components Professional turntable, the new Professional Junior model features a 12-inch belt-driven weighted table of non-magnetic polished aluminum with non-slip cork record pad. It is a 4-speed machine, including 16-2/3 rpm. Rumble,



flutter and wow are stated by the manufacturer to be negligible. The Professional Junior is now being distributed to high-fidelity equipment dealers throughout the country. Further information may be had by writing to Components Corporation, Denville, N. J. **B-12** resonator and when the loudspeaker strikes the resonant frequency of the box the motion of the air in the vent will be at a maximum and in phase with that of the cone, in which case, since the air in the enclosure is being brought under compression or tension by both the loudspeaker cone and the air piston in the vent simultaneously, its effective stiffness rises and the cone velocity is reduced at this frequency.

Another way of looking at this is to consider the electrical analogy where the vented box is represented by a parallel tuned circuit in series with the loudspeaker series circuit we have seen previously. This is shown in *Fig.* 10.

Again the cone velocity is represented by I and at resonance the impedance of the parallel tuned circuit becomes high and I is reduced. We will call this

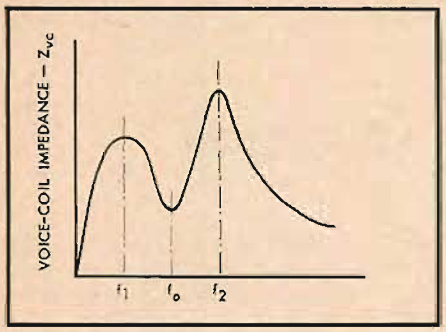


Fig. 11. Impedance curve for the vented box or bass-reflex enclosure.

frequency f_o. Since the cone velocity falls at f_o, it is an antiresonance.

Below the resonance of the enclosure the vent air mass moves in anti-phase to the cone, i.e. as the cone moves inwards the air compression forces the air in the vent outwards, and vice versa. Under this condition the volume of air in the enclosure is mainly employed transferring the motion of the cone to the vent air mass; consequently this mass can be considered for most purposes as being added directly to the mass of the cone. The latter thereby exhibits a resonance at a frequency lower than its unbaffled value.

This condition is represented in the circuit shown in *Fig.* 10 where below the resonance the dominating reactance of the parallel circuit is M_e and the resulting series circuit consisting of R_1, M_c, C_c, R_a, M_e, and R_1 has a resonant frequency we shall call f_1, where the cone velocity rises.

Again, above the resonance of the enclosure the vent air mass becomes too inert to move readily at these higher frequencies and the vent will behave as though it were blocked. The vented box thus becomes effectively a closed box and, due to the stiffness of the enclosed air the loudspeaker cone exhibits a resonance at a higher frequency than its unbaffled value.

This may be represented again in *Fig.* 10 where, above its resonance the dominating component of the parallel section is C_e and the resulting series circuit R_c, M_c, C_c, R_a, and C_e has a resonant frequency we shall call f_2. A typical impedance curve showing this is shown in *Fig.* 11.

It will be realized from the foregoing that at resonance f_o the radiation from the port is in phase with that from the front of the cone, and at frequencies below this the phase of the port radiation changes and is 180 deg. out of place at f_1 and the lower frequencies. This has little effect when the area of the port is small compared to the cone piston area. If, however, the port area is comparable to the piston area then the radiation from the port, at frequencies around the cabinet resonance f_o, will add to the radiation from the cone and substantially compensate for the fall in output from the cone due to the reduced velocity at this frequency. At frequencies approaching f_1 and below, the port radiation, under these conditions, will tend to cancel the radiation from the cone and consequently below f_o the output falls rapidly. In these circumstances, velocity curves are not an indication of the over-all radiation efficiency but they are used to indicate the nature of the air loading applied to the cone.

Thus we have seen that a loudspeaker mounted in vented box will show two resonant frequencies f_1 and f_2, in between which is an anti-resonance f_o. The expression for the resonant frequency f_o of a vented box is the same as that for a Helmholtz resonator, which, including corrections, becomes:

$$f_o = \frac{C}{2\pi}\sqrt{\frac{\pi R^2}{V\left(l+\frac{16}{3\pi}R\right)}}$$

where v is the volume of the box
A = the area of the vent
$R = \sqrt{\frac{A}{\pi}}$
l = length of tunnel or thickness of wood and all dimensions are of the same denomination.

