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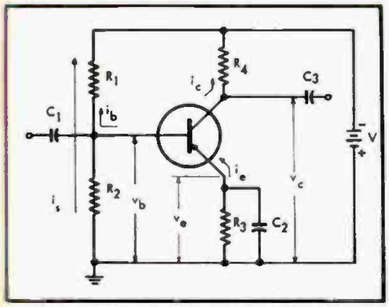

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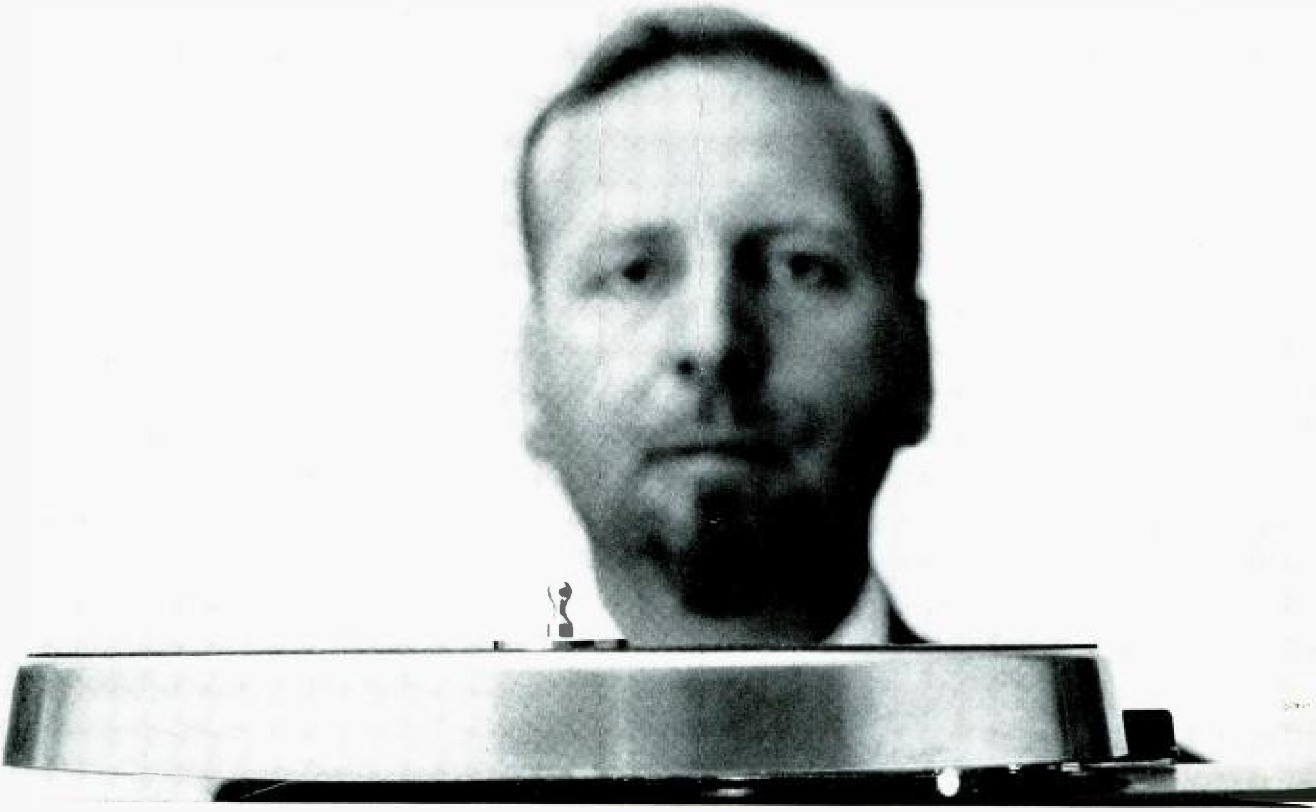

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Sounding Board

again . . . that irresistible impulse!

There are, apparently, some impulses which are positively irresistible.

One of these is for uninformed writers to always try to be funny or sarcastic when they write about high fidelity. The case in point this month is the New Yorker's "Talk of the Town" and its (?) his (?) coverage of the recent New York High Fidelity Show.

The "Talk of the Town" finds it possible to be pleasantly sympathetic to a group of citizens who inexplicably take pleasure from wandering about New York City gaping at the cornices on old buildings. It can be warmly tolerant of match book collectors who, when they meet, apparently wear shirts imprinted like match book covers! These people are OK in the New Yorker's book, but when a high fidelity show is visited, an attempt just has to be made to make all the visitors appear to be just plain "nuts." Passing comments overheard in the corridors are quoted out of context, the noise is exaggerated and the fact that completely different types of music are being played in different exhibit rooms has to be made to sound balmy.

The "Talk of the Town" comments that many exhibitors had their "little white rooms" strung with velvet rope, "like a funeral parlor." Of course, funeral parlors aren't amusing per se, but the association strikes "Talk of the Town" as something comic to point out to its readers. Now, we don't know how many sorts of velvet ropes there are, but we are sure that the ones used at the High Fidelity Show were not only similar to those used in funeral parlors, but equally similar to those used at the Pump Room, the 21 Club and in the lobby of the theatre where "My Fair Lady" is now being shown. Why reach from left field to make it sound droll, and make a pass at the people who stand behind it or in front of it?

We wish that we could truly understand the compulsion which makes it necessary to treat the desire for quality in musical reproduction as if it were a sort of harmless lunacy. Frankly, we just don't fathom it. We took a careful look at this column, and were made to wonder whether this writer, with his "uneducated tympanum," seriously meant to comment on high fidelity components or

(*over*)

The Sounding Board

(continued)

on the high fidelity show. Fully half of the space was given to a discussion of one manufacturer's television exhibit and another's short wave packaged unit, neither of which, of course, are high fidelity equipment anyhow. More than two-thirds of the article covered introductions, the lyrics of a few records being played and the above irrelevancies.

We, of course, have no way of knowing what sort of equipment is used by the Editor of "Talk of the Town" when *he* listens to recorded music, if indeed he does at all; but even if it is not worthy of the title "high fidelity equipment," it is probably infinitely better than the sort of thing he was listening to some years ago, and this upgrading of the entire field is demonstrably due to the efforts of the same high fidelity enthusiasts he pans in his column.

As is well known, there are an awful lot of sincere and honorable men in our industry who have honestly striven to produce better and better equipment, trying to bring a greater degree of listening pleasure to devotees of recorded music. To go out of one's way to make these people appear comic is certainly out of line . . . especially at this time, when so many of the audience of the New Yorker have become seriously interested in the subject of high fidelity.

We are, of course, not suggesting that high fidelity enthusiasts ought to cancel their subscriptions to the New Yorker. We certainly do not intend to cancel ours. And despite the rather shoddy treatment we think our industry has been accorded, we still find "Talk of the Town" well worth anybody's reading any week . . . in fact, we heartily recommend it. On the other hand, those of us who take our industry (one could say our "art") seriously, would not be wrong to take the old pen in hand and drop a note when it appears that any publication is straining violently in order to introduce a comic or sarcastic aspect to what is a worthwhile and progressive industry.

We wouldn't attempt to match wits with "Talk of the Town." As Joe E. Lewis says, we might be entering the fray half prepared! But we *will* match sincerity of purpose any old day . . . and we'll bet that our airedale can lick his airedale!

Leonard Carduner

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ABOUT MUSIC

HAROLD LAWRENCE*

Watch Your Language!

LONG BEFORE the curtain fell on the New York City Opera Company's season opener, *Orpheus in the Underworld*, an old controversy was being warmed over in the minds of the audience. Offenbach's bubbling satire on Greek mythology had just been provided with a brand new English libretto filled with the sort of jokes that would be summarily rejected at a preliminary conference of gag writers for a TV comedy hour. The rhyming was greeted by what a *Time* reporter described as the "embarrassed sighs of the audience."

Example:

JUNO—The air is full of your infidelities.

JUPITER—No? The hell it is.

Nor was the musical score helped by conductor Erich Leinsdorf's un-Gallic interpretation. All in all, this English version of *Orpheus* had not merely broken through the language barrier; it had shattered it. Once again, the topic of opera in English had been re-opened for discussion.

Opponents of opera translation, however, really could not base their arguments on the new *Orpheus*, since their adversaries would readily admit that the libretto was a dismal failure. The debate will therefore have to revolve around better examples. But whatever specific translations are examined, certain issues will invariably be raised.

Elaborate cases have been prepared on both sides. Supporters of opera in English generally maintain the following:

John Mason Brown's statement that "every opera is too long except *Carmen*," is shared by large numbers of music lovers whose appreciation of opera depends upon an understanding of the text. The weighty philosophy of Hans Sachs' famous monologue from *Die Meistersinger*, the intricate and amusing goings-on in Count Almaviva's castle in *Le Nozze di Figaro*, the Tsar's struggle with his conscience in *Boris Godounov*—these and other operatic situations are lost to audiences not intimately acquainted with the libretti. Opera goers who insist upon all operas being sung in the original tongue are members of a snobbish, multi-lingual minority who, along with the trained musicians, want to keep the art form in the hands of a few. Conversely, opera in English would automatically enlarge the audience and pave the way for wider acceptance of all operas, not merely the ever popular *Carmen* and *Bohème*.

The history of opera performances in Europe represents by the same token "opera for the people." Most operas are heard in the nation's own language. *Die Götterdämmerung* at the Paris Opéra becomes *Le crépuscule des Dieux*, in Milan *Die Zauberflöte* is turned into *Il Flauto Magico*, and Berliners hear *Pagliacci* as *Der Bajazzo*. In fact, only in the United States is there such a purist approach to opera translation.

Until recent years, when the Metropolitan Opera and other companies in the land began introducing opera in English, Americans seldom heard their native language on the operatic stage. This was, of course, a concomitant effect of the nation's cultural inferiority complex which set a premium on anything imported from Europe. Thus, foreign conductors, singers and opera companies roamed the countryside performing works in strange languages for bewildered audiences. Since Europeans themselves seldom hesitate to translate libretti, why should we? As for the esthetic considerations, the fact that Mozart welcomed performances of his works in different European capitals and languages should go further in convincing the doubtful.

Another point in favor of opera in English was introduced by Paul Henry Lang in the *New York Herald Tribune* on April 10, 1955. "Every foreign language," wrote Mr. Lang, "calls for entirely different voice production. . . . In Italian, there are no clusters of consonants, therefore an Italian voice, even when raw and untutored, soars freely." Special elements of vowel qualities, consonantal structure, as well as climatic effects on vocal development apply to French, German, English, and all tongues. Therefore, continued Lang, such Metropolitan Opera singers as Risë Stevens, Leonard Warren, George London and Roberta Peters perform under handicaps when they sing in Italian "because they are forsaking their mother tongue and all that this implies in natural ease of voice production."

Literal translation of opera libretti is obviously out of the question, the advocate of opera in English readily confesses. Howard Dietz, whose English versions of *Fledermaus* and *Bohème* are incorporated in the Metropolitan repertoire, described this task as being "more difficult than the most difficult crossword puzzle." However, since there is plenty of room for improvement in many libretti, no harm is

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So much for the proponents of opera in English.

The Argument Against

The basic argument against presenting opera in English is that opera translations involve more than word meanings. A great opera is a perfect marriage of words and music. The rise and fall of the melodic line in "Voi che sapete" from *The Marriage of Figaro* blends exquisitely with the instrumental score, and with Da Ponte's Italian verses. Even the most poetic translation would sound commonplace next to the original. The flow of these words was in Mozart's mind when he created his musical setting. Had he been provided with a German text, something else would undoubtedly have evolved. Of all opera composers, Mozart was especially sensitive to the relationship of words to notes.

Since literal translations are impractical, the English libretto must of necessity contain some entirely new material not found in the original. Where there is a play on words or a witty sequence of rhymes, changes are unavoidable. But the result, in many instances, amounts to far more than a mere verbal substitution; it can affect the fundamental meaning of a scene or a role.

The fact that European theatres give opera in the native tongue does not justify the practise. Anyone who has heard Wotan soliloquizing in French, or Manon saying farewell to her little table in German realizes how ludicrous such productions can become.

One of the more practical objections to opera in English is that you can't understand the singers any better than when they're performing in a foreign tongue.

While it is true that Mozart agreed to have his operas performed in different languages, his primary objective was to obtain performances and not to make his operas understood by foreign audiences.

Paul Henry Lang's statement on vocal production as related to language demands is undisputed. But every leading opera company with an international repertoire contains a roster of singers from many countries. Logically, all of these companies are "handicapped."

In 1949 an English film company produced an excellent version of Pushkin's *Queen of Spades*. Apart from Anton Walbrook, everybody in the cast delivered their lines in clipped, British accents. The effect was a little bit disconcerting. In the same way, opera in English can erase the flavor of the original.

A year ago, a man named Paul W. Samuel came up with a solution for the irreconcilable arguments for and against opera in English. He suggested to Rudolf Bing of the Metropolitan Opera House that, "during the performance, there would be a filmed strip of an English translation high above the stage or right below it. . . . Everybody would be able to understand every word at all times, regardless of language barriers. Such a filmed strip would no more detract from the flow of the opera than do the English titles during the performance of a French movie."

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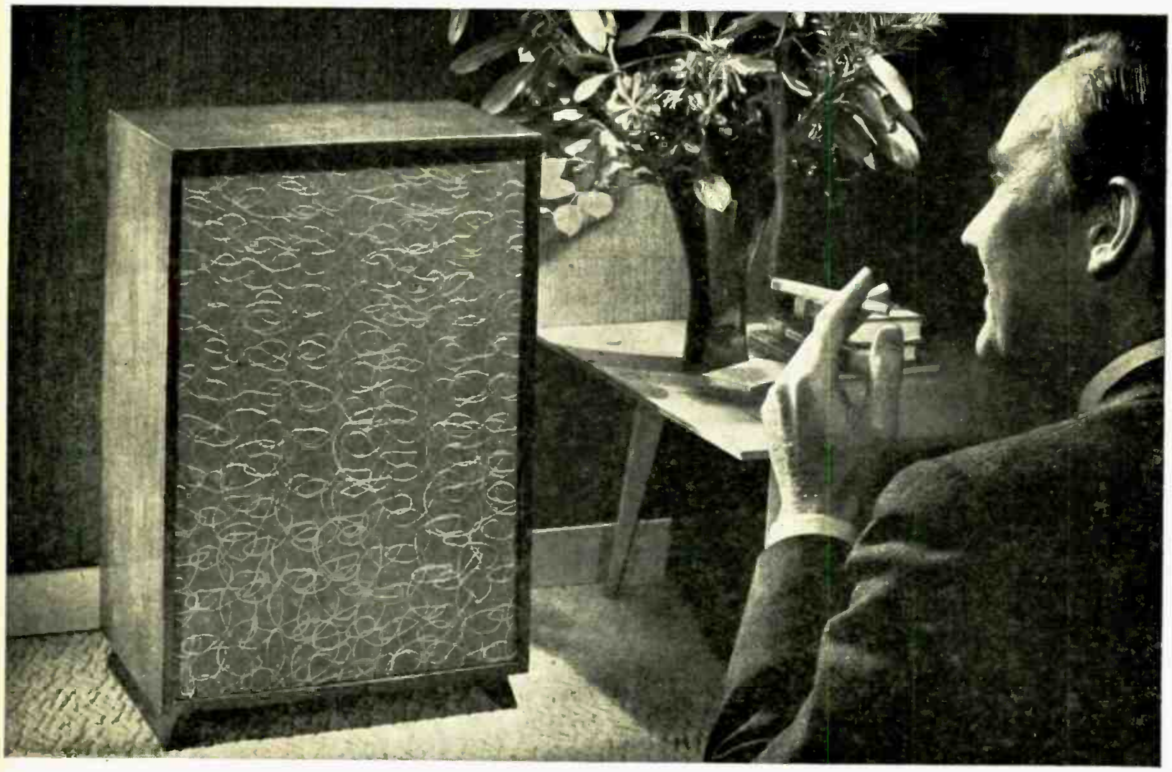

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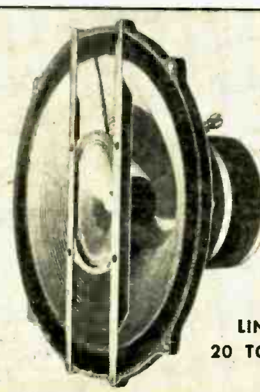

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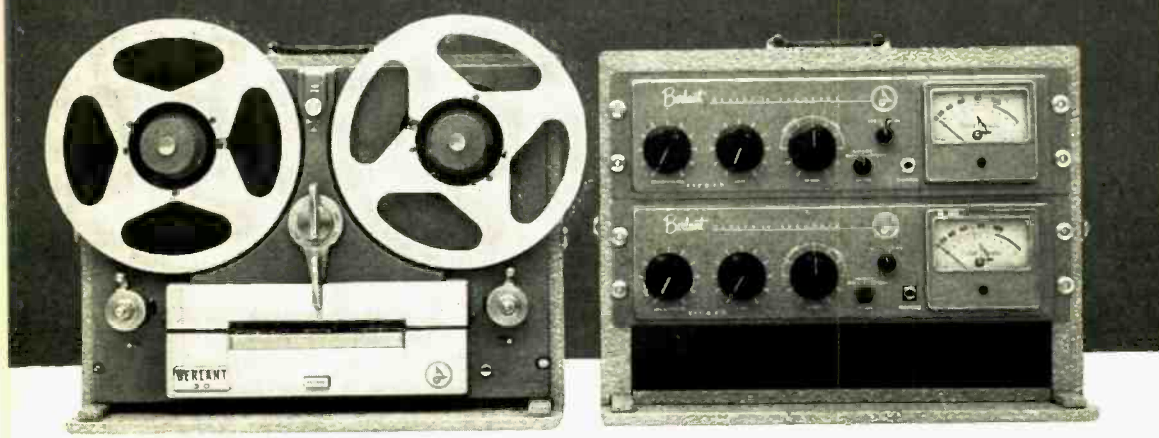

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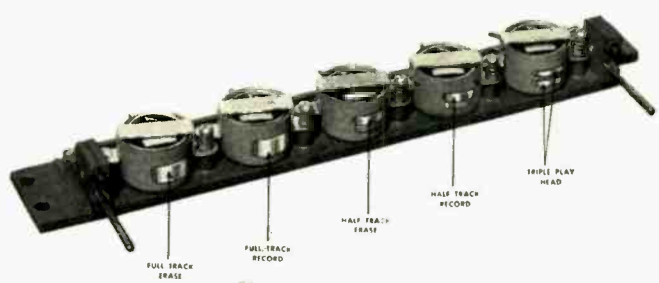

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Transformer Query

SIR:

I have had some trouble agreeing with part of the viewpoint of Mr. Crowhurst in his article "Audio Transformer Design" in the September issue. Rather than attempt a piecemeal attack, I submit herein my viewpoint of the subject. Because your article was so informative, the only points I shall cover will be those few with which I disagree.

An audio transformer can usually be designed by solving only the low- and high-frequency ends. Let's start at the low end (I do).

The first decision to be made is the type of steel. Characteristics to be desired are: high permeability and high saturation level. High permeability (for a given size and design) determines the low-frequency response (only). The high saturation level determines the power rating at this low-frequency end. This saturation level determines the power rating in two ways: the first is by reducing the low-frequency response by lowering the steel's permeability at these high flux densities; the second is by causing a *change* in permeability, which causes distortion. This may seem like simplification, but it is not in error. The one best steel is Grain-Oriented Silicon.

The second choice to be made is between grain-oriented silicon laminations or grain-oriented silicon "C" cores. Lams are cheaper (much) and more flexible. "C" cores are easier to laminate (negligibly so if you are trying to use this to compensate for its high material cost) and about 20 to 30 percent better electrically. Other variables may modify these characteristics, but the price of "C" cores is so much higher than lams that unless the Hi-Fi goes into rocket equipment the use of 30 per cent more of the cheaper laminations is definitely called for. *However, this discussion is between grain-oriented steels, and not between grain-oriented "C" cores and laminates of poorer grades of steels.* Grain-oriented "C" cores *are* a better choice than *cheap* steel laminations, as so much more steel and turns of wire have to be used on the cheaper lams that the high-frequency response is sacrificed. The answer to our second choice is the *best grade* of grain-oriented steel laminations available.

The low-frequency design is now a matter of enough turns and steel to have the required impedance, flux density, and wire-current density. Gaps should be kept to a minimum; however, this is a function of the amplifier design, since gaps are a function of the unbalanced d.c. in the primary of the transformer. The more the d.c., the larger the gap. The larger the gap, the larger the transformer has to be to compensate for the lower inductance caused by the gap. This is the amplifier designer's problem, as he has to pay for the larger transformer caused by his unbalanced d.c. specifications.

As far as the high-frequency end is concerned, my only contribution to your rather complete analysis of the problem would be as follows: the high-frequency dropoff is due to only two things—leakage inductance and winding capacitance. There is only one variable that affects both factors in the same direction—*turns. I don't stress anything as much as this point:* Swap steel for turns. Everything else being equal, if you can get the same inductance by using more steel and less turns, your high-frequency end will be better.

H. BUSCHMAN, Dir. of Engrg.,
Transformers, Inc.,
200 Stage Road,
Vestal, N. Y.

Mr. Crowhurst's Reply

SIR:

After reading Mr. Buschman's letter carefully, it seems we do not disagree on any vital points in transformer design.

Under the heading "Frequency Response" in my article, I gave substantially the same analysis of the factors affecting low-frequency performance that Mr. Buschman gives in his letter. There is a point, however, that I would like to take this opportunity of adding: in both our statements, we speak of saturation level as determining the low-frequency power; while this is basically true, it should be qualified.

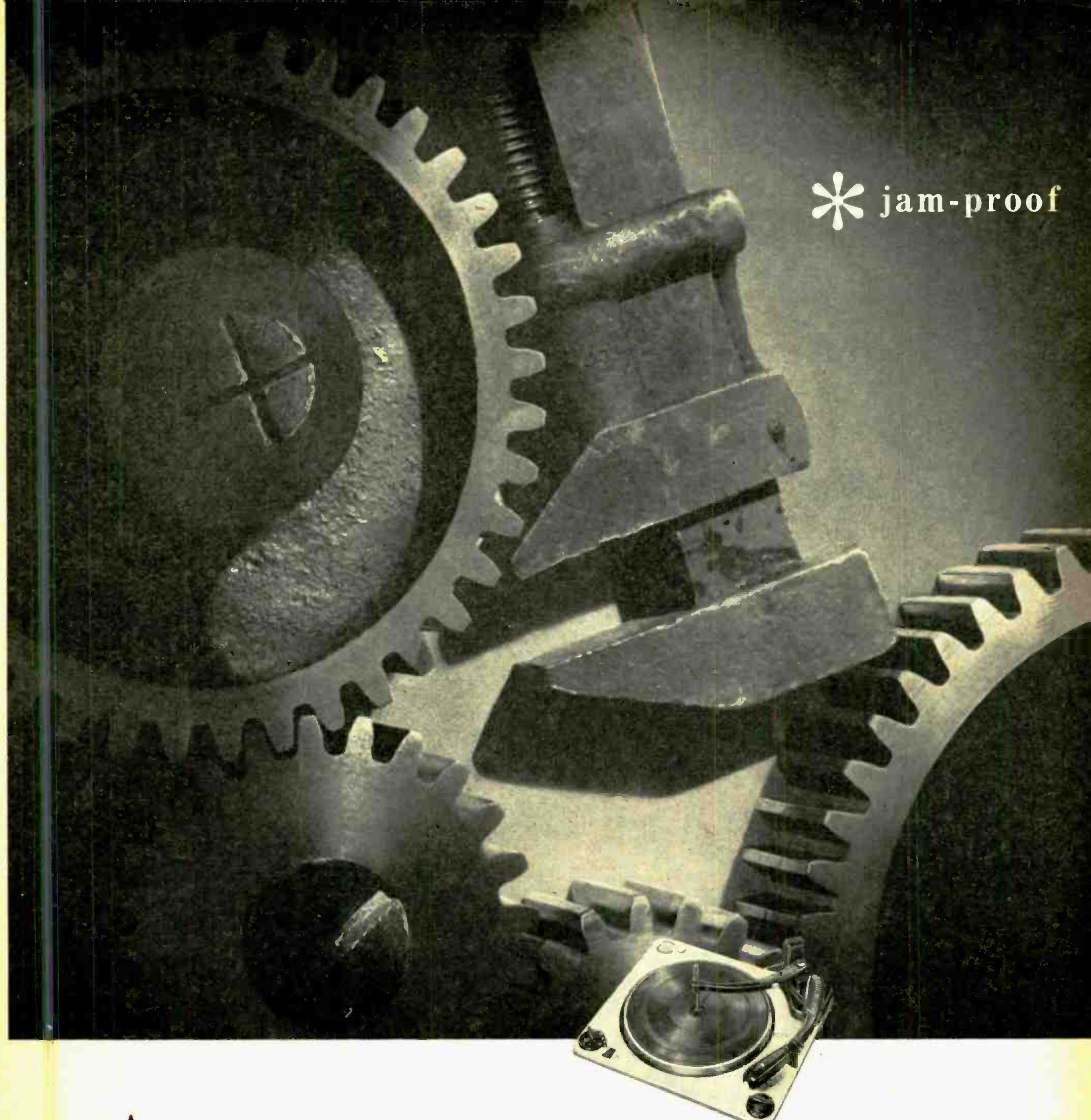
In many modern designs, saturation level is not *immediately* responsible for overload effect or distortion at the low-frequency end. The abrupt rise in reactive magnetizing current that occurs with the onset of saturation does not always produce a *measurable* distortion component. The distortion measured under test conditions often does not occur until the reactive current caused by saturation is large enough to start distortion *due to tube characteristic overload.* This can be an important factor in modern output-transformer design, and is one that further stresses the importance of the liaison I suggested at the end of my article.

Mr. Buschman's quantitative assessments are based on a different comparison from mine. I was comparing grain-oriented strip-wound C-cores with high-grade, non-oriented silicon alloy laminations. Here I am afraid Mr. Buschman's use of the word "cheap" is somewhat relative. A high-grade non-oriented alloy is much more costly than the really cheap materials, although it is much cheaper than C-core materials. The grain-oriented laminations, which are relatively much newer than either of the materials I mentioned, take up a position approximately midway between the two materials I compared. They also introduce a third possibility into the "variable relative merit" discussion. I cannot agree to any such sweeping statement as Mr. Buschman makes. In many applications his conclusions are correct, but each application must be considered on its own requirements, and economic comparisons made. The conclusions reached will not *always* agree with Mr. Buschman's.

His letter next mentions the amplifier designer's problem. In pre-feedback days, the principal low-frequency factor was possible out-of-balance d.c. But with a modern feedback amplifier, the stability of the whole amplifier is dependent on the choice of critical rolloff parameters. In some designs it may be necessary to exercise close control of primary inductance—another possible reason for requiring a gap.

In his last paragraph Mr. Buschman expresses a common fallacy: keeping other things constant, increase in turns raises leakage inductance but *reduces* capacitance. See *Fig.* 11 in the July issue of AUDIO (page 18) to confirm this. I believe this fallacy arises from a different application.

(*Continued on page 12*)



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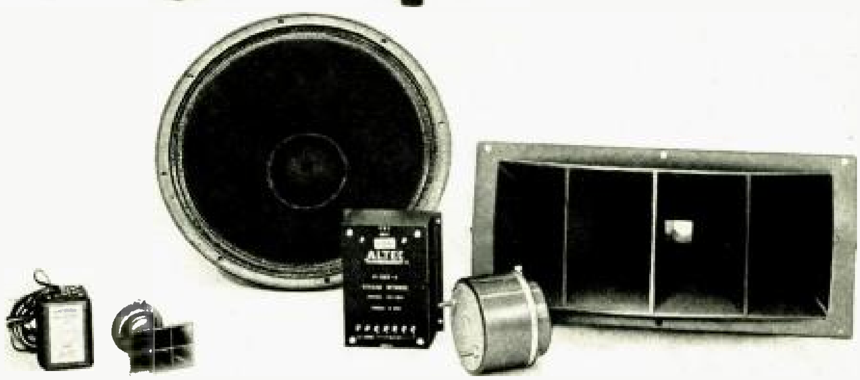

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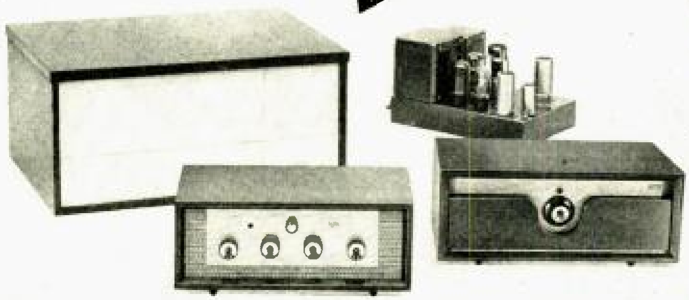

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LETTERS

(from page 8)

In input transformers, for example, increasing secondary turns increases referred impedance by T^2. At the same time it reduces *actual* capacitance by $T^{1/2}$. But since this actual capacitance shunts a much higher impedance, its *effect* is increased by $T^{3/2}$. But this argument does not apply in all cases—certainly not where all impedances are laid down in the design specification.

The last point Mr. Buschman stresses is insufficiently specific: if you "swap turns for steel," what is the "everything else" that stays equal—wire guage, lamination stack, window shape or size? At least one of these must change in making the "exchange." How it changes will affect the accuracy of Mr. Buschman's statement, which, *as a generalization*, is mostly true.

Two more points Mr. Buschman apparently considers unimportant—I presume he delegates them as problems to the amplifier designer—but I think they also point up the need for liaison:

(1) *Efficiency:* He says a transformer can usually be designed by solving only the low- and high-frequency ends. I admit that the difference between 80 and 90 per cent efficiency is only 0.5 db, and as such should not be important. However, it is also the difference, when a pair of tubes will only deliver 55 watts undistorted with a certain B+ supply, etc., between 45 watts output and 50 watts output, which can be very important to a designer in these days when watts are to amplifiers what horse power is to automobiles!

(2) *High Frequency Parameters:* In pre-feedback days, I would agree with Mr. Buschman's statement that high-frequency dropoff is due to only two things, leakage inductance and winding capacitance. But in these days of feedback amplifiers, the response with the feedback loop closed is more important than that without feedback, so much closer attention to the *relative* values of these parameters is necessary.

In conclusion, I would like to thank Mr. Buschman for writing, and giving me the opportunity to insert these additional points.

Norman H. Crowhurst,
Audio Consultant,
150–47 14th Road,
Whitestone 57, N. Y.

Loudspeakers

Sir:

In his article "A Semicircular Exponential Horn" in the October issue, Dr. Cares referres to my "Concrete Monster" (Audio, July, 1954) and asks the question, "But how about phase agreements between, say, a 22-foot woofer-to-ear path and a 10-foot tweeter-to-ear path of treble sound for a listener facing the system from a living-room chair?"

In my case, the bass and treble speaker horn mouths (both are exponential-horn loaded) are separated left and right by about 10 feet, and are about 28 feet from the listening area. Phasing is of no more importance than it would be to phase the individual instruments of an orchestra. Phasing of speakers is not essential unless they are close together, and then it makes little difference except at or near the crossover frequency.

James Ferguson,
11900 Westminster Place,
Los Angeles 66, California.

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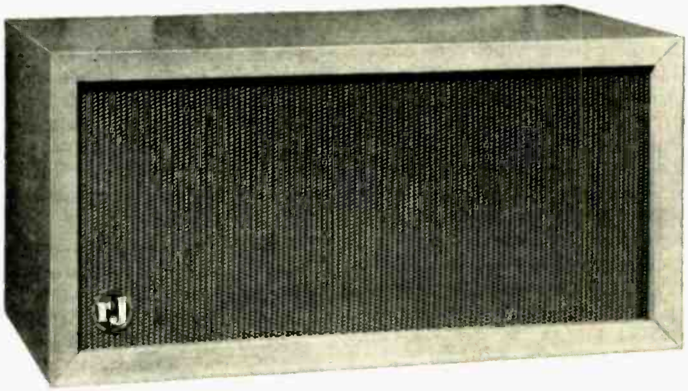

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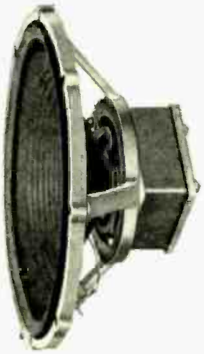

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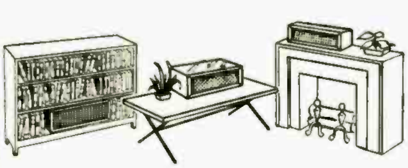

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EDITOR'S REPORT

FONO FALLACIES

First and foremost in the year's fono fallacies is the idea that because a phonograph is labeled "Hi-Fi" on the front or called so in the advertising is no reason to assume that it actually is high fidelity. And before anyone gets the idea that we are referring to audio components, let it be made clear at the beginning that no such implication is intended, nor should it be inferred by anyone. But as the pioneer in high fidelity—and as a magazine which has consistently believed that standards should be kept high—Audio often cringes, figuratively, at some of the liberties taken with the term "hi-fi." It should only be necessary for anyone who had ever in his life heard a live orchestra or soloist to listen to some of the merchandise labeled hi-fi to make sure for himself. As mentioned once before several years ago, it is regrettable that high quality equipment is rarely offered in the same showrooms as the shoddy so-called hi-fi stuff because the listener does not have much opportunity to compare the two side by side. And with that tirade off our editorial mind for the month, we go to more specific points which might justly be called "fono fallacies."

One of the more common fallacies in the minds of newcomers is that the speed of a phonograph turntable must be *exactly* 33⅓ rpm. Questions often come in from readers regarding some turntable or changer that had been timed by said reader, either by observing a stroboscope disc or by actually counting the revolutions over a period of, say 10 minutes. Upon inquiring further, we are told that the measurements were made without actually playing a record. Consequently, our advice is that the test be repeated while playing a record, which will usually account for about two revolutions per minute at the LP speed.

But there are many things to consider in this matter of absolute speed. First, unless the original tape recording was made on an exceptionally fine machine, it is possible that the tape itself was not at *exactly* 15 ips—even a tiny variation in capstan diameter could easily cause the tape to be as much as 2 per cent off in the speed. The thickness of tape will make a difference in some machines. Then too, there is the fact that a second machine, which might be of an entirely different make, may be used for the dubbing to the master disc. And the disc machine may be off by one or two per cent. So there is always the possibility that the record itself could be off by as much as 3 per cent, shall we say.

We have mentioned before that an induction motor does not run at the same speed when hot as it does when cold—the variation being about one per cent, since the "cold" speed is likely to be about 1725 rpm while when hot the typical four-pole motor runs at about 1740. The speed of the playback turntable depends on the load placed on it—bearing friction, stylus drag, or what not—and, except in the case of the most expensive professional machines which employ synchronous motors and which are gear driven through vibration dampers and flutter-reducing couplings, the turntable speed depends on the tension of the idlers to some extent.

However, a variation of two per cent from the *exact* speed through the entire system is certainly not likely to be detectable by anyone but the well trained musician—or by those relatively few people who have absolute pitch. The difference between C and C♯, for example, is almost six per cent, so the difference is about one-third of a semi-tone. In other words, the whole subject becomes pretty trivial when the figures are compared. (For those who must have the exact speed, however, there are several turntables and changers which have a vernier adjustment, even though we do not think they are an absolute necessity for anyone who does not intend to play a musical instrument along with his records.)

And, just to enter the season of joy and happiness with no "beefs" on our mind, let us discuss briefly just one more fallacy—that record wear is minimized by decreasing stylus force as much as possible. To a certain extent this is true, but the stylus must make firm contact with the groove at all times, and must not be allowed to "bounce" around in the groove. Not only will the bouncing cause greater wear to the record *and* the stylus, but it will also cause an increase in intermodulation distortion from the pickup itself. We believe that the optimum stylus force is that at which IM distortion is at a minimum, and we think that figure is the one that should be recommended.

