An Interview with David Hafler

Part 1: The Acrosound Years

By Charles Kittleson

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?

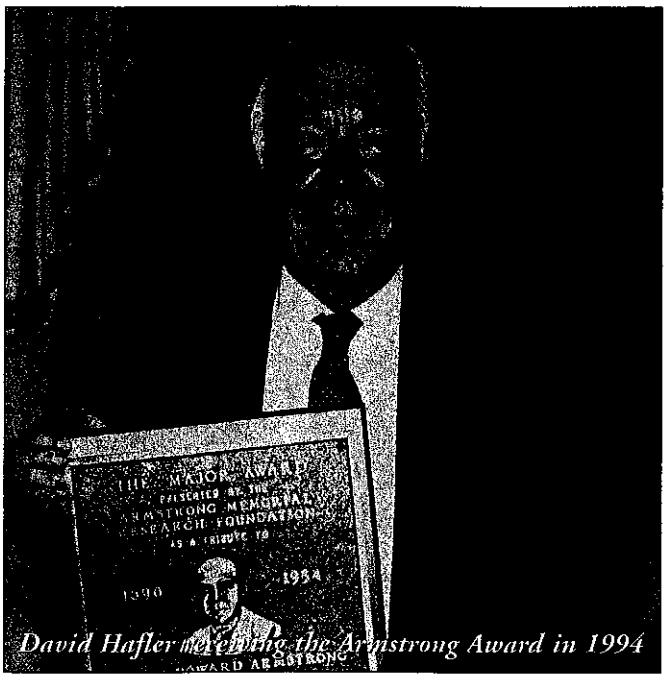
Yes, bass reflex, of course, and they had this bass boosting function. They were used with a Bogen PA system and it sounded magnificent. They had only the one FM station in Philadelphia at that time which was mostly experimental. But I had never heard anything sound that good, except the real thing. 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



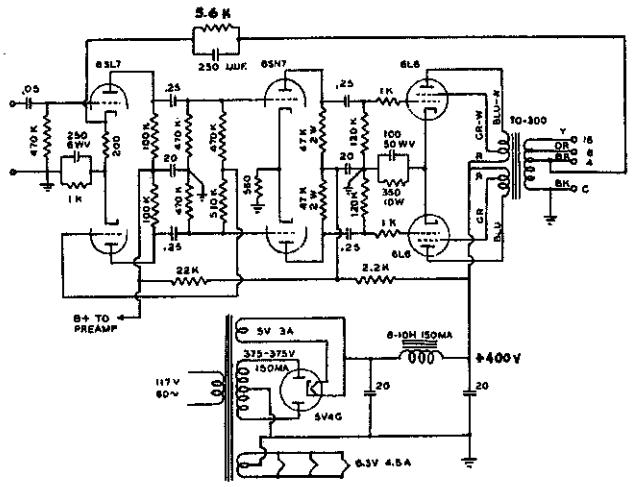
David Hafler receiving the Armstrong Award in 1994

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.

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



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 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 test. 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?

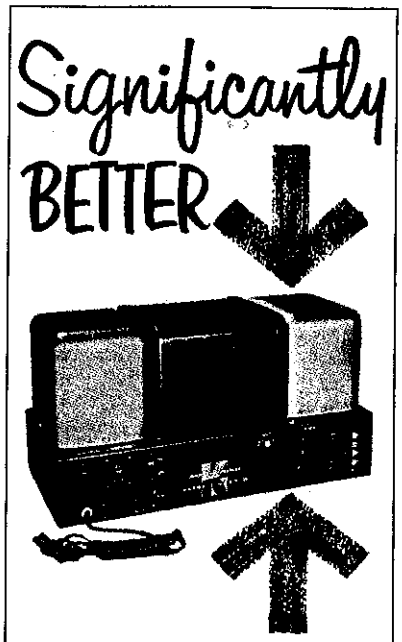
Right after WWII, the GE Variable Reluctance phono cartridge was a popular item. It was the only good cartridge and sold at a reasonable price. It was a big step forward in record reproduction compared to the crystal cartridges, which were being used up to that point. There were a few moving coils, but 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 though was pretty good and when we compared the specifications for the Consumer Reports amplifier with what we had in the amplifiers that we were