Evaluating constants and expressing dimensions in inches we have:–

$$f_o = 3{,}824\sqrt{\frac{R^2}{v(l+1.7R)}}\ \text{cps}$$

from which $v = \frac{1.463 \times 10\ R^2}{f_o^2(l+1.7R)}$ in ins.

The vented box then has two advantages over the previous systems. (1) The stiffness of the enclosed air is relieved by venting, thus the amplitude of the resonance f_2 due to this stiffness acting on the cone is reduced.

(2) Since f_1 is below the normal cone resonance, the bass response from the speaker is extended down to this frequency if the port area is small.

In practice, the design of a vented box is a process of trial and error. It is not usual for such an enclosure to have a duct extending from the vent so the effective duct length equals the thickness of the cabinet material plus end correction. The "tuning" of these enclosures is accomplished by varying the area of the vent and in many cases facilities for doing this are given to the user. Needless to say, there is no attempt to tune these enclosures to a predetermined frequency, but rather to tune them until they sound right which is after all a very commendable ambition. As a guide, however, as the vent area is decreased the lower resonant frequency of the system f_1 will decrease both in frequency and amplitude, whereas the upper resonant frequency will increase in amplitude. *Fig.* 12 shows this effect.

Obviously, it is very much a matter of opinion which of these is to be preferred, the curve showing the most extended bass also has the most prominent resonance at f_2. It is interesting to note that if the vent were closed up completely f_1 would disappear and we should be left with a very prominent f_2 which is of course the characteristic we have shown for the closed box.

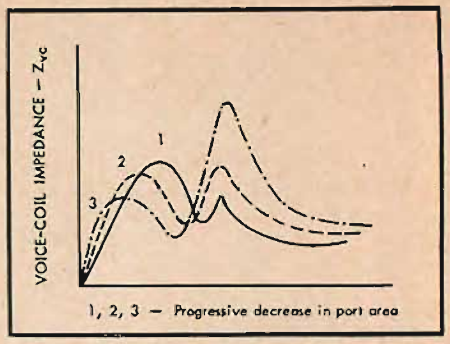


Fig. 12. Varying port area affects the impedance curves for bass-reflex enclosures.

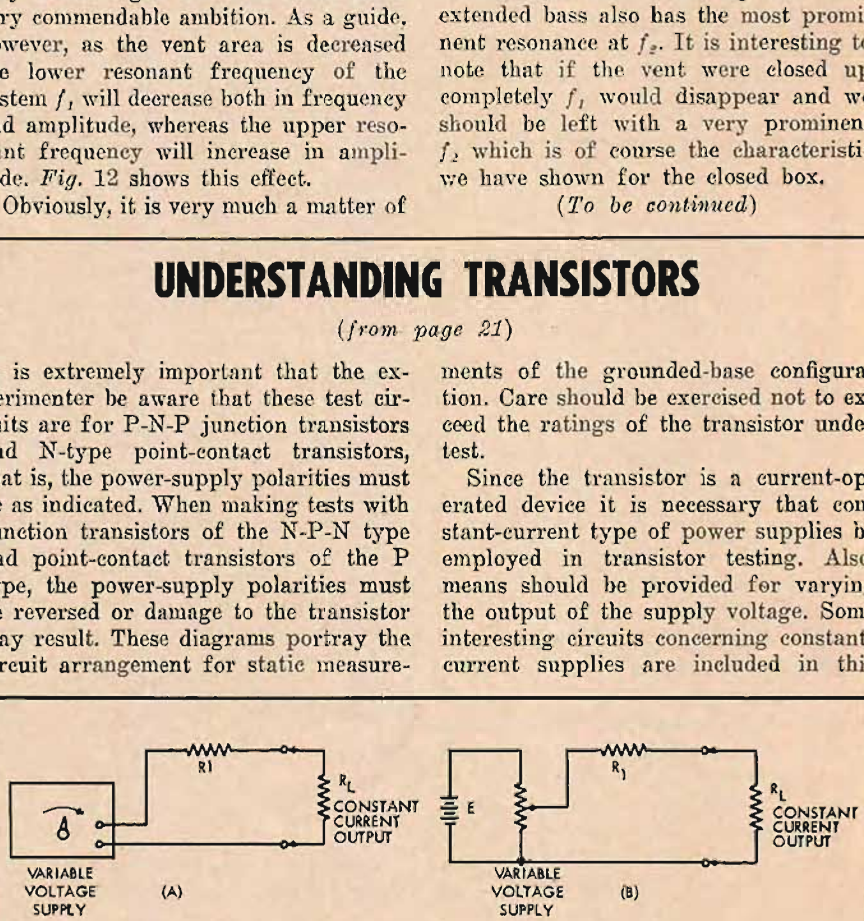
(To be continued)