And thus, having purged ourself of these thoughts, we can—without hypocrisy—extend the usual

Christmas and New Year Greetings from the Editors and Staff of Audio

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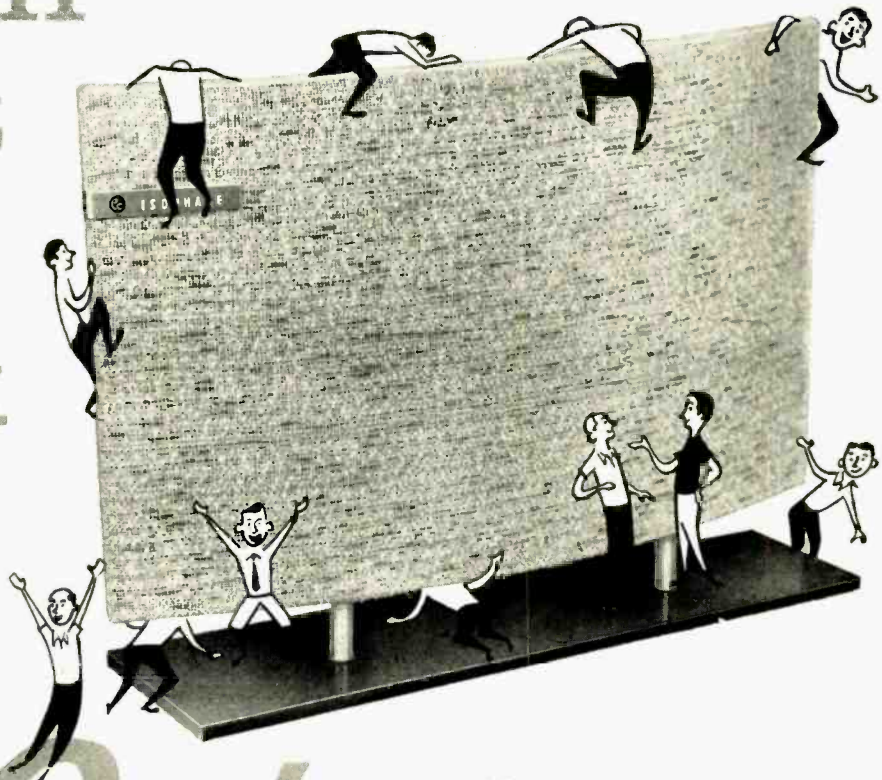

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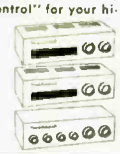

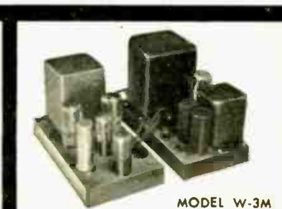

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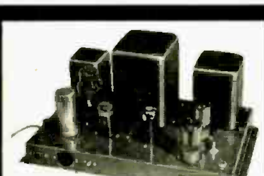

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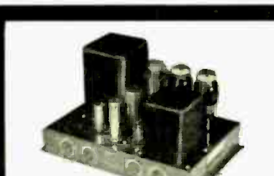

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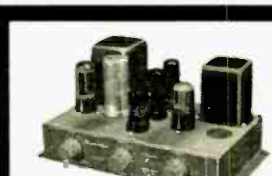
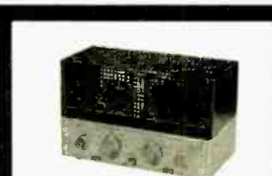


MODEL A-7D



MODEL XO-1

Heathkit Model W-4AM Single-Chassis High Fidelity Amplifier Kit
The 20-watt Model W-4AM Williamson type amplifier combines high performance with economy. Employs special-design output transformer by Chicago Standard, and 5881 output tubes. Frequency response is ± 1 DB from 10 CPS to 100 kc at 1 watt. Harmonic distortion only 1.5%, and IM distortion only 2.7% at this same level. Output impedance 4, 8 or 16 ohms. Hum and noise 95 DB below 20 watts.

$39.75 Shpg. Wt. 28 Lbs.

MODEL W-4A: Consists of Model W-4AM above *plus* Model WA-P2 preamplifier. $61.50* Shpg. Wt. 35 Lbs. *Express only*

Heathkit Model A-9B 20-Watt High Fidelity Amplifier Kit
Features full 20 watt output using push-pull 6L6 tubes. Built-in preamplifier provides four separate inputs. Separate bass and treble tone controls provided, and output transformer is tapped at 4, 8, 16 and 500 ohms. Designed for home use, but also fine for public address work. Response is ± 1 DB from 20 to 20,000 CPS. Harmonic distortion less than 1% at 3 DB below rated output.

$35.50 Shpg. Wt. 23 Lbs.

Heathkit Model A-7D 7-Watt High Fidelity Amplifier Kit
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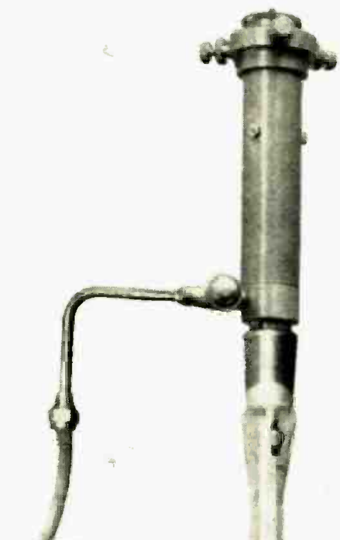
THE HOW AND WHY OF THE WORLD'S PUREST SILICON



The purification of silicon by Bell Laboratories metallurgists has been richly rewarding. Their original research in this field revealed the chemical factors that control semiconductors; it was a major advance leading to Bell Laboratories' invention and development of transistors and the Bell Solar Battery. Now they have devised a simple but highly effective way to remove boron—one of the most difficult impurities to extract from silicon.

During refining, a stream of hydrogen and water vapor is kept flowing past the silicon. As the water vapor passes over the liquid silicon, it seizes boron atoms, forming boron oxide. The oxide is then pulled away to condense on the wall of the refining tube which is cooled by a water stream. Result of refining: boron and other harmful impurities are reduced to less than one part in 10,000,000,000.

The new silicon is being used to develop still better transistors and rectifiers for telephony. It is another example of how Bell Laboratories metallurgists help open the way to improved telephony.

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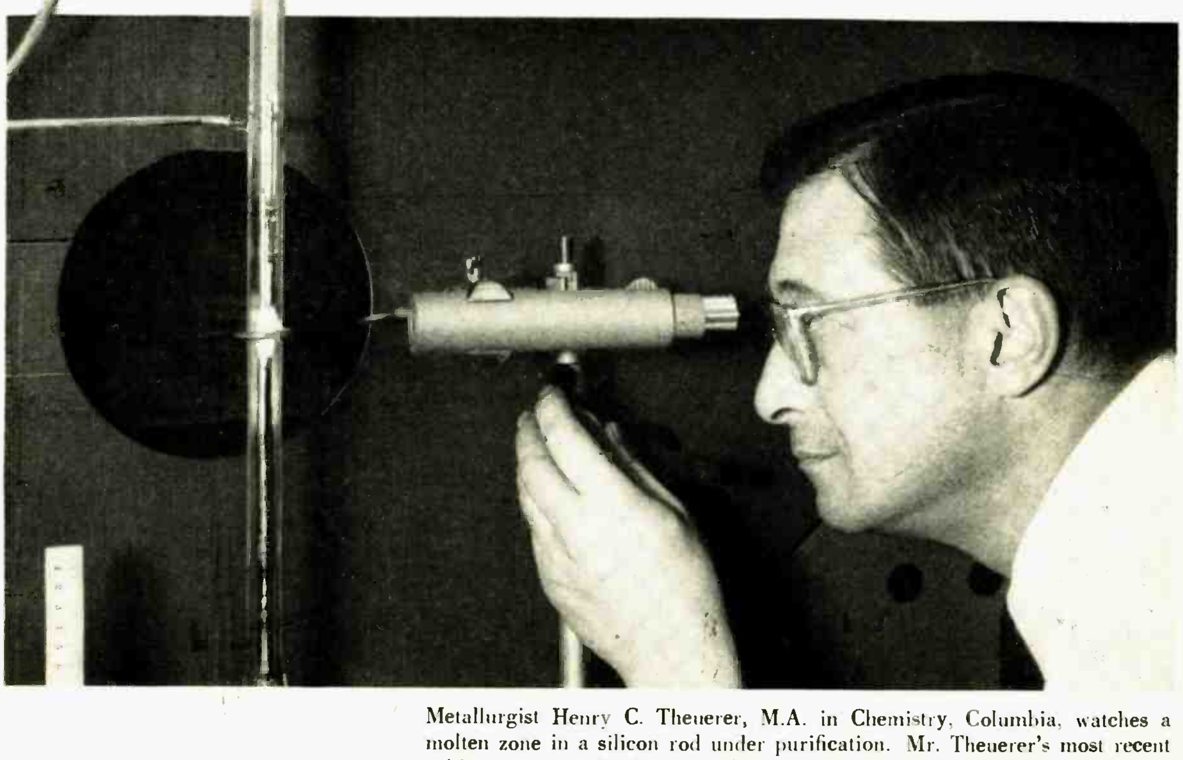

Metallurgist Henry C. Theuerer, M.A. in Chemistry, Columbia, watches a molten zone in a silicon rod under purification. Mr. Theuerer's most recent achievement was development of water-vapor treatment for removal of boron.

The Future of Loudspeaker Design

NORMAN H. CROWHURST*

A brief discussion of some of the differences and the differing requirements of moving-coil and electrostatic loudspeakers. The author suggests a possible arrangement which might lead to an entirely new configuration for the electrostatic unit.

Modern loudspeakers of the dynamic or moving-coil type have been developed to an extremely high standard of performance, but it is evident from all the literature on the subject and the work which manufacturers are putting into it that there is still dissatisfaction with the performance of even the best loudspeakers, although at least one manufacturer makes the claim of producing a perfect loudspeaker. There are certain inherent deficiencies in the moving coil loudspeaker which make it impossible to entirely eliminate the electro-mechanical defects from its performance, certain manufacturers' claims notwithstanding.

This is undoubtedly the reason for the interest in such developments as the electrostatic loudspeaker and the Ionophone. Although little has been heard about the Ionophone since the first announcements concerning experiments with it, it seems that it does not hold out much immediate hope of being an efficient transducer, whereas electrostatic loudspeakers are in production by quite a number of companies already. The question comes: What hopes do the electrostatic units hold out for achieving better results than the dynamic units have achieved in the past few decades, during which they have enjoyed popularity?

The big reason put forward by the electrostatic protagonists for preferring the new type, is that the dynamic loudspeaker causes problems arising from the fact that the diaphragm is driven at one point, the voice coil, whereas it is expected to radiate throughout its entire surface. The electrostatic loudspeaker, in theory at least, has the driving force applied throughout the entire surface of the radiating element, which gives it a better inherent chance of eliminating from the performance of the unit the mechanical properties of the diaphragm.

It is sometimes unfortunate that a new product gets on the market before it has achieved a status of development to make it worthwhile. This can often create a negative reaction in the minds of a great many people who might otherwise accept it, and thereby delay its general acceptance instead of expediting it. This seems to have happened in the electrostatic loudspeaker to some extent.

For some years now, we have had small electrostatic tweeter units. While these have enjoyed a measure of popularity with a minority of high fidelity fans, who like to hear all the surface noise as assurance that their system is reproducing high frequencies, a great many more people have come to the conclusion, on making listening tests with this new unit, that all it enables you to hear *is* the extra surface noise. This is largely because these earlier units were all designed to take over at a very high frequency, well towards the high end of the spectrum, and thereby to extend the range of the moving coil or dynamic units, which were already quite good, instead of being given a definite allocation amounting to part of the spectrum containing characteristic intelligence—and not just "highs." More of this anon.

Now the trend seems to be becoming more sensible and the crossover from the dynamic to the electrostatic type unit has come down to frequencies as low as 800 cps. This begins to give us the chance to hear how electrostatic loudspeakers can perform on program material instead of just surface noise.

Movement Must be Small

The big problem with electrostatic loudspeakers that delayed their application to lower frequencies is the fact that, however the movement of the diaphragm is controlled, to have any degree of sensitivity it can only be allowed to move through a very small amplitude. The dynamic type can use relatively large movement, allowing comparatively small diaphragms to be used for the radiation of the lower frequencies. Restriction of diaphragm movement means that a proportionately larger diaphragm area must be used to radiate the same amount of energy at the low frequencies.

In the case of the dynamic type the driving force on the diaphragm is proportionate to the current in the voice coil and to the magnetic field produced by the magnet system in the air gap. In the electrostatic loudspeaker the driving force is produced by the electric potential between the moving and fixed plates for given potential, and is inversely proportional to the square of the distance between the plates. If the space between the plates is increased this means that either the sensitivity is decreased in proportion to the square of this increased spacing, or else a correspondingly higher driving potential must be applied to maintain the same driving force.

As we want to avoid getting up to the region of millions of volts—which can be dangerous—the only reasonable solution seems to be to keep down the diaphragm spacing, which in turn automatically involves limiting the available diaphragm movement.

The next question we encounter is the one of distortion. Inherently the electrostatic driving principle, when used as a single-ended device, possesses non-linear distortion. The deflecting force applied to the diaphragm over its area is proportional to the electric field intensity squared. This means that if the voltage is doubled, the force on the diaphragm is quadrupled. Under these conditions the only way to keep distortion to a reasonably low figure is to use a very large polarizing potential with a much smaller audio signal superimposed on it, so the audio signal is always only a fraction of the polarizing potential.

Supposing a polarizing potential is used of ten times the magnitude of the peak audio potential; to choose round figures; suppose the polarizing potential is 1000 volts, while the peak audio is 100 volts in alternate directions. This means the potential between the fixed and moving portions of the speaker vary from 900 to 1100 volts from one peak to the other. The force between these elements will vary in proportion to the square of these voltages, which can be given the numerical values, 81, 100 and 121, the mean, or quiescent, value being the 100 figure. But the midway point between 81 and 121 should be 101, so under this condition we would have a displacement

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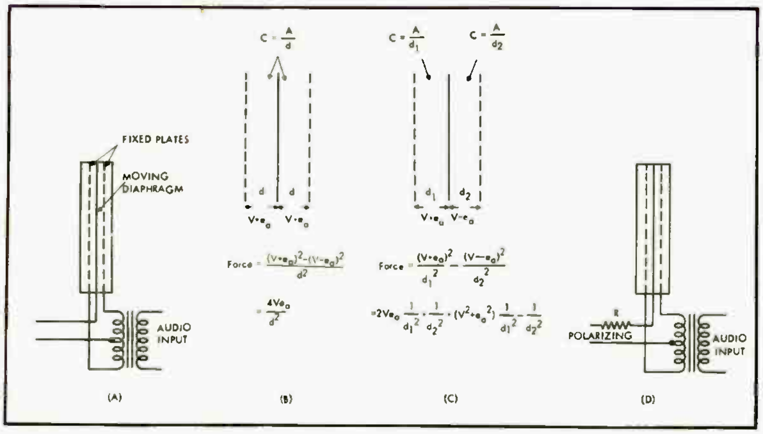

Fig. 1. The development of the distortionless push-pull electrostatic loudspeaker unit: (A) the basic arrangement with its drive unit; (B) this produces a linear driving force on the diaphragm, provided the diaphragm does not move; (C) when the diaphragm moves, the driving force becomes non-linear; (D) preventing the charge flow, mentioned in the text, by means of the resistor R, eliminates, or reduces, this nonlinearity of driving force.

of one part in forty from the true mean, which means that, using a driving voltage equal to 1/10 of the polarizing voltage, there will be a second harmonic distortion of 2½ per cent.

The obvious way to improve this situation is to provide a push-pull arrangement, as shown basically at *Fig.* 1. This means that the second harmonic in the driving force will be balanced out. However this does not get rid of our distortion completely: under this condition the harmonic component of the driving force is only eliminated *provided the diaphragm spacing remains unchanged during the cycle,* which means that it must not move, and if the diaphragm does not move, how is it going to radiate any sound?

As soon as the diaphragm is allowed to move, the different electric potentials are not applied across uniform spaces at every instant. The higher potential gets applied across a smaller gap than the lower one because the diaphragm has moved over toward the electrode that is momentarily at higher potential. The same thing will happen during the opposite excursion. This results in generation of third and higher odd-order harmonics.

Fortunately, as Mr. Peter Walker pointed out in recent articles in *Wireless World*, there is a fairly simple way of overcoming this. When the diaphragm moves, the capacitance between the diaphragm and the fixed plate changes, which means that to maintain the same potential difference a charge will have to flow into the diaphragm. The current flowing in the center lead will be twice the fundamental frequency, because the same thing will happen with each excursion from the center position, regardless of backward or forward polarity. It will contain higher harmonics, due to the reciprocal law of charge held. The driving force on the plate or diaphragm will have third and other odd-order harmonics added to it as a result of these currents.

This can be prevented by isolating the diaphragm so that it has a fixed *charge* relative to the stationary plates of the speaker rather than a fixed *potential.* Under these conditions the force is due at all times to the difference in potential between the outer or fixed plates and hence the inherent distortion figure has disappeared. And how are we going to maintain a constant charge on the moving diaphragm instead of a constant potential?

This is relatively simple. We apply our polarizing voltage to a high resistance such that the value of the resistance is higher at the lowest frequency we want to reproduce than the reactance represented by the plate of the capacitor made up by the speaker unit. This enables harmonic distortion to be reduced to a very low figure.

So now we have gotten rid of some of the disadvantages of the electrostatic loudspeaker principle: its inherent distortion and the large polarizing potential relative to the drive potential.

The necessity for a large diaphragm still remains but the diaphragm is all we have to provide as a radiating surface. There are no large appendages as in the dynamic loudspeaker nor is a large enclosure required. The requirement of the large diaphragm is not necessarily so detrimental. Of course there still is a possible problem of resonance between the diaphragm mass and the controlling force, but in this case it is much simpler to control because the driving force is applied over the entire surface. This avoids any of the pendulum kind of effects associated with dynamic transducers where the driving force is applied at one end, i.e. the central periphery of the cone, while the load is applied uniformly distributed over the cone.

Large Physical Size

What usually makes a large reproducer unit inconvenient is its physical bulk. If it is large but flat, so that it can be placed against the wall, it can easily be disguised as a picture or some similar piece of furnishing, and hence does not provide the problem encountered in using a unit that requires to have a volume of 8 or 12 cubic feet to give successful reproduction.

From the electro-acoustic angle, the design of a loudspeaker now appears to reduce to a matter of how large a diaphragm we need, to be able to produce the required air displacement at the lowest frequency in the audio spectrum, using the permissible diaphragm movement that can be allowed in an electrostatic loudspeaker.

A certain amount of attention is necessary to the design of the assembly so as to avoid acoustic resonances due to the cavities that are bound to be trapped behind the diaphragm. However, with the push-pull design, it is a fairly simple matter, acoustically, to design a system that is critically damped and will have a flat response over the audio spectrum. It is certainly a very much simpler problem than the design of a dynamic transducer to achieve the same result.

However, we are left with an electrical problem now, that of producing correct matching of impedance which an electrostatic loudspeaker presents to the amplifier. In the case of a dynamic transducer the matching is relatively simple and we have become quite used to thinking in terms of this particular problem.

The principal elements to the impedance of the dynamic unit are: the voice-coil resistance; the radiation resistance, which appears to be in series with the voice coil resistance; and various other reactances reflected into the electrical

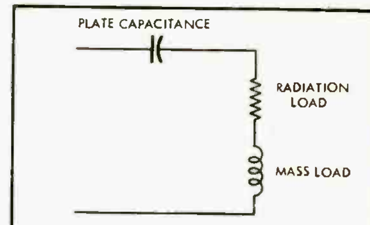

Fig. 2. The basic impedance elements in an electrostatic loudspeaker unit. This is not complete, but shows the principal elements.

circuit due to mechanical and acoustical characteristics; and the voice coil inductance. This latter does not present a reactance comparable with the other circuit values until a frequency toward the top end of the audio range is reached.

In an electrostatic loudspeaker, if the diaphragm does not move, its impedance is virtually that of a capacitor. As soon as the diaphragm moves (which of course it must to radiate sound) the impedance reflected back into the electrical circuit contains a component of resistance due to the work done in moving the diaphragm. This resistance is, of course, the useful part of the loudspeaker's impedance, although the biggest proportion of the impedance is due to the reactance as a capacitor. The simplest equivalent electrical circuit to an electrostatic loudspeaker is shown at *Fig.* 2, consisting of a resistance, capacitance, and inductance in series.

The capacitance is due to the plates of the loudspeaker behaving as a simple capacitor, with some slight modification because of the fact that its value varies when the diaphragm is allowed to move. The inductance and resistance are due to the motional impedance of the diaphragm. The mass of the diaphragm and the associated air in contact with it produces the inductance component, while the energy radiated in the form of sound is responsible for the resistance component.

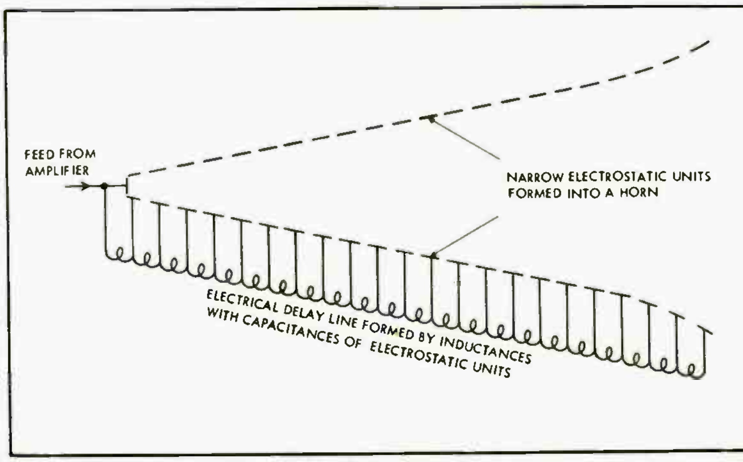

Fig. 4. The basis for a possible future development of a more efficient electrostatic horn type unit, proposed in the text.

Efficiency

The electrostatic loudspeaker is generally viewed as being an inefficient device as compared to other kinds of transducers. This is because the reactance of the capacitor element in *Fig.* 2 is large compared to the resistance. However, the true meaning of the word efficiency means the proportion of the *energy* applied to the circuit which comes out as output and in this sense an electrostatic loudspeaker is more efficient than any other kind of transducer. By this we mean that the effective resistance of the unit is almost entirely due to the energy radiated in the form of sound.

Otherwise expressed, if we can produce a constant voltage with varying frequency *across the resistance component* of the equivalent circuit, most of this component of voltage will appear as radiated output, and the frequency response will be extremely flat. The problem then consists of providing a driving power that gives constant voltage with varying frequency, across the resistance component.

This necessitates the reorientation of our thinking. What we need to drive an electrostatic speaker is *a constant current source*, or a very low damping factor, instead of a constant voltage source which is represented in the high damping factor usually provided for dynamic types.

Thus it is not very convenient to use the same driving force with some kind of crossover to effect the transition between a dynamic type unit and an electrostatic type unit in a two unit system. For this reason a popular practice consists of connecting the two virtually in parallel by using the output transformer to feed the moving-coil loudspeaker while the electrostatic loudspeaker is fed from the primary of the same transformer.

The basic circuit is shown in *Fig.* 3. If the electrostatic loudspeaker is well designed for the purpose, even without any further resistance in the form of amplifier damping, its impedance composition will provide a frequency response of reasonable band width. The capacitance and inductance elements of its effective impedance in conjunction with the resistance element, will provide low and high rolloff at predetermined design points.

But some feed circuits, intentionally or unintentionally, incorporate some extra series inductance, which offsets some of the series capacitance due to the electrostatic loudspeaker itself and improves the efficiency with which energy is transferred to the resistance component, representing radiated sound, *over an extremely narrow band of frequencies.* This means the electrostatic loudspeaker is resonated at some very high frequency.

This has been a popular method of making it very apparent that the small electrostatic tweeter is actually working —the unit intended only to handle from frequencies such as 5000 cps up, or maybe even higher than that. By resonating it to 10,000 or 12,000 cps an extremely high efficiency is achieved *at this resonant frequency.* As a result the surface noise becomes severely colored at this frequency, also any components in the program material at this frequency. But it satisfies the kind of hi-fi enthusiast who is merely looking for something that sounds very "*high*" and doesn't bother about the *fi*delity to the entire range.

The larger electrostatic loudspeakers, having a considerable surface area, give

(*Continued on page 71*)

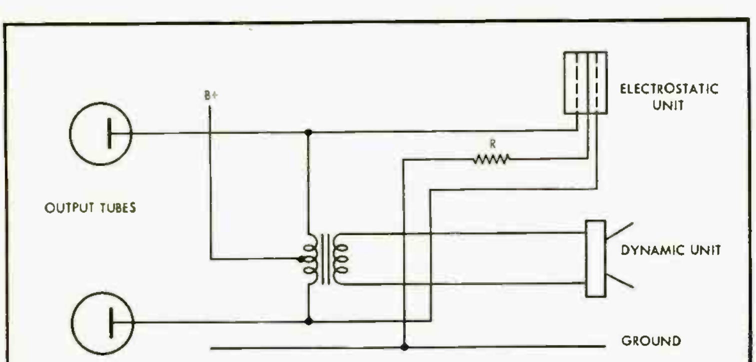

Fig. 3. Basic method of connecting a dynamic and an electrostatic unit to the same amplifier output as a two-unit system.

Graphical Solution of Electrical Network Impedances

L. U. HAMVAS*

Anyone who has tried to solve some of the more complicated electrical networks knows how difficult they can become unless he is able to resort to some labor-saving device such as is described here.

COMPUTATIONS INVOLVING electrical networks frequently become very complicated and laborious. Even relatively simple networks can be very time-consuming and result in much "trial and error" work.

Take, for instance, the very simple case of three resistances in parallel. The formula is

$$R = \frac{R_1R_2R_3}{R_1R_2 + R_1R_3 + R_2R_3}$$

which is anything but simple. Compare the labor of computing the R with the graphical solution shown in *Fig.* 3.

In many cases a graphical method can be used with considerable saving in time. The graphical methods described in this paper are faster than slide-rule solutions in many cases but give answers of comparable accuracy.

The methods described depend on the particular combination in question. There are three of them.

1. Combinations of resistances, or capacitances or inductances only.
2. Combinations of a resistance and a reactance.
3. Combinations of a capacitance and an inductance.

Parallel Resistances

Let us take two resistances in parallel, for which combination it is known that

$$R = \frac{R_1R_2}{R_1 + R_2}$$

The graphical solution is shown in the diagram of *Fig.* 1.[1]

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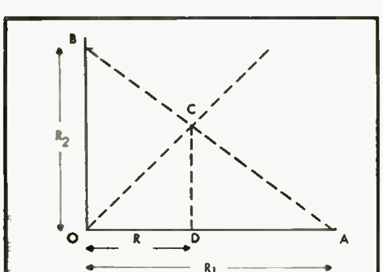

Fig. 1. Graphical solution for two resistances in parallel.

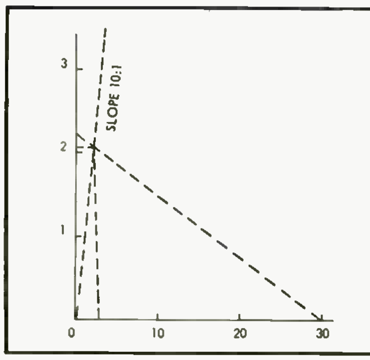

Fig. 2. When values differ widely, the scales may be changed and the transformation line is therefore no longer at an angle of 45 deg.

Mark $R_1 = \overline{OA}$ on the abscissa and $R_2 = \overline{OB}$ on the ordinate. Connect A and B and get the intersection C on a straight line drawn at a 45-deg. angle. The projection of $\overline{OC}$ on *either* coordinate is the resulting resistance, i.e., $R = \overline{OD}$.

It is most convenient to use regular crossection paper for the purpose. The accuracy is considerably better than the tolerances of the values of commercially available resistors.

If one resistance is much larger than the other, it may be difficult to mark the smaller one accurately. In such cases one may use dissimilar units on the coordinates. When the units are dissimilar, the slope of the transformation line must be changed so as to equal the ratio of the units. In *Fig.* 2 the vertical unit is ten times that of the horizontal. Therefore the slope of the transformation line is ten to one.

If more than two resistances are in parallel, one constructs the result of any two of them and then add the third, the fourth, etc.

Figure 3 illustrates the construction for three resistances in parallel, while in *Fig.* 4 there are four resistances.

In *Fig.* 4 we marked R_1 on the horizontal and R_2 on the vertical coordinate ($\overline{OA}$ and $\overline{OB}$ respectively). The intersection of $\overline{AB}$ with 45-deg. transformation line is C, the projection of which is D on the ordinate. The R_3 is marked on the abscissa E. The intersection of ED is F and its projection G. The resistance R_4 is then marked on the ordinate H. The projection L of the intersection K marks the resulting resistance so that

$$R = \frac{R_1R_2R_3R_4}{R_1R_2R_3 + R_1R_2R_4 + R_1R_3R_4 + R_2R_3R_4}$$

Reactances can be handled similarly—inductances in parallel and capacitances in series.

[1] The proofs of the validity of the described methods are given in the appendix.

Resistance and Reactance

Let us now investigate the cases where a resistance is combined with a reactance. We shall use the conventional connotations throughout as follows:

resistance	R
capacitive reactance	$X_c = -\frac{1}{\omega C}$
inductive reactance	$X_L = \omega L$
impedance	$Z = R + jx$
magnitude	$\lvert Z \rvert = [R^2 + X^2]^{\frac{1}{2}}$
phase angle	$\phi = tan^{-1}\frac{X}{R}$

The graphical solution of a resistance R and a capacitance C in series is well known and may be found in textbooks. It is done by treating the combination as a complex vector in an Argand diagram as it is shown in *Fig.* 5.

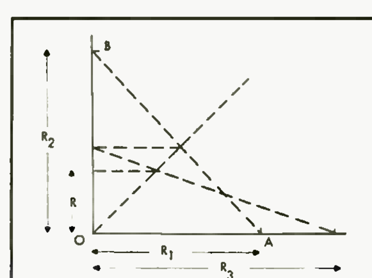

Fig. 3. Construction for three resistances in parallel.

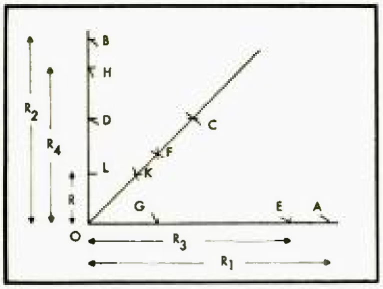

Fig. 4. Construction for four resistances in parallel.

The impedance is represented by the vector $\overline{OA}$ when the resistive component is $\overline{OB}$ and the capacitive reactance $\overline{OD}$. The phase angle is ϕ and the magnitude is the length $\overline{OA}$.

When solving such problems we probably shall need the reactances of several capacitances and/or inductances. While it is no hardship to compute them on the slide rule, it will be advantageous to keep some chart handy for the purpose. Such prepared charts may be found in many publications. Most of them are either direct reading (on log-log paper) or nomographs. For easy reference, such a nomograph is attached as *Fig.* 11.

Graphing the parallel combination of a resistance R and a capacitance C one may proceed as illustrated in *Fig.* 6.

After marking the resistance on the abscissa as $R = \overline{OA}$ and the capacitive reactance on the ordinate as $X_c = \overline{OB}$, connect the two points A and B. Draw a line from the origin O perpendicular to $\overline{AB}$. The intersection is C and vector $\overline{OC}$ is the impedance sought. The phase angle is ϕ and the magnitude is the length $\overline{OC}$.

When the reactance is inductive rather than capacitive, the *RL* combination should be handled almost as described in the *RC* cases, the one difference being that the inductive reactance is taken positive. The two cases (series and parallel) are illustrated in *Figs.* 7 and 8, respectively.

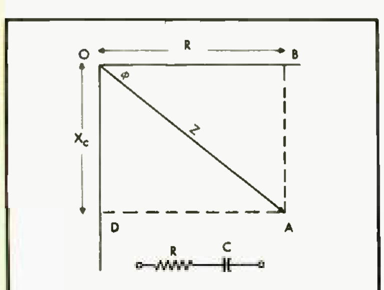

Fig. 5. Diagram representing resistance and capacitance in series.

LC Combinations

Series LC combinations do not cause trouble. The two reactances, X_L and X_C, are added algebraically as illustrated in *Fig.* 9. If the point A falls above O, then the impedance is inductive; if it is below, then the impedance is capacitive. If A coincides with O, then the circuit is tuned and its impedance is zero at the frequency involved.

The solution for the case of the parallel *LC* combination is shown in *Fig.* 10. Mark point C on the ordinate so that $\overline{OC} = X_L$ and D on the abscissa so that $\overline{OD} = X_C$. Draw a 45-deg. line through the origin. Extend $\overline{DC}$ until it intersects the 45-deg. line either in the first, or in the third quadrant. Project the point of intersection B onto the abscissa E. Then $\overline{OE}$ is the impedance sought.

If the intersection occurred in the first quadrant, then $\overline{OE}$ is positive and the impedance is inductive. If B is in the third quadrant, then $\overline{OE}$ is negative and the impedance is capacitive. If $\overline{DC}$ is parallel with the 45-deg. line then there is no intersection. In other words, the impedance becomes infinite. Then, of course, the circuit is tuned to the resonant frequency of the particular *LC* combination.

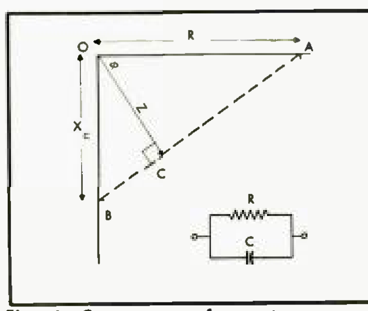

Fig. 6. Construction for resistance and capacitance in parallel.

Series-Parallel Combinations

Finally, let us demonstrate the use of the described methods in a somewhat complicated circuit.

The circuit is part of the tone control in the General Electric preamplifier Model A1-200. The circuit is shown in *Fig.* 12, and is redrawn in *Fig.* 13 for the purpose of analysis.

We are interested in the attenuation of the circuit at any particular position of the point B of the potentiometer. The attenuation is the ratio of the output and input voltages E_{out}/E_{in} which equals to the ratio of the two impedances, Z_{out}/Z_{in}, working into an infinite load, where Z_{out} is the impedance between the two points B and C, while Z_{in} is the total impedance (between the points A and C).

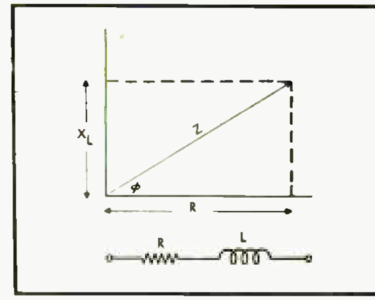

Fig. 7. Construction for resistance and inductance in series occupies different quadrant from that with capacitance.

