

An Interview with David Hafler

Part 1: The Acrosound Years

By Charles Kittleson ©2000 All Rights Reserved

David Hafler, the founder of Dynaco, Inc., has probably been more instrumental in the development of component hi-fi for home use than anybody in the history of the industry. He was born in Philadelphia, Pennsylvania in 1919, received his degree in mathematics from the University of Pennsylvania in 1940 and served as a communications officer in the military during WW2. After the war, he worked for a market research company until he and Herb Keroes formed Acrosound Transformer Company in 1949.

He started Dynaco in 1955 and produced more vacuum tube power amplifiers and preamplifiers than any other company in the world. We interviewed David in May of 1999 and this is the first part of a two-part interview.

David, I'm sure a lot of people would like to know when you first became interested in audio. Maybe you could tell us a little about that.

I first became involved in audio because I was fascinated with music reproduction. I liked certain kinds of music very much, and was rather deeply interested in knowing about them, however, I never was much of an instrumentalist myself. But my interest in music carried over to a fascination with equipment and that happened, I guess, in the late 30's. Then, when 1941 came along and most of us my age went off to the military service, I had no special capabilities as far as the military was concerned. They just put me in the mill and ground us through. But while I was in the service, I found my interest in music got carried over into my interest into audio or rather vice versa. I've learned a little bit about audio equipment from what Uncle Sam taught me. It was because I was a Communications Officer in the military.

When did you first experience high fidelity?

In 1940, I went to a radio parts shop here in Philadelphia to buy some batteries. The shop was under elevated rail tracks where you couldn't hear an AM radio at all, because the noise was just horrendous. There was some beautiful chamber music coming out of this box and I was thinking "what is that?" The shopkeeper said "Oh, that's a new Jensen speaker system." They had a Jensen infinite baffle enclosure

Were these bass reflex?

Yes, bass reflex, of course, and they had this bass boosting function. They were used with a Bogen PA system and

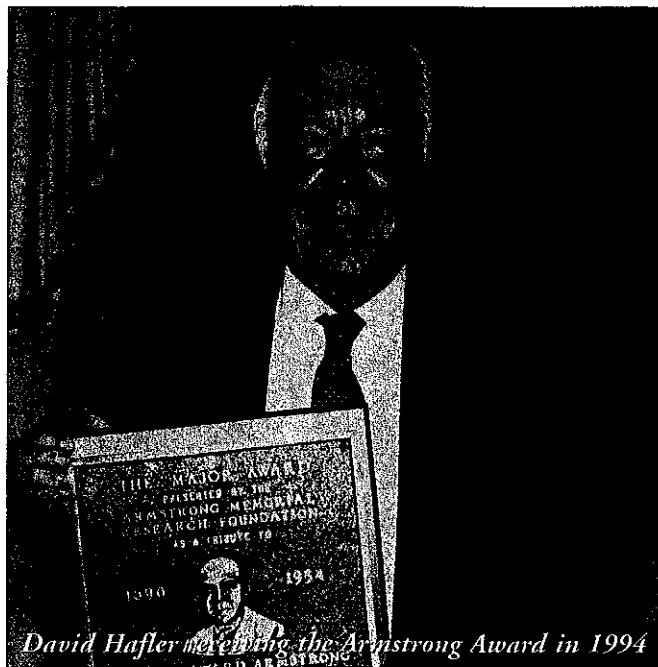
it sounded magnificent. They had only the one FM station in Philadelphia at that time which was mostly experimental. But I had never heard anything sound that good, except the real thing. That kept me quite interested, so when I got home from military service, I went to hook up my rig which at that time was a Crosley radio with an external record player. When I turned it on, it went up in smoke. The capacitors had dried out and hadn't been used for four years, so the system was worthless. It was then that I decided I had to make something as good as what I heard at the radio parts shop.

Can you describe the first amplifier that you built?