UNDERSTANDING TRANSISTORS

(from page 21)

It is extremely important that the experimenter be aware that these test circuits are for P-N-P junction transistors and N-type point-contact transistors, that is, the power-supply polarities must be as indicated. When making tests with junction transistors of the N-P-N type and point-contact transistors of the P type, the power-supply polarities must be reversed or damage to the transistor may result. These diagrams portray the circuit arrangement for static measurements of the grounded-base configuration. Care should be exercised not to exceed the ratings of the transistor under test.

Since the transistor is a current-operated device it is necessary that constant-current type of power supplies be employed in transistor testing. Also, means should be provided for varying the output of the supply voltage. Some interesting circuits concerning constant-current supplies are included in this



TO DETERMINE REQUIRED VOLTAGE $E = I(R + mR)$

Where E is the required voltage
I is the desired current
R is the resistance of the load device
m is the desired ratio of series resistance (R_1) to load resistance (R_L)
mR = the value of the series resistance

TO DETERMINE MAXIMUM SERIES RESISTANCE FOR USE WITH A GIVEN VOLTAGE

$R_s = (E/I) - R_L$

Where E is the available voltage
I is the desired current
R_L is the resistance of the load device
R_s (or R_1) is the maximum permissible series resistance

TO DETERMINE CURRENT REGULATION % REG. = $100\ I/I_1$

Where I is the difference between the initial current value (I_1) and a final current value (I_2) resulting from a change in load resistance from an initial value (R_{L_1}) to a final value (R_{L_2})

$I_1 = E/(R_s + R_{L_1})$ $I_2 = E/(R_s + R_{L_2})$ where R_s is the series limiting resistance, and R_L is the load resistance

Fig. 3. Two basic constant-current circuits useful for transistor testing.

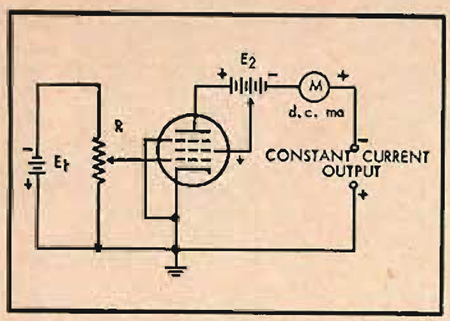


Fig. 4. Pentode vacuum-tube current regulator circuit.

article through the courtesy of the Aerovox Research Worker.[1]

Figure 3 shows two fundamental constant-current circuits. The value of R_1 is considerably greater than the load, R_L (that is, the device is operated with constant current). Therefore, R_1 is the predominant factor in determining the magnitude of the current in the circuit. Three simple equations for determining required voltage, required maximum series resistance, and per cent current regulation are included with the diagrams.

It can be seen that the greater the value of R_1 with respect to R_L the more constant the current with large changes in R_L, and also, as R_1 is increased, E must also increase in proportion to obtain the required current for R_L.

A pentode tube current regulator is shown in *Fig.* 4 which takes advantage of the well known constant-plate current characteristic of the pentode tube. E_1 and E_2 may, of course, be a. c. line-operated power supplies.

A very interesting constant-current supply is given in *Fig.* 5. The collector voltage-current curves of a junction transistor are similar to pentode-tube plate curves. Within the operating limits of the transistor and for loads from 15 to 1500 ohms this circuit will provide excellent current regulation.