In *Fig.* 14 we demonstrate the diagramming procedure:

1. Mark R_3 on the horizontal ($\overline{OA}$) and X_{C_3} on the vertical ($\overline{OD}$).
2. Draw the diagonal $\overline{AD}$ and drop a perpendicular onto it from the origin. $\overline{OF}$ will represent Z_3.
3. Add R_4 to Z_3 by marking from point F a horizontal line of length equivalent to R_4.
4. Draw the diagonal $\overline{OB}$. This represents the Z_{out}.
5. Starting at B, mark $R_2 = \overline{BE}$ and $X_{C_2} = \overline{BG}$.
6. Erect the perpendicular $\overline{BH}$ onto the diagonal EG. This $\overline{BH}$ represents Z_2.
7. Mark $R_1 = \overline{HK}$ and $X_{C_1} = \overline{KL}$ as shown (these two are in series).
8. The diagonal $\overline{L}$ represents Z_1.
9. Now all impedances to be added are in proper position. Therefore, the diagonal $\overline{OL}$ is their sum and is Z_{in}.
10. Divide Z_{out} by Z_{in} and get the attenuation.

By following this procedure, the numerical example given may be solved. The circuit is the one shown in *Fig.* 12. The published data are:

$R_1 = 51{,}000$ ohms

$R_2 + R_3 = 500{,}000$ ohms (potentiometer)

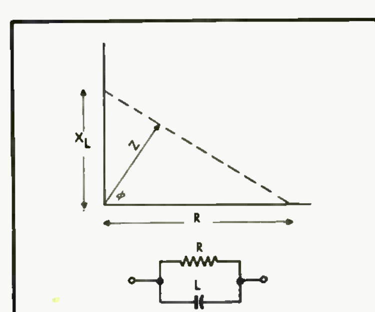

Fig. 8. Resistance and inductance in parallel network, which is handled similarly to that of Fig. 6.

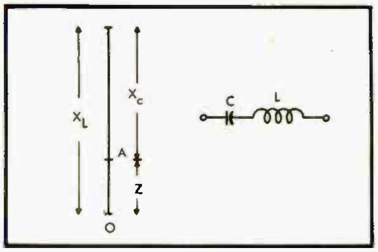

Fig. 9. Inductance and capacitance in series involve only vertical straight lines.

and

$$OD = \frac{\overline{AO} \times \overline{BO}}{\overline{AO} + \overline{BO}} = \frac{R_1 R_2}{R_1 + R_2}$$

which is known to be the total resistance of two resistances in parallel.

To Figure 5

Figure 5 is the direct application of the concept that impedances may be expressed as complex numbers.

$Z = a + jb$ where a represents the resistive component, while b represents the reactive component. According to the convention, if b is inductive, its sign will be plus; if it is capacitive, its sign is minus. Thus Z always can be written

$$Z = a + jb = R + jX$$

Two complex quantities are equal if the vectors representing them have the same length and the same direction. Thus it will be necessary and sufficient to show that the answer reached by the graphical methods has the same phase angle and the same magnitude as the analytical solution.

This is readily seen in *Fig.* 5 where

$$\phi = -\tan^{-1}\frac{X_C}{R} = -\tan^{-1}\frac{1}{\omega CR}$$

(*Continued on page 82*)

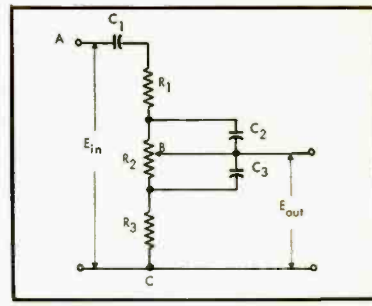

Fig. 12. Network of tone control as normally drawn.

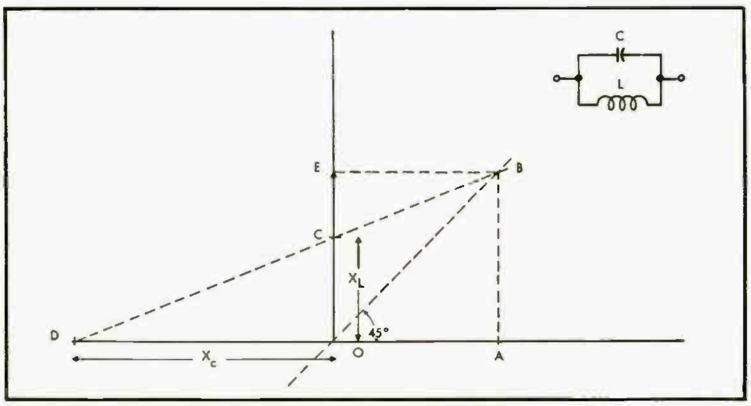

Fig. 10. Construction for capacitance and inductance in parallel.

$R_4 = 5{,}100$ ohms

$C_1 = 0.1$ μf

$C_2 = 0.006$ μf

$C_3 = 0.06$ μf

The conditions selected are:

$R_2 = 160{,}000$ ohms

$R_3 = 340{,}000$ ohms

$f = 100$ cps

With these values the construction yields

$Z_{out} = 27{,}500$ ohms

$Z_{in} = 197{,}000$ ohms

giving 14 per cent voltage attenuation.

Numerical computation (with the aid of the slide rule) results in 13.8 per cent.

Appendix

To Figure 1

The two triangles OAB and DAC are similar. Therefore

$$\overline{CD} : \overline{BO} = \overline{AD} : \overline{AO} \qquad (1)$$

But, by construction,

$$\overline{OD} = \overline{CD}$$

and

$$\overline{AD} = \overline{AO} - \overline{OD}$$

Thus Eq. (1) may be written

$$\overline{OD} : \overline{BO} = (\overline{AO} - \overline{OD}) : \overline{AO}$$

or

$$\overline{OD} \times \overline{AO} = (\overline{AO} - \overline{OD}) \times \overline{BO}$$

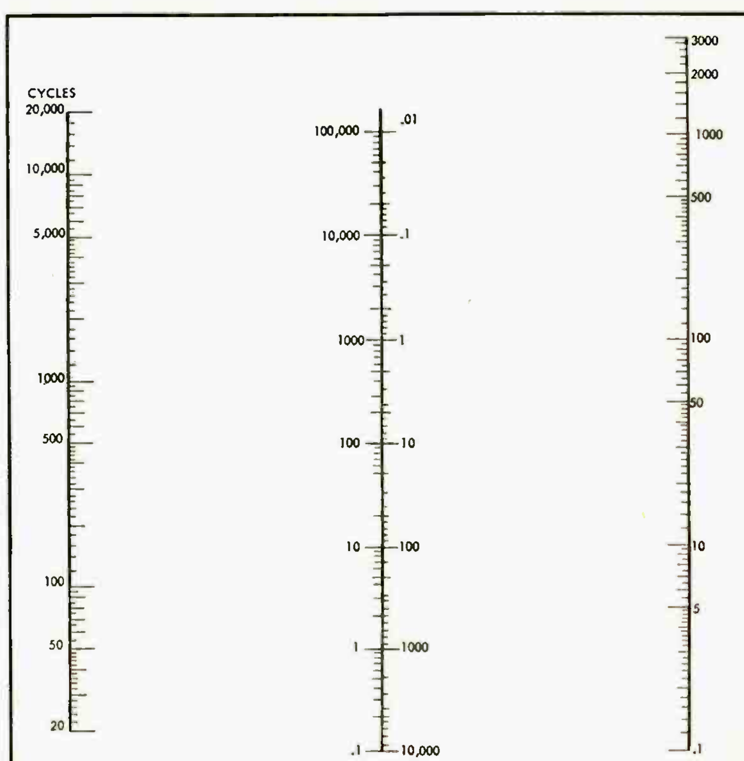

Fig. 11. Nomograph useful in determining values for complex network problems.

Concrete for Loudspeaker Enclosures

PHIL J. WALUSEK*

How to build an extremely solid loudspeaker enclosure with a minimum of effort. The author indicates how simple it must be by picturing his small fry in the various stages of the construction—although he doesn't say they did it all without his help.

There are numerous references to the high-quality sound obtainable by the use of loudspeakers mounted in concrete enclosures. Although the consensus favors concrete it precludes the use of this type of construction because of the supposed lack of portability of such enclosures. This, to the average individual, accustomed as he is to associate the word concrete with tremendous building projects, sounds quite logical.

Not believing that concrete necessarily makes an enclosure immovable, one of generous proportions was built to prove the practicability of this type of construction. The enclosure was relatively simple to construct, requiring no specialized skills or tools. It is extremely rigid to preserve the advantages of concrete construction.

The enclosure is portable, not in the sense that it can be lifted and carried from one spot to another, but in the sense that it can be moved from one apartment to another, from one home to another with relatively little effort.

Concrete is an extremely flexible medium. It can be moulded into any shape desired, its strength can be varied to suit any individual need, and its weight can be controlled to an extremely fine degree. Concrete lends itself to any number of surface treatments, can be cast smooth and painted or panelled with wood veneers or one of the many printed plastic adhesive finishes on the market. The surface can be wire brushed to expose rough, colored, pattern, or ordinary gravel, or can be ground away slightly to obtain aggregate patterns as in terrazzo.

Last, but by far not the least, concrete is a relatively inexpensive material to procure and to handle, and portland cement, its prime ingredient, is available in any locality.

To insure mobility it was decided to precast the enclosure in panels to weigh not more than 50 pounds each in order that one person could easily make, handle, assemble, and disassemble the enclosure. The panels were mortared together with plastic caulking compound so that the enclosure has the advantage of non-vibrating mass and yet can be disassembled into light weight, easily handled units for moving to other locations.

Design of Enclosure

The design of the enclosure is such that it insures high-quality sound reproduction. An endless number of types of enclosures was studied and one that held the greatest promise chosen. An infinite baffle enclosing approximately nine cubic feet and housing four fifteen-inch drivers was built in a corner of a twelve-by-twenty-foot living room. The drivers are mounted close together to

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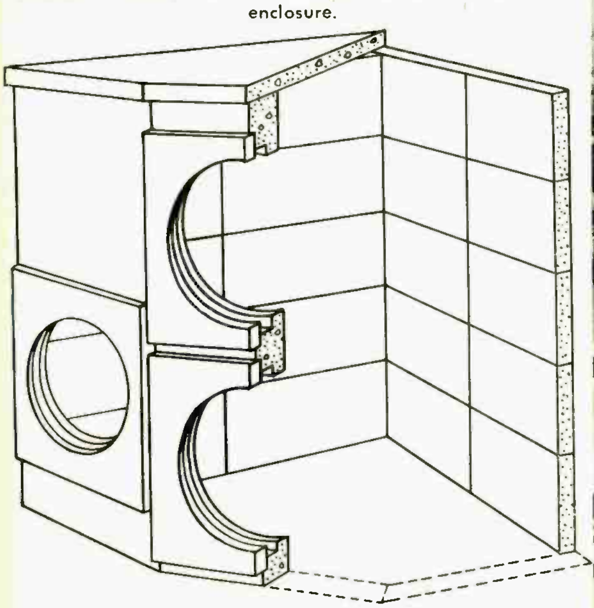
Fig. 1 (right). Apparently—and actually—very solid, this enclosure is built with relatively little effort. Fig. 2 (below). Diagram showing how wall-section blocks form back of enclosure.



take full advantage of the "bonus factor" that accrues,[1] and to avoid out of phase effects that occur in the mid-frequency region when drivers are separated by a distance of three diameters or more.

Freshly mixed concrete is a material of high plasticity and, although it can be mixed stiff enough to be readily shaped by hand, it is generally placed in forms made to predetermined shapes and dimensions until it hardens in order to insure similarity in repeated patterns. The base for the form was ¾-inch plywood. Side forms were sawn with the inside edge bevelled and screwed to the plywood base for ease in disassembling, cleaning, and re-assembling for each use. End pieces were fastened to the side pieces and to the plywood base with wood screws.

A circular mould piece to form the speaker opening was made by cutting circles of Celotex and covering with aluminum foil. This mould was fastened in place on the plywood base with wood screws. 5/16-inch holes were drilled in the plywood base and 3-inch dowels were pegged in to form holes in the concrete panels through which the speaker mounting board bolts would run. The interior surfaces of the form were brushed with a form oil to break the bond between the form and the concrete, and to facilitate removing the cast panel from the form.

Portland Cement

At this time it may be well to say a few words about portland cement, the glue that binds the sand and the gravel together to form concrete. Portland cement, when water is added, forms an adhesive which sets in about four hours and continues to harden while kept damp until it attains usable strength in seven days and its maximum average strength in twenty eight days. It is for this reason that contractors keep the forms on concrete for seven days after placement, or, if stripping forms earlier, cover the concrete with straw, burlap, or vapor seal, and keep it damp for the proper curing time.

The amount of mixing water controls the strength of the cement paste and therefore controls the strength of the concrete. The greater the amount of mixing water the greater the dilution, and therefore the weaker the paste. It is important to use only as much mixing water as will give the desired strength concrete.

A garden cart was used for mixing the concrete, mainly because it was the largest, most convenient container that did not leak, an important consideration when mixing concrete in the living room. Using the 32-ounce graduate which had originally been purchased for compounding the baby's formula, three quarts of cement and six quarts of sand were placed in the cart and thoroughly mixed with a shovel that is sold as part of a child's set of garden tools.

Three quarts of water were then added and the batch mixed until a consistant color was achieved. Six quarts of lightweight aggregate, in this instance expanded slag, were added and the entire batch mixed until every particle was completely coated with cement paste. When using light weight aggregates it is important to add them last since they have a tendency to absorb the mixing water. If added earlier, inconsistant batches may result.

The concrete was mixed for a minute or so longer and then shovelled into the form. It was pushed into all the corners, patted with a wood float, and the form jarred by tapping with a hammer to dispel as many air bubbles as possible in order to obtain a smooth finish on the surface against the form. When it was found that not enough concrete had been made up in the first batch, smaller batches were mixed up using the same proportions but in smaller amounts until the form was full.

⅜-inch reinforcing rods were forced into place, and after thorough compacting, the excess concrete was struck off with the edge of a board very much like striking the excess cap off a glass of draft beer, though the consistency was a bit different. Since the top surface faces into the enclosure, no efforts were made to finish it other than to level it off.

The cart and the tools were immediately washed off to prevent the cement's hardening on the surfaces while the concrete in the forms was left to set. After about eight hours, wet burlap cloths were placed on the surface of the concrete and the whole covered with sheet plastic to prevent evaporation until the concrete had attained its seven-day strength. It was possible to speed up the casting operation by carefully removing each cast panel on the third day and laying it aside, covered with damp cloths and plastic sheets while another panel was being cast. Two panels were cast with one speaker mounting hole per panel. One panel with two speaker mounting holes was cast in the same form using two forming circles instead of one. While the three panels were curing, the top was formed and cast.

Back Wall Panels

The room where the enclosure was to be used was dry wall construction and it was feared that the walls would vibrate, so two back walls which ordinarily

[1] *Electrical Engineer's Handbook*, Fourth Edition 13–04, "Multiple pistons." Wiley, 1950.

Top to bottom: Fig. 3. Mixing the concrete in a garden cart. Fig. 4. Brushing the interior of the form with a form oil. Fig. 5. Dowels make holes for speaker mounting bolts. Fig. 6. Concrete being finished with a wood float.

would not be necessary were constructed of $2 \times 8 \times 16$ inch lightweight concrete masonry units. Instead of laying these up as one would lay up a wall, the units were positioned on a plastic covered plywood panel in such a manner that the outside edges of the blocks came to the desired dimensions. The blocks were dampened with a fine spray of water from a garden sprayer and a cement grout consisting of one part cement, two parts sand, and one part water, thoroughly mixed, was pushed down between the blocks to mortar them together. The grout set rapidly and it was possible to finish off the mortar at the edges of the panel very well.

Two layers of waterproof paper were placed on top of the first layer of blocks and the second back wall blocks positioned and grouted together right on top of the first set. The whole was covered with wet burlap cloths and a sheet of plastic to prevent evaporation, and allowed to cure seven days. After curing, the panels were uncovered and allowed to dry out.

The plywood under the block wall panels served as a pallet to enable the wall sections to be tilted up and moved into position without undue stress being placed on the mortar joints. The two waterproof sheets of paper prevented the panels from sticking to each other.

Three-inch long $\frac{1}{4} \times 20$ threaded rods were fastened in place through the holes formed in the front panels by the dowels, leaving one inch of rod extending beyond the face of the panel. This was to allow the speaker mounting boards to be attached from the front of the enclosure.

To prevent the panels from bonding to the floor, strips of aluminum foil were positioned where the panels would rest, and cords of caulking compound placed thereon. The back wall panels were set up on the caulking compound, positioned in the corner, and the corner joint caulked tight. The front panels were then placed in their bed of caulking compound on aluminum foil, and caulked to each other. Caulking compound was run around the tops of all the panels, and the top was seated thereon.

There is considerable give to the compound, and the panels were pushed and pulled into the best position and allowed to rest until the weight of the unit settled them somewhat. The excess foil and compound were trimmed away and the whole job generally tidied up. The exposed concrete surfaces were painted with a latex rubber base paint. Since concrete retains moisture for some time, the enclosure was allowed to dry out thoroughly. An electric light bulb left lit in the enclosure helped shorten the drying time considerably.

The entire enclosure was filled with odd size pieces of glass wool insulating material to minimize internal reflections. To prevent possible damage to the drivers by glass dusts, a cover of muslin was taped over the back of each loudspeaker.

Mounting the Loudspeakers

For the speaker mounting panels $13\frac{1}{2}$-inch diameter holes were made in 18-inch squares of $\frac{3}{4}$-inch plywood and $\frac{1}{4}$-inch dowel rods 18 inches long were nailed two inches apart across the openings to act as a protective grille. A 1/16-inch cork gasket was glued to the rear of each mounting board to insure airtight fit. 15-inch loudspeakers were fastened to the rear surface of the mounting boards with wood screws and the assemblies bolted to the concrete panels.

Various combinations were tried with excellent results and after numerous tests, one Jensen G-610 and three Jensen P-15LL loudspeakers were decided on. The G-610 gives a smooth response throughout the useable range, and the reinforcement in the bass supplied by the three P-15LL loudspeakers gives a cleanliness in the bass that is not evident with enclosures utilizing loudspeaker back radiations for bass reinforcement. It has been the opinion of the author that the use of back emanations from loudspeakers to extend the lower range of any unit results in poor reproduction of complex musical signals because it is believed impossible to accurately phase the back signal with the front signal.

While it is true that a reinforcement and apparent increased reproduced bandwidth into the lower bass regions is indicated by test using frequency generators, this method does not insure faithful reproduction of complex musical signals which requires not only a smoothness in volume of reproduction but also in keeping all audio frequencies in their proper phase relationship.

It is believed that this enclosure, built in the living room with the understanding encouragement of a sympathetic wife opens an entirely new field for the enterprising audio fan in his quest for more faithful sound reproduction. The lack of sympathetically vibrating structural panels results in a smoother completely boom free bass. And the properties of concrete lend this medium the advantage of being the most plastic, the most practicable of all materials available for the construction of any type, size, or shape of enclosure imaginable.




Top to bottom: Fig. 7. Covering panels with wet burlap cloths ensures maximum 7-day strength. Fig. 8. Back panels caulked to floor with protecting layer of aluminum foil. Fig. 9. Mounting bolts being fitted in holes made by the dowels. Fig. 10. Musician Friend places stamp of approval on the enclosure. No enclosure is worth its weight without the approval of a Musician Friend.

Design for a College Music Room

MERLE FLEMING* and ELLIOTT FULL*

A practical arrangement for providing music to a variety of rooms and for a variety of purposes—all built under the traditional limitations of budget under which educational institutions are known to operate.

THE MUSIC ROOM in the new wing of the University of Iowa Union is rapidly becoming one of the most popular places on the campus. Within a week after the room was in regular operation, consistently from four to five times as many people were using the facilities on a regular basis.

The music room is an integral part of the Student Union at Iowa. The 36 by 46-foot room is air conditioned; the walls are of curly maple paneling and glass. The ceiling is acoustical tile and the floor is carpeted. The loudspeaker in the northeast corner is the focal point of the room. A control room houses much of the accompanying equipment.

Students and staff at the University of Iowa are finding that one of the best places to spend several hours is the new music room of the Student Union. When the control room (right window) is manned by the hostess a typical hi-fi system plays through the loudspeaker at the far corner. Otherwise the students play music from the 100-record Seeburg Select-O-Matic shown at the left.

Control Room Equipment

The control room equipment used to feed the loudspeaker is as follows:

A. Program Sources
  1. Rek-O-Kut B-12H turntable with Fairchild diamond cartridges
  2. Garrard RC-90 record changer with Fairchild diamond cartridges
  3. Concertone 20/20 tape recorder
  4. Stephens microphone
  5. Browning AM short wave tuner

B. McIntosh 30-watt amplifier

C. McIntosh C-8 preamplifier

In addition to the above equipment, the control room contains a Radio Craftsman C-400 amplifier connected to an 8-inch monitoring speaker. This may be switched between the tape recorder, the preamplifier output and the radio, thereby furnishing a means of monitoring program sources before being played into the music room, as shown in *Fig.* 1.

The record changer is to be used primarily when the hostesses are called away or busy elsewhere during the normal operating time of the control room. With very careful listening, the only difference noted between the transcription table and the changer is the superior ability of the Rek-O-Kut to handle the powerful bass of some organ recordings and the lack of rumble even when a good deal of bass boost is used. On most recordings, there is no perceivable difference in results.

A hostess is on duty in the Union music room during specific hours only. No one else is allowed to operate the control-room equipment. There was thus a need for a source of music outside the control room, and with a good corner loudspeaker available, it seemed desirable to channel all music through it. A Seeburg Select-O-Matic was installed in the music room so that University students and staff may have the pleasure of the music room all the time the Union itself is open. The Seeburg drives the speaker through a Radio Craftsman C-400 amplifier and a changeover relay whenever the control room is not in use.

Since non-technical people with numerous other concurrent duties are in charge, all of the control room equipment is connected to the light switch.

* *Custom Electronic Devices, Iowa City, Iowa.*

Both changer and transcription turntable play through the amplifier system in this control room. The tape recorder at the right makes it possible to record student activities when desirable.

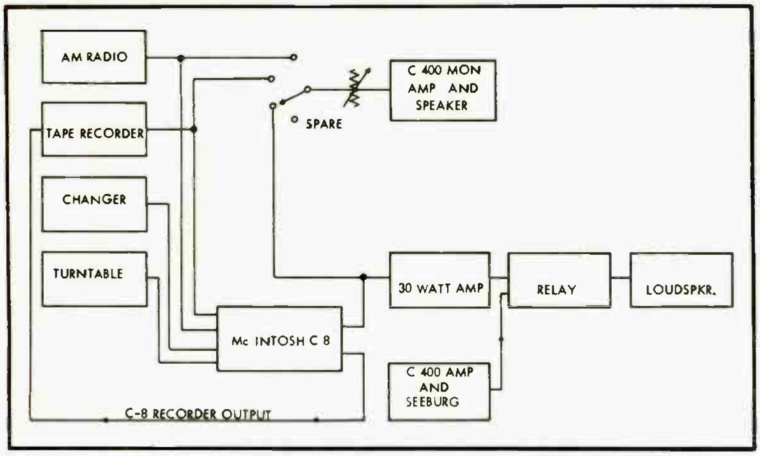


Fig. 1. Block diagram of the control room equipment used in the college music room.

This switch, as well as the master equipment switch and the preamplifier on-off switch, makes the large loudspeaker available to the Seeburg, as seen in *Fig.* 2.

During the planning stages, many suggestions were made by interested University people wanting the best equipment installed. While a wide variety of equipment would have given equal or nearly equal performance, in this particular situation, there was a specific reason for the purchase of nearly every item in the system.

Dr. Earl E. Harper, the director of the union, decided the recorder was essential since tape is a superior medium and a fine system of this type would not be complete without a means of using it. It followed naturally that a microphone was also a necessity.

Recording Requirements

The only conceivable use for a microphone in this set-up is for recording, so the microphone is connected to the tape recording input only. Policy has not been established for use of the recording facilities. The tape machine will probably be used primarily for playing tapes of University concerts and other recorded tapes as they become available. The size and other attributes of the music room would make it a desirable studio for recording small chamber or choral groups. The University of Iowa is unusually short of auditoriums of any size.

The microphone is used for University lectures in the main lounge of the Union and for other university functions, particularly those connected with union activities.

The individual units all connect into an a.c. and speaker control box that also houses the changeover relay and fuse. The relay is mounted on a small piece of acoustical tile to minimize chances of hum conduction. This arrangement enables each unit to be unplugged and removed for servicing with a minimum of trouble. This power control box has a switch mounted on a short length of cord which is in turn mounted on the control console.

All speaker wiring is four-conductor #18 with opposite pairs tied together. One pair is grounded and connected to the grounding pole of the three-prong speaker outlets. The other pair is connected at the speaker plug. This type of wiring, with two pairs available, aside from increasing effective wire size and improving damping characteristics, makes possible the installation of a stereophonic audio system at a later date without rewiring. The music room has an extra speaker outlet, as does the large adjacent lounge, which is 59 × 112 feet in size.

Recorder-Speaker Experiment

Prior to the opening of the music room, the equipment was used to record and play back to a "packed house," the first part of a combined University chorus and orchestra concert. The recording engineer was "off speaker" and it was therefore difficult to adjust volume properly. If this experiment were performed on a frequent basis, a volume monitoring device in the audience would be desirable.

Immediately following the concert, a short portion of the tape was played. The comments, as could be expected, ranged from "superb" to "I was disappointed." The average remark seemed to be "It was very good, but wasn't there too much volume?" What does this imply to the advocates of 50-watt amplifiers?

The issue of too much volume was highly debatable. The effect may have been actual or it might have been related to the sound from the speaker coming from a small radius while the concert itself came from the board source of a chorus and orchestra.

This experiment took place in the main lounge of the old section of the Iowa Union. The acoustics of this room are extremely bad. The ceiling is very low for an auditorium. It is carpeted throughout and has a large quantity of upholstered furniture, not to mention the sound absorbing qualities of 2000 people. Satisfactory mike placement in this situation is practically impossible.

All this adds up to a short time constant and lack of direct treble from the

(*Continued on page 81*)

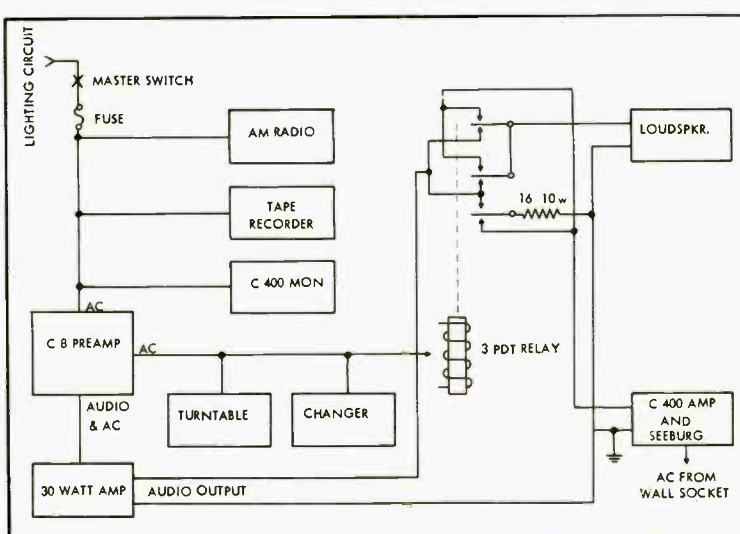


Fig. 2. Block diagram of the a.c. supply circuits and the speaker switching for the entire system.

Increasing Sensitivity and Lowering Distortion In FM Tuners

JOSEPH MARSHALL*

Additional gain and extra bandwidth can be added to an FM tuner by this outboard double-detection i.f. amplifier. The result is complete saturation of the limiters for quiet signals, even in fringe areas, and optimum distortion reduction for the sound.

Several problems arise in the use of FM tuners for high-fidelity reception. One is lack of sensitivity or gain with the result that on weak signals the limiters are not completely saturated and reception is not sufficiently noise-free. Another is distortion. One form is the residual detector distortion even when the circuit is properly aligned and the signal properly tuned in. With discriminator and ratio type detectors this residual distortion in the average tuner is commonly about 1% with good alignment of the i.f. amplifier, and increases to higher values as the response curve is deformed by the detuning caused by changes in circuit capacitance with the passage of time. This is not noticeable in the ordinary commercial FM receivers where it is masked by higher distortion in the audio amplifier; but when a tuner is used with modern high-quality amplifiers whose distortion is only a fraction of 1% it can be very annoying to golden ears.

More serious, however, is the distortion due to improper tuning, frequency drift, and too narrow a bandwidth. Both the discriminator and ratio of detector depend on the linearity of the response curves of the tuned circuits for proper operation, and since the tolerance is very small drift or detuning of as little as 15 or 25 kc is sufficient to produce non-linear detection. High-quality reception is therefore achieved only by great care in tuning and by frequent retuning to compensate for drift, even if the receiver is equipped with automatic frequency control.

Finally, a bandwidth of 150 kc at 6 db down has been accepted as the compromise standard and is characteristic of even the highest-grade FM tuners, although theory calls for a total bandwidth of 240 kc for distortionless reception. The idea behind the compromise is that distortion due to the narrow bandwidth will be suppressed by the limiters. We have already pointed out that on weak signals the gain of the average FM tuner is not sufficient to produce saturation of the limiters; therefore, on weak signals the distortion due to a narrow bandpass will not be suppressed. As a matter of fact, it will not be suppressed completely on strong signals either. It has been pointed out that when the signal has to operate on the curved portion of the receiver response curve, there occurs not only amplitude, but phase and therefore frequency distortion. Regardless of how thoroughly the limiters suppress the amplitude distortion, they have no effect on the phase and frequency distortion which is then evidenced in the audio output as serious amplitude distortion.

This was not seriously noticeable in the early days of FM because available audio amplifiers generated enough distortion of their own to mask it; but it has been noted in the past few years by those using wide-range, low-distortion systems. The need for narrowing the bandpass comes from the need for sensitivity; therefore, any device which would permit an increase in gain would also permit a widening of the band-pass with consequent elimination of phase distortion.

All in all, it is ironic that FM reception, which originally promised an approximation of the ideal in radio reception, is subject to distortion which can, and commonly does, exceed that of AM reception. In other words, as we have improved the terminal devices of the chain—amplifiers and loudspeakers—we have become aware that in FM we face again the same old bugaboo of high fidelity: as we increase the total system band-width the residual noise and distortion limit the quality and enjoyment more and more. Fortunately, there are solutions, relatively simple and inexpensive ones, for both problems.

Increasing Sensitivity

More complete quieting, assuming the use of a two-stage limiter, requires an increase in receiver gain to produce saturation of the limiters at lower signal levels. Although we have had improvements in recent models of FM tuners in this respect, there is a limitation to receiver gain when the conventional design is used. With an i.f. of 10.7 mc, three i.f. amplifier stages with a total gain of about 90 db represent the practical limit for stable operation, and even this is achieved only by keeping the band-pass narrow. Therefore, highly sensitive commercial receivers (such as the REL) employ double conversion with additional amplification at a frequency of about 5 mc. This is both costly and critical since the addition of further tuned circuits, especially at a lower frequency, not only makes symmetry and linearity of the response curve more difficult to achieve and maintain, but also because at lower frequencies it is even more difficult to keep the band-width large enough for distortionless reception.

Just after the War, W. W. Moe of General Electric suggested the use of a second intermediate frequency of about 200 kc with R-C tuning of the 200 kc channel. This would provide additional gain without critical tuned circuits and at low cost. Moreover it would permit—indeed require—the use of the frequency-counting detector which possesses the best distortion characteristics of all available FM detectors. The author constructed a receiver using this circuit. He found it excellent except for one thing. With a second i.f. of 200 kc there is an image point only 400 kc off resonance. This is well within the skirts of the selectivity curve of a 10.7 mc amplifier with a 150–250-kc bandwidth and produced two-spot tuning on very strong signals. This was not a serious problem in the author's case since the strongest signal had a field strength less than 100 microvolts; but it did appear to limit the wider application of the circuit.

As is usually the case, the solution was a very simple one but unfortunately did not suggest itself for several years, perhaps because the problem was not serious enough to stimulate the required concentration. It consists of the use of absorption traps in the 10.7-mc channel to provide a dip in the response curve at the image frequency of 11.1 mc. At first thought this appears to lead to compli-

* *Ozone, Tenn.*

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cated and nonstandard i.f. transformers; but actually it can be achieved very simply with standard transformers only slightly modified, and results in making possible a receiver of tremendous sensitivity—1 microvolt or better with full quieting—at a cost of only a few dollars more than conventional receivers.

Decreasing Distortion

It is very seldom that increased fidelity and lower distortion are obtained through the same measures which yield high sensitivity; but that is the case in this instance. With a terminating i.f. of 200 kc the frequency-counting detector is not only possible but mandatory since it would be practically impossible to obtain the linearity at this frequency necessary for discriminator or for any other type of detection dependent on the tuning slope. The frequency counting detector has been analyzed and discussed frequently in the literature and there is no point in going over the ground again. A few points, however, are noteworthy.

In the first place, the frequency-counting detector is completely independent of the slope of the response curve and is a very linear device *per se*. For this reason it is employed in precision monitors for checking the distortion characteristics of transmitters and generators. Residual distortion can be held down to a fraction of 1% which makes it fully comparable to our best audio amplifiers. Moreover, because it does not depend on the slope of the tuning curve, it minimizes the distortion due to detuning, whether the detuning is caused by improper centering of the signal or by frequency drift. In fact, it will produce reproduction with very little distortion even when the receiver is detuned as much as 100 or even 125 kc off resonance—or, in other words, when only one set of sidebands is passed. This endows the receiver employing it with a tremendous tuning tolerance. The results are (1) that the receiver can be tuned very simply and uncritically even without a tuning indicator, and (2) that it will provide reception of very low distortion even without a.f.c. over a considerable range of frequency drift. In fact, given a reasonably stable first oscillator, the over-all tuning stability is comparable to that of a broadcast-band receiver, even without a.f.c. Although the circuit seems to make the receiver tune very broadly, the effective selectivity can be made fully as good as or better than that of receivers employing the more conventional detectors.

Finally, given the increased gain made possible by a second i.f. channel, we no longer require the narrow band-width in the 10.7-mc channel. Therefore, where adjacent-channel selectivity is not important, the receiver can be aligned for a bandpass of 240 kc, which will eliminate the distortion due to narrow bandwidth

Since the second i.f. channel, though lower in frequency, is very broadly tuned, this is easy to achieve without critical alignment.

The Practical Circuit

Fig. 1 gives the schematic diagram of a practical i.f. amplifier employing these ideas, now in use in the author's FM tuner. It consists of two stages of amplification in the 10.7-mc channel followed by a second converter which provides additional amplification and converts the signal to 200 kc. The 200-kc channel consists of one stage of R-C-coupled amplification, followed by two limiters and the frequency-counting detector. On strong signals, the 200-kc amplifier becomes saturated and becomes a third limiter with the result that the receiver possesses extremely high quieting ability.

Although the diagrammed circuit uses metal tubes, it can be converted to miniature tubes. Both the 6AC7 and 6AB7 now have miniature equivalents. Either the 6AH7 or the 6AU6 can be used in place of the 6AC7, while the 6AB7 can be replaced by the 6BA6. The 6SA7, of course, can be replaced by the 6BE6, the 6H6 by the 6AL5. The only changes would be in the bias resistors—68 ohms for the 6BE6 and 100 ohms for the 6AU6.

It will be noted that link coupling is specified at the input. This is necessary whether or not the i.f. amplifier is adjacent to the r.f. front end; in fact, it is the secret of the satisfactory operation at low cost of the whole circuit. Standard i.f. transformers are used. The links are 3 or 4 turns of hookup wire wound at the ground end of the grid winding and the B-plus end of the plate winding, respectively, of the two transformers. The link can be passed through a hole in the can or the base to the other transformer. If the link has to be longer than 2 inches, it should be shielded to prevent pickup of interference in the 10.5- to 11-mc range. The unused winding in each transformer now becomes an absorption trap tuned as described subsequently. It is these traps, which by eliminating or at least minimizing two-spot tuning, make the whole circuit practical.