My boyhood friend Herb Keroes, was a hi-fi hobbyist who lived a block from me when I was growing up in Philadelphia. I also knew other people with similar interests, like Bill Schraeder in Washington who was interested in hi-fi and he was able to give me some advice. Herb gave me a schematic for a push-pull triode amplifier. The design used two 6J5s. One of them was a voltage amplifier and the other was a phase inverter. The output stage used a pair of 6A5Gs, which is a 6B4 with sleeved cathodes. I think it was only Sylvania made them and they were hard to locate. The output transformer was about a 2 ounce unit made by UTC. GE had a mid-quality units that cost about 2 or 3 dollars.

That system worked and I was very pleased with it. It sounded better than other stuff around. I also made a bass reflex cabinet out of plywood that had a 10 inch Jensen, oh they called it the Concert Series wide range speaker system, which was rated to go from about 50 cycles to 5 kHz.

I had no equipment for distortion measurements. I was able to borrow a RCA VTVM and was trying to find out



the best operating conditions for this amplifier. Then I played around by ear, changing values step at a time. For instance, on the cathode of the first 6J5 I had a 1,000 ohm resistor and I varied that in a range from 100 ohms to 2000 ohms, listening for differences. And there places where differences were pronounced and there were places where they were not. All together, I had sort of assumed the tube manuals were correct and if you get the thought of that you get 10 watts out. I learned a little later, through a little misery, that I couldn't get anywhere near 10 watts clean. There just wasn't enough drive capability in the 6J5. But then I got a little fancier phase inverter which used a push pull driving system that came off of a motor circuit design. I started to put feedback into the circuit and I found that instead of the operating conditions, eventually it was that which made me happy, except that I didn't like the output transformer.

What was it like after WWII, the audio scene? Can you describe that era a little bit?

Well, it was a very small group of enthusiasts and they had very little choice of equipment. They were in each large town or city. There were some small shops that sold radio parts, let's say, or radios. Where the proprietor was interested in hi-fi himself and he expanded into record changers, they didn't do much with studio-type turntables, it was mostly record changers with Garrard and Webster leading the pack. The interest in hi-fi was very small. There were some places that catered to the amateur radio enthusiast, and those were places where I went to get advice from the behind the counter people.

Some of these people got to be quite well known. Authorities like Anton Schmidt, who was at Harvey Radio in New York (which at that time was expanding into electronic hobbyist equipment.) Harold Weinberg, who I mentioned to you before, was also there in the early 50's working for Harvey Radio. Which was, I guess, one of the most active hi-fi groups, people who shopped there and around Philadelphia. There was Ted Greenfield who was the first person to have a strictly audio shop. First person that I knew of in the country for this purpose. Then I met Bill Schrader later who had the equivalent in Washington. These little centers of hi-fi enthusiasm popped up at random and they interchanged information. There wasn't really very much of an industry, people didn't know what hi-fi was. When somebody said, "what do you do?" I said, "make hi-fi equipment." They always looked at me blankly and said, "what's that?" That was what we had up until, I guess, the beginning of the 50's. When we got into 1952 or 1953 the scene broadened out considerably.

When and where did you meet Herb Keroes?

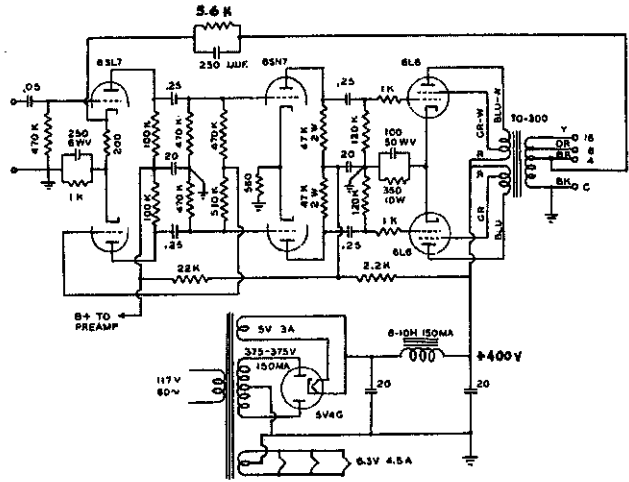
He lived about one block from where I lived and we went to school at Philadelphia High School and had the

ULTRA-LINEAR 6L6 AMPLIFIER

This circuit for 6L6's or 5881's was described in AUDIO ENGINEERING November, 1951. Its performance set a new standard of audio quality and has been widely acclaimed as one of the most important

steps forward in audio design in recent years. The amplifier furnishes 20 watts of essentially undistorted audio with an input of only .7 volts.