The two circuits just discussed are given and explained in greater detail in the *Aerovox Research Worker* and the transistor experimenter will do well to refer to this publication.

[1] The Aerovox Research Worker, Vol. 25, No. 6, June 1955.

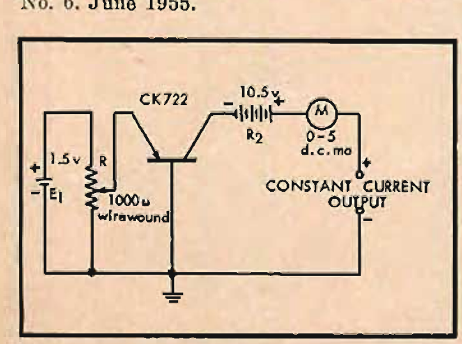


Fig. 5. Constant-current supply using a transistor.

TONE CONTROL CIRCUIT

(from page 20)

tirely possible to build a circuit giving the same curves as the original Baxandall circuit. In *Fig.* 4 is shown a circuit with four controls so that the turnover frequencies and the slopes of the bass and treble can all be varied nearly independently. The switches with the capacitors select the turnover frequencies determine boost or droop. The continuously variable resistors vary the slopes of the tone control curves with only negligible changes of the turnover frequency.

How to design a tone control circuit with any arbitrary set of frequency curves will be shown in the following paragraphs. If it is desired to precede the tone control with a circuit whose output is greater than 16,000 ohms, in the case of the switch type tone control it is possible to design a tone control that will give the desired response for some particular driving impedance.

To show how the tone control frequency responses can be easily calculated, the equivalent circuit for bass boost is shown in *Fig.* 6, leaving out those circuit elements which do not affect the bass response. (C_1, C_2, R_5, and R_6 in *Fig.* 3 are just for coupling the tone-control network into the circuit and do not affect the operation of the bass or treble controls.) Then

$$Gain = \frac{|Z_1|}{|Z_2|} = \frac{\left| R_1 + \dfrac{1}{\dfrac{1}{R_2} + j\omega c} \right|}{|R_1|} = \left| \frac{1 + \dfrac{R_1 + R_2}{j\omega CR_1R_2}}{1 + \dfrac{1}{j\omega CR_2}} \right| .$$

From this we can immediately see that the upper turnover frequency is

$$f_1 = \frac{1}{2\pi}\,\frac{R_1 + R_2}{CR_1R_2}$$

and that the lower turnover frequency is

$$f_2 = \frac{1}{2\pi}\,\frac{1}{CR_1}.$$

The general form of the response is sketched out in *Fig.* 8(A). The gain above the upper turnover frequency is asymptotic to unity. Between the two turnover frequencies the gain is asymptotic to a line with a slope of 6 db per octave or

$$Gain_{asymptotic} = \frac{f_1}{f}$$

at frequency f. Below the lower frequency the gain is asymptotic to a fixed value f_1/f_2 or

$$Gain_{asymptotic} = S = \frac{f_1}{f_2} = \frac{\dfrac{R_1 + R_2}{2\pi CR_1R_2}}{\dfrac{1}{2\pi CR_2}} = \frac{R_1 + R_2}{R_1}.$$

In the equivalent bass-boost network (*Fig.* 6) there are three component values R_1, R_2, and C. R_1 is given as 470,000 ohms, and the other two are unknown. These two can be determined by selecting values for two of the parameters for the bass-boost response curve. The author finds it most convenient to use the upper turnover frequency f_1 and S, which he calls the shape factor. Then solving the above equations for R_2 and C gives

$$R_2 = (S - 1)\,R_1,\ and\ C = \frac{R_1 + R_2}{2\pi f_1 R_1 R_2}.$$

A set of universal response curves for various values of S is shown in *Fig.* 9. In the process of synthesizing a tone control curve, first choose a value of S to give the desired shape for the curve, giving a value for R_2. Then pick the desired turnover frequency f_1, giving a value for C. A useful auxiliary relationship is that the maximum boost in db for a given