To obtain maximum gain with stability, the 10.7-mc channel is stabilized by bypassing the plates to the screen and bypassing to ground from there through the .003-μf capacitors. This forms a bridge circuit which neutralizes the plate-grid capacitance. The .01-μf plate, grid, and cathode bypass capacitors are dressed with leads about ½ inch long. This provides enough inductance to form

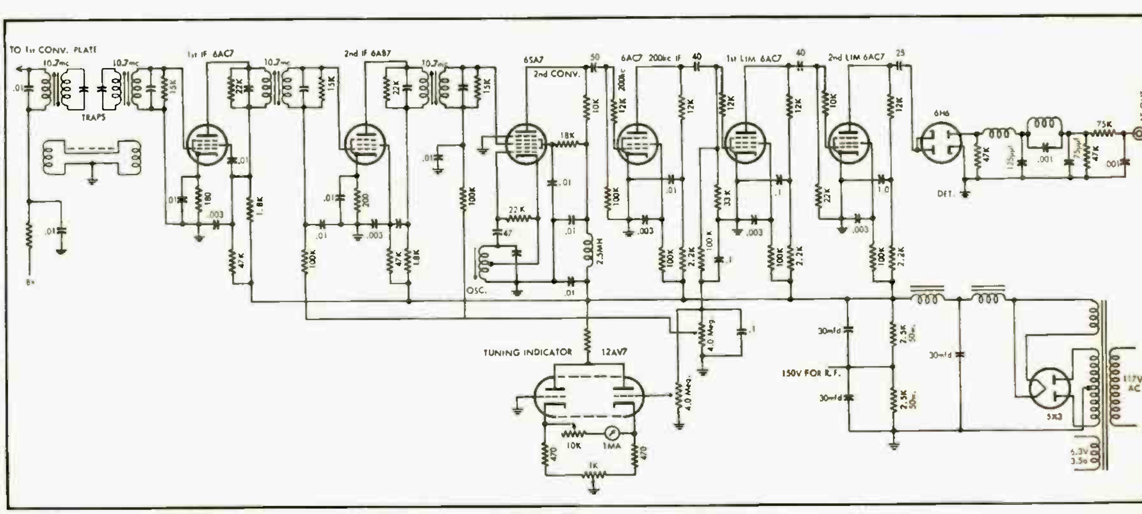

Fig. 1. The circuit schematic for the outboard i.f. amplifier. The second i.f. is at 200 kc and the detector is a frequency counter. Some old hands at audio may feel timid about tackling r.f. circuits, but there is nothing hard about it.

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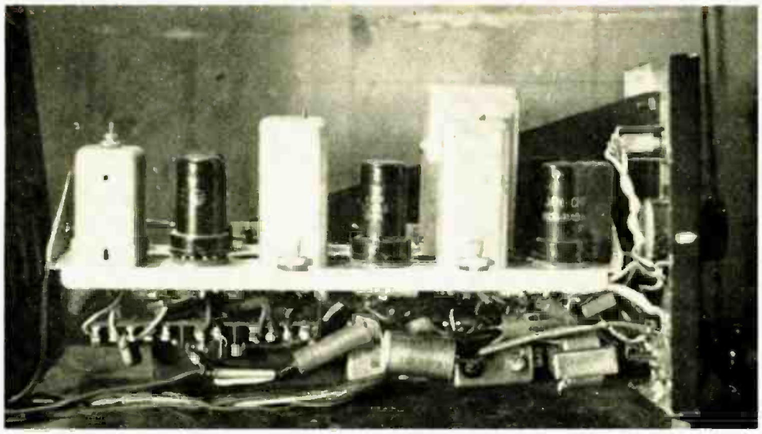

Fig. 2. This is the author's version of the i.f. amplifier.

a series resonant circuit tuned to approximately the 10.7-mc range, thus providing more effective bypassing.

The amount of loading of the transformers if any, will be determined by the transformers themselves. The Stanwyck transformers used in this model provide a bandwidth of 150 kc with grid loading only. For maximum distortion-free fidelity, however, the circuit provides for loading resistors in the plate circuits as well. This gives a bandwidth which equals or at least approaches the theoretically ideal 240 kc.

It will be noted that a.v.c. is applied to the second converter and the second 10.7 amplifier through a 4-megohm potentiometer which determines the amount applied. Ordinarily, to get complete saturation of the limiters the amplifiers should operate at maximum gain. However, it is possible to obtain distorted reception by overloading the converter on very strong signals. The variable-a.v.c. method of controlling gain provides good control with minimum risk of instability and the least possible trouble due to mishandling of controls.

The second converter is a standard pentagrid type. The oscillator coil can be one of the tapped permeability-tuned types intended for shortwave receivers; or a 10.8-mc i.f. transformer can be modified by tapping one winding and removing or shorting the other winding. In any case, the whole oscillator circuit should be completely shielded and bypassed as possible. If it can be placed in a separate shielded compartment, tube and all, it should be. Despite the most valiant measures, however, it is altogether likely that the 9th harmonic of this oscillator will be radiated and picked up by the front end at about 98 mc. If this happens to fall in a spot occupied by a desired station, the oscillator can be moved upward or downward slightly —but not too much, or the 8th or 10th harmonic will appear at either the upper or lower end of the tuning range. The presence of this one harmonic within the tuning range is the only disadvantage of the circuit and it is a very small price to pay for the otherwise greatly improved performance.

If it is desired to add the benefits of this circuit to a presently inadequate FM receiver—which can be done quite simply—the first and possibly the second amplifier stages of *Fig.* 1 should be left out. The addition of an outboard amplifier of this type can be accomplished without seriously disturbing the present receiver. The only change is to provide a link on the plate winding of the i.f. transformer following the last i.f. amplifier (but not the discriminator transformer). This can be done by removing the shield can and winding a 3-turn link as described previously. The other winding is not disturbed and neither is the rest of the present receiver. The following tubes are simply removed and the grid winding of this transformer is tuned as an absorption trap. The receiver can be placed in original condition simply by removing the link, replacing the tubes, and re-trimming the transformer.

If the present receiver has an a.f.c. circuit and it is desired to retain this feature, it can be done simply by leaving the tubes in. In this case we sacrifice the trap, but except in local areas a single trap will probably suffice anyhow; and now, by taking the a.f.c. off the outboard amplifier we can combine the new circuit with a.f.c.

The second i.f. channel produces no problems whatever either in construction or adjustment. There are a lot of components but if small resistors and ceramic capacitors are used, room can be found for them easily. The 1-μf capacitor in the second limiter plate circuit cannot be made smaller without loss of low-frequency response.

It will be noted that the detector output is followed by a low-pass filter. This filter is desirable if the amplifier which follows, like most modern high-fidelity amplifiers, has a response beyond 30,000 cps, to filter out the r.f. which might otherwise cause trouble in the audio system. The filter can be left out, in which case the 47,000-ohm detector load resistor should be bypassed with an 0.1-μf capacitor. The detector output is about 1 volt. Unless the amplifier is supplied by a ripple-free power supply, it is better not to have an AF amplifier on this chassis, but to obtain the needed amplification on the audio chassis.

Although a tuning indicator is not necessary, it is helpful. Since proper tuning involves only peaking the signal, a simple indicator will suffice. The meter indicator diagrammed is both simple and effective, but for ordinary purposes can be replaced with a 6E5 tuning eye.

Fig. 2 shows the writer's finished outboard amplifier.

Alignment And Adjustment

One of the great virtues of this circuit is the simplicity of alignment and adjustment. An oscilloscope is helpful, especially in adjusting the traps and obtaining the best possible selectivity for a given bandwidth. The tuning indicator alone will suffice however. A signal generator will produce the best results but excellent results are obtainable by using a station signal. The procedure is as follows:

First, set the second oscillator to approximately 10.9 mc. This is most easily achieved by tuning a nearly shortwave receiver to 10.9 mc and turning the slug on the oscillator coil until the receiver detects the generated signal. However, if no shortwave receiver is available and if the i.f. transformers are presumed to be set to approximately 10.7 mc, the oscillator slug can be adjusted until the signal is detected on the meter. Final adjustment is made later and a slight error will make no difference.

The 10.7-mc channel is now peaked in the usual manner. If a scope is being used, trim the second oscillator now for the most symmetrical response. If no scope is used, tune in an actual signal and adjust the oscillator for best quality and lowest distortion. It will be found that the oscillator peaks at three points: at a point about 200 kc lower than 10.7 mc, at 10.7 mc, and at a point about 200 kc higher than 10.7 mc. The second position can be recognized by the beat note with the signal. The proper position is the one around 10.9 mc since this is the only one which will reduce the appearance of harmonics in the r.f. range to only one.

The final step is to adjust the absorption traps. Tune the signal generator to about 11.1 mc and adjust one trap for minimum response. If this reduces the response to a point so low that it will

(*Continued on page 84*)

Multiple Tape Copying

R. E. BAIRD*

With the aid of a few simple chassis designed for a specific purpose, this station succeeded in reducing the time required in making multiple copies of tape recordings at a minimum of cost.

A FEW RADIO STATIONS and many institutions of higher learning have inaugurated tape transcription services for the purpose of disseminating radio programs to be broadcast over a number of stations. Sometimes the distribution may be only a half dozen stations but most generally the number gets much higher. The problem of taking a "master" tape and copying it many times becomes one of economics and time. If you need 50 copies of a 15-minute program it would be ludicrous to use one play-back machine and one copying machine for the whole process.

* *Chief Engineer KWSC, Washington State College, Pullman, Wash.*

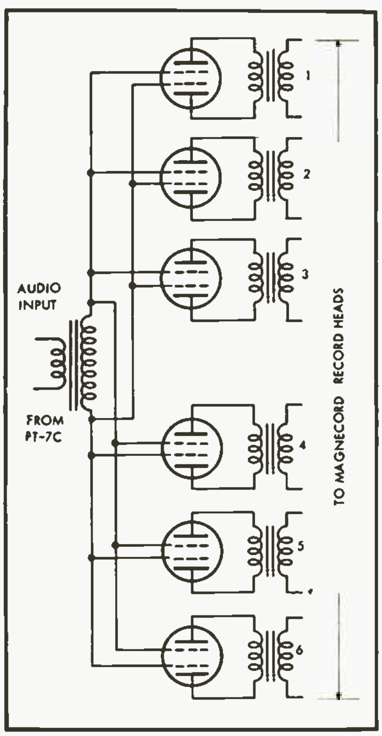

Fig. 1. Six separate output stages fed by the same input transformer eliminate the problem of interaction between bias circuits.

Likewise 50 copying machines would be equally unreasonable. Depending on the individual requirements the number of copying machines will lie somewhere between these two extremes.

The most obvious answer to the copying problem is to buy as many tape transport mechanisms and associated amplifiers as needed. At the State College of Washington, KWSC, we did not take kindly to the idea of buying so many tape copying amplifiers when it appeared that one amplifier might do the whole job.

The purpose of this article will be to describe two different setups that achieve the above end, using specific equipment.

The first system involves the use of six Magnecorder, PT-6 series, mechanisms. In our actual case we built the entire amplifier including the equalizer circuits. This was before the PT-7C amplifier came out. It would be advisable at the present time to buy a PT-7C and connect on a "home brew" final amplifier.

The solution is quite simple. You just build six push pull amplifiers with a common input. Each amplifier terminates with a hi-fi output transformer feeding a recording head, as shown in *Fig.* 1.

Bias Oscillator Heterodynes

The reader might think on first observation that all the heads could be driven from a single, more powerful amplifier. In the case of Magnecorders this is not possible because each mechanism has its bias and erase oscillator self-contained. Since more than one is being used the bias frequency varies slightly from machine to machine and heterodynes would be produced if record heads were paralleled.

Using separate final amplifiers did not completely solve the heterodyne situation. Using a common power supply for all of the oscillators created heterodynes about 20 db below zero level. To remedy this, 50-kc wave traps were inserted in each B+ lead. Each of these is composed of a 10-mh r.f. choke and a .001-μf mica capacitor (L_1 and C_1 in *Fig.* 2).

Some time after this system went into operation, conversion kits changing the mechanisms to three heads were obtained.

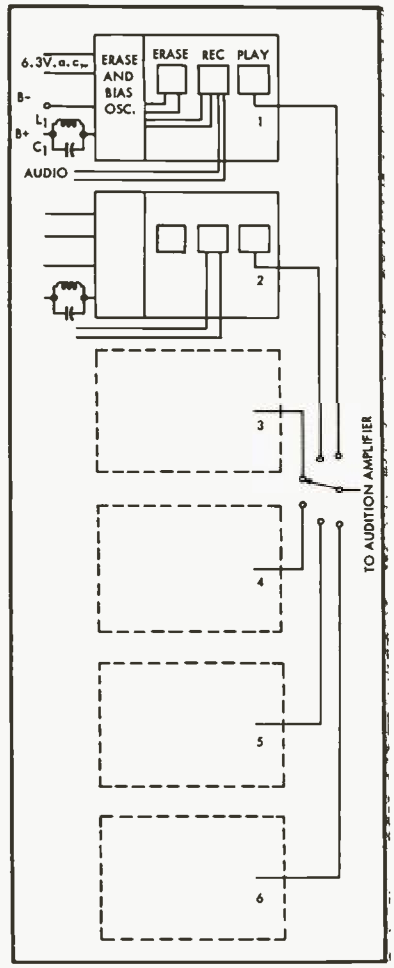

Fig. 2. Block diagram of connections to play heads of six recorders to permit audition of any one of them at will.

The output from the third head was then fed through a six-way selector switch to an audition amplifier so that spot checks might be made on each tape in the process of copying. If a console with audition facilities is to be used in conjunction with the equipment the third heads can be sent through the selector to a spare mike channel. This will result in loss of bass but still will suffice

(*Continued on page 78*)

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Semi-Solid Corner Enclosure

H. P. FOERSTER*

Having once lived with a slate loudspeaker baffle, this reader has gone onward toward a more practical material, and in doing so he comes up with a cabinet which combines some of the tried and proven principles of several other designs.

Some Audio readers will recall my solid enclosure described editorially in March '53 issue. As a result of that experience I devised the following enclosure for fitting my 18-inch Baker speaker into a corner of my living room. Basically, it consists of a "modified-RJ-distributed port-bass reflex" built in a corner as shown in *Figs.* 1 and 2. The semi-solid feature is obtained by bolting the front panel and mounting board (both cut from half-inch asbestos cement board) to birch hardwood corner posts cut from 3 × 4" stock as per *Fig.* 4. The two back panels, the top, and the bottom (cut from ¾-in. plywood) are then attached as a necessary evil in order to form an enclosure. Note that this construction allows only two parallel faces—top and bottom—which are reinforced by 4-inch strips of ¾-in. plywood to form lips for the front panel to fit into. Also, the top and bottom as well as the back panels are liberally padded inside with under-rug cocoa-matting. This results in a negligible vibration as compared to none with the previous concrete job.

* *1951 De Maricourt St., Montreal 20, P.Q., Canada.*

Fig. 1. The completed enclosure, with the baffle itself covered with a suitable grille cloth.

First, the cut-out in the front panel was made approximately 70 sq. in. in area and gradually increased to a final 160 sq. in. area shown as listening tests appeared to favor the larger aperture. Considerable experimenting was done with damping of ducts, damping of holes, variation of number of holes, etc., but the configuration as finalized was decided the best by listening tests and frequency runs with audio oscillator. From *Fig.* 3, it will be seen that the twenty-eight half-inch holes are concentric through the front panel and mounting board—thus the back emission of the speaker has multiple exits of varying path lengths—two RJ-type ducts of unequal length, two distributed port areas, and combinations of both.

A good woodworker would no doubt fit the plywood into rabbited corner posts but I used butt joints, casein-glued and liberally put together with 1½-in. wood screws. The asbestos-board panels are bolted to corner posts with ten ¼-in. flathead stovebolts with lock washers under the nuts.

For mounting feet I sawed two three-inch sponge rubber balls in half and glued the halves to the bottom panel. I also glued two strips of ¾-in. square felt to the lid just behind the corner posts to hold the enclosure away from walls and clear baseboards—thus the weight of unit holds it into the corner.

Half-inch asbestos cement board is available in 4 × 4 ft. sheets. These weigh

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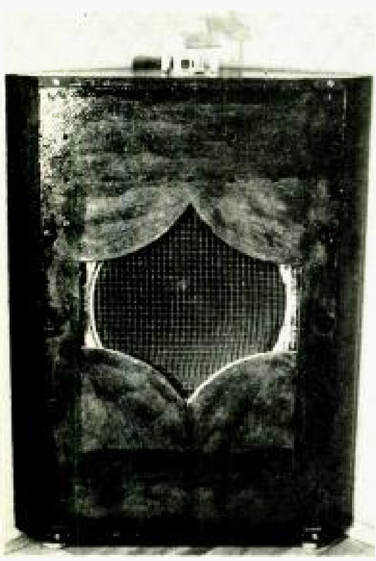

Fig. 2. With the "furniture" front panel removed, the arrangement of baffle, distributed ports, and loudspeaker protective screen can be seen clearly.

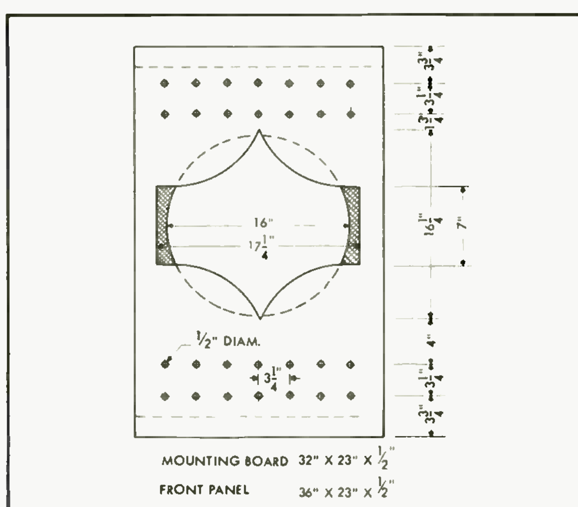

Fig. 3. Dimensions of the asbestos-cement board which comprises the baffle.

A Folded Horn Design

RICHARD A. GREINER*

The ways of folding horns are myriad—but there is always room for one more. This one gives excellent horn loading to two low-frequency drivers, and provides space for midrange cones and tweeters.

WAY BACK IN 1950 the author decided to look into the problem of designing a speaker system which would be superior to those then in common use. The object of any of the enclosures is to get the electrical power output of the amplifier into the room as acoustical power, and at the same time keep the over-all distortion of the system very low. The corner horn, which was then coming into use, seemed to be superior to any other type of speaker enclosure.

A properly designed corner horn is able to meet the requirements of high efficiency and low distortion quite well. However, one additional requirement which many corner horns do not meet is that of ease of construction. The reason for the complexity of construction is largely due to the length of the horn needed to couple a small throat area to the necessarily large mouth area with a smooth gradual taper. It seemed that it might be possible to simplify the construction of the horn by making it shorter, thus eliminating many of the tortuous turns and discontinuities usually present. These discontinuities are a source of unwanted resonance and give some horns a characteristic sound which colors the music being reproduced in an undesired and uncontrollable way. In order to meet the requirements of low-frequency cutoff, the mouth of the horn must be large regardless of the length. The other factor controlling the cutoff is the taper of the horn. For a given mouth area and taper the short horn must have a larger throat than the longer horn. This means that possibly several speakers would have to be used to drive the shorter horn. This fact is not necessarily a disadvantage as will be seen directly.

Even the best speakers are very nonlinear devices. If a speaker can be used at a small fraction of its rated power, the speaker cone will move very little and that motion which does occur will be over the most linear part of its possible range. There is no standard method of rating speakers used by manufacturers that is known to this author at present. One method which has been commonly used is to place the speaker to be rated in a suitable enclosure and then increase the audio power delivered to it from a sweep generator until the speaker fails mechanically. The power rating is then set at that value of power at which the speaker is destroyed. The whole problem of speaker power handling capacity and speaker distortion is a very difficult one since there are so many parameters to control. One can only hope that the speaker manufacturers will give the audiofan as much actual test data as possible for individual evaluation. At best, an intermodulation distortion of 1 to 2 per cent at a level of 1 watt is attainable with a speaker rated at 20 watts. The average power that a system in a large living room may be called upon to deliver is only a fraction of a watt. However, there is no longer much argument that peak powers of tens of watts are reached in peak level passages. The necessity for using several speakers to drive a short horn may now be seen to be an actual advantage in that, the large power-handling capacity available in several speakers, while not always used, does provide for much more linear operation of the speakers.

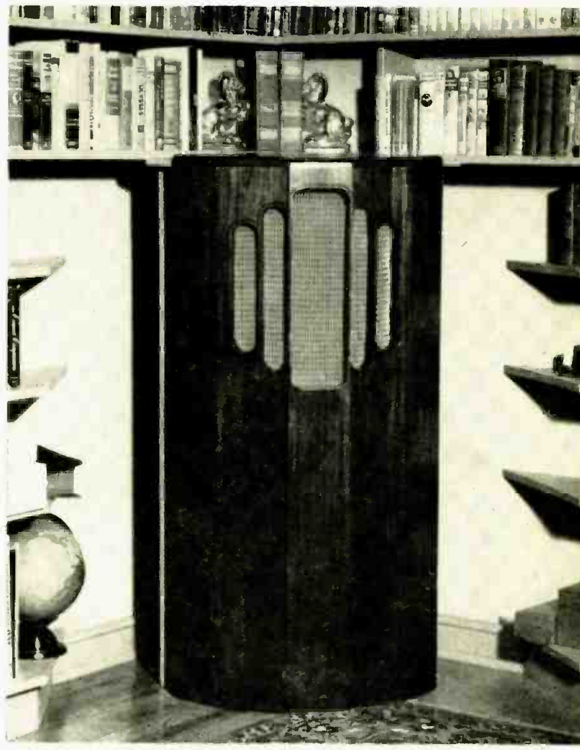

Fig. 1. Front view of the completed corner loudspeaker cabinet.

Description

For the horn to be described, *Fig.* 1, it was decided to use two high-quality 15-inch speakers for the bass section. These speakers have a power handling capacity totaling 70 watts and enable one to use a throat area of about 160 square inches.

If the mouth area and the taper are both selected to give a 35-cps cutoff it is possible to make the horn only 52 inches long. It is easy to provide for this length by using only one fold at the corner of the room. As can be seen in the diagram, the plan view of the horn is quite simple. All of the panels shown are the same length—50 inches. This alone simplifies the construction. The taper of the horn is approximated by straight sections as is the case for most

* *College of Engineering, University of Wisconsin, Madison 6, Wis.*

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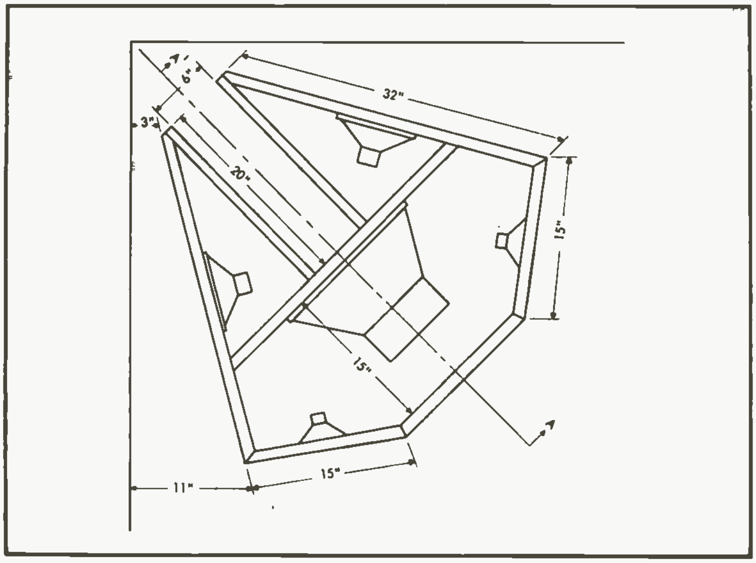

Fig. 2. Plan view of the horn-loaded cabinet, showing the two mid-range cones in the return sides, two tweeters on two front panels, and the position of the 15-in. woofers.

folded horns. Though the actual dimensions of the horn are not at all critical, some features of the construction are. The structure must be solid. The main exterior of the horn should be made of 1 inch laminated or other heavy wood. The internal partitions may be made of ¾ inch panels. It is essential that the volume behind the speaker be tightly sealed off in order to provide the proper loading to the backs of the speaker cones.

The finishing of the front of the horn is largely a matter of personal taste. In the horn shown, a panel made of 2-inch mahagony planks glued together and finished into a curved shape for an earlier speaker enclosure was used. There are two triangular shaped regions which are used to house the midrange speakers. These speakers bounce their sound off of the wall. The tweeters used must be of the completely enclosed type, either horns or cone type with enclosed shields over the back, and may be mounted in the front panel of the horn. In the horn pictured, two Jensen tweeters are mounted behind the grill cloth at an angle to one another to provide wide-angle high-frequency coverage. The bass speakers are Jensen P15-LL types. It is desirable to use amplifiers with low internal impedance to drive a horn. In order to accomplish this there are *no speaker crossover networks* used with this system. Instead, three amplifiers are used to drive the three ranges. An electronic crossover with level controls for the individual sections in order to adjust for the different efficiencies of the speakers is used. Quite conventional triode feedback amplifiers designed by the author deliver 40, 20 and 10 watts to the bass, mid, and treble ranges respectively. Crossover points of 350 and 4000 cps are used.

Performance

After listening to this system for a long time, it was found that there is almost no point at which the music is *too loud*. This frequently heard phrase is usually directed at systems which are

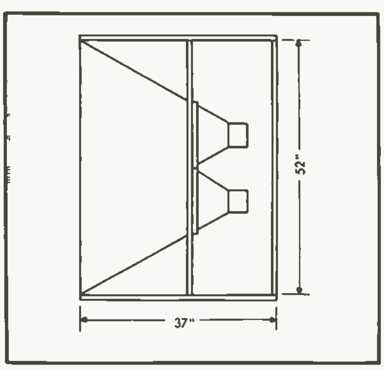

Fig. 3. Section through A-A of Fig. 3 to show flare at top and bottom of main horn.

being played at much lower than realistic intensities, not because of the loudness but rather because of the distortion in the system. To a point, music sounds fuller and better when it is played at close to concert hall intensities, if the distortion is low. The system described coasts most of the time and there is no listening fatigue. That this design is versatile is witnessed by the fact that a scaled up model of this horn using two 18-inch speakers was built by a friend of the author and gives astounding response and realism.

It is hoped that the description of this simple and rugged system will lend encouragement to others to build a reliable and *adequate* sound system and then to listen to and enjoy the music of their choice.

COMING EVENTS

Jan. 23–25, 1957—Very Low Frequency Propagation Symposium, National Bureau of Standards' Boulder Laboratories, Boulder, Colorado. Sponsored by NBS Boulder Laboratories and the IRE Professional Group on Antennas and Propagation.

Feb. 4–8—West Coast Convention of the Audio Engineering Society, Ambassador Hotel, Los Angeles. Annual banquet on evening of Feb. 4 in Cocoanut Grove; papers presented on Feb. 7–8. Grant Graham, Triad Transformer Co., Venice, Calif., section chairman.

Feb. 6–9—Los Angeles High Fidelity and Music Show, presented by the Institute of High Fidelity Manufacturers. Ambassador Hotel, Los Angeles.

Feb. 15–18—San Francisco High Fidelity and Music Show, presented by the Institute of High Fidelity Manufacturers. Hotel Whitcomb, San Francisco.

March 18–21—IRE Annual Convention and Radio Engineering Show. The Coliseum, New York City.

Apr. 9–11—Fourteenth Annual British Radio Component Show, Great Hall, Grosvenor House, Park Lane, London, W. 1, England. Admission by ticket only, obtainable from the Radio and Electronic Component Manufacturers' Federation, 21, Tothill Street, London, S.W. 1.

Apr. 12–15—The London Audio Fair, 1957. Waldorf Hotel, Aldwych, London, W. C. 2.

April 28–May 3—81st Convention of the Society of Motion Picture and Television Engineers, Shoreham Hotel, Washington, D. C.

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by R. W. Mitchell, Mich

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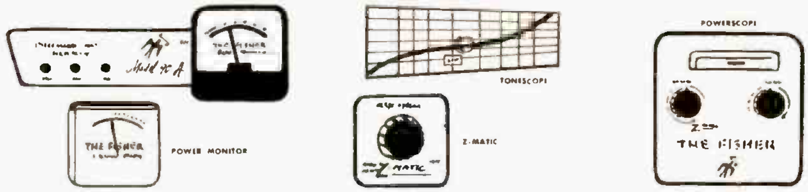

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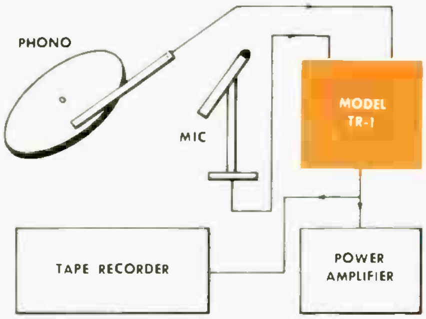

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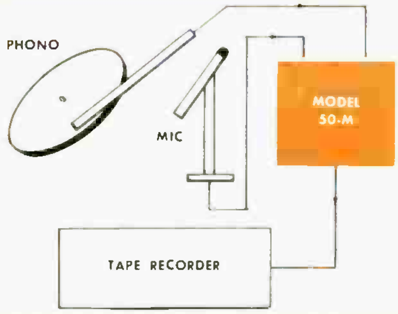

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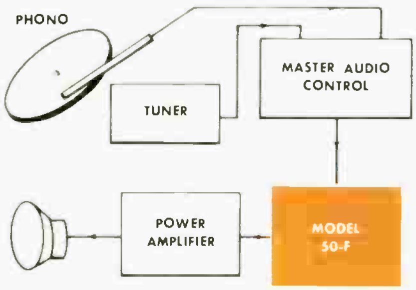

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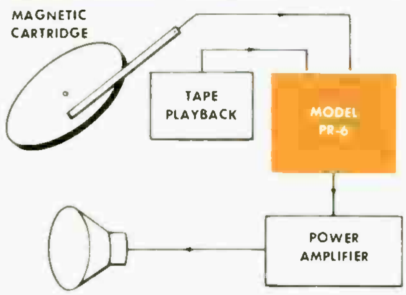

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Stabilizing Transistor Amplifiers

RICHARD H. SMALL*

Another approach to the problem of stabilizing transistors so that they will continue to perform predictably over a long period of time. The author shows how the typical stabilizing circuits are developed.

SINCE THEIR INTRODUCTION some years ago, transistors have been applied to many fields of electronics. Attempts to replace vacuum-tube circuits with circuits utilizing transistors have met with frustration for several reasons.

1. The transistor, unlike the tube, is a *current* amplifying device.
2. Transistors, as yet, cannot be produced with uniform properties.
3. Transistor properties vary with temperature.

One of the worst blows dealt by well meaning people to the popular acceptance of transistors is the publication of circuits which tend to accentuate the shortcomings of transistors. Actually, transistors are capable of excellent, dependable performance when used with proper circuitry. In this article, a very popular transistor amplifier circuit will be shown to be basically undependable because it does not allow for normal transistor variations. An improved circuit will then be presented.

First, let us consider the popular grounded-emitter amplifier circuit shown in *Fig.* 1. The poor dependability of this circuit has led many experimenters and manufacturers to believe that transistors are perverse little devices that are far inferior to vacuum tubes.

The transistor is biased as follows: Since the base to emitter voltage is negligible in a transistor, R_1 determines the base current i_b:

$$i_b = \frac{V}{R_1}.$$

* 1180 Rubio St., Altadena, California.

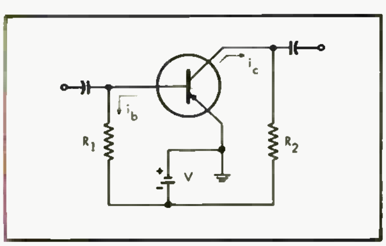

Fig. 1. Typical circuit for a low-power transistor as shown in many of the experimental applications. No provision is made for stabilization.

TABLE I

β	i_c, ma.	v_c, volts
10	0.34	6.6
13	0.41	5.9
15	0.51	4.9
18	0.62	3.8
24	0.93	0.6
31	0.98	0.2

The grounded emitter current gain is

$$\beta = \frac{i_c}{i_b}.$$

Thus the collector current will be

$$i_c = \beta i_b = \beta \frac{V}{R_1}.$$

The collector voltage will be

$$v_c = V - i_c R_2 = V\left(1 - \frac{\beta R_2}{R_1}\right).$$

For maximum swing each side of the operating point, the collector voltage should be one half of the supply voltage, or

$$v_c = \frac{V}{2}$$

Therefore

$$\beta \frac{R_2}{R_1} = \frac{1}{2}.$$

and the value of R_2 must be

$$R_2 = \frac{1}{2} \frac{R_1}{\beta}.$$

Now we can see that for the fixed base current provided by this circuit, the collector current and collector voltage are dependent on β. This property, the grounded-emitter current gain, will vary considerably among any group of identically labeled transistors, often as much as a factor of two to one. Also, the value of β is temperature dependent. The result is that the operating point will vary with temperature, and replacement of the transistor may cause the circuit to become completely inoperative.

Example

To illustrate this effect, let us design such a circuit around a CK722 transistor. For this transistor, a typical value of β is 15. If we select $V = 10$ volts, and $i_c = 0.5$ ma, we can calculate

$$v_c = \frac{V}{2} = 5 \text{ volts},$$

$$R_2 = \frac{v_c}{i_c} = 10{,}000,$$

$$R_1 = 2\beta R_2 = 300{,}000.$$

The measured values of collector current and collector voltage for this circuit are shown in Table I for several transistors with different values of β. For the last two transistors, the collector voltage is so low that operation as an amplifier will be seriously impaired.

It is easy to see the analogy between this circuit using fixed base current biasing, and the vacuum-tube circuit using fixed grid voltage biasing. This vacuum-tube circuit is well known to be unstable with respect to changes in tube transconductance.

Since we have thus far found an analogy between the transistor circuit of *Fig.* 1 and the vacuum-tube circuit with fixed grid bias, perhaps we can develop a better transistor circuit by analogy with an improved tube circuit which is already well-known. Such a tube circuit contains a resistor in series with the cathode, of such a value that the voltage developed across it by the passage of the plate current is equal to the required

(*Continued on page 76*)

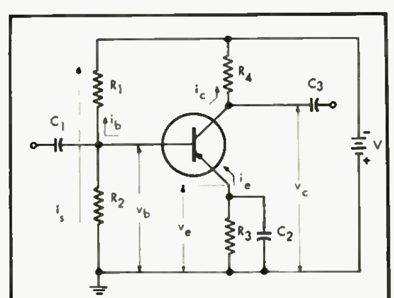

Fig. 2. By the addition of the voltage divider R_1–R_2, the potential of the base is held fairly constant even though the emitter current may change appreciably.

Features of Patent-Licensing Agreements

ALBERT WOODRUFF GRAY*

The interest in patents and in court decisions affecting the validity and effectiveness of them is particularly important to the inventer, especially considering the most recent decisions. The author gives a resume of some of the earlier law on the subject.

Suit by the Zenith Radio Corporation against the Radio Corporation of America, Western Electric Company, and General Electric Company asked a court decree that thousands of radio patents pooled by these companies be held unenforceable against Zenith. In answer, Radio Corporation of America and the others charged Zenith with the infringement of these patents.

To this Zenith maintained this patent pool was "part of a plan or conspiracy to dominate and monopolize in violation of the anti-trust laws." As a consequence of these acts, it contended, the owners of these patents were abusing the privileges of the Federal patent system and had forefeited any right they otherwise might have had to the protection of these patents by the courts from infringement. This it followed with an application that brings into sharp outline the distinction between the licensing of a patent and its assignment.