Circuit



same geometry class. One day this chap approached me and he said he understood that I had built an enlarger, of course I was a photographic enthusiast and so was he, and he wanted to see this thing. So he stopped by to look at it and made some suggestions and we got to be very close friends. He eventually went to work for a transformer company as I had mentioned a bit earlier and he helped me with getting started with the circuit that he gave me, and with the modifications that he adjusted later. Then I sort of went off more independently as I learned something about it. I had the Radio Amateur's Handbook, which, was a bible of sorts, and I had the Radiotron Designer Handbook by Langford Smith.

The Radiotron book was very important to me. It came out with 2 editions. The later edition referred to articles that I had written, but the first one was out prior to WWII and it had good basic information. It was quite useful for engineers and students.

When did Herb Keroes first start getting interested in audio?

I think he always had some interest. He didn't really actively try to do anything until the middle 40's. I guess at the same time that I had come back from the military. We both had interest about the same time. I was living in Philadelphia at that time and he was working in Gettysburg. But he came in on weekends occasionally and we kicked ideas around. I showed him things that I had experimented with.

Did Herb have a degree in engineering?

Yes, he did from Drexel University, in electrical engineering. His first job out of college was designing antennas for a company in Washington, DC. After that, he worked for Daven Attenuator Company and then

Acrosound TO300 Series Ultra-Linear Transformers

(From a 1959 Acrosound catalog)

Acrosound Design - Acro transformers had distinctive design features. They permitted comparable performance on all taps of a tapped transformer. They were designed for wider bandwidth—far in excess of the audio band so as to allow more stable feedback and to insure good transient response. Acro transformers were designed for lowest possible distortion at all frequencies and all power levels using generous design margins which made all the performance ratings conservative.

Acrosound Materials - Acro used the finest grades of core material in specially shaped laminations. These were not the ordinary scrapless type of laminations as used in the power transformers, but a more expensive style which had unusually fine properties in audio design. Even such a comparatively small detail as potting compound had been integrated in the Acrosound design. A special microcrystalline wax was used for better protection and performance even though its cost was higher than conventional potting materials.

Acrosound Production - Acro production of output transformers was carried out on winding equipment which had been specially designed and custom manufactured for producing this basic type of transformer. Windings are carried to the exact turn without deviation. Complete uniformity is achieved through maintenance of extremely close production tolerances.

Acrosound Testing - Every Acro transformer was subjected to a series of tests. These included: test for balance on all balanced windings (AC balance was guaranteed to 1%); test for accuracy of reflected impedance between primary and all secondary windings and taps; test for shorted turns; test for shorts from primary to secondary and from secondary to case; test for open windings; test for exciting current to insure maintenance of inductance and core power handling capacity; 2000 volt test of insulation. Additional tests were applied to a representative sampling of production to insure maintenance of all performance characteristics.

Gettysburg Transformer Company. He was a very good engineer. I can only say he had good ideas. But his ideas for marketing other things were not up to those standards that we developed later. His interest was producing thousands of transformers for TV sets at very small profit margins. My interest was making hi-fi stuff that sounded good. It was a completely different kind of business at first. What was in his mind was a good company on a large-scale. I was working on the idea that I could make a good product on a small scale and still get along. This was the biggest difference between our thinking.

What was Herb like to work with?

An example of his business inability: the hi-fi shows came a little later and one of the participants in the first show was a prospective customer for transformers that we were selling at that time. I said to Herb "Let's get together with this chap while we are in the same city because he is interested in getting some transformers from us." So he said, "If he wants these transformers, let him come to me." In other words, he wouldn't bother to go to the customer. It was kind of a "do it my way or don't do it at all." We ended up disagreeing, and I went into the kit business in 1955. He went into the transformer business, and later audio kits which didn't work out too well in the end.

When did you and Herb Keroes actually decide to form Acrosound?