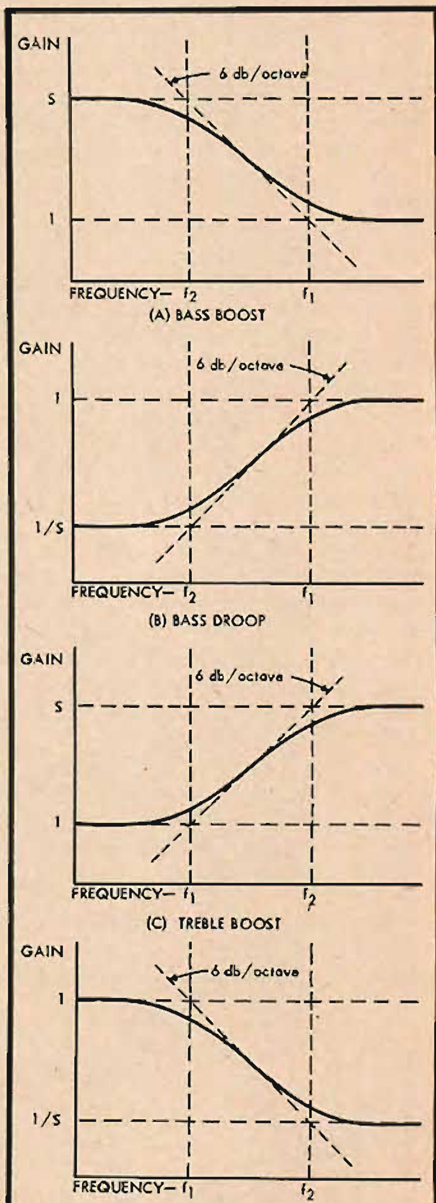


Fig. 8. Generalized curves for the equalizer frequency responses.

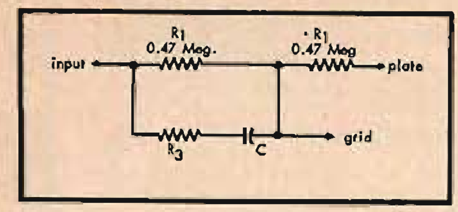


Fig. 6. Equivalent circuit for bass boost.

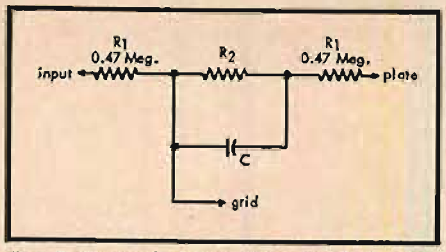


Fig. 7. Equivalent circuit for treble boost.

value of S equals $20 \log_{10} S$. Bass droop can be obtained using the same circuit by merely interchanging the input and plate connections, so the same relationships can be used for synthesis of the bass-droop curves. The general form of the response is sketched out in *Fig.* 8(B).

The treble boost can be calculated in an entirely analogous manner. The equivalent circuit is shown in *Fig.* 7. Proceeding as before,

$$Gain = \frac{|Z_2|}{|Z_1|} = \frac{|R_1|}{\left|\dfrac{1}{\dfrac{1}{R_1} + \dfrac{1}{R_3 + \dfrac{1}{j\omega c}}}\right|} = \frac{|1 + j\omega c(R_1 + R_3)|}{|1 + j\omega c R_3|}.$$

Hence the lower turnover frequency is

$$f_1 = \frac{1}{2\pi}\,\frac{1}{C(R_1 + R_3)},$$

the upper turnover frequency is

$$f_2 = \frac{1}{2\pi}\,\frac{1}{CR_3},$$

the gain below the lower turnover frequency is asymptotic to unity, and the shape factor is

$$S = \frac{f_2}{f_1} = \frac{2\pi C(R_1 + R_3)}{2\pi C R_3} = \frac{R_1 + R_3}{R_3}.$$

This shape factor is the same as the one used for the bass, and the curves in *Fig.* 9 can be used. The equations for determining R_3 and C are then

$$R_3 = \frac{R_1}{S - 1}, \text{ and } C = \frac{1}{2\pi f(R_1 + R_2)}.$$

The equivalent circuit for treble droop is the same for treble boost except that the input and plate connections are interchanged, so the same equations can be used. The general form of the treble curves for boost and droop are shown in (C) and (D) of *Fig.* 8.