Two other companies, the American Telephone and Telegraph Company and Westinghouse Company, contended Zenith, were co-owners of these pooled patents and that, as they were interested parties in the claim of infringement and had not been made parties to the suit, the claim for infringement should be dismissed.

In a decision of the United States rendered over a century ago it was held that those parties are essential to a lawsuit "who not only have an interest in the controversy but an interest of such a nature that a final decree cannot be made without either affecting that interest or leaving the controversy in such a condition that its final determination may be held inconsistent with equity and good conscience."[1]

On the authority of this old ruling Zenith pointed to the omission of these other interested companies and demanded a dismissal of the infringement charge on this ground of a failure to include all those interested in the controversy.

The court said of the provisions of these patent pooling agreements, in holding that these other companies were licensees not owners and hence, not interested parties.

"Each party to the agreements, including American Telephone and Telegraph Company and Westinghouse Electric Company, shares with the nominal owner and independently exercises in its fields the vital right to grant or withhold licenses and the concomitant right to collect and retain under such licenses, as well as to control and share, any recoveries in infringement litigation and to grant releases for past infringements with respect to all the patents in the pool."[2]

Then resting its determination of this contention of Zenith on that century old decision of the Supreme Court, the Federal District Court said of the distinction between the licensees and the assignees of a patent,

"Two constituent property elements of distinct source, nature and divisible content inhere in every patented invention. One is the property in the invention itself—the right to make, use or sell the patented article personally or through others—the second is property in the monoply—the right effectively to prohibit others from practicing the invention or profiting therefrom without the owner's consent.

"Means of transferring these two property rights have pertinence here and vary greatly. Rights in the invention itself may be transferred either separately or together, upon one person or many, and each may, independently of the others, use the rights received. The monopoly is indivisible except as to locality, although several assignees may jointly hold the undivided interest in the patent.

"When the patentee conveys the exclusive right to make, use and sell the invention he has no longer any occasion for the exercise of the prohibitory powers created by the patent, while they become essential to his alienees for the assertion and vindication of their exclusive rights. If he transfers the undivided portion of the entire interest in the invention he thereby confers upon his transferees rights equal to his own in all respects in the invention and receives them into copartnership with himself in the monopoly which is now as essential to their protection as it was to his."

In the formation of this patent pool in this litigation however, the agreements between the parties were not assignments of patents but "non-exclusive licenses."

Non-exclusive Licenses

Of this feature of this controversy the court said, "The term 'non-exclusive' is a key description of the extent of the patentee's conveyance, be it applied to a vital right such as sublicensing or a lesser fringe benefit under a patent. It spells the difference between the patentee abandoning the field or any part of it in favor of his alienee or retaining the paramount rights to his monopoly to which his patent entitles him. To my mind it cannot be a door through which one can enter into co-ownership. A true non-exclusive conveyance is inconsistent with co-ownership status in patents.

"If it were, any bare license would qualify for ownership. A non-exclusive grant, in fact, demonstrates the opposite. By it a patentee expressly negates the exclusion of both himself and all others to whom he may later choose to grant rights of the same or even greater calibre. Having conveyed only non-exclusive rights, the patentee retains all others and through them continues his dominion over the monoply."

Recently another patent licensing agreement, of which there are legion in the industries of this country, came before the Supreme Court for consideration in a suit to recover unpaid royalties. This non-exclusive license agreement, covering 570 patents and 200 applications of the Hazeltine Research, granted

(Continued on page 56)

* 112–20 Seventy Second Drive, Forest Hills, New York

[1] Shields v. Barrow, 58 U. S. 129, page 139 (1854)

[2] Zenith Radio Corp. v. Radio Corp of Am., 121 F.S. 803 May 20, 1954

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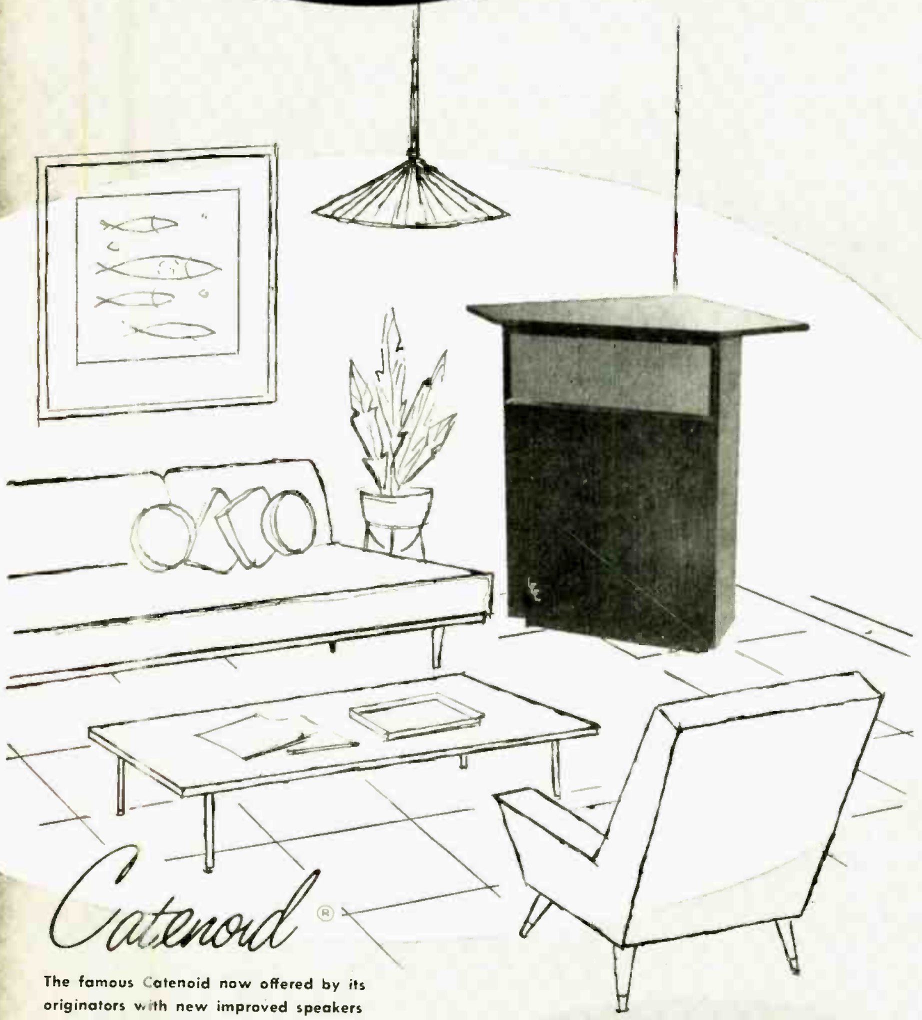

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Equipment Report

Heathkit Speaker System (SS-1) and Range Extending System (SS-1B)—Tannoy "Variluctance" phonograph pickup cartridge—Stentorian line of loudspeakers and accessories—Additional information on the AMI model R-1250 amplifier.

In this age of "do-it-yourself" activity, there does not seem to be any end to what the ambitious and enterprising individual may put together, either from scratch wherein he actually does all the work himself—as Audio readers have done with amplifiers and speaker enclosures for years—or with the aid of a prepared kit which has much of the more difficult work done already.

The assembly of pre-cut wood parts into various types of furniture makes it considerably easier for the average individual—and by that we mean one who is not equipped with power saw, router, joiner, planer, and the many other items which grace the hobby shops and mail order catalogs—to complete a desired unit with the assurance that it will not look "homemade" when it is put in the parlor alongside the products of Grand Rapids. Fortunately, there are many speaker systems which are available in kit form, and by and large they work out to be just as satisfactory as their "store-boughten" counterparts.

Not all, however, have all of the advantages of the Heathkit speaker system—that of starting with a comparatively inexpensive unit which gives good quality of sound in itself, and then adding to it the means for reproducing perhaps an octave at the top end and probably more than that on the bottom. The final result is that the builder acquires a four-way system that performs remarkably well, and he does it with surprisingly little effort—except the finishing. Lucky is he whose furniture is of the painted type, for he can avoid much of the work of rubbing and polishing.

The SS-1 "Basic" System

In the normal course of building the complete Heathkit speaker system, it is likely that a person would begin with the basic system (the term "basic" is ours, since Heath offers no such simplification) which consists of a ducted-port bass-reflex enclosure measuring 11½ in. high, 23 in. wide and 11¾ in. deep. Its external appearance is shown in *Fig.* 2. This unit employs two speaker mechanisms—an 8-in. cone and a compression driver with an exponential horn, both of special design, and both built by Jensen. By the use of a series capacitor, the high-frequency unit does not function until approximately 1600 cps. When complete, the system will cover the range from 50 to 12,000 cps within ±5 db, according to specifications, and there is certainly audible output over this range.

Range Extending System

The larger section of the entire system consists of another ducted-port bass-reflex enclosure which houses a heavy-duty 15-in. woofer cone and a super-tweeter—the former extending the range downward and the latter extending it upward. The tweeter is installed against the front baffle with an air-tight gasket so the high pressures normally generated in a bass-reflex enclosure do not damage it—as they would be sure to do if the delicate diaphragm of the super-tweeter were open in back. The range extending system, shown in *Fig.* 1, is the same width as the basic unit, and is 29 in. high. It is designed to serve as a base for the smaller unit, and when the two are connected together the dividing networks (two of them) in the range extending system divide the frequency range into three parts—the lowest being fed to the woofer and the highest to the super-tweeter, while the midrange band is fed to the smaller cabinet. Thus the woofer works from 35 to 600 cps, the 8-in. cone from 600 to 1600 cps, the compression driver and horn from 1600 to 4000 cps, and the super-tweeter handles all the frequencies above 4000 cps.

Construction

All the wood pieces are cut to size and beveled or grooved as required. It should be possible to put the smaller unit together easily in less than two hours, and the big one goes together in about four—both of these figures exclusive of sanding and finishing, of course. The two front frames are completely assembled and require only final sandpapering to be ready for the finishing operation. The internal construction of the basic system is shown in *Fig.* 4.

Electrical Circuitry

Figure 3 is a schematic of the two units in working form, with the smaller system shown enclosed in dotted lines. The dividing networks are of the constant-resistance type, with the parallel configuration. A switch (not shown in the schematic) permits testing of the separate sections, and

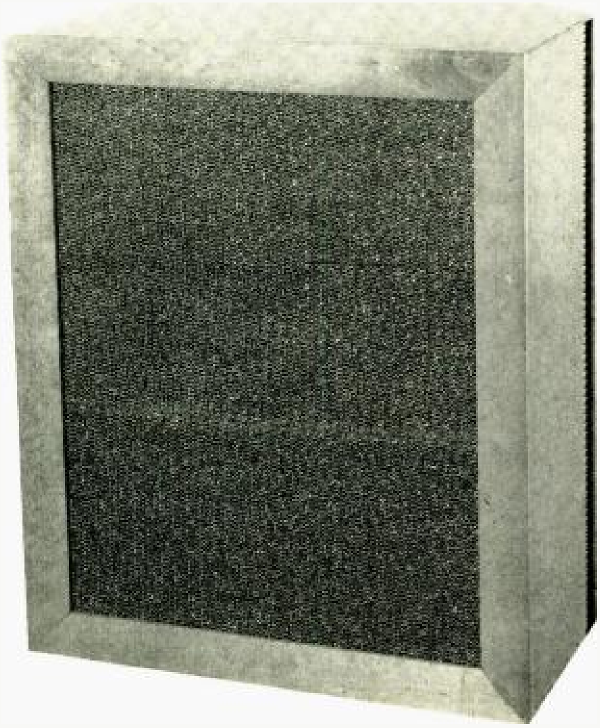


Fig. 1 (left). The Range Extending system occupies a sturdy and solid ducted-port bass-reflex enclosure which houses a 15-inch woofer and the little super-tweeter, as well as two dividing networks with crossovers at 600 and 4000 cps. Both employ air-core coils and paper capacitors. Not intended to serve as a complete speaker system by itself, this unit is designed to work with the basic speaker system, Fig. 2 (below) which consists of an 8-in. cone and a compression driver with a short exponential horn. The smaller unit may be used by itself, however, to cover the entire range.

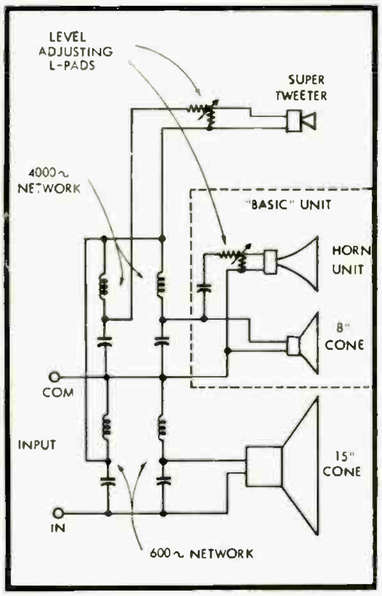


Fig. 3. Simplified schematic of the complete system. Section enclosed in dotted lines is the system in the small cabinet.

individual level-adjusting controls make it possible to balance the system quite accurately, although the balance between the 15-in. woofer and the lower-midrange 8-in. cone depends upon the built-in sensitivity of the two mechanisms.

Performance

While no attempt was made to make absolute measurements on the system, it was compared with another of accepted high quality on an A-B test basis and the Heathkit system is judged to compare favorably. Our simple test for the lowest frequency that a speaker system will reproduce *as a loudspeaker* (that is, not like a sail flapping in the wind) is to play the scale portion of side 2 of "The King of Instruments" organ record, Vol. 1. The scale, which appears about the center of the side, commences at 16 cps and progresses upward in the scale of C. In using this test, one observes the first note at which the tone has a definite musical pitch and ceases to be just noise. By counting up from C, this note may be located very easily, and the frequency of the lowest note which has a musical tone may be said to be the lowest frequency that the speaker will reproduce. Using this method, the note at which the system became musical was B. which is approximately 30 cps. The lowest we have ever heard on any system is G, or 24 cps.

Without question, the performance of this system belies the simplicity of its construction. Some slight experimentation with the small system leads us to the belief that the cabinet needs some internal damping, since it seems to sound better (in our environment) with about four square feet of Ozite for padding, making sure to avoid getting any padding adjacent to the duct. Lacking the Ozite, it is probable that the Kimsul used in packing the kit would serve equally well if tacked carefully on the inside of the cabinet.

It is difficult to evaluate the need for padding in the large cabinet, but it seems likely that it might help to reduce any vibration of the cabinet walls. Actually, very little such vibration is noticed because of the self-bracing construction, but we have a preference for some damping in any speaker enclosure. However, without any padding whatsoever, the complete system will certainly be considered an improvement over the vast majority of systems now in use—as might be expected from the lineup of speaker mechanisms and the design of the cabinets. D-18

THE TANNOY "VARILUCTANCE" CARTRIDGE

One of the older standbys among the many phonograph pickups on the market is the Tannoy "Variluctance" cartridge, which has always seemed to perform with audible smoothness whenever it has been demonstrated at the audio shows. The tests show why it "sounds good," since there is almost no peak in the performance curve throughout the entire range, and the slight boost at the top is rounded off so that there is no noticeable coloration.

Measurement of pickups is likely to result in a portrayal of the response of the particular record under test. In the first place, most good magnetic pickups will turn in a smooth curve up to about 10,000 cps, since practically none of them has any resonance below that frequency. Therefore, if one record is used for a series of tests, the resulting curves will all have the same general characteristics. In our testing of pickups, the Cook Series 10 disc is used—the one designed for 78 rpm. This brings up the question of Vinylite resonance, since all measurements are made at 78 rpm and yet the pickups are used at 33⅓. However, as with many other "semi-rigorous" tests, if the same equipment and methods are used for all, the tests may be considered directly comparable.

The curve of *Fig.* 5 shows the response measured from a new Cook record, which shows a difference in response of 3 db at 10,000 cps over one that had been in use for some time, but both resulted in smooth curves. By direct comparison, some pickups will be found to have a definite resonant peak—in many cases of as much as 10 db—before the final dropoff, and the listening tests show this by a ringing tendency at the higher frequencies. This is called by some a "peaky" response. None of that is noted in the Tannoy, however.

The Tannoy should be considered a low-level pickup, since its output is 21 mv for a stylus velocity of 10 cm/sec. This means that the maximum output from this pickup will practically never exceed 40 mv, even on the loudest records. Certain preamplifiers will overload when the pickup output is too high, and if this condition is suspected, the Tannoy would be a good choice.

The cartridge is a turnover model, fitted with two easily replaceable diamond styli, one for microgroove and one for standard. Response on both sides is practically identical both in shape and level. The unit is designed to work with a load of 47,000 ohms, and of itself has a d.c. resistance of 775 ohms and an inductance of 300 mh, resulting in a source impedance of 2050 ohms at 1000 cps—a figure which is of no importance with conventional input circuits to the preamplifier. Optimum tracking force, as far as intermodulation is concerned, is 6 grams, so that the unit may be used with changers without having to work at a stylus force above the optimum, which we consider the point at which the intermodulation distortion is minimized, and it is well known that changers rarely give thoroughly satisfactory operation with stylus forces of less than 6 grams. D-19

THE STENTORIAN LINE OF LOUDSPEAKERS AND ACCESSORIES

One of the largest of the imported lines of loudspeakers is the Stentorian, which ranges all the way from a duplex 15-in. model down to a simple and inexpensive 6-in. cone, with excursions into the area of super-tweeters, crossover units, and constant impedance controls.

We have had an opportunity of testing four of the speakers—a 12-in. full-range unit, *Fig.* 6, and 10- and 8-in. cones, and the 8-inch high-frequency model housed in an attractive wooden box which would serve well as a tweeter in conjunction with an existing speaker deficient in highs.

The 12-inch model, HF1214, has a rather deep cone which is laminated (as all the Stentorian cones we have seen) from a conventional paper cone and a treated cambric which gives a certain degree of stiffness that is desirable to prevent breakup. The cambric extends beyond the paper section of the cone and serves as the surround, while the treatment makes the outer edge airtight as well as retarding reflections from the rim. One feature of the cones in all of the full-range speakers consists of cutting a number of 1⅝-in. holes in the cambric before it is laminated with

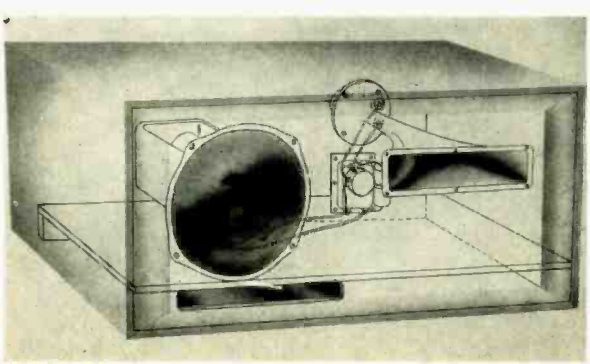
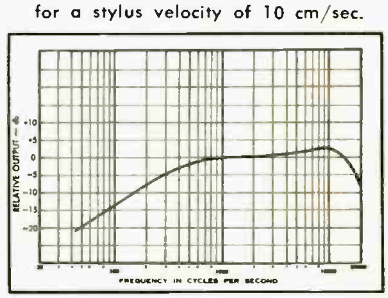


Fig. 4. Internal construction of the small system.

Fig. 5. Response curve for the Tannoy cartridge, run from the Cook Series 10 test record. Output at 1000 cps is 21 mv for a stylus velocity of 10 cm/sec.



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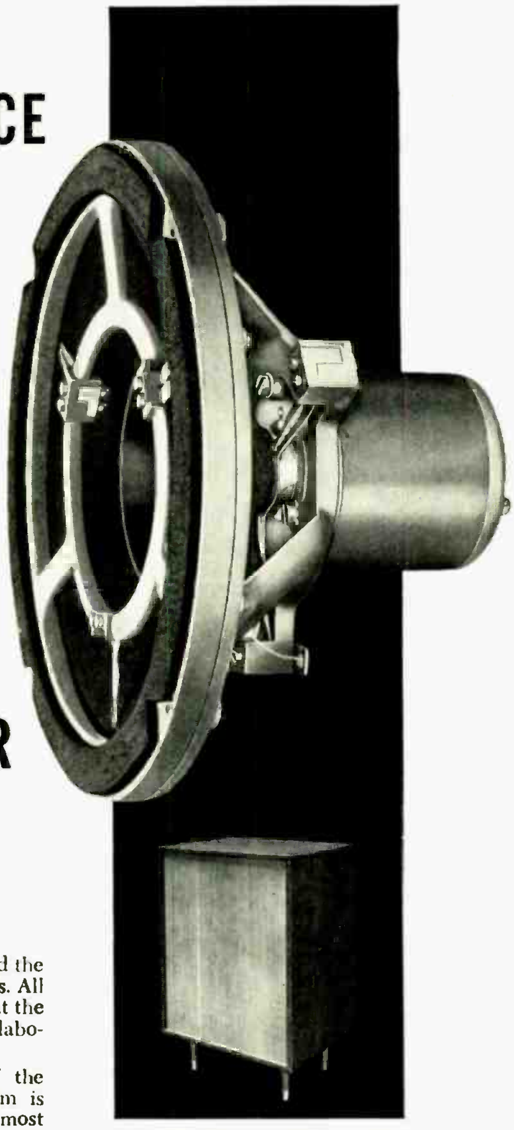
WITH A
SINGLE CHANNEL SPEAKER SYSTEM



GOODMANS
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AXIOM 80 LOUDSPEAKER
IN
'friction loaded'
ARU ENCLOSURE

The Goodmans Axiom 80 is a 10-inch, twin-cone, full range loudspeaker, whose performance, in a proper enclosure, is as astounding as its unique design.

The most revolutionary advance embodied in the Axiom 80 is its achievement of *free cone suspension*—the theoretical ideal that permits the cone to move as a true piston at low frequencies, without restriction and without distortion. Another direct result is that the fundamental resonance of the Axiom 80 is only 20 cycles—lower than that of any other commercially available loudspeaker.

The new ARU Friction Loaded Enclosure represents the perfect solution to the enclosure requirements of this superb reproducer. The Axiom 80, mounted in a Model C-1800 ARU Enclosure, will reproduce true bass fundamentals down to 20 cycles—with no 'hangover' and without peaks above that frequency. Mid-range reproduction is clean and articulate and the 'highs' smooth to 20,000 cycles. All of this is accomplished without the use of special 'tweeters' and elaborate crossover networks.

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the paper cone, thus reducing the stiffness in parts of the cone so that there is little chance of any undesired local vibration in the cone itself throughout the midrange. These cutouts are known as "midrange stabilizers."

The HF1214 has a wider excursion range than most models of this size, being nearly ½ inch, and it is apparent that the voice coil does not get out of the magnetic field throughout the entire travel. The amplitude of the resonance peaks of all the Stentorian models tested seem to be relatively high, which might indicate that enclosure design would be rather critical. The frequency of the resonant peak of the HF1214 was measured at 30 cps, which is low for a 12-in. speaker unit. The output is of normal loudness for a given sound input, indicating an average efficiency.

In a listening test with the speaker mounted in an infinite baffle—in a wall between two large rooms—quality was good, and the low resonant frequency worked to give an apparent boost to the very low frequencies. The high end was smooth and pleasant to the ear.

HF 1012

This is a 10-in. model of similar design to the 12, but equipped with a voice-coil arrangement which may be used at 4, 8, or 16 ohms depending on the connections. Four terminals are brought out, the two sections of the voice coil being paralleled for 4 ohms, either one used alone for 8 ohms, and the two sections connected in series for 16 ohms.

The comments regarding this model on listening tests would be essentially the same as those for the 12-inch speaker, with the 35-cps resonant frequency aiding in

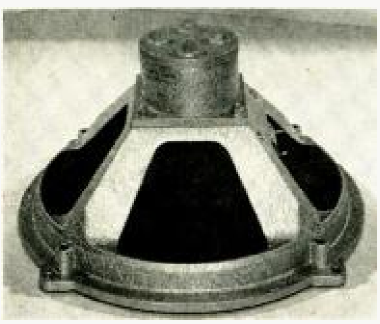


Fig. 6. Stentorian model HF1214, a 12-inch extended range speaker with a resonant frequency of 30 cps.

the low-frequency response. Over-all performance is such as to indicate that the unit would work satisfactorily in constricted space, provided it was matched to the enclosure carefully.

HF-812

This 8-inch speaker is similar in design to the 10 and 12, and shows a resonant frequency of 50 cps. It is also equipped with the two-section voice coil that will match 4-, 8-, or 16-ohm outputs.

A similar model in appearance is the HF816, which employs a 3½-lb. Alcomax magnet in contrast to the 2-lb. magnet used in the 812 and 1012 models. This model was not tested, though it would be expected to offer some advantages over the lighter model—as it should, since its cost is more than twice as great.

The Cabinet-Model Tweeter

Model T-816C consists of an 8-inch high-frequency speaker mounted in a polished mahogany enclosure measuring 13 in. wide, 10½ in. high, and 7½ in. deep. This model would serve well to enhance the high-frequency response of an existing loudspeaker without the need for modifying the present enclosure. It would only be necessary to add one of the crossover units available to result in a complete two-way system. The range of this unit is claimed to be from 1500 to 17,000 cps, and output is measurable above that range, with the response smooth to the ear; no pronounced peaks were noticed.

Two horn-loaded tweeters are included in the line, with model T-12 being shown in *Fig.* 7. This model employs a 9-lb. magnet, and offers considerable efficiency to the range from 3000 to 20,000 cps. The T-10 is much less expensive, and is only claimed to extend to 16,000 cps.

Crossover units are available for impedances of 15 ohms and crossover frequencies of 500, 1500, and 3000 cps. No level controls are incorporated in the networks, but constant-impedance balance controls are separately available, not only for 16 ohms, but also for 4 and 8 ohms. One of these units is shown in *Fig.* 8. Each consists of a wire-wound T-pad with ten steps of approximately 1 db per step and an additional "off" position. The switch proper is attached to a recessed plastic housing which mounts in a 2¼-in. hole, leaving the surface essentially flush.

Fig. 7. Model T-12 Super Tweeter—a heavy-duty horn leaded tweeter for the range from 3000 to 20,000 cps.

A study of the entire Stentorian line will indicate that practically any desired combination of speakers may be selected, together with the necessary dividing networks and level controls to provide a wide and varied range of speaker systems, in addition to the duplex concentric models designed to cover the range from 20 to 20,000 cps with the convenience of mounting only a single mechanism. **D-20**

FURTHER INFORMATION ON AMI R-1250 AMPLIFIER

Audio engineers at AMI differed from us in the measurement of the R-1250 amplifier, reported in this section in the September issue, and as a result we made a recheck in the manner which might be said to be more correct. This amplifier is equipped with an unusual output transformer because it is designed for use with multispeaker systems in addition to the more common single-speaker installation. The secondary of the transformer has five terminals, and the load range from 12 to 20 ohms is covered by one pair of terminals. In our normal method of measurement, this pair was fed to a 16-ohm load resistor, and the output power was measured for the distortion test on the basis of this load.

AMI engineers claim, however, that since the terminals may feed into a maximum impedance of 20 ohms, the amplifier should be measured under these conditions, and the power calculated accordingly. While we do not agree altogether with this idea—since it is not likely that the amplifier will be used with 20-ohm speakers—we must admit that there is some merit in their position, and in those cases where

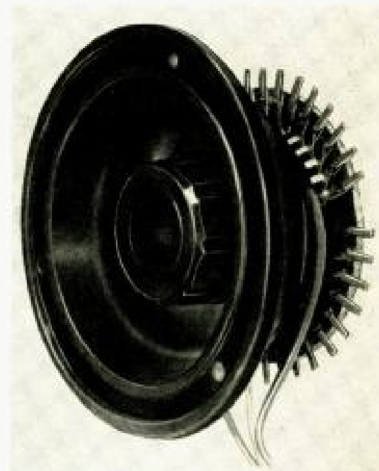


Fig. 8. Constant-impedance T-pad used for balancing levels between speakers, or for remote speakers in a complete home installation.

the speakers are more closely matched to the amplifier the available power output could surely be calculated by the manner suggested.

In any case, the amplifier was tested again with a 20-ohm load, and the power output calculated on this basis, with the result shown in *Fig.* 9. While the original measurement with the amplifier feeding into a 16-ohm resistive load indicated a power output of approximately 12 watts at 2 per cent IM distortion, the new measurement shows an output of 19 watts at the same amount of distortion.

In the interests of accuracy of presentation of this type of information, it is felt that the optimum conditions may well be considered as standard for test purposes, whether or not the amplifier is to be used under those exact conditions. We trust the presentation of the new distortion curve will indicate a desire to be fair in the testing procedure, and that it will give a truer picture of the performance of what is unquestionably an excellent unit.

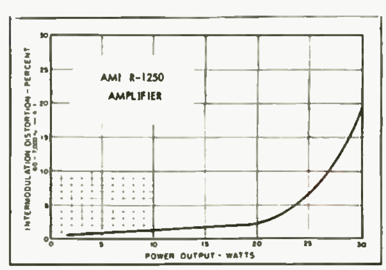
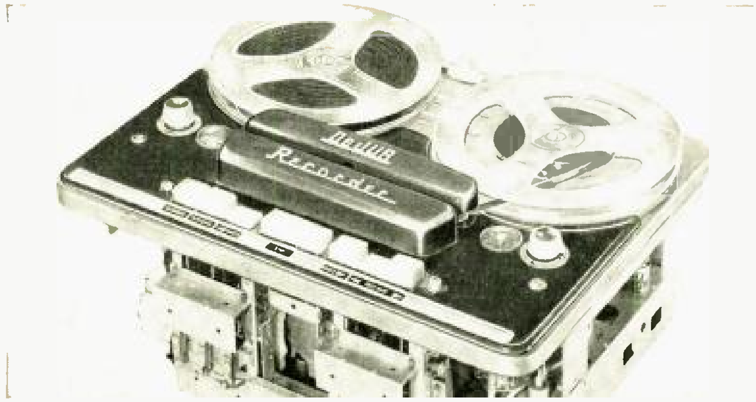


Fig. 9. Output vs. IM distortion curves for AMI R-1250 amplifier measured into a 20-ohm load.



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WOW AND FLUTTER. Less than 0.1% at 7½ ips, 0.2% at 3¾ ips (The competitive recorder closest in performance has 0.25% and costs $100 more!) Such a low figure is made possible by the use of a heavy-duty, dual-speed, reversible *hysteresis* motor (*not* a 4-pole motor) which is independent of line voltage fluctuations.

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PATENT LICENSING

(*from page 48*)

the licensee permission to use these patents in the manufacture of its "home products" and in return the licensee agreed to pay Hazeltine Research a minimum annual royalty of $10,000 on its sales of radio broadcast receivers. In its defense this licensee contended that this agreement was illegal and unenforceable as a patent monopoly.

"The mere accumulation of patents, no matter how many, is not of itself illegal," said the court. "This record does not support the incendiary yet vague charges that the patentee uses its accumulation of patents 'for the exaction of tribute' and collects royalties 'by means of the overpowering threat of disastrous litigation.'

"This licensee cannot complain because it must pay royalties whether it uses Hazeltine patents or not. What it acquired by the agreement into which it entered was the privilege to use any or all of the patents and developments as it desired to use them. If it chooses to use none of them it has nevertheless contracted to pay for the privilege of using existing patents plus any developments resulting from the patentee's continuous search. We hold that in the licensing of the use of patents to one engaged in a related enterprise, it is not of itself a misuse of patents to measure the consideration by a percentage of the licensee's sales."[3]

Another feature of these patent licensing agreements became the subject of an infringement action brought several years ago by the Western Electric Company. In this instance a notice on the carton containing an amplifying device was in part "The sale of this device carries a license only for (1) talking machine use, (2) radio amateur use, (3) radio experimental use and (4) radio broadcast reception and only where no business features are involved."

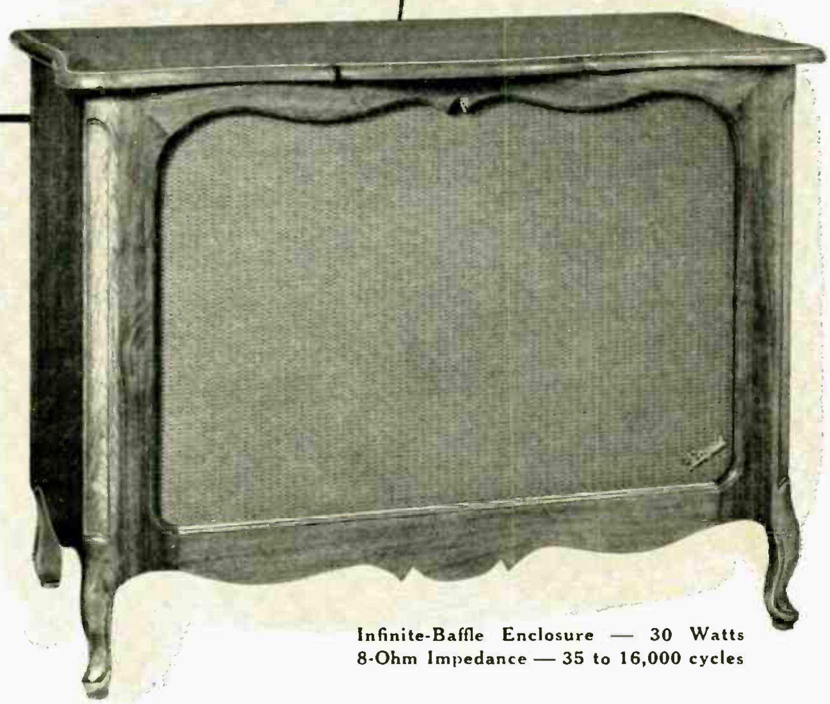
Use of these amplifiers in theaters in violation of this license restriction had been held by the lower courts to be an infringement of the amplifier patents. When that determination was sustained by the Supreme Court of the United States, it was said of such restrictions on the use of patented articles,

"That a restrictive license is legal seems clear. The patentee may grant a license upon any condition, the performance of which is reasonable, within the reward which the patentee by the grant of the patent is entitled to secure. The practice of granting licenses for a

(*Continued on page 66*)

[3] Automatic Radio Mfg. Co. v. Hazeltine Research, 339 U. S. 894, June 5, 1950

GOOD TO HEAR ... GOOD TO SEE



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AUDIOCLINIC ? ?

JOSEPH GIOVANELLI*

Mixer

Q. *I am interested in obtaining a mixer which will enable me to mix the outputs of two or three microphones and some high-level sources such as crystal pickups and tape recorders. Most of the units available for this purpose, capable of giving gain enough to feed a standard tape recorder input, are too expensive. Do you know of any circuit which will satisfy my needs? Roy Jacobs, Bronx, N. Y.*

A. *Figure* 1 shows a schematic of such a mixer. It has three separate channels, and each one can be used with either microphone or high-level input. J_1, J_2 and J_3 are the microphone inputs, while J_4 is the phono input for the first stage. J_7 is the output jack. When a high-level source is connected to any of the three inputs designed for it, the mike input corresponding to that channel is disabled by the switching action of the jacks used. This was done in order to prevent the shunting action of the mike stage from adversely affecting the frequency response. R_1 is a hum balancing potentiometer. Turn the volume up on all channels and adjust this for minimum hum. The impedance at the input of each microphone channel is 5 megohms, suitable for crystal or dynamic microphones. Matching transformers should be used if low-impedance microphones are called for. The impedance at the high-level inputs is 100,000 ohms. A voltage divider would therefore be needed if the 500,000 impedance required for most crystal or ceramic cartridges is to be arrived at.

Mixing action is accomplished in the plate circuits of the three amplifiers by virtue of their being connected through separate isolating resistors, as indicated by R_{11} to a common coupling capacitor, C_9.

It is possible to incorporate more than three channels, though there will be a shunting effect of load resistance, plus the capacitances of the tubes which will have an adverse effect upon the frequency response, as more and more channels are added.