Right after WWII, the GE Variable Reluctance phono cartridge was a popular item. It was the only good cartridge and sold at a reasonable price. It was a big step forward in record reproduction compared to the crystal cartridges, which were being used up to that point. There were a few moving coils, but they were so rare that you can't count them. The first transformer we had was a matching transformer to be used with the GE cartridge and didn't require a preamp. In other words it was a step up transformer that took over for the GE cartridge and put it up to a reasonable voltage for playback.

It had its winding arrangement so that the low frequencies had a bigger boost. In order to get the recording correctly compensated, it did give you satisfactory reproduction, but the frequency response didn't carry far enough down at the low end so it petered out below 100 cycles. But it sold for \$9.95 and everybody then had to buy either that or a preamp to use with the cartridge.

When did you decide to manufacture out with audio output transformers such as a TO200?

That was in 1949 also. Herb had an idea for an output transformer which was better than what was available and rather inexpensive to make. Just at that time Sun Radio in New York started to produce an amplifier that **Consumer Reports** magazine designed. Consumer Reports apparently had an engineer there who was a hi-fi hobbyist and came up with the amplifier circuit design and they published that for people to build. There was not even a kit. When it was published it was just a suggested amplifier circuit. When I saw that thing advertised from Sun Radio I thought, "here's a customer for us" to make the transformers for, because we were in the transformer business on a very, very small limited scale at that point. We had a design, which I thought was pretty good and when we compared the specifications for the Consumer Reports amplifier with what we had in the amplifiers that we were

Acrosound Ultra-Linear

TRANSFORMERS
for the ultimate in
High Fidelity amplification



TO-300 for Ultra-Linear circuits with 6X4, 6X5, etc. \$24.75 net

TO-310 for Ultra-Linear operation of 6Y6 tubes 18.75 net

TO-330 for push pull parallel Ultra-Linear circuits 39.75 net

TO-350 for Ultra-Linear 300 watt smallies with 6146 tubes 49.50 net

Prices slightly higher in West

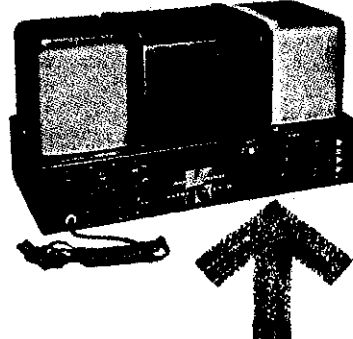
It takes more than a tapped output transformer to make an Ultra-Linear amplifier. It takes the exclusive patented Acrosound Ultra-Linear transformer designed for this application and crafted to the most rigorous specifications. Whether you build your own, convert an existing amplifier, assemble a kit, or buy a manufactured amplifier you can have genuine Acrosound Ultra-Linear circuitry, the finest available. Full transformer data and high fidelity circuits are available on request.

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ACRO PRODUCTS CO., 369 Shurs Lane, Phila. 28, Pa.

1959 Acrosound Advertisement

Significantly
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ULTRA-LINEAR II*
Amplifier

Significantly better—of course—because it features a new feedback system in the proven Acro-Developed, Ultra-Linear circuit that sets a new standard of stability in amplifier performance.

Significantly better—the heart of the 60 watt Ultra-Linear II amplifier is the Acrosound TO-600 output transformer which provides a degree of feedback unaffected by the impedance of the speaker system.

Significantly better—the Ultra-Linear II amplifier is supplied in kit form with all critical wiring preassembled on a rugged printed circuit board... simple construction requires only 2 hours' assembly time.

Significantly better in every way:

- RATED POWER OUTPUT—60 watts
- IM DISTORTION—less than 1% at 60 watts
- HARMONIC DISTORTION—Less than 1% between 20 CPS and 20 KC at power output within 1 DB of 60 watts
- SENSITIVITY—1.8 volts RMS for 60 watts output
- OUTPUT IMPEDANCE—4, 8, 16 ohms
- TUBES—2-EL34/6CA7, 1-GZ34, 1-12AX7, 1-12AU7
- DAMPING FACTOR—Variable 0.5 to 10.
- HUM—90 DB below rated output
- SIZE—7" x 15" x 8" high.
- WEIGHT—30 lbs.
- Price \$79.50 complete with all components. \$109.50 wired and assembled (slightly higher in West)

* Patent Pending
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Please send literature on illustrated Ultra-Linear II Amplifier.