If the output impedance R_0 of the stage preceding the tone control circuit is not negligible, then

$$Gain = \frac{|Z_2|}{|Z_1|} = \left(\frac{R_1}{R_1 + R_2}\right)\left|\frac{1 + j\omega C(R_1 + R_3)}{1 + j\omega C\left(R_3 + \dfrac{R_1 R_0}{R_1 + R_0}\right)}\right|$$

for the case of treble boost. From this it can be shown that

$$R_3 = \frac{R_1}{S - 1}\left(1 - \frac{SR_1R_0}{R_1 + R_0}\right), \text{ and } C = \frac{1}{2\pi f(R_1 + R_3)}.$$

Similarly for the case of bass droop

$$Gain = \frac{|Z_2|}{|Z_1|} = \left(\frac{R_1}{R_1 + R_0}\right)\left|\frac{1 + \dfrac{R_1 + R_0 + R_2}{j\omega CR_2(R_1 + R_0)}}{1 + \dfrac{1}{j\omega C_2}}\right|,$$

$$R_2 = (S - 1)\ (R_1 + R_0), \text{ and}$$

$$C = \frac{R_1 + R_0 + R_2}{2\pi f_1 R_2 (R_1 + R_0)}.$$

R_0 does not affect the frequency response of the treble droop or bass boost, but it does reduce the over-all gain by a constant amount $R_1/R_1 + R_0$ as it does in the other two cases.

The method described for determining the frequency response of the tone control is really quite general and can be applied to the design of other types of tone controls and equalizers. Although the exact equations may be different, the universal response curves in *Fig.* 9 are always the same, provided only equalization networks with a single effective reactance element are used.

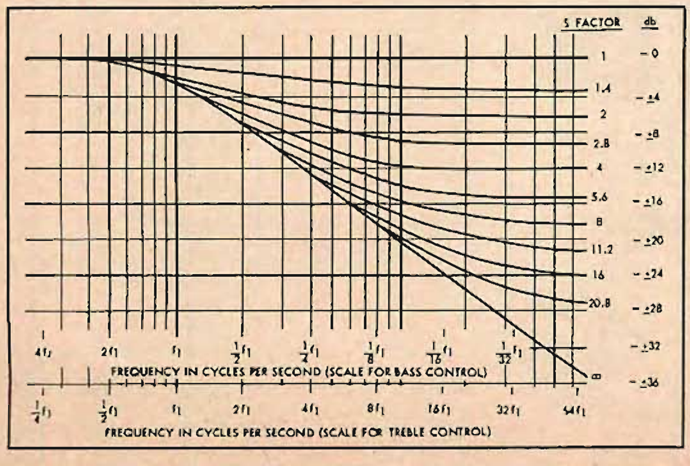


Fig. 9. These universal frequency curves are used in conjunction with the material in the text to calculate variations on the basic circuitry.

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AUDIOCLINIC

(from page 24)

vacuum or rarefied region of air. This vacuum is far from perfect, so that its effects sneak around to the front, tending to reduce the pressure in front of the cone, and the pressure in front of the cone seeks to balance the decreased pressure behind it. This partial cancellation of pressures results in the reduction of the acoustical output from the speaker; in other words, the system is not efficient. This inefficiency might be tolerable except for an additional factor: the reduction is not uniform with frequency. The highs are affected far less than the lows; the exact result depends on the size of the speaker and how flat it is electro-mechanically. For the shorter wavelengths (highs), the area of the cone itself is large enough to prevent too serious an amount of cancellation. As the wavelength increases to the point where it becomes larger than the diameter of the cone, it can be seen that the ability to sneak around is increased.