The unit is built on a 5×10×3 inch aluminum chassis. If the unit is to be portable, a foundation chassis may be used, eliminating the need for any further housing.

Layout: There is a considerable number of components to be mounted and, to aid those who have not done much constructing of equipment, the placement of the major components will be described.

The power transformer, T_1, is mounted at the upper left corner of the chassis; below it is the rectifier tube, V_1, with the filter capacitor, C_4, to its immediate right. The front edge, then, is taken up by the rectifier, filter capacitor, and the three decoupling capacitors, such as C_{1A}–C_{1B} in the first stage. Behind each dual decoupling capacitor is mounted a shielded noval tube socket. On the left edge of the front apron is mounted the on-off switch, with the pilot lamp directly above it. The remaining space is taken up with the three potentiometers such as R_7, corresponding to their respective vacuum tubes. Proceeding from the transformer end of the rear apron, there are mounted the line cord grommet, fuse post, hum-balancing potentiometer, R_1, then the jacks for the third stage, and second stage, and first stage (J_1 and J_4) one above the other. All jacks are insulated from the chassis, as are the filter and decoupling capacitors. A ground bus is grounded to the chassis at J_1, and this bus runs through all ground terminals on the jacks and filter capacitors. When wiring all other circuit components, make all ground connections to the bus, never to the chassis. This type of wiring was done to minimize hum pickup.

Aside from the method shown in the schematic in *Fig.* 1, there are two alternative means for connecting the filaments of the three tubes. By connecting these filaments to a five-volt source rather than a six-volt source, noise output from the mixer is lowered, with some sacrifice in gain. The filaments could also be connected to a d.c. source rather than to alternating current, which would result in a considerable reduction in hum, although the hum is quite low anyway.

The unit may be constructed at a cost of between forty and fifty dollars, depending upon the components used.

* 3420 Newkirk Ave., Brooklyn 3, N. Y.

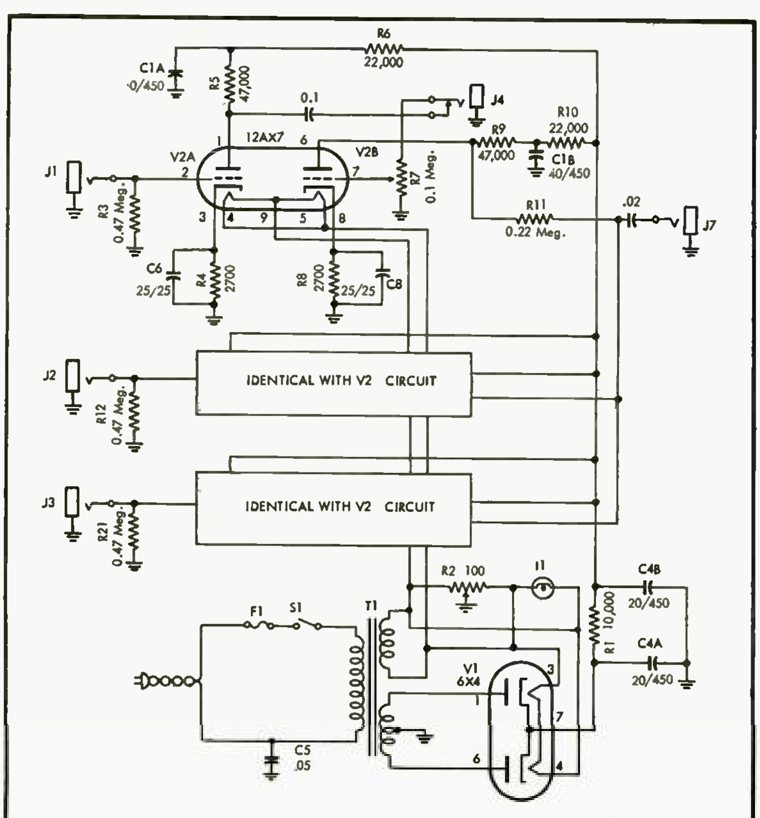


Fig. 1. Simplified schematic of three-channel mixer-amplifier which is flexible in application.

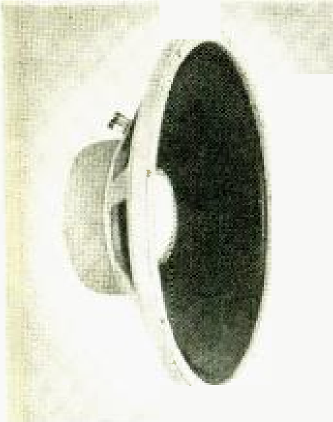
Linear Speed Recording

Q. *What is linear speed recording? Allen Jensen, Lakeland, Florida.*

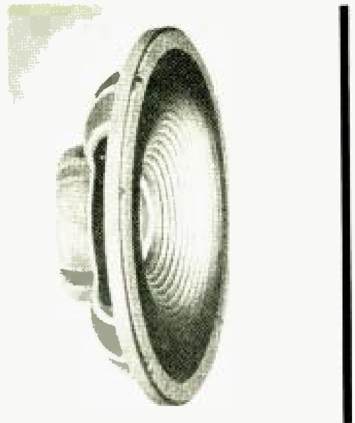
A. In order to explain what linear speed recording is, it will be necessary to point out some of the properties of conventional disc recording.

Assume that a recording is being made on a 12-inch blank, at 33⅓ rpm. At the start, the circumference of the disc is approximately 38 inches. Thus, it follows that at this point, the disc material passes under the recording needle at the rate of 20 inches per second. This is, of course, an instantaneous value, since the circumference is constantly growing smaller as the needle moves toward the center. As the rate at which the material passes under the needle decreases, the high-frequency response is gradually attenuated. This happens for the following reason: Suppose the frequency is 15,000 cps. One cycle, therefore, takes 1/15,000 of a second. Assume now that the circumference is such that 15 inches per second is passing under the cutting stylus. During one cycle, 1/1,000 of an inch has passed under the needle. The size of the stylus for microgroove work is one mil (1/1,000 of an inch). Note that the size of the needle is equal to the amount of material comprising one cycle at 15,000 cps. As the circumference becomes still smaller, the needle size becomes greater than that of a single cycle, with the result that this frequency and those above it can no longer be recorded. The

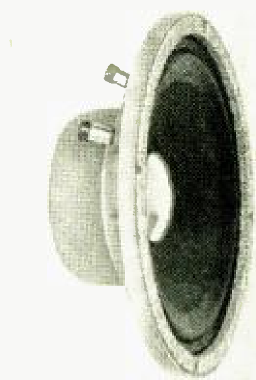
(*Continued on page 81*)



Model D130 JBL Signature Extended Range Loudspeaker has cast frame, 15" diameter shallow curvilinear cone, 4" voice coil and dural dome.



Model D123 JBL Signature Extended Range Loudspeaker has shallow cast frame, 12" diameter very shallow cone, 3" voice coil and dural dome.



Model D208 JBL Signature Extended Range Loudspeaker has cast frame, 8" diameter shallow curvilinear cone, 2" voice coil and dural dome.

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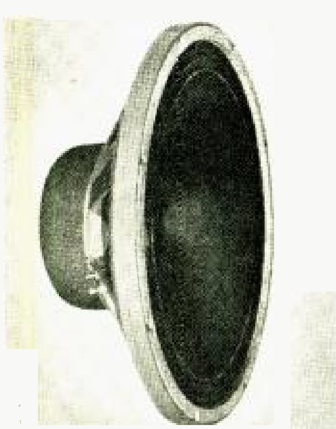

Model 150-4C JBL Signature Low Frequency Driver has cast frame, 15" extremely rigid, straight-sided cone, 4" voice coil. This is a fine theater speaker and is also used in the Hartsfield.

It has been said repeatedly that the way to select a loudspeaker for your high fidelity music reproduction system is to listen carefully and choose the one your ears like best. This is a good way. When you have learned to listen objectively and have sharpened your hearing by attentive listening to live music, then you are able to appreciate smooth, accurate coverage of the complete audio range when you hear it. You can recognize honest bass reproduction — bass notes that are musical tones, crisp, not boomy. High frequencies that are smooth way on up to the very limits of audibility; treble tones that are clean and clear, not shrill or squeaky. You can appreciate a full mid-range reproduced with unfaltering precision. You can admire the performance of a speaker system that reproduces sudden, sharp peaks of sound without distortion. When reproduced music is true high fidelity, you can listen for hours on end without feeling listening fatigue, devoting all of your attention to the music itself.

Listening, when you know how, is a good way to judge a loudspeaker. Fortunately, there are other "earmarks" of a top quality loudspeaker that can be seen quickly by the eye. First of all, consider the frame, sometimes called the "basket." Since it must hold the edge of a rapidly vibrating cone, the prime requirement of a frame is that it be extremely rigid. If the frame vibrates with the cone, it will contribute unwanted sound. A *cast* frame, rather than one that is stamped out of sheet metal, is by far to be preferred.

If you plan to install, initially, an extended range loudspeaker, such as the JBL Signature D130 or D123, look for a shallow cone. This permits maximum dispersion of high frequency radiations. If you are selecting a low frequency driver which will be used primarily for reproducing notes below middle C, look for a straight-sided, funnel-shaped cone. This type provides a more rigid acoustic piston. The JBL Signature 150-4, used in the mighty Hartsfield, is an outstanding example of straight-sided cone construction.

Look for a loudspeaker with a large voice coil. The JBL Signature D130 15" Extended Range Speaker is made with a 4" voice coil. The JBL D123 12" Extended Range Speaker has a 3" voice coil. The D208 8" unit has one that is 2" in diameter. This 1 to 4 ratio between voice coil and cone diameter is unique in JBL Signature Speakers. It results in cleaner bass and smoother treble. The visible evidence of a large voice coil is the silvery dome in the center of the cone. But be sure this dome is attached directly to the voice coil as it is in JBL Signature units.

The magnet assembly is not visible in most speakers, and even if it were, you probably would have difficulty assessing its value. But there is a simple demonstration you can perform. Dangle an iron key near the "pot" which covers the magnet. If the pot exerts little or no magnetic influence on the key, you can be sure there are no stray magnetic fields present. This is an indication of excellent, efficient magnetic circuitry. Try this test with a JBL Signature Speaker.

The precision and care which have gone into a JBL Signature Speaker can almost be felt when you lift and examine one of these sturdy units. It is easy to see in your mind's eye the voice coil of fine aluminum ribbon which has actually been wound on its narrower edge. This is but one example of the meticulous craftsmanship, the close tolerances, the hundreds of refinements that go into every JBL Signature Speaker. Doing everything just right is responsible for the lifelike qualities of JBL Signature High Fidelity Music Reproduction.

Listen to JBL Signature Speakers in the component demonstration room of the Authorized JBL Signature Dealer in your community. He is the expert who is waiting to introduce you to the miracle of true high fidelity sound. He is the specialist who will help you plan improvements for the system you may now own. For his name write to James B. Lansing Sound, Inc., 2439 Fletcher Drive, Los Angeles 39, California.

EDWARD TATNALL CANBY*

FOUR B'S AND AN H

Beethoven: Piano Sonatas Ops. 109, 110, 111. Glen Gould. Columbia ML 5130.

Having teed off his recording career, hardly out of his teens, with Bach's tremendous "Goldberg Variations," Glen Gould moves youthfully on to the very ultimate in piano music, with the brash modesty of a really gifted, but very young musical talent. The three greatest giants of the classic sonata literature! The finest thing that can be said here is that there is no failure. On the contrary, Gould's playing is interesting from start to finish, his approach both remarkably knowing and pleasantly naive.

With all the genius imaginable, these sonatas, the last mature works in a life-time of creative experience, music of an elder-statesman sort, are not likely to be fully penetrated in a few short years of youth. No criticism of Gould at all; he makes a remarkable beginning, worth anybody's attention. But the long years of work by older pianists—Schnabel, Kempf, Myra Hess—can't help but show in their varied performances of these same sonatas. Eventually, Gould may well join them, after a couple of million playings.

Columbia's rather brilliant piano blends oddly, at close range, with Gould's irrepressible humming. At least, unlike some famous pianists and conductors, he hums in tune!

Music at M.I.T.: Beethoven: Piano Sonatas Op. 109, Op. 110. Ernst Levy. Unicorn UNLP 1033

Here's a real piano thunderer, of the old school, a miracle man with Beethoven in a style that is strangely of another time, of, say, the very early 20th century. I've heard Ernst Levy play Beethoven before, in person, but I think these are his first LP records. He does the thing in the grand style and he's a big interpreter any way you look at it, though he'll also be somewhat "controversial" as far as listeners and critics are concerned.

These playings are a far cry from the steely, powerhouse performances now the general rule. They are romantic, large, florid, even eccentric; everything is first of all *felt*, even when the sense of the music is oddly interpreted, even when the Levy pedal seems to add a bit too much of a grand blur to the Beethoven shape. (How seldom do the new pianists use pedal, these days!)

No, not all the experts will be pleased. But nobody could deny these records a big, swashbuckling place in the pianistic ranks, and those who aren't so familiar with the music will particularly enjoy their expressiveness, their utter lack of mechanistic technique-projection.

Music at M.I.T.: Handel: Organ Concerti. Lawrence Moe, organ; Unicorn Concert Orch., Klaus Liepman. Unicorn UNLP 1032

"Music at M.I.T." is a good title for this series and a fine idea; the inspiration came in part from the opening of several new and ultra-modern buildings on the M.I.T. campus, in which these recordings have been made.

The question comes up, of course, how much advantage does Unicorn derive from the very specially designed acoustics of these buildings, a church and an auditorium that will knock your eyes out, as the pictures and description on the backs of these recordings indicate. The series is consciously focussed on this architecture, the publicity and the record notes alike feature it heavily.

Well, I've always looked askance at "modern" architecture as a medium for better recording acoustics, at least in music. (Speech is another thing.) The modern style is all against success. What music needs, generally, is a well-broken-up, mellow, live acoustical situation. Older European buildings of numerous styles are ideal. The more hideous of our own Victorian monstrosities are just fine for recorded sound. Gew-gaws, decorations, much carving in wood or plaster or stone (good or bad, it makes no difference), a maximum of irrelevancy and/or complication in the reflecting surface, that's what recording likes best for music, and the modern styles just don't provide it, even with the fancy adjustable liveness panels now often used.

The trouble is that architecturally we insist today on (a) simplicity and (b) symmetry. We like flats, curves, sweeping lines. And when we come to roughnesses, for breaking up of sound, we still tend to let them fall into regularity. We can't bring ourselves to create the marvellous *irregularity*, the dynamic shape-rhythms, of the Gothic cathedrals or the wood-carved interiors of the past. And so our sound, in modern buildings, tends to be not only over-dry but, worse, over-simple in its reflection pattern.

It's a compliment to Unicorn to be able to say that the sound of the music recorded in these ultra-modern halls is well up to normal recording standards. That, to my mind, is an accomplishment in the face of unusual difficulties. (And the earliest recordings made here were acoustically not so good.) But as to there being any marked advantage in all this modernity, I'd say No. Not in the hearing.

The Handel Organ Concertos? Lovely music and a nicely balanced, rich hi-fi sound, as I noticed with pleasure in several demonstration rooms at the Hi-Fi show last fall, where this record had been passed around for trial. An outstanding job, acoustically.

But on more leisurely listening I have a few reservations. The performance seems to me only so-so, rather stiff and unplastic, considering the exuberance of the material. A bit on the academic side—though Handel is irrepressible and the life of the music will not be denied; it gets through.

I wonder, too, about the organist's staccato playing on the fancy new Baroque-style organ with the ultra-modern pipes. (See picture). That is a trick easily learned by organists who must cope with soggy organs that simply do not cut through the big reverberations of church buildings. Play staccato, then, shorten the notes, separate them, and beat the echo.

But the whole point of the Baroque organ is that it does cut through reverberation by virtue of its special tone colors—the great secret of the old organ builders, now restored to practice. There's no need to play staccato on such an instrument when the registration is well chosen.

Moreover, the recording organist must never forget that his mike is close, hears all, and can minimize any blur that may present itself. You don't play long-distance style to a close-up mike.

All of which means the recording Baroque organist must do a bit of adapting, to a new situation. I don't think this one did enough thinking on these lines, before the tapes started to roll.

Still in all—it's a nice record. I'm just splitting a few hairs.

Beethoven: Symphonies #4, #8. Minneapolis Symphony, Dorati. Mercury MG 50100.

I heartily recommend these two performances as the most satisfacrory in a long time, in spite of some relatively unplastic playing, a lack of feeling for the longer phrases and rhythms that seems to be characteristic of Dorati's work.

The Fourth and Eighth, the two "problem symphonies," have caused the greatest conductors no end of anguish. Somehow, these works tend not to "come off," and you don't hear them too often in concert compared to the others.

Yet this doesn't mean that the music is less than first rate—far from it. Somehow here, perhaps simply by being uncomplicated and direct and natural, Dorati has hit the bullseye in both works. Phrasing or no, subtleties or no, the over-all feeling for each is so convincing that, in these performances, there's every reason for the two works to become favorites among record collectors.

The recording is superb, matching Dorati's forthright, vigorous approach with its brilliant, close-up sound.

Brahms: Symphony #1. Pittsburgh Symphony, Wm. Steinberg. Capitol P8340.

You can always expect something interesting from Steinberg, whatever he tackles. He's an enterprising and very musical conductor.

This one, the umpty-umpth Brahms First, is different with a vengeance, but consistently and musically so. I'm not sure whether I want to swallow the differences or not—but there's no doubt I'm going to have to play this again, and maybe still again. Good.

The most striking difference here is one of tempo. Brahms, for instance, didn't write the high-speed scherzi common in symphonies since Beethoven except in his earlier, pre-symphony music. Instead he turned to slowish, lyric song movements often labelled "grazioso"—graciously. There's one of these in this symphony and Steinberg has whomped up the speed on it. Very odd at first, but then again, he might, he just *might* have something. Is it just habit, what we are accustomed to, that makes us react with a quick No? So it goes in other respects with this stimulating reading of an old-time warhorse.

It's always good to have what is usually called "new light" thrown on a familiar piece like this and it always stirs many to wrath. This one will do just that—but I like it, provisionally.

* *780 Greenwich St., New York 14, N. Y.*


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Bach Organ Works, Vol. 2: Vars. on "Sei Gegrüsset, Jesu Gutig"; Prel. and Fugue in C; Passacaglia in C Minor. Anton Heiller. Epic LC 3261.

There are three recordings of the Complete Organ Works now current; Westminster's with Carl Weinrich is also appearing in segments, whereas that by Helmut Walcha in the Archive Series (Decca) came out complete in one enormous release (but is available in separate discs). Bach being Bach, then, it would surely be possible for a reviewer to spend the rest of his life comfortably studying Bach on the organ! The material justifies it, but time and space don't allow.

I'm not overly excited by this set, so far. Perhaps organ playing on records, especially at such lengths, poses its own standards of variety and inner treatment of organ music—I'm inclined to think so. I feel, simply, that this organist's work tends to become monotonous in the listening, to sound rather "organy" and a trace academic. Not by any means much. The playing is intelligent and reasonable as to tempos, without eccentricities, not chilly and soulless a bit. (Some organists are that.) It's just that, in the long run, the listener's attention may wander afield. It takes positive hard work in Bach to keep the listener listening, as we all know—the old man did very little in the way of superficial attractiveness.

Let's not exclude the organ itself and the recording from our consideration. This is a good organ, but again, not particularly brilliant or startling, as here recorded. The sound is conservative and so is the microphoning: at a safe distance, so to speak.

I like the variations on the tune "Sei Gegrusset" best. The well-known Passacaglia is good but not overly exciting.

Bartok: Sonata for Two Pianos and Percussion. Music for strings, Percussion and Celeste. Soloists, Pro Musica Chamber Orch., Stuttgart, Rolf Reinhardt. Vox PL 9600

These two pieces neatly brought together by Vox, are related in their extraordinary use of percussion in "chamber" style small ensembles of terrific hitting power. The "Music for Strings, Percussion and Celeste" is already familiar to hi-fi record collectors in other versions, notably that on Capitol that came out some years ago and made a good name for itself.

The Sonata, a far more furious work—unbelievably furious and very exciting—has pretty much resisted attempts to record it until now. Vox once issued a memorable radio air-check of this work as played, 'way back, by Bartok himself and (I think) his wife. It was pathetically feeble—and a network recording at that. The pianos sounded like bells, the percussion was almost inaudible, so completely did the recording mechanism "break up" at the appalling noise. There probably has never been composed a more fiendishly demanding test of recording technique than this work! It is the ultimate in sheer transient music.

In view of this, you'll find Vox's recording quite astonishing. Indeed, the fact that this record can be played from beginning to end full-range, without noticeable blasting or break-up is a fine tribute to the totality of today's record-reproduction technique, from mikes and tape right through to the loudspeaker at home.

Leave it at that—I won't attempt an evaluation of the music except to say that it will simply blow you out of the room with its fantastic frenzy, whether you like it or not. A real masterpiece, hi-fi or no, in case you are interested, and I find it marvellous listening.

MIDDLE STRAVINSKY

Stravinsky: The Fairy's Kiss ("Le Baiser de la Fee"); Complete Ballet. Cleveland Orch., Stravinsky. Columbia ML 5102

We're now re-discovering Stravinsky of the middle period, of the Twenties and Thirties, and it's a pleasure. Re-discovery for me, anyhow, but something new for a lot of people who will now find, to their surprise, that this slightly raucous, slightly jazzy in-between Stravinsky suits today's ears remarkably nicely. We're catching up—all of us, not just the aesthetes.

This one is a specialty, a ballet score based on ideas from Tchaikowsky. It's a superb combination. The Tchaikowsky element in it makes for easier listening for the person who isn't yet on sure ground in modern music, but is well aware that maybe it has something. On the other hand, the Stravinsky "beat," the modernly brassy orchestration here and there, the jazzy fragmentation of ideas, add a streamlining to Tchaikowsky that to many another ear will be wonderfully welcome.

Whatever your viewpoint, the chances are that this long score will come to be a favorite after you've let it sink in a bit. A big work, and superbly recorded with the composer at the controls.

Stravinsky: Concerto for Piano and Winds; Capriccio for Piano and Orchestra. Nikita Magaloff; L'Orch. de la Suisse Romande, Ansermet. London LL 1392

Stravinsky's piano writing is thoroughly modern. He uses the instrument deliberately for percussive effects, rather than the old song-like music; he arranges to have his piano banged hard, just as do jazz pianists. That is the Twentieth Century approach, in a very wide variety of piano music, popular as well as "classical."

The Concerto for Piano and Winds is a real humdinger of an Early-Twenties opus. In two seconds flat you could date it yourself, whoever you are. 1924! It's amazing how, at a distance, everything now begins to telescope together. Gershwin and Stravinsky sound alike and are obviously of the same epoch. It's a pleasant accident that this brassy, noisy 1920s music is extremely good for hi-fi purposes and makes marvellous recording material, as of today. Try it and you'll see.

The Capriccio, a sort of piano concerto, is a bit later, 1929. It's more serious, more "classic," less raucous but still with the hard, edgy contours of the Twenties. This piece has been quite widely played and was recorded years ago on 78 by the Boston Symphony and that perennial Boston pianist, Jesus-Maria Sanroma. That's where I first got to know it.

An interesting facet of this recording is the peppy 1920s treatment from that long-bearded conductor, Ernest Ansermet. His earlier Stravinsky, "Petrouchka" and the like, tended to be a bit slow-paced, almost old fashioned. But there's none of that here; the music comes out as snazzily as you could imagine. Recording is ffrr's very best and excellent for the music, big liveness and close-up coloration. Superb, big-bassed piano tone.

Stravinsky: Apollon Musagètes. Renard. Solo voices, L'Orch. de la Suisse Romande, Ansermet. London LL 1401

Here are two more works in the London-Ansermet series. "Apollon" is another ballet of the Twenties, 1928, but again a very special kind of music, entirely for string orchestra. It makes a wonderful companion piece to "Baiser de la Fee" (above), which because of the Tchaikowsky element in it also has much lyric writing for strings.

If you want to know how a string orchestra should sound at its very best, let the team of Stravinsky-Ansermet-London show you, here. The music is gorgeously composed for strings, the playing is done with the utmost in expansiveness and careful ensemble, the recording is one of the finest of string sound I have yet to hear. If you want to try two Stravinsky middle-period discs, take this one and the "Baiser" disc, above. You won't do better.

The part of one side left over is devoted to the oddly comic semi-ballet of 1917, "Renard," a piece about Renard the fox and the silly rooster who is tempted to fly down off his perch by the fox's wily flatterings. A new kind of singing, this, and at first you may think it's all just yelling—but there's a fine, steady rhythm and a cockeyed witless quality to it that suggests the grotesqueness of animals masquerading as humans—talking.

Only trouble here is that London doesn't include a text for you to follow. Silly—everything depends on what's going on at the moment. There are several other records (in various languages) which do include texts.

Stravinsky: Chamber Works 1911-1954. Soloists, Conducted by the Composer.
Columbia ML 5107

This one straddles the middle period of Stravinsky's life, but I'll toss it into the pot here, even so. The title is slightly misleading; all the music but one piece is for voice with instruments. One side goes to early music, around the time of World War I, the other side to quite recent work, from the 1950s.

You'll need some background idea of Stravinsky's very consistent and unique use of the human voice before you can plunge wholeheartedly into this. As he uses the piano in a new fashion, percussively, so he treats the voice instrumentally, setting the word-syllables in an instrumental fashion, rather than according to their spoken accent and shape. This makes for an oddly sing-song effect on first hearing (as in "Renard," too) but in the end you will come to respect it mightily for its musical logic and expressiveness.

The songs are gems, mostly very short, sung by voices that are markedly unlike the usual concert and opera singers, and nearer to the "popular" singer. The earlier works have been newly instrumented by Stravinsky and these are in effect their first performance. Note particularly the moving "In Memorian Dylan Thomas" (1954), set for trombones, string quartet and tenor to a poem by Thomas, who was to have worked with Stravinksy on a joint project at the time of his death.

Incidentally, the late works here, several songs and the instrumental Septet, show Stravinsky experimenting in the higher mathematics of the "Twelve-Tone" school of thought, as will be apparent if you read Robert Craft's detailed notes. Inversion, retrograde and the other mathematical transpositions are everywhere—but if you don't hear them in a literal way, don't be worried. These devices are intended to add to the versatility of *musical* expression. Exactly as in other musical devices, they can have an effect directly upon you without your being conscious of the precise mathematics involved. You don't need to bother.

You can make Beethoven and Bach sound dreadfully mathematical if you want to analyze them on paper, and Grieg, Tchaikowsky and Schumann, too, not to mention Gershwin! Better just to listen and let nature take its course, by ear.

SPECIALTIES

Vivaldi: The Seasons. I Musici; Felix Ayo, vl.
Epic LC 3216.

A very exciting performance of the four connected concertos—Spring, Summer, Autumn, Winter—that make up this now very popular work. I have never heard so much real musical drama made of it. There is no exaggeration, no lack of taste, just simply superb playing and a real, electric, super-Italian rendering of that freshness and almost revolutionary daring of harmony that the piece surely had for its first listeners, back in the 18th century.

It's an odd commentary on our perceptions that we really can to a considerable extent hear music as it was once heard, we can experience the meaning of it in its original terms, in spite of the centuries of later development that are part of our experience now. We can, that is, if the performance helps us.

A dull, unsympathetic performance merely makes music like this sound antiquated and feeble. It *is* antiquated, in such a situation. (Just try the Columbia recording with the Philadelphia Orchestra!) But an aware, alive playing can project the original high intensity, as though there had been no long centuries of "progress" since that day. That's what happens here.

I might suggest, incidentally, that the shift from Angel to Epic seems to have done "I Musici" good. Don't ask me how; maybe it's a different recording technique. Whatever the reason, I like this group of a dozen-odd strings very much here and so will you.

SPECIALTIES

Mozart: Fantasia in C Minor, K. 475; Sonatas #10, K. 330, #14, K. 457; Rondo, K. 511. Wilhelm Backhaus, piano.
London LL 1399

Here is the solo aspect of London's continuing series with this leading German pianist. I'm all for it, except in the case of the extraordinary C Minor Fantasia: there, it seems to me, Backhaus lamentably misses the sense and the architectural lines of the memorable slow opening (and closing) section, one of the strangest, most revolutionary tonal progressions in all Mozart, linking the distant, dissonant keys of C and F-sharp together.

Backhaus is not the one to play his Mozart in a flippant or show-off fashion. It is serious, dedicated, respectful, on the whole a bit stiff, not so much in the technique (he has all of that) but in the conception. Still, you'll find it good listening and good Mozart, and the piano is London's usual full-toned best.

Folklore of the United States: Jack Tales. Told by Mrs. Maud Long, Hot Springs, N. C. **Libr. of Congr. AAFS L47**

This is not exactly a hi-fi record, but I wouldn't let that bother you. The tales on it are quite hair-raising. Jack, in case you didn't know, is the U.S. counterpart of that famous Jack who climbed up to Heaven (or somewhere) on a beanstalk. The American Jack does all sorts of things, and in some of the Jack Tales (lots of people tell them, and the tradition allows you free rein to add your own modern details, for realism—like Ford pickup trucks and the like) the hero is so bumptuously American you'd hardly know he had British ancestry.

Mrs. Long tells the more old-fashioned versions, minus Ford. But her's are the real thing, from her own Ma and not out of any book. Makes a huge difference. These are potent, up-dated legends and if you're a psychiatrist you'll goggle at the easy-going symbolisms that pop up at every phrase—the age-old theme of all humanity in folksy, local-yokel disguise. She's a good tale teller, Mrs. L., and you'd know in a moment that her stuff comes straight down the generations. It's that good.

The Golden Treasury of Irish Verse. Read by Padraic Colum. **Spoken Arts 706**

This is one of the large new series launched by Westminster in this field. I'll be touching on more of them later.

As you listen to this you'll realize a solid truth—that the "stage Irish" and "stage Scottish" accents we know from a million and one jokes and plays and films, aren't quite the real thing: they're doctored, both to exaggerate and at the same time to make them more easily understood. Mr. Colum's Irish is the real thing, and his speech is a bit different from the kind you expect. Interesting, and it's a lovely language, the Irish-English.

Colum reads many poems here, speaking in the old time way with a long, sing-song phrasing. Good for Irish verse, no doubt about it, though it isn't the thing that's popular nowadays on radio and TV. The poetry lends itself to it. There's new and old poetry and many of the poets' names are unfamiliar to most of us, but we can afford to take Mr. Colum's word on his own selection; his written introduction, on the album liner, helps a lot.

Also note one complete spoken story, by Colum himself, about a fellow named Maeshaughlin (wait'll you hear him pronounce *that*) who goes to the local Irish fair and loses all his money, but fast.

Recording is excellent, from modern tape.

The Art of Ruth Draper, Vol. 1.
RCA Victor LM 1959.

If you want to be mesmerized, as the old phrase goes, just put this on your machine and let it play.

Perhaps some old-timers will remember Ruth Draper, the one-lady theatre, in her heyday. Maybe others will have heard her recent shows in New York and elsewhere. Early or late, the Ruth Draper touch is that of genius. She is surely the greatest dramatic monologuist of this century, at least.

The lady just talks. She writes her own plays, for herself, and the thing that amazes is that they are full of people—dozens of them. By the most wonderfully timed breaks, pauses, juggling of ideas, she simply creates the other people in your mind, to the point where you forget entirely that this is merely one person speaking. Fantastic!

Take her acidly humorous sketch, here, of the high-society lady trying to do an Italian lesson in the midst of house-hold management and the telephone. After a half-hour of this, you are positively exhausted with the strain of that woman's hectic life and the dozens of people surrounding her—from husband to children, manicurist to portrait painter to social secretary. . . .

Enough. If you don't try this on your friends and relatives, not to mention yourself, you're nuts.

The Art of Paderewski.
RCA Victor Camden CAL-310.

Poor old Paderewski, relegated to the low-priced line! A passing thought, for this once most famous of world pianists is treated technically just as well on Camden as he might have been on RCA Victor Red Seal as of old, and he can be had for less cash. Reflects no more than the passage of time, which robs every man of his fame, sooner or later.

Anyone who remembers the great days of this artist will want to try him out here. But you must make sensible reservations. First, the recordings are hardly thundering hi-fi, though in places they have plenty of power.

Second, it's a fact that many of Paderewski's records were made late in life when his powers were already slipping. Do you remember the great debacle, when this gentle old man was hauled out for a nation-wide broadcast on the fanciest top-drawer scale, and could scarcely play at all, his old fingers missing notes pathetically? And the anticlimax when shortly afterwards a mammoth Madison Square Garden Paderewski recital was called off, mercifully, because of Doctors' orders? He died soon afterwards, as I remember.

Some of these recordings reflect the beginnings of that senility, though I must say hastily that it's not more than a trace.

Thirdly, remember that Paderewski is of an earlier generation of pianists, right out of the 19th century. His playing is utterly unlike the steely power-stuff of today's younger men. At first you may think it sentimental and meandering. It's not, really. And you'll notice a standard trick of many pianists of old, the habit of playing the bass notes a bit ahead of the melody on each beat, for a kind of tear-jerking effect. Old-fashioned.

He was the world's greatest pianist, for a good while, and don't think that some of it isn't to be heard on this record, which includes a whole gamut of concert favorites, from Beethoven to Couperin, plus even that arch-modern, Debussy. And Chopin, as a matter of course.

Saint-Saëns: Le Carnival des Animaux. Franck: Psyché — Symphonic Poem. L'Orch. Symph. de la Radiodiffusion Belge, Andre. Telefunken LGX 66028

This Telefunken LP offers a juicy piece by César Franck and the original version of the familiar "Carnival of the Animals," for two pianos and small instrumental ensemble.

The Franck piece is competently played and recorded but somehow it lacks the romantic punch that can make this one of the loveliest works of the late-Romantic school. Sounds sort of hum-drum and old-fashioned here, and the dead acoustics, radio studio style, do not help.

The "Animals" fare very well, however, after a so-so start, and this in spite of some relatively inept playing by the two pianists, who come perilously near to derailment in a couple of places. (But you and I had better be glad *we* don't have to play the fiendish scale passages, etc.!) The original scoring is nice—the single string bass, for instance, is a lot more elephantinely humorous by itself than the whole battery of basses in the usual full-orchestra version of the piece.

PATENT LICENSING

(from page 56)

restricted use is an old one. So far as it appears its legality has never been questioned. As the restriction was legal and the amplifiers were made and sold outside the scope of the license the effect is precisely the same as if no license whatever had been granted."[4]

Frequently however, the licensing of patents has been prostituted to practices in violation of the anti-trust laws. Such an instance occurred in the marketing of "dry ice," where each invoice of this product carried an endorsement, "The merchandise herein described is shipped upon the following conditions: that dry ice shall not be used except in dry ice cabinets or other containers or apparatus provided or approved by the DryIce Corporation of America and that dry ice cabinets or other containers or apparatus provided or approved by the DryIce Corporation of America, shall be refrigerated or used only with DryIce."

In the decision of an infringement suit by the owner of these dry ice patents the Supreme Court said of such stipulations,

"To permit the patent owner to derive its profit, not from the invention on which the law gives its monopoly, but from unpatented supplies with which it is used, is wholly without the scope of the patent monopoly.

"If a monopoly could be so expanded the owner of a patent for a product might conceivably monopolize the commerce in a large part of the unrelated materials used in its manufacture. The owner of a patent for a machine might thereby secure a partial monopoly on the unpatented supplies consumed in its operation. The owner of a patent for a process might secure a partial monopoly on the unrelated material employed in it. The owner of a patent in suit might conceivably secure an unlimited monopoly for the supplies not only of solid carbon dioxide but also of the ice cream and other foods, as well as the cartons in which they were shipped.