Name

Address

City State

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369 SHURS LANE, PHILADELPHIA 20, PA.

1957 UL II Advertisement

playing with at the time. We thought we had a winner and a good prospect to sell.

So the first hi-fi show/audio fair was in April 1949. At that point we had run our first ad for the GE cartridge transformer and we had total sales of maybe 40 or 50 units. It wasn't a very big item. The industry was very small, of course, but we went to the first New York audio fair. They had a demonstration of a Peerless transformer with square wave being passed through it and they said this is the same transformer which is going to be used in the Consumer Reports suggested circuit. They eventually made a kit out of it. I came up to them with our transformer in my hand looking for Irv Green, who was in charge of that exhibit. I asked him if we could see what ours looked like and they put the square wave through ours and it was a better square wave than the one that they were selling. On the way home, on the train that evening, after we spent the day at the show we were very hopped up with enthusiasm because we had something good and we had a way to demonstrate it. Every place that Peerless showed that thing we had somebody come along with one of ours right behind. Sure it was better. (Laughter)

Was that the TO300?

No, that was I guess

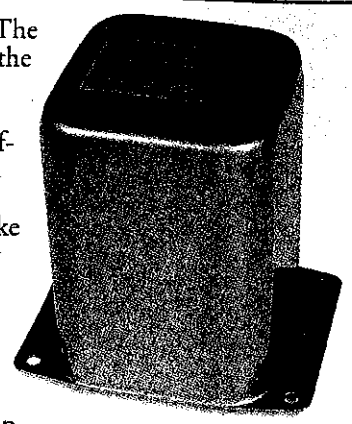
the first of the 200 series. The TO300 didn't come until the UltraLinear circuit a few years later. There was the TO 290 which was a specific replacement for use in Williamson amplifiers. We decided that we would make a very specialized company around the output transformer. Forget about the pickup transformer, which wasn't doing very great, and we were trying to do something to build up the transformer business. To do that we would publish some circuits to make it easier for people to do the job at that time. You still couldn't buy much in the way of assembled high quality amplifiers during that period.

We got started with the transformer for the Williamson circuit, because the circuit had just been publicized in the States at that time. It had been out in England for a while. It was a just recently gaining popularity in the US. The Williamson was a good amplifier, with the exception that it had inadequate power for the low efficiency speakers that are used nowadays.

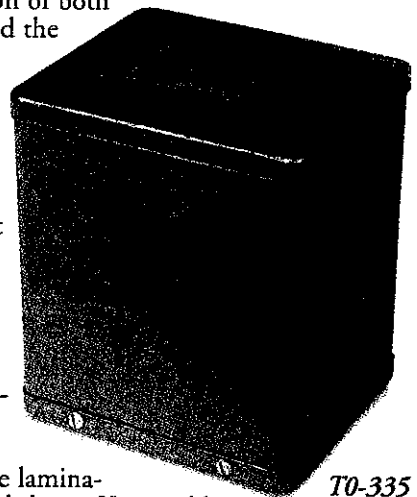
Who actually designed the TO series transformers?

It was a combination of both Herb and I. Herb had the idea using a different shape of lamination than the conventional type. It was one that used a real long coil, which gave better coupling, and that was the thing we started with. It was a design that was not too expensive but it used a different lamination than most people used, yet they couldn't tell when they got it because the lamination was sort of buried there. You couldn't see where it was. But the top of the thing was horizontal or vertical. Technically it was an A1-7 I think was the one that we got started with for the Williamson amplifier. That particular shape "E" form, the center tongue was longer and so it was proportioned differently in a way that made for a lower capacity and an extended high frequency response.

That was Herb's contribution. I always have said "What can we do to make this better?" He was interested in producing them, not necessarily in improving them. We were doing a good transformer business, mostly with people who built Williamson amplifiers during that era.