The baffle is a means of preventing that kind of cancellation from resulting, either by elimination of the back or front wave altogether, or by reintroduction of it in a different phase relationship, such that it will reinforce rather than cancel its opposite. The infinite baffle is designed to eliminate the backwave. It is nothing more than a tightly closed box with a single opening, that of the front of the speaker. The inside of the box is filled with some type of sound absorbing material, such as finely-spun glass. Thus, the backwave is transmitted directly into this material and cannot be radiated by vibration of the cabinet or in any other way. Of course it must be realized that this system, like all others, is not 100 per cent efficient. Other precautions must be taken to eliminate cabinet vibration, such as using wood at least ¾ in. thick, with internal bracing where panel areas are large. The shape of such a box is not too critical; the volume should be at least six to eight cubic feet for good results, with larger volumes working still better. With smaller volumes, considerable air pressure is built up within the box behind the cone, reducing the over-all efficiency and increasing cone resonant frequency, leading to a reduction of low-frequency response. We have found, however, that such a cabinet with a volume as small as 4 cubic feet can give surprisingly good performance.

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Industry Notes...

Annual NAMM Trade Show. The greatest testimonial yet accorded the growth of High Fidelity in the music industry was evidenced in the annual convention and trade show of the **National Association of Music Merchants** which took place in New York July 23 to 26. Manufacturers and visiting buyers alike were taken aback by the way Hi-Fi literally ran away with the show. No other single element of the show even remotely approached Hi-Fi in stimulating buyer interest. Held partly in the **New York Trade Show Building**, the NAMM clambake afforded many manufacturers of audio equipment their first look-see at the exhibition facilities which will be used for the **New York High Fidelity Show** sponsored by the **Institute of High Fidelity Manufacturers**, scheduled to begin September 27. Wide halls, acoustically treated walls and ceilings, and air conditioning add up to only one conclusion—if there is an ideal spot in the entire country for an audio show, the NYTSB is it.

Audio participants at the NAMM show are to be accorded a congratulatory note for their good taste in holding the sound level of their exhibits within enjoyable limits. It is to be hoped that this same sense of reason will prevail at all future audio shows, wherever they may occur and no matter under whose sponsorship.

EIGHT NEW IHFM MEMBERS. Seven new general members and one associate member have joined the **Institute of High Fidelity Manufacturers** within recent weeks, according to George Silber, president. The seven general members are: **Sherwood Electronic Laboratories, Inc.**, Chicago, Ill.; **North American Philips Co., Inc.**, New York City; **Neshaminy Electronic Corp.**, Neshaminy, Penn.; **Brociner Electronics Corp.**, New York City; **Acoustic Research, Inc.**, Cambridge, Mass.; **Ercona Corp.**, New York City, and **Jensen Manufacturing Company**, Chicago, Ill. **A-V Tape Libraries, Inc.**, New York City, is the new associate member. Membership of the Institute now totals 68.

OLYMPIC BUYS PRESTO. Presto Recording Corporation, Paramus, N. J., has been purchased by **Olympic Radio & Television, Inc.**, New York. Earlier this year Olympic acquired the **David Bogen Company**. Under the new arrangement, Bogen will transfer part of its manufacturing activities to an 80,000-sq.-ft. plant adjoining the Presto factory. Present Bogen facilities in New York will be retained. Presto will continue as a separate manufacturing entity but as a wholly-owned subsidiary of Olympic.

Industry People...

Clifford P. Shearer has joined Rek-O-Kut Company in the newly-created post of Director of Advertising and Sales Promotion. **George Silber**, Rek-O-Kut prexy, announces that the appointment is the first in a series of projected plans for company expansion . . . Jocund **Ed Cornfield** has set up his own factory representative firm to cover metropolitan New York and Northern New Jersey; his first account is Magnecord, Inc., Chicago tape recorder manufacturer . . . **Theodore (Skip) Weshner**, who formerly sold hi-fi equipment from behind a counter, is now operating from the business end of a microphone—his nightly hi-fi program on New York's Station WBAI has built up one of the county's largest FM audiences . . . **London England** has joined the industrial sales staff of Gates Radio Company to cover Houston and East Texas . . . The Distributor Sales Group of the West Coast Electronic Manufacturers Association has elected **L. W. Howard**, president of Triad Transformer Corp., as chairman for the next year . . . **G. L. Carrington, president,** announces that the name of Altec Service Corporation has been changed to Altec Companies, Inc.

ADVERTISING INDEX

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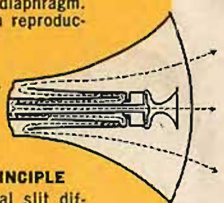

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