"The attempt to limit the licensee to the use of unpatented materials purchased from the licensor is comparable to the attempt of a patentee to fix the price at which the patented article may be resold. In both classes of cases courts deny relief against those who disregard the limitations sought to be imposed by the patentee beyond the legitimate scope of its monopoly."[5]

License vs. Assignment

In the decision long ago of an appeal by the Federal Supreme Court, was set forth clearly the distinction between the license and the assignment of a patent and this distinction has been scrupulously followed by the courts of the country since that time.

"The patentee may assign his whole interest or any undivided part of it. But if he assigns a part, it must be an undivided portion of the entire interest of the patent, placing the assignee upon an equal footing with himself for the part assigned. Upon such an assignment the patentee and his assignees become joint owners of the whole interest secured by the patent according to the respective portions which the assignment creates.

"The patentee may assign his exclusive rights within and throughout a specified part of the United States and upon such an assignment the assignee may sue in his own name for an infringement of his rights. But in order to enable him to sue the assignment must undoubtedly convey to him an entire and unqualified monopoly which the patentee held in the territory specified—excluding the patentee as well as others.

"For it was obviously not the intention of the legislature to permit several monopolies to be made out of one and divided among several different persons within the same limits.

"Such a division would inevitably lead to fraudulent impositions upon persons who desired to purchase the use of the improvements and would subject a party who, under a mistake as to his rights, used the invention without authority, to be harassed by a multiplicity of suits instead of one and to successive recoveries of damages by different persons of the patent right in the same place.

"Unquestionably a contract for the purchase of any portion of a patent right may be good between the parties as a license and enforced as such in the courts of justice. But the legal right in the monopoly remains in the patentee and he alone can maintain an action against a third party who commits an infringement upon it."[6]

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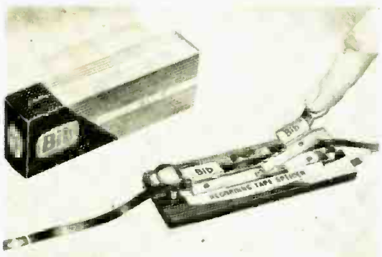
[4] General Talking Picture Corp. v. Western Electric Co., 305 U. S. 124, November 21, 1938

[5] Carbice Corporation v. American Patents Development Corp., 283 U. S. 27, March 9, 1931

[6] Gayler v. Wilder, 51 U. S. 477, page 494. December, 1850

NEW PRODUCTS

• **British-Made Tape Splicer.** Suitable for both mending broken tapes and for editing purposes, the new BIB splicer comes mounted on a flocked base, or it can be mounted directly on any tape deck. The body of the splicer, which is made of nickel-plated brass, has two pivoted clamps which lock into position to hold tape sections firmly in the splicing channel.

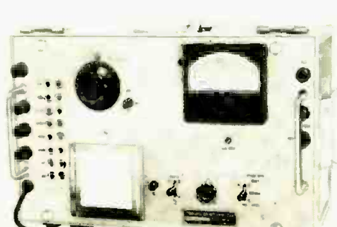


Both vertical and diagonal mitres are provided for either editing or mending. Horizontal mitres are also provided for use in trimming off surplus mending tape. A razor-type cutter is provided, which fits conveniently under the splicer body. Complete information may be obtained from Ercona Corporation, 551 Fifth Ave., New York 17, N. Y. **D-1**

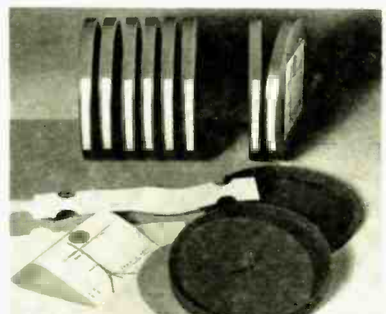
• **Spillproof Tape Reel.** The Irish "No-Spill" reel recently announced by ORRadio Industries, Inc., Opelika, Ala., is a new convenience for tape recorder users which eliminates the messy tangle of tape that frequently plagues the average fan. The reel utilizes two notches molded into each of its flanges. As shown in the illustration,

a rubber band is slipped over the notches, holding the tape securely in place on the reel. The No-Spill reel also offers easier access to the threading eye. An additional feature is 28 square inches of indexing space on the four large flange areas. All Irish brand recording tape on 7-in. reels is now being delivered on the No-Spill reel without extra cost. **D-2**

• **Noise Measuring Set.** Designed primarily to measure noise over telephone circuits, the Daven Type 34-B Noise Measuring Set can also measure acoustic sound levels, function as a transmission measuring set, and as a high-gain calibrated amplifier for audio frequency measurements. It is a portable, battery-operated instrument entirely self-contained in a metal carrying case provided with a removable front cover for protection of the front panel. Noise measurements of different frequencies are measured in terms of their interfering effects on speech as heard by the human ear. The dynamic characteristics of the meter are such that its response approximates the speed of appreciation of sounds by the ear. Weighting circuits which simulate the action of the ear are also incorporated between the "Noise Input" and the indicating meter. Three weighting circuits are available for measurement of acoustic sound levels. Additional data can be obtained from The Daven Co., 530 West Mt. Pleasant Ave., Livingston, N. J. **D-3**



• **Tape Storage Container.** Stor-A-Tape is an integrated storage and shipping container for recorded tape, recently introduced by Concertapes, Inc., 522 Green Bay Road, Winnetka, Ill. Made of tough, high-impact plastic material, Stor-A-Tape is equipped with a center pin which suspends the tape inside the container. Another patented feature prevents the container

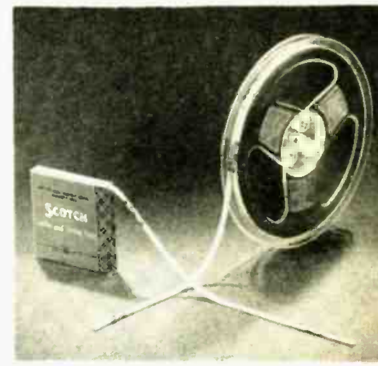


from rolling and permits neat placement side-by-side on a library shelf. One large self-adhesive front label and two edge labels, with spaces for titling and cataloging, are provided with each Stor-A-Tape. Replacement labels are available at nominal cost. Of special interest to tape correspondents is the fact that tapes can be shipped easily in Store-A-Tape containers without additional packing. **D-4**

• **Printed Circuit Kit.** Intended for accurate and simplified production of engineering models or prototypes of printed-circuit parts, this model maker's kit features a newly-developed drawing pen which obviates the use of paints, tape, photo-sensitive coatings, negatives, etc. A completely etched circuit, ready for assembly, may be

had in about 30 minutes. The kit is composed of the drawing pen and etchant resist ink, etching powder, a drawing guide, 10 copper-laminated Bakelite sheets, 10 popular tube sockets and detailed instructions for use. The entire kit is self-contained in its etching tray and cover. Materials supplied are sufficient for producing at least a dozen circuits. Full information is obtainable from Photocircuits Corporation, Glen Cove, N. Y. **D-5**

• **Improved Leader Tape.** A special anti-static coating and greatly increased strength are among the features of the new Scotch brand plastic leader and timing tape No. 43-P, recently introduced by Minnesota Mining and Manufacturing Co., 900 Fauquier St., St. Paul 6, Minn. The anti-static coating is said to reduce noise



as the tape passes over the playback head, while the increased strength—50 per cent greater than the company's previous paper leader tape—reduces possibility of breakage. A new marking system also has been provided for more convenient use in timing. For use by professionals there are indicator arrows every 15 inches, while for pros and amateurs alike there are "Scotch" plaid markers at 7½-inch intervals. The tape can be labeled with either pencil or ball-point pen. **D-6**

• **Ronette Microphone.** Called the Ronomike, a new semi-directional microphone now being delivered by Ronette Acoustical Corp., 135 Front St., New York City, N. Y., is a high-impedance instrument with output of –55.4 db. Response is virtually peak-free from 30 to 10,000 cps, according to the manufacturer. The Ronomike is cased in a slim die-cast housing which is chrome plated. Modern, convenient shape and excellent performing characteristics make it ideal for use with tape recorders, public-address systems, and in ham shacks. **D-7**

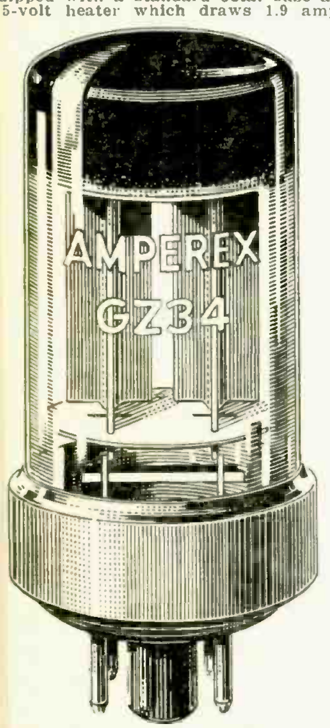
• **Stereo Record-Playback Head.** Developed to meet the need for a low-cost high-quality stereo magnetic head, the TLD in-line unit can be compensated for flat response between 30 and 10,000 cps at 7.5 ips. It is compact and will provide long wear with negligible oxide accumulation, provides excellent rejection of surrounding

fields, and is highly uniform in frequency and amplitude response. The head features precision ground and lapped gap, balanced electric and magnetic structure, high output, and precise colinear alignment. Detailed dimensional drawings, specifications, and prices will be furnished to manufacturers, distributors, and dealers upon request. **D-8**

• **Klipsch Corner Speaker System.** Known as the Shorthorn Model T, the newest speaker enclosure designed by Paul W. Klipsch is built to dimensions which permits its use as a base for a table model television receiver. Frequency range of the Model T is slightly greater than that of the Shorthorn Model S. Extending from below 40 cps, its range extends to above

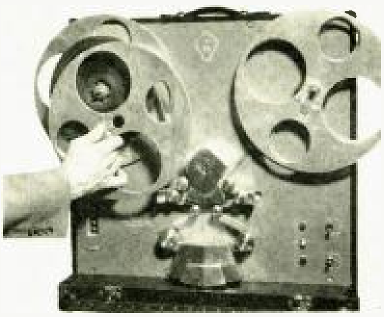
22,000 cps, with substantial efficiency from 45 to 16,000 cps. While it achieves its maximum range when used in room corners, the Model T has a built-in corner which permits it to be used in any part of the room with slight sacrifice in the bass response. It is equipped with casters as a convenience for those who may wish to move it from one location to another. For further information, write Klipsch and Associates, Hope, Ark. **D-9**

• **Improved Rectifier Tube.** Latest to be released in the new series of Amperex 'preferred' tubes for audio applications is the GZ34 rectifier, a heater-type tube designed to replace, without circuit changes, such rectifiers as the 5U4, 5V4, etc. It is equipped with a standard octal base and a 5-volt heater which draws 1.9 amps.



Output capacity is 250 ma, characterized by low output impedance. Other features of the GZ34 include excellent voltage regulation, exceptional linearity in non-class-A power stages due to lowered power supply impedance, and reduced ripple. Detailed data sheets are obtainable from Special Purpose Tube Division, Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N. Y. **D-10**

• **Detachable-Flange Reels.** To meet the demand for a quick loading film reel for magnetic recorders, projectors, laboratory processing equipment and editing equipment, Stancil-Hoffman Corporation, 921 N. Highland Ave., Hollywood 38, Calif., has announced detachable-flange reels for 16-, 17.5- and 35-mm film. The 1200-ft. reel has a removable flange which allows the raw stock to slip over the reel, after which the flange is secured in place by a half turn to a locking position. The reel is made of aluminum so that magnetic film can be handled safely. Further information will be mailed on request. **D-11**



• **Knight Enclosures and Enclosure Kits.** The new Knight speaker enclosures, in kit and completed form, have been announced as additions to the Knight line of high-fidelity equipment by Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. Designed essentially for the low-cost hi-fi system, the units introduced include one for corner placement to afford extended bass response, and another of conventional bass-reflex design. Each enclosure is highly flexible and can be used with a 12- or 15-in. speaker for single, two-way or three-way systems. Both cabinets are constructed of ¾-in. plywood with mahogany veneer. Highly attractive woven maroon plastic grille cloth is included. Builders' kits include all parts, screws, glue and step-by-step instructions for quick, easy assembly. Unfinished kits are smoothly sanded, ready for finishing. Full details will be mailed on request. **D-12**

NEW LITERATURE

• **Heath Company,** 305 Territorial Road, Benton Harbor, Mich., now has available the "Heathkits for 1957" catalog, a 55-page book which lists a complete line of high fidelity equipment, amateur radio gear, and service test instruments in kit form. Among kits listed for the first time is the new Heath "Legato" speaker system which uses Altec Lansing drivers. Other new items include an oscilloscope, a voltage calibrator, voltmeter, vibrator power supply, and CW transmitter. Copy of the catalog will be mailed free upon request. **D-13**

• **ORRadio Industries, Inc.,** Opelika, Ala., deserves high commendation for the effectiveness of a small pocket-size booklet recently introduced under the title, "The 7 Old-Fashioned Villains of Tape Recording and How They Were Foiled." Cartoon illustrations are combined with interesting text to stress the excellence of the company's Irish brand Ferro-Sheen recording tape. The back cover is devoted to a chart which shows the playing time for various tape lengths and recording speeds. This booklet is both enjoyable and informative. Get a copy. **D-14**

• **Amplifier Corp. of America,** 398 Broadway, New York 13, N. Y., describes and illustrates the Magnemite series of portable battery-operated spring-motor tape recorders in a new 4-page folder which will be mailed without charge. The brochure describes features of 15 models, all of which were especially designed for field applications. A complete listing of performance characteristics permits easy reference and simplifies selection. The recorders' operating features are concisely explained and complete technical specifications, as well as direct factory price, are included. **D-15**

• **Keroes Enterprises,** 369 Shurs Lane, Philadelphia 28, Pa., has issued a new 24-page booklet which presents a detailed study of the theory and operation of the Ultra-Linear Circuit. Included in the booklet are the mathematical analysis of ultra-linear operation and a typical ultra-linear amplifier design. Booklets are available at 25 cents per copy.

LOUDSPEAKER DESIGN

(*from page 21*)

better prospects of presenting true wide range without this effective resonance. But it is still necessary to see that the amplifier feeding it is provided with the necessary characteristic. We really need to reorient our thinking, rather like changing over from tubes to transistors.

Instead of thinking in terms of driving *voltage* it would be more convenient to think in terms of a driving *current* since the current has to be passed through all the various reactances in series with the actual load we want to feed, which is the resistance element.

It would seem that the best way to combine a low-frequency dynamic unit with a high-frequency electrostatic unit, if this is desired, would be to use separate amplifier outputs for each, so the necessary high damping factor can be used with the dynamic unit, and a low damping factor with the electrostatic unit.

An alternative method would be to make the electrostatic unit very inefficient by using a large series resistance to feed it.

The Final Objective

The writer rather feels that the final objective will be to make the radiating surface area sufficiently large so that the electrostatic unit can handle frequencies right down to the bottom end of the audio spectrum successfully. Experimental units have already been made which will do this and it is probably only a matter of time before production versions of a similar type appear on the market.

Another interesting possibility arises from a method of matching that has already been tried by Mr. Peter Walker. This consists of using a number of electrostatic units arranged as the capacitor elements in an electrical delay line. If these elements are arranged as the faces of a horn, and the energy fed in at the throat, it may be possible to improve the acoustic matching as well as the electrical matching by this means. As the air wave travels down the horn the walls will be activated to build it up as shown in *Fig.* 4. This requires an electrical delay line where the physical displacement between plates corresponds with the propagation velocity of sound. Such a unit would require a large number of units to satisfy requirements at both ends of the spectrum, but, with modern circuit methods, who knows, it may yet prove feasible?

AUDIO ETC.

Edward Tatnall Canby

I had a number of incomplete projects on hand when I skipped the country, last season, for a long vacation from audio. Most of them, as usual, involved simple trial of promising products by the you-use-'em system, plain ordinary household use, the sort of gruelling test that this department excells in. Time is of the essence in such things—lots of it. The longer I use a product, the more intimately do I know its pros and cons and the only limitation to such a trial, aside from the complete collapse of the hard-pressed product itself, is the inconvenient fact that maybe a new model is already out and, in any case, readers want to know what happened, at least within a couple of dogs' ages.

So I simply extended my tests by the deadly expedient of leaving selected equipment in the gentle hands of various friends and with the renters who took over my house for a few months. That, as any housewife knows, is the ultimate field test.

Well, my hot water heater burnt out, my toaster is kaput, the screen door won't close and the garbage disposer collapsed; the water pump failed, the lawn mower drags one side of its roller and the woodchucks ate my chrysanthemums. All in all, the house came through pretty well, I'm telling myself, though even my barometer, hanging unobtrusively on a perfectly safe wall, pointed to "Hurricane" when I got back and has since progressed downward to "very dry." Somebody must have bopped it.

But when I turned on the Hi-Fi System, it sailed off without so much as a squawk of protest. Pretty good.

The same was true of another quality system that got a somewhat less drastic workout in New York while I was gone. No trouble at all. But, on the other hand, two patched-up affairs I loaned out to friends, made out of assorted odd items I had lying around, were both dead ducks when I got back, and loud were the laments. Cartridge trouble, plus a couple of elderly changers that got tired of changing. They do that, after a few years.

1. An Arm and Two Cartridges

My two good systems—the ones that worked—had respectively an ESL Concert cartridge and a Fairchild, magnetics of related sorts, the moving-coil. The ESL cartridge was (and is) installed in a viscous-damped arm, and I must say the combination is excellent. My arm is that intriguing Japanese model, sent me from Japan, that is inspired by the Gray arm. (Did I hear that it now calls itself the Grace? That's straightforward honesty!) Whether you use the Gray, or the Grace, or somebody else's viscous-damped, I recommend the principle to you as a real honey for delicate cartridges on long arms that are to be used by careless souls. Rentees, for instance.

The fact that you can't accidentally drop the stylus on the record removes a large hunk of potential danger. It floats down, slowly. Yes, one can still scrape the point sidewise over the record surface, but this isn't too likely since most sidewise swipes are combined with some sort of accidental dropping action. In any case, my ESL was used all summer by people who didn't even know it was expensive—they had kids, too—and it survived the roughage remarkably well, as did my records, which were lying about in scads. Only a minor bending of the stylus arm testified to at least one side-swipe. But the cartridge still plays. And so I'm all for the viscous arm. And, incidentally, the viscous fluid is so thick that it won't pour out by accident unless you leave your player on its side for hours or overnight. Perfectly safe to carry.

Give credit to ESL, too. It's a very fancy item of merchandise and one of the finest pickup cartridges available today. But in a light arm with fairly low needle pressure (it can take it) this cartridge has so far proved quite stable and solid. I'd rate it—so far—as a pleasingly foolproof pickup.

It gets itself out of the way easily, bends its point gracefully against the withering scrape and comes up unscathed and ready to play—so far. "So far" includes many months of my own playing (with much carrying of the turntable hither and yon while the arm swings crazily about, banging into this and that obstruction) as well as a couple of months in the hands of the Phillistines, my rentees. So the evidence is impressive.

As to tone quality, I haven't heard anything yet that's noticeably better than ESL. Mind you, things have now got to the point where all top quality pickups really sound the same. They have to, after all, if they produce no distortion worth mentioning. And so I'll split no hairs as between ESL and a number of quality rivals. I'll just say that the ESL, like others in its class, is so extremely good that it's virtually transparent to sound. What you hear is the music, the recording, the speaker. The pickup's individual contribution to the sound quality is negligible, and in that very fact it approaches absolute perfection. What more can you ask.

One minor mechanical observation. The ESL models made in the U.S.A. have side-pieces next to the diamond point that serve as buffers and protectors. They also serve as excellent lint-catchers and, like several other pickup cartridges, including GE and Audak, the ESL, will occasionally foul itself up with lint to the point where the sound is affected—until you blow the stuff loose or pick it off with your finger. Not important, unless you're obtuse enough not to notice what's the matter and decide the pickup is going bad and ought to be returned to the manufacturer! People have done dumber things than that, I assure you. (And anyway, you shouldn't have lint on your records. . . .)

The transformer-filter that comes with the ESL is unexpectedly functional. The transformer, of course, is required to boost the very low voltage of the moving-coil type unit up to par for the average amplifier. The filter is also an unexpectedly useful addition to take the edge off the extremely high frequencies, mostly supersonic.

It turns out, you see, that a really flat pickup response, 'way up in the tonal stratosphere, is a two-edged sword. Many recordings, non-too-perfect, produce assorted high supersonic hash that, *if* it is picked up, reacts most unpleasantly with the lower audible frequencies to give a harsh, ugly sound. Intermodulation. Most cartridges are blissfully insensitive to the highest highs, supersonic, and so all is well here. But these new moving-coil models, the ESL and, for another, the Fairchild, do a fine job of reproducing the supersonic hash. And so—the supersonic filter. ESL builds it directly into the transformer assembly, the whole thing mounted as a miniature attachment. However, for many really good new recordings, minus hash, you can turn the filter off and this type of cartridge then gives you every last bit of true sound that can be recorded on plastic.

Fairchild

I haven't tried to make any sound distinction between the ESL and the Fairchild, two magnetics of similar principle. If there are differences noticeable, they are utterly minor as far as I am concerned. That is, other differences that crop up—between recordings, between room-situations, between loudspeakers—are so very much greater, that the difference in pickup sound is of inaudible importance.

The Fairchild cartridges have been inching up in output to the point where, though of the low-output moving-coil type, they can now be used directly in most amplifiers minus the extra transformer. Saves cash and is simpler. The newest moded Fairchild has the highest output so far. I've been using the next-to-last, the 220, for some time now, and I deliberately put it to work without a transformer just to see for myself what it would do.

Well, the answer is borderline. Minus transformer, the Fairchild output is entirely OK in some situations, perhaps not quite potent enough in others. But before you take that in, remember a very important point.

It isn't the power output of your amplifier that counts here at all; it isn't the wattage you have on hand. The *input sensitivity* is what counts. That's not so often mentioned in the published specs and not nearly as well known a figure.

To put it colloquially for those who may not be clear on this point, the sensitivity represents how hard your amplifier will jump for a given (input) kick in the pants. Some older babies, though they may give out with a whopping 50 watts under provocation, need plenty of that provocation —a high input kick—in order to do so. Others though rated at, say, a mere 10 watts, may bust a 10-watt blood vessel for half as much input kick.

On my somewhat elderly and averagely sensitive 20-watt amplifier, a quality piece of equipment, the Fairchild 220A without transformer gave with enough kick to drive the power stage to a reasonably loud room volume, plenty for my listening. Not enough, however, to reach maximum. And when I came to do some recording work I found I didn't have the wallop I needed, and got with the usual variable-reluctance types of magnetics. Top sound quality, but still a relatively low output.

Nevertheless, this is good. It's not easy to get both quality *and* reasonable output out of the top-ranking moving-coil type of cartridge and Fairchild has done nobly to get enough to drive any amplifier at all, minus transformer.

The newest Fairchild, the 225, does better still and on the basis of this personal experience with the earlier model I'd say that for all normal listening the current Fairchild will perform for most people very nicely without transformer. So much the better. But if you whomp up the volume, play music super-hi-fi and blast your neighbors out of their seats, you'd better get yourself a supercharger . . . I mean a transformer.

2. The Big Z.

It's just as well the JansZen people put that big Z in the middle of their name. I was beginning to get desperate, trying to remember how to spell it, and though the Jensen speaker people probably weren't turning a hair, I was losing mine thanks to telephone calls and questions in person that constantly wanted to know about Jensen when it was JansZen and JansZen when it was Jensen. . . .

"You mean the one with the big Z in it," I now ask. Or vice versa.

Anyhow, the JansZen electrostatic speaker has beeu operating in my home for some months now and, after all that time, I am well enough used to it so that I can say in all confidence, it's good.

It's not that I notice it. I didn't really notice much change when I first installed it, as tweeter to my present AR-1 woofer. On casual acquaintance it sounded—well, just like a tweeter. It gave out with the highs and the music was complete. Funny feeling, after all the fuss that's been made about electrostatics!

But the fact is that most people will notice no immediate and stunning miracle. The electrostatic tweeter just goes to work, faithfully and unobtrusively. Mine is still working and nothing has burnt out or busted—yet.

The funny thing is this. Now, however, I hear the other tweeters, *as speakers*, and I don't like it. I hear them themselves, between me and the music. I'm aware of them as speaker-entities. The JansZen is less in evidence to my ear. It's more transparent. I'm hardly aware of it at all.

Now that may seem anticlimactic. But it happens to be exactly what the JansZen ought to do, by claims and by rights. It is transparent to sound, as in a similar manner is the ESL cartridge I'm using with it. In this day of near-perfection in audio equipment, there can be no greater compliment.

I haven't tried any of the other quality electrostatic units yet, but I fully expect you will find the same thing true of them. And indeed, at the New York High Fidelity Show, I listened to the Pickering experimental full-range electrostatic speaker system (not for sale) and experienced the same odd feeling of anticlimax—I simply heard a good record, straight *through* the speaker. I scarcely seemed to notice the speaker as such.

These electrostatic people are going to have a time selling their hi-fi. It doesn't make enough noise on its own. But, speaking seriously, I am convinced that the electrostatic speaker has already sounded the death knell for the raucous, ear-splitting kind of "hi-fi" that has been so popular these last few years.

As long as speakers continued to have

audible, measurable individuality, hi-fi was really a matter of taste. Pick your speaker and choose your own brand of hi-fi sound. Speakers have long been far behind, inevitably, in the race for low distortion. Couldn't be helped. But now, with electrostatics, the high end at least is beginning really to catch up. The electrostatic (and, I gather, one or two other new types of speaker, such as the ribbon tweeter) is inherently and by principle "flatter" in its response than conventional drivers. True sound transparency, where all speakers will sound alike, is not far off in the higher tonal range, and I'll be only too happy when it arrives.

3. The Ultimate Transparency?

Indeed, I can't help thinking, what else is real hi-fi but complete sound transparency? What else have we been working towards, all these fine years?

Now we have, at least on tape, recording that comes close to technical sound transparency, thanks especially to fine mikes, now almost sound-transparent. Records are not too far behind but it's possible they'll soon be our weakest link, hi-fi or no. Amplifiers, the all-electric part of the chain, are 'way out ahead. No measurable distortion.

And at other transducer points, we now have virtually transparent pickups. Our speakers are approaching transparency through many different paths of development.

We've eliminated one of the biggest headaches in one part of the reproduction chain—record equalization. Now, we no longer can "hear" equalization. It, too, has become transparent thanks to the now nearly universal RIAA curve.

What more is left? Not much! We'll just have to pay more attention in the future to the original sound, the living source of all the hi-fi we've ever had. Speech and music.

That'll be just fine with me. I always was a music critic.

4. Hi-Fi versus the Real Thing

As I go to press, so to speak, I've just had to miss another in the current series of High Fidelity Concerts, those big, public demonstrations before a paying audience where the best in hi-fi equipment is dramatically pitted against the "real thing," the old original, the actual, unrecorded, living sound. This one involved the entire Hartford (Conn.) Symphony and should have been a honey—if everything worked out as promised. FM radio got in, too, rounding out the hi-fi picture.

This kind of supreme test makes for a good show stunt. The crowds are likely to rush to it, and you drag out not only the hi-fi bugs but, if you're good, a fair number of music-lovers as well, come to see how their art stands up to hi-fi's best, and even some professional musicians, there to watch the torture of their confreres! So they confidently expect, anyhow.

Whether the living music and the fleshly musicians get murdered or not depends on some very tricky and, indeed, crucial factors. It's more likely, alas, that the hi-fi will get the acoustical axe, right in front of the paying customers. That's what can hurt! There is so much to understand, so much to get done in these tricky shows, that to undertake one of them is to risk your living soul. I hereby warn anybody who plans such a venture to watch not only his Ps and Qs but to take off a year or so, first, to learn just what he's up against. A big proposition.

I'd like to suggest right here that there is a dangerously wrong emphasis going around these days in connection with such shows, which can do a lot of harm—not to the audience, which at worst is merely disappointed or misinformed, but to the promoters who, we can assume, are hoping to sell hi-fi, not to sell it down the river. I think two things ought to be better understood.

First, I don't feel it's really necessary any more to point out to the public that hi-fi reproduction now comes close to a mechanically exact imitation of "live" sound. Second, I am very sure that it is dangerous and misleading to suggest that a literal comparison be made between sound recorded and reproduced in a hall and the same sound produced there directly by living musicians.

As to the first point, I'll admit that there still is gold to be mined out of the idea of perfect sound reproduction. It is not yet taken for granted by the public, in spite of generations of power-packed advertising on the subject. Maybe the ads aren't as potent as they claim. All I know is, sound reproduction was claimed indistinguishable from "live" sound 'way back in the acoustical period. Old Tom Edison himself put on dramatic demonstrations that pitted living singers against their own recordings, and everybody seemed to think there wasn't any difference at all. Yet people still won't believe it. It takes continued persuasion, and the idea still has fascination. It'll draw crowds, and sell hi-fi.

Yet the fact is that quality sound reproduction *can* be taken for granted today and by all rights should. I, for one, am really not at all surprised when I hear reproduced sound that, on grounds of distortion, is in effect as good as the original, a true facsimile for the entire length of the reproduction chain.

On the other hand, I am shocked on those occasions when I hear less than perfection, when there is audible distortion in a public showing of hi-fi, or when there is hiss, rumble, sputter, or worst of all, hum. Distortion in all its forms is now inexcusable in public except in minute quantities, mostly in the still-weakest-link, the loudspeaker end of the system.

In other words, the technical perfection of reproduced sound that is so loudly ballyhooed in the publicity for the hi-fi comparison shows should be taken for granted. Anything less is a technical disgrace.

Yes, I know, the gremlins are always around. Things just do go wrong, people make miscalculations, do silly things with connections and go around losing parts at the crucial moment. Gray hairs are bound to start sprouting in anyone who brashly gets himself involved in a public hi-fi demonstration. I commiserate. But nevertheless, I must state that these risks are part of the deal. Gremlins are not allowed for in the specs, nor in the advertising. The show must go on, and as far as the mechanical and electrical elements are concerned it has to be perfect, and that is that. Or at least as perfect as Ivory soap.

Perfect, except, of course, for certain Other Factors, not even concerned with the equipment. My second point.

Those Other Factors, not usually mentioned in the prospectus, not touched upon in the advertising, sometimes not even known to the operators, are so big they actually dominate the entire hi-fi-versus-live program. They are "it." It is they, the strictly non-electric, non-equipment aspects, that will make or break your show.

The invited and/or paying public comes in droves to these hi-fi "concerts" to hear what they expect to be *equipment* perfection. What they actually hear is very largely a juggling of the local *acoustics*—well juggled for a good comparison, or badly juggled for a ghastly flop. The sheer quality of the assembled equipment, alas, has a relatively small role in this drama. That's the horrid rub.

If you have solved your acoustical nightmare-problems with skill, understanding and, maybe, good luck, you can get away with all sorts of semi-distortion, you can use surprisingly mediocre equipment, and still the audience will be thrilled. But if you have not faced up to the acoustical problems, if you dodge the issue or flub it, you may have the best equipment in the world and the results will be dreadful. Who, what, gets the blame? Natch, the hi-fi sellers and their equipment. Lousy equipment, says the audience, and how very, very wrong they can be! Bad thing.

Frankly, I am delighted when a relatively mediocre batch of equipment, thanks to a good acoustical set-up, does better in the way of realism than it has any technical right to. It happens often enough and not only in concert halls. Many a so-so home hi-fi system can sound out with incredible realism because of ideal acoustical set-up. Even little peanut radios and miniature portables can do it, on occasion.

But on the other hand, I am deeply distressed, and so would you be, when I see and hear equipment that I know to be excellent maligned simply because it sounds punk in a poorly calculated acoustical situation. It happens at every hi-fi equipment show, as we all know. (One reason why I never try to judge sound quality at a hi-fi show.) And it can happen with a vengeance in the trickier and more sensitive situation where reproduced sound is to be compared directly, AB, with living sound. In that comparison you simply ask for the worst by pitting the natural, on-the-spot, two-eared original against sound that is reproduced through the acoustically unnatural medium of the loudspeaker, with its one-eared, double-echoed reproduction.

What's the general approach that's safest, if you are bound and set to compare your local symphony orchestra, string quartet, organ and what-not with the sound of the same, reproduced hi-fi?

I'm not worried about the details, which will differ radically in every set-up, anyhow. Let's stick to principles.

Natch, first and foremost, be sure that your equipment is good, has enough power, enough versatility (for equalization—equalizing the live and the recorded sound) and that it *works*. Kill off the gremlins before they're born. And be sure to have as much quick-action stand-by equipment, just in case the impossible happens and everything goes up in smoke or you get nothing but loud blats and squawks. I hate to say so, but the impossible is quite probable on these hectic occasions! Or you should assume so, anyhow.

Then, before you have even begun to complete your equipment set-up, begin to work overtime on DOUBLE LIVENESS.

Unless you are a sound wizard, you will not be able to record your musicians *and* play them back *in the same hall* for a direct comparison with themselves.

You must immediately face the fact that in the recording you have two livenesses added together, with no directionality (or at best a limited separation, as with stereo recording), pitted against *one*, single liveness and *infinite* directionality in your live music. These are fundamental differences that can make the two sounds as utterly unlike as you can imagine in your worst nightmares. And—almost always—the "real" music sounds better. The reproduced sound, *through no fault of the equipment*, is the sound that suffers. Fine thing!

Therefore, you must plan knowingly and experiment constructively, using every trick you can lay your hands on to come out with as near to an exact acoustical match in the two sounds as possible. If you understand what you're up against, you've won half the battle.

Don't mislead the public by ignoring these factors. You'll do your explaining at the actual Hi-Fi Concert, or maybe you won't explain at all. But in your advance publicity, don't give a wrong impression. Don't tell the prospective audience in so many words, that your hi-fi equipment will offer a LITERAL reproduction "identical with the living music as recorded on the very same stage."

Not, at least, unless thanks to extreme wizardry, incredible intuition, or darned good luck, you actually have been able to make a recording on your concert hall stage that will play back without acoustical complications, for a relatively perfect comparison. It's impossible of course, but it has been done. It can be done—sometimes.

If so, you're entitled to tell your public what's in store for them—you can claim a REMARKABLE similarity, a fantastically ingenious illusion, you can imply, correctly, that your technicians have solved mountainous technical *and acoustical* problems. Even if your show *seems* to make a perfect match between hi-fi and the real thing, even if your orchestra can put down its instruments and the sound apparently goes on with never a break—don't mislead. In the name of constructive honesty and in your own self defense and that of the industry, don't *ever* imply that the two sounds, recorded and live, can be identical merely because your hi-fi equipment is 99.44 per cent perfect. That is simply not true, no matter how good your show is.

And if things don't go so well in your first experiments, be sure *you* know it. I have heard enough acoustically faulty demonstrations to be well aware of how badly things can go. Too little experimenting and too late. Be sure you have your hall available well ahead of time, and your equipment and your orchestra too. Be sure, somehow, that you allow for the differences between empty and full hall acoustics (always assuming you'll have a fine audience)—not an easy calculation to make.

And keep working at the tricks, at mike placement, at loudspeaker placement, over and over again, until you are dizzy and your musicians have practically worn out their instruments. This you'll have to expect, unless you're just plain incredibly lucky. Or unless, as I say, you have on hand a wizard, a magician, who can set up his mikes and get the ideal recording the very first time. But don't count on that. Wizard or no, the reasonable odds of nature are all against it. Normal procedure is to try, try, and try again, and that means hours and hours and hours of work, over and above that expended merely on assembling the necessary hi-fi equipment in the hall.

I'll continue this discussion in a later issue, and will hope that there'll still be a few brave souls around willing to stick necks out and try a "Hi-fi Concert," living musicians, hi-fi systems and all. I don't doubt that there will be, for not only does hope spring eternal in the human breast, as somebody once said, and the next guy is always sure *his* big demonstration is going to be the ultimate, but it's a plain fact that the millions of people who buy hi-fi are truly concerned with it, and they really do want to hear what happens when hi-fi runs head-on into the Real Thing, right in front of their own ears. They turn out in droves.