TO-270



TO-335

Acrosound Output Transformer Data

Type	P to P Impedance	Rated Power	Primary Current (per tube)	Tube Type
TO230	3000 ohms	20-40 watts	150mA	2A3 or 6B4 fixed bias
TO250	5000	10-20	75	2A3 or 6B4 self bias
TO270	10,000	10-20	75	6V6, 6K6
TO280	9000	20-40	75	6L6 (AB1)
TO290	12,000	20-40	75	807, 5881 (triode conn.)
TO300*	6600	20-40**	75	KT66, 807, 5881, 6L5
TO310*	8000	10-20**	75	6V6, EL84
TO320*	3500	10-20**	75	6Y6
TO330*	3800	50**	150	6550, EL34, KT66PPP
TO340*	5000	50**	150	6550, KT88
TO350*	6600	100***, ****	175	6146
TO600*	5000	60***, ****	75-85	EL34, KT88

* Ultralinear; ** +/- 1dB 10 Hz to 100 KHz; *** +/- 1dB 7Hz to 70 KHz; **** Feedback Winding;

did not produce any increase in power output, let's put it that way. They did make for a smoother sound than what was around in those days. You could hear more difference than you can hear now because there was greater difference between the various circuits and components. Today, everything gets pushed into a common pot and comes out the same. The differences are very small.

I kept pestering Herb on the idea of interleaving. He didn't like the idea, because the transformers were more complicated. It didn't use any more material, but it made for more complex production. He wasn't interested in that. He wanted to have the simplest production, in order to get the highest volume.

Besides the longer EI core, do you remember anything about the windings? How did you achieve such a low leakage inductance in tight coupling with the transformer?

There wasn't too much else besides that that was different from the normal ones. But I kept trying to find different winding arrangements. Norman Krogers was a gentleman who wrote for Wireless World and other electronics magazines. He was a very good theoretical man. He wrote articles on evaluating transformers and on interleaving the windings and getting different types of results. I studied those rather studiously and they gave me ideas and I told some these ideas to Herb. He liked the idea and we would try it, and if he didn't I would try it on my own. At the time, with the circuit arrangement, which was popular, there was a need for something that would produce higher power and this brings up the old triode versus pentode arguments. There were people that swore triodes were better and those that said pentodes were better and that was a smaller number. It was difficult to make a choice between these various things which were being discussed and written about.

I was always tinkering with new variations and I got the idea for interleaving that was done by using parallel rather than series windings. I made a simple calculation that showed less capacity in voltage reactions which had less distortion at high frequencies because you had direct coupling between the push-pull sides. I was playing with such a transformer and I had an amplifier which I used at home to experiment. I tried hooking up various loads to see what effects they would have. I got what I thought was a very nice transformer arrangement that could be done in a very simple way but it didn't quite click. I guess I fiddled around with different permutations and variations.

How did you come to develop the Ultra Linear transformers?

We were producing transformers of the 200 series. They

He was chasing orders for transformers used in TV sets which was far from my interest. Then he had a clever idea. He would put in a separate winding, and use that to run feedback, but not normal negative feedback, positive feedback. He calculated that he would get more power. It would be a big advantage and a unique feature in the field. He put together a breadboard with this thing to try it out and it didn't come out nearly as good as he expected. Positive feedback increased the power output very slightly, but had higher distortion. By this time we were measuring distortion by comparison of input and output and that is a very sensitive way to do it.

We didn't have distortion meters at that time because we couldn't afford them on the scale of the business that we were doing. I looked at what he had done, and I asked "why not use negative feedback with a separate winding, it shouldn't be any worse and maybe it will be better."

We had a transformer that I had been playing with that utilized different interleaving ideas with separate windings. I strapped it up and put the thing into the amplifier tester that I had at home. The phone rang and I went back to answer it and it was Herb who wanted to tell me something. I had just put the stylus down on the record for a piece of music that I wanted to hear with the system. My wife came running in to me and said "what did you do? It sounds marvelous!" I told Herb to wait a minute. When I returned to the phone, I told Herb that this was his transformer using negative feedback on the extra winding. He said, "Well maybe this is it!" That was really the start for the ultra-linear circuit.

Part 2 of the David Hafler will be continued in VTV Issue 15