They don't even know about double liveness, but *you* had better.

(To be Continued)

TRANSISTOR

(*from page 47*)

grid bias: this is the normal cathode-bias arrangement. The advantage of this is that the grid-bias voltage is dependent on the plate current, so that changes in plate current due to aging or other effects cause a change in bias voltage which tends to maintain the plate current at its original value, thus stabilizing the operating point.

Guided by our knowledge of the tube cathode-bias circuit, let us examine the effects of placing a resistor in series with the emitter of a transistor, as shown in *Fig.* 2. We analyze this circuit as follows.

The *voltage* at the base is set by the divider R_1R_2, so that the base voltage is

$$v_b = V\frac{R_2}{R_1 + R_2}.$$

As before, we can assume that the base-to-emitter voltage drop is negligible, and the emitter voltage will be

$$v_e = v_b = V\frac{R_2}{R_1 + R_2}.$$

The *current* in the emitter circuit is

$$i_e = \frac{V_e}{R_3} = \frac{V}{R_3}\,\frac{R_2}{(R_1 + R_2)}.$$

The current flowing in the collector will be

$$i_c = \frac{\beta}{\beta + 1}\,i_e,$$

and since β is large compared to one, changes in β will have only a slight effect on i_c. Compare this to the circuit of *Fig.* 1, where i_c was directly proportional to β.

The value of R_4 can now be chosen for the best operating point:

$$R_4 = \frac{1}{2}\frac{(V - v_e)}{i_c},$$

so that

$$v_c = V - \frac{1}{2}(V - v_e) = \frac{1}{2}(V + v_e).$$

Since changes in β cannot appreciably affect the collector current, these changes must "reflect back" to change the base current which will be

$$i_b = \frac{i_c}{\beta}.$$

However, changes in i_b have a negligible effect on the operation of this circuit. This will be true for values of R_1 and R_2 such that the current i_s, flowing in the divider R_1R_2, is large compared to the base current i_b drawn by the transistor. That is to say that

$$\frac{V}{R_1 + R_2} > i_b$$

Unless this is true, changes in i_b will cause v_b to change, and the circuit will be less stable. Since the operating point is essentially independent of β, this circuit will be insensitive to transistor replacement or temperature change, insofar as bias conditions are concerned.

A Correct Example

Using the improved circuit of *Fig.* 2, let us design an amplifier with a CK722 transistor. Select $i_c = 0.5$ ma, with a supply voltage of 10 volts. The value of $v_e = v_b$ should be twenty to thirty percent of V, say 3 volts. Now calculate

$$R_3 = \frac{v_e}{i_c} = 6K,$$

$$R_4 = \frac{1}{2}\frac{(V - v_e)}{i_c} = 7000,$$

$$v_c = \frac{1}{2}(V + v_e) = 6.5 \text{ volts.}$$

Since a typical value of β for CK722's is 15, we will have

$$i_b = \frac{i_c}{\beta} = \frac{1}{30} \text{ ma, or } 33\ \mu a.$$

For good stability, the current i_s flowing through R_1 and R_2 should be several times as large as i_b, or about 200 μa. Then

$$R_2 = \frac{v_e}{200\ \mu a} = 15{,}000,$$

and

$$R_1 = \frac{V - v_e}{233\ \mu a} = 30{,}000.$$

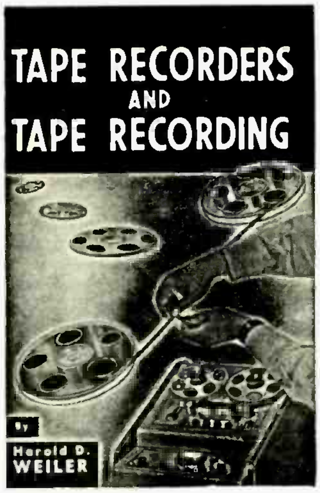
Note that since the transistor input impedance is only about 1000 ohms, the signal power lost in the divider will be negligible. For the circuit values calculated above, the measurements in Table 2 were recorded. The transistors were the same ones used in Table I. Note the considerable improvement in changes in

TABLE II

β	i_c, ma.	v_c, volts
10	0.46	6.8
13	0.47	6.6
15	0.49	6.5
18	0.50	6.4
24	0.54	6.2
31	0.55	6.1

i_c and v_c with respect to β, compared with those of Table 1. The stability could be further improved by reducing the values of R_1 and R_2 so that i_s is even larger compared to i_b.

It is apparent from comparing Tables 1 and 2 that no product incorporating transistors could be mass produced using the circuit of *Fig.* 1. Each transistor would require a different value of R_1 to set the collector current to the proper value, and even then, i_c would drift considerably with age and temperature changes. Only a stabilized circuit such as that of *Fig.* 2 would be practical.



Referring again to *Fig.* 2, C_2 must be large enough to bypass the transistor emitter resistance at the lowest frequency of interest. For audio frequencies, its value should be at least 50 μf, but for high fidelity applications, 500 μf will be required. Use low-voltage electrolytics for this purpose. The value of C_1 should be 2 to 10 μf for audio frequencies, unless the preceding stage has a very high output impedance. In this case a somewhat lower value will suffice. The value of C_3 will be determined by the load impedance. To couple into another transistor at audio frequencies, use 2 to 10 μf. If a vacuum tube circuit follows, a .05 μf capacitor will do the trick.

Remember, the tremendous advantages of transistors can be realized only if proper circuits are used. The type of circuit described here has been operating for over six months in a high fidelity preamplifier and control system. It is completely trouble free, and provides sound quality equal to or better than comparable vacuum tube circuits.

MULTIPLE TAPE

(*From page 36*)

for spot checking.

The foregoing is included because the Magnecorder PT-6 is still widely in use and is well liked by many. It may peculiarly fit somebody's pocketbook. Each of our machines has recorded between 4000 and 5000 tapes and they have become worn and are now retired.

Modifications to System

Since a change in our setup was imminent, we decided in favor of direct drive and easy speed change. Further, our transcription service had stabilized to the point where it appeared economical to use four machines. The upshot resulted in four Berlant BRXD tape transport mechanisms and one BRX-P amplifier, shown in operating position in *Fig.* 3.

Much to our surprise the Berlant problem turned out to be much simpler than our previous experience with Magnecorder. It was thought at first that, since the Berlant has the bias and erase oscillator in the amplifier section, it would be necessary to build an erase amplifier which would also furnish bias for all four machines, and that a separate audio power amplifier would be necessary to supply audio. Final result of the experimentation is revealed in *Fig.* 4. A capacitance-coupled erase amplifier using a dual 50,000-ohm poten-

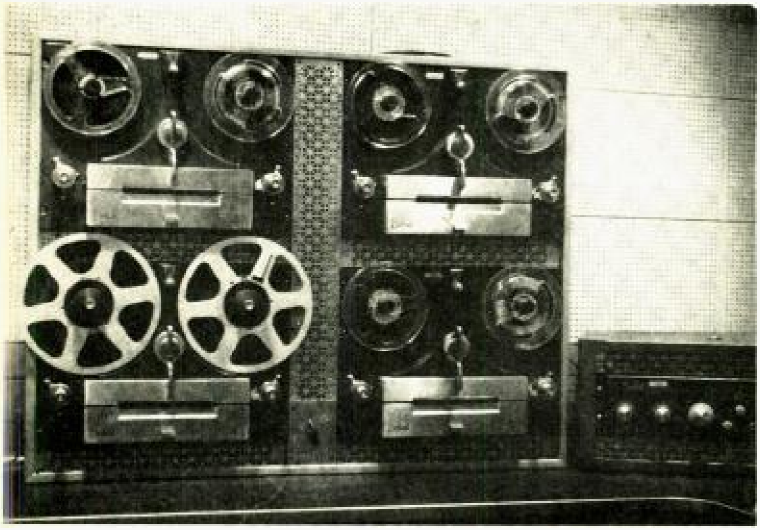


Fig. 3. Four Berlant tape-transport mechanisms and one amplifier comprise new setup giving same advantages over older equipment.

tiometer on the input could be easily adjusted to give the desired voltage to the four erase heads. The use of the 50,000-ohm dual pot unloaded the Berlant oscillator to such an extent that optimum bias could be achieved by taking bias for all four record heads, in parallel, from the original source. Also there was sufficient audio to drive the heads with no additional amplifier. Flat response from 40 to 10,000 cps at the 7.5 ips is easily attainable with no audible distortion. The play heads go through the selector switch to the Berlant playback amplifier.

With this setup if any one machine is on RECORD, all are energized even though their individual pushbutton may not be depressed. This makes it impossible to play back (thru the console) on one machine and record on another. It is possible to play back on one machine and record on the "master" machine, in our case an Ampex. If you wish to erase a certain portion or particularly all after a certain portion, pressing the record button on an idle machine will erase the desired portion going through another machine operating on play back.

All in all this setup is proving very satisfactory and the saving of $600 in amplifiers is not to be overlooked.

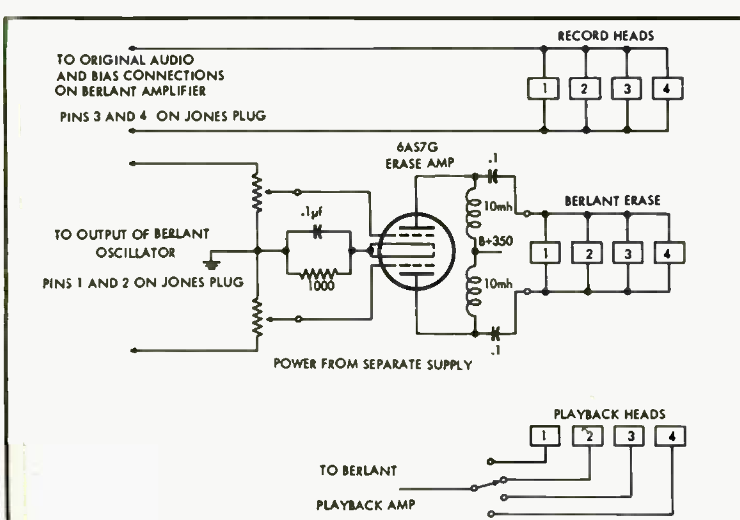


Fig. 4. Using one erase oscillator and an erase amplifier enables the station to employ only one amplifier to record on four machines simultaneously.

SEMI-SOLID ENCLOSURE

(from page 39)

75 lbs. and have a density of 1.8. They are not as good as slate, which has a density of 2.9, but they are much cheaper than slate and better than 1¼-in. plywood.

Dimensions and drawings for the two back panels and the top and bottom panels are not given, as no one will probably wish to duplicate the carpentry previously referred to. However, the unit measures 20 in. along each back panel into the corner; thus the top and bottom can be cut from one 24-in. square of ¾-in. plywood. If a half-sheet (2′×8′) is purchased in the first place, the remaining 24×72-in. piece is more than sufficient to provide for the two back panels and reinforcing strips for top and bottom panels. The 4′×4′×½″ sheet of asbestos-cement board cost $6.00 in Montreal; the birch hardwood corner posts (which had to be radial-sawed) cost $6.50, and the half sheet of plywood cost $5.60. Even with the few extras such as the front grille, hardware, and varnish stain, the total cost of unit was under $25.00. From *Fig.* 2 it will be seen that the asbestos cement board was given several coats of varnish stain as a moisture sealer; also that king-size snap-fasteners are used to hold the front grille in place.

The internal volume is approximately 3.5 cu. ft. and free resonance of the speaker is 27 cps. The curve in *Fig.* 5 speaks for itself—note that the "peaks" at 79 and 89 cps represent a rise of only 1 db. There is no boominess and reproduction of male speech is excellent. Appreciable output exists at 31 cps from the Cook frequency record and although no separate tweeter is used, the integral 6-in. duplex cone appears adequate up to 12,000 cps. This duplex cone is visible in *Fig.* 2 through the screen of rubberized under-rug anti-skid netting used to protect the cone from probing little fingers.

So—if you can't accommodate a slate-panelled concrete enclosure, settle for a semi-solid one made from asbestos-cement board.

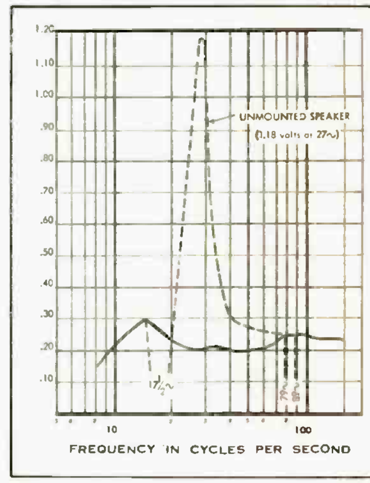


Fig. 5. Impedance curves of loudspeaker enclosed in the housing described by the author, and in open air (dotted curve).

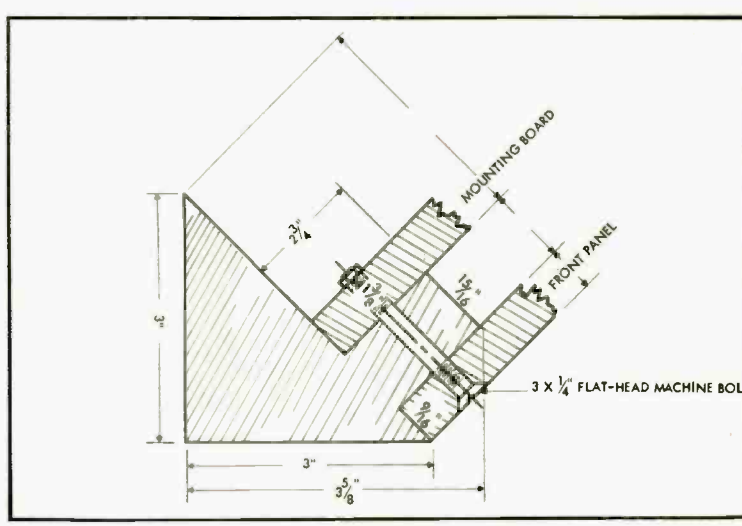


Fig. 4. Details of the front panel, speaker mounting board, and the hardwood corner post to show how the front corner of the cabinet is assembled.

COLLEGE MUSIC ROOM

(from page 29)

orchestra as the floor is level. The treble from the speaker was directed toward the audience. This, judging from the comments, was where the greatest discrepancy between the live and recorded sound sources was observed. It represents a most difficult situation for a recording engineer who refuses to attenuate the treble to any extent.

The experiment was quite successful in showing what the equipment could do and in creating interest in the new music room. There were considerable delays in the completion of the building. At the time of dedication ceremonies, the music room equipment was one of the few things in operation in the new wing (although the decor of the room was not complete) and was well received by the many visitors.

At the time of this writing the music room had been in regular operation for over a month. The components chosen are functioning so well that, playing constantly before a critical audience, music coming from the main loudspeaker via the control room has received no critical comments aside from frequent recommendations for equalizer changes and criticism of older records.

Considering the size of the music room and the performance of the system, one professor described it this way, "It's bringing the concert hall into the concert hall."

AUDIOCLINIC

(from page 58)

smaller the circumference, the greater the high-frequency loss will be.

It can easily be seen that though the rotational speed of the table remains unchanged, the speed which really counts is constantly being reduced. In linear speed, the rotational speed changes so as to maintain a constant speed of disc material passing under the recording needle. This keeps the frequency response constant over the entire playing surface, with the upper limit of that response being determined by the linear velocity chosen.

This has never been used commercially for high fidelity sound reproduction. The only products which make use of this principle are office dictating machines produced by Gray Audograph Co. In these devices, the recording starts at the *center* of the disc, meaning that this is the point at which the rotational speed is greatest.

Amplifier Trouble

Q. I have encountered a phenomenon that I am at a loss to understand. Using an amplifier with a conventional ultralinear circuit with 5881's in the output, performance is beautiful—hum, distortion, and so on, at a minimum. However, I find *that if the input of the amplifier is fed a sudden high-level signal or the input is "shocked" by touching the input cable, the effect is that of an extreme overload or block: volume of output will drop considerably and distortion is extreme. This condition will exist until it gradually fades or bleeds away, taking five to ten minutes —or I can relieve it by turning off the amplifier, pulling one of the 5881's and shorting either the plate or screen socket connection to ground. Can you tell me what is causing this trouble and how I can eliminate it? Jackson C. Ream, Albuquerque, New Mexico.*

A. The circuit design of such amplifiers is very stable, so that the difficulty lies in some faulty component, or perhaps an accident in wiring. Assuming that the unit has been wired properly, check all tubes, especially the output tubes. Much time has been lost by many a serviceman by looking for a bug which proved to be nothing more nor less than a defective tube. Make the amplifier block, and note the color of the output tube or tubes. One or both of them may have a blue coloration. This means that the tube is gassy. A gassy tube conducts by ionization, allowing it to draw high current. The effect of the signal voltage supplied to the grid will be small and the output will be distorted. If this condition is allowed to continue, there is danger of damaging other components.

If the tubes appear to be all right, you may have an open grid return resistor. These are resistors which connect the grid of a tube either to ground or to a point where fixed bias is applied, or perhaps to some portion of a phase splitter network. If such a resistor were to become open (infinite resistance), the grid of the tube would become more negative than it should be for proper operation, and the plate current would be at least partially cut off.

Such troubles can also be caused by intermittent coupling capacitors or cathode resistors.

GRAPHICAL SOLUTIONS

(*from page 24*)

and the magnitude

$$|Z| = [R^2 + X_C^2]^{\frac{1}{2}} = X_C\left[\frac{R^2}{X_C^2} + 1\right]^{\frac{1}{2}} = \frac{1}{\omega C}[\omega^2C^2R^2 + 1]^{\frac{1}{2}}$$

which answers are identical to the analytical solutions to be found in textbooks.

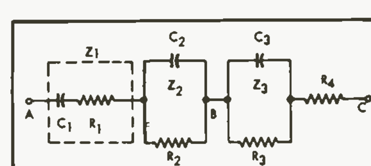


Fig. 13. Circuit of Fig. 12 redrawn for purpose of analysis.

To Figure 6

In *Fig.* 6 the angle

$$OBC = AOC = \phi$$

Then

$$\phi = -\tan^{-1}\frac{R}{X_C} = -\tan^{-1} R\omega C \qquad (2)$$

From the two similar triangles

$$\overline{OC} : \overline{OA} = \overline{OB} : \overline{AB}$$

and

$$\overline{OC} = \frac{\overline{OA} \times \overline{OB}}{\overline{AB}} \qquad (3)$$

$$\overline{AB}^2 = \overline{OA}^2 + \overline{OB}^2 \qquad (4)$$

Substituting the values $\overline{OA} = R$ and $\overline{OB} = X_C$ into Eq. (4) and then into Eq. ( ) we get

$$\overline{OC} = \frac{RX_C}{\sqrt{R^2 + X_C^2}} = \frac{R}{\sqrt{\frac{R^2}{X_C^2} + 1}} \qquad (5)$$

$$X_C \text{ being } -\frac{1}{\omega C}$$

by definition, Eq. (5) becomes

$$\overline{OC} = \frac{R}{\sqrt{1 + \omega^2 C^2 R^2}} \qquad (6)$$

The value arrived at in Eq. (2) is identical with the expression derived analytically for the phase angle; that in Eq. (6) is identical with the magnitude. Thus the vector $\overline{OC}$ does represent the impedance of a resistance and a capacitance in parallel.

To Figures 7 and 8

To prove the validity of the constructions illustrated in *Figs.* 7 and 8 one proceeds exactly as described above, except for the sign of the reactance which is now positive instead of negative.

To Figure 10

The two triangles DAB and DOC are similar. Then

$$\overline{BA} : \overline{OC} = \overline{DA} : \overline{OD} \qquad (7)$$

$$\overline{DA} = \overline{OD} + \overline{OA} \text{ and } \overline{OA} = \overline{AB}$$

by construction. Substitute these into Eq. (7):

$$\overline{BA} : \overline{OC} = (\overline{OD} + \overline{AB}) : \overline{OD}$$

and

$$\overline{BA} \times \overline{OD} = (\overline{OD} + \overline{AB}) \times \overline{OC}$$

whence

$$BA = \frac{\overline{OD} \times \overline{OC}}{\overline{OD} - \overline{OC}} \qquad (8)$$

Substitute

$$\overline{OC} = X_L = \omega L$$

and

$$\overline{OD} = X_C = -\frac{1}{\omega C}$$

into Eq. (8) and get

$$BA = \frac{\frac{L}{C}}{\frac{1}{\omega C} - \omega L} = \frac{\omega L}{1 - \omega^2 CL}$$

which is identical with the analytical solution.

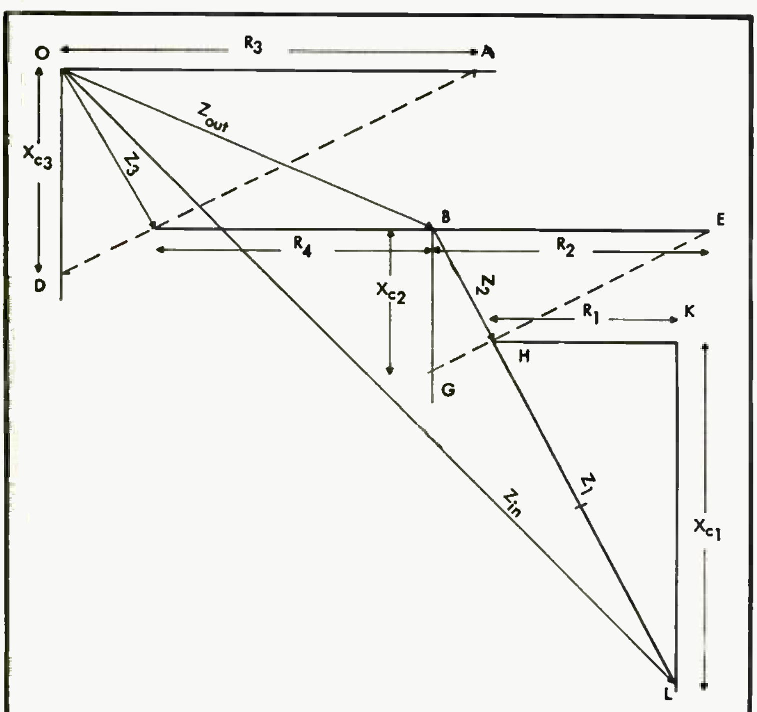


Fig. 14. Graphical solution of problem of Fig. 12. The step-by-step progress is described fully in the text.

FM TUNERS

(*from page 34*)

not affect tuning of normal stations, the other trap can be adjusted at about 10.3 mc. In this way the response curve on this side is steepened and the adjacent-channel selectivity improved. If one trap will not eliminate two-spot tuning, tune the other trap to this (11.1 mc) frequency also.

No further alignment is necessary. The detector, if no error in wiring has been committed, requires no adjustment. If distortion-free results cannot be obtained, check the 10.7-mc channel for regeneration, oscillation, or a badly distorted and too narrow band-pass.

The simplicity of the alignment process, makes it possible to keep the tuner at peak performance by occasional re-adjustment of the trimmers using the tuning eye.

The simplest way to build the complete amplifier would be to purchase the Collins Audio Products Company's IF-6 amplifier and modify it to the new circuit. The modifications would not be great and the use of this chassis would eliminate punching and assembly. The third i.f. tube would be replaced by a 6BE6 as a converter, and the stage rewired. The discriminator transformer would be converted into a 10.9-mc oscillator coil by shorting out the discriminator winding and tapping the plate winding about one-fourth of the way up from the low end. This transformer would then replace the fourth i.f. transformer, which could be used at the front-end output transformer if a whole new receiver is constructed. The spot now occupied by the discriminator transformer would be filled in with a socket to take the 6AU6 which was the third i.f. and will now be the second limiter. The whole section from the converter to the detector would now be rewired into a 200-kc channel and detector. Only one additional tube, the 6BE6, and a few resistors and capacitors, would be necessary to make the change.

The Collins FM-11 kit thus modified should produce a receiver with useable sensitivity better than 1 microvolt, equalling the sensitivity and surpassing the fidelity of the $300 to $600 monitoring and relay receivers used by FM broadcast stations.

If the amplifier is used as an outboard accessory to a present FM receiver, no attempt should be made to use a common power supply, for instability in the 10.7-mc channel would surely result. Indeed, when used as a boosting amplifier, it would be well to shield the whole rig and place it a foot or more from the present receiver.

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THE AUDIO EXCHANGE has the largest selection of new and fully guaranteed used equipment. Catalog of used equipment on request. Audio Exchange, Dept. AE, 159-19 Hillside Ave., Jamaica 32, N. Y. AXtel 7-7577; 367 Mamaroneck Ave., White Plains, N. Y. WH 8-3380.
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Industry People...

Randolph (Randy) Ketcham, widely known and highly regarded in broadcast and recording circles, has joined Cook Laboratories, Inc., Stamford, Conn., as national sales manager . . . **Robert G. Bach** has rejoined Fairchild Recording Equipment Company as sales manager; formerly with Fairchild in a similar capacity, for the past year he has been advertising manager of Harman-Kardon, Inc. . . . Personnel realignment of Altec Companies, Inc., finds **Bert Ennis,** in charge of publicity, dividing his time between New York offices and the manufacturing plant of Altec Lansing Corporation on the west coast; principal assignment is to establish liaison between Altec's east and west publicity activities. **S. M. Anderson,** formerly merchandising manager of Altec Service Company at the firm's New York headquarters, has been appointed purchasing agent for Altec Lansing Corporation at the company's manufacturing plant in Beverly Hills.

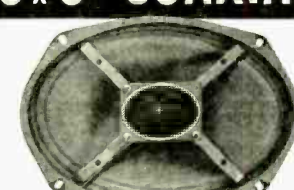
Appointment of **Nils Hillstrom** as national sales manager has been announced by **Robert D. Newcomb,** president of Newcomb Audio Products . . . Promotions at University Loudspeakers, Inc., include **Lawrence J. Epstein,** who has been named director of sales and merchandising, and **Charles Ray,** who has been named jobber sales manager. **Arthur L. Foster** has resigned as advertising manager of the special products division of Stromberg-Carlson Company to join J. H. Sparks, Inc., Philadelphia distributors, as hi-fi sales manager . . . Appointment of **Neal W. Turner** as merchandising manager of Heath Company has been announced by **Robert Erickson,** Heath president. Prior to joining Heath in 1950, Turner was with the Hallicrafters Company.

Industry Notes...

Appointment of Francis C. Healey as general manager of a newly-formed division of **Minnesota Mining and Manufacturing So.,** has been announced by Robert L. Westbee, vice-president in charge of 3M's Electrical Products Group. The division, to be known as **Mincom,** will continue electronic research and product development activities formerly conducted by the electronics division of **Bing Crosby Enterprises, Inc.** John T. Mullin has been named research director. A group of Crosby research staff members, headed by Mullin and Wayne R. Johnson, have also joined 3M. The Mincom division will headquarter in new office and laboratory facilities in the Los Angeles area. The exact site has not been selected.

Magnecord, Inc., Chicago, has established another division, **MagneMatic,** to specialize in the development and manufacture of magnetic tape recording equipment for industrial applications, particularly in the fields of automation and advanced instrumentation. This move, another step in the company's program of planned diversification within its professional field, was given initial impetus by the purchase of all designs of **A-V Manufacturing Corporation.** Charles Rynd, president of A-V, has been retained as consultant. Another Magnecord subsidiary, **Magne Music, Inc.,** supplies tape reproducers and recorded RCA tapes for commercial installations of background music.

ORRadio Industries, Inc., Opelika, Ala., manufacturers of recording and video tape, has been confirmed as a general member of the **Institute of High Fidelity Manufacturers.** Admitted as an associate member was **The Elektra Corp.,** New York City, manufacturers of hi-fi records. Membership of the Institute now totals 72 companies.



AUDIO

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ADVERTISING INDEX

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SIMPLE AS A B C

To make it just as easy as possible for AUDIO's readers to subscribe, order books, get further information about the new products and the new literature mentioned in the pages of the magazine, or to get catalog sheets and brochures describing articles advertised, we provide herewith three cards. We know that many readers are loath to cut coupons from the pages of their favorite magazine because they have told us so. And we know that many times one would like to have complete and thorough data about something he sees in these pages, yet he considers it too much trouble to hunt up paper and envelope—not to mention the stamp—and write a long letter detailing what he wants to know. This is just as simple as we know how to make it with the exception of stenciling each subscriber's name and address on each of the postcards—an operation which would be highly impractical from the printing standpoint. But from now on, when you want more information about something you have seen advertised or mentioned in AUDIO you need only indicate it on the appropriate card, print your name and address, and drop it in the nearest postbox. We pay the postage, and it goes without saying that we wouldn't include these cards if we didn't welcome your use of them. And, for the first time, you can enter your subscription without sending a penny with your order—we'll bill you later. For books, we'll have to ask for the money in advance, but only for books.

Readers have told us that they often want to know more about some of the items mentioned in the *New Products* and *New Literature* pages of the magazine, but that they do not want to take the time and effort to write to each one of the sources individually to get all the information they need. As a matter of fact, in an average issue there are usually ten items in the *New Literature* column, and between ten and fifteen on the *New Products* pages. It is conceivable that the average reader might want information on at least ten of these items, since they are selected with the interests of most of AUDIO's readers in mind. Thus one would have to have ten envelopes, ten sheets of paper, and ten three-cent stamps, together with the need for writing the ten letters and inscribing each with name and address. We do it all for you, assuming that you are willing to circle the items about which more information is desired and to write your name and address once. We will forward your inquiries to the organization involved, and you will receive the data you want with only one inquiry. Isn't that as simple as A B C?

In just the same way you can get more information about any product that is *advertised* in the pages of AUDIO. Note the page on which the advertisement appears and circle it on the back side of this card. When there are two or more ads on the same page, the page number is followed by a letter, and the designation appears under each individual advertisement. Write your name and address clearly—someone has to decipher it—and it is a good idea to mark the card for all the information you want the first time, for there is only one card in each copy of the magazine. Of course, you *could* subscribe to two copies.

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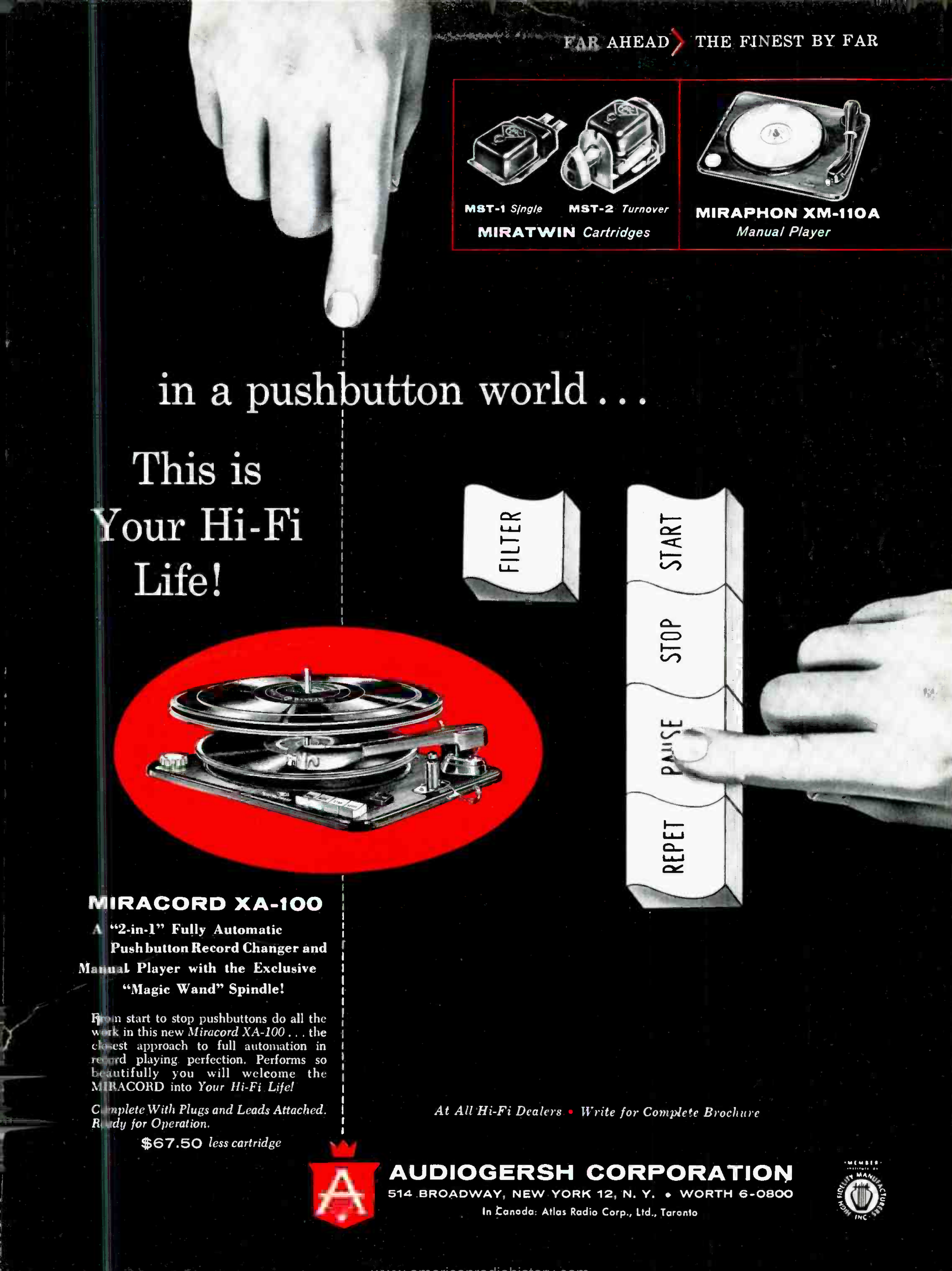
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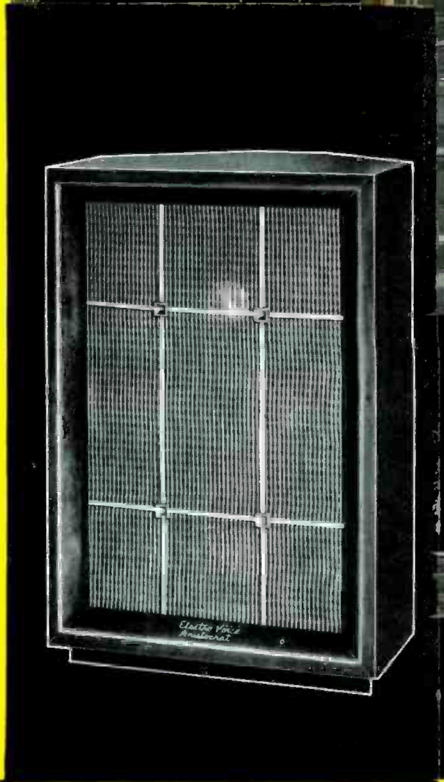

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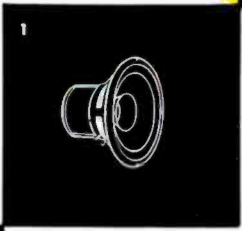

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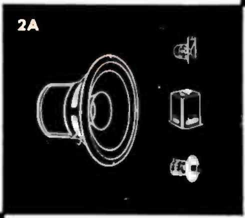

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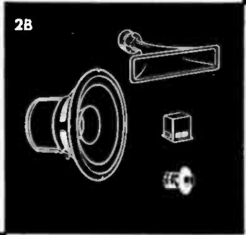

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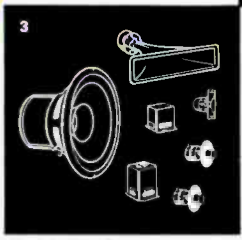

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