1959 Acrosound Advertisement



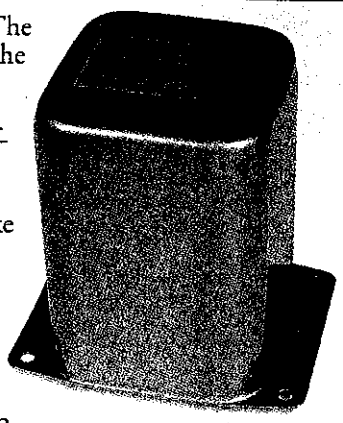
1957 UL II Advertisement

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.

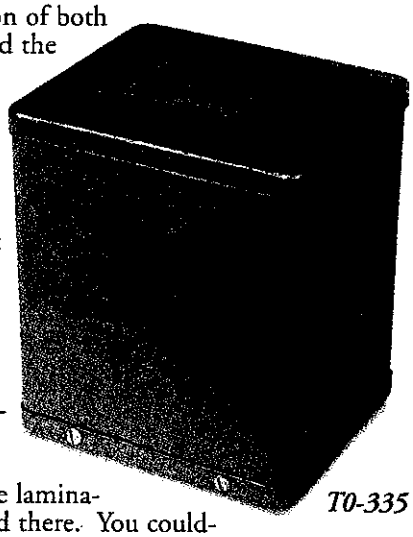


TO-270

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 AI-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.



TO-335

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.

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;

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 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 then 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. 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

An Interview with David Hafler

Part 2: The Dynaco Years

By Charles Kittleson

This is a continuation of the interview we conducted with David Hafler in May of 1999. The first part of the interview, in VTV #14, covered the early years and his affiliation with Acrosound. This part covers the Dynaco era.

When and why did you begin your own company, Dynaco?

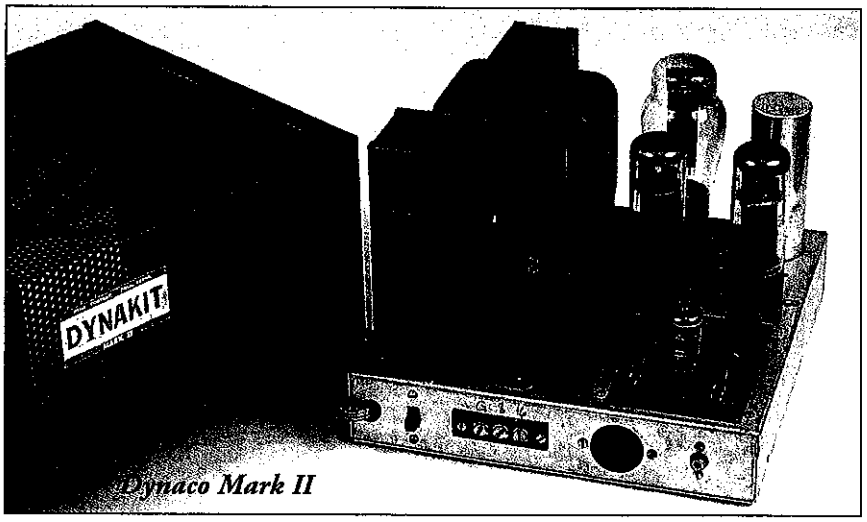
I saw that there was a hole in the market. I had been doing a lot of customer contact, but not so much sales contact. I'd have people from all over the country write in with questions about using the Acrosound transformers. We had a brochure showing about three or four circuits and different power brackets. I would get people who would write in "Where do I buy the parts to do this?" I would speak by telephone with them or by correspondence. I found that I could handle a lot of normal sales activity as part of my general work. I saw the need for something other than just selling transformers through parts jobbers.

At that time, I was, and still am, into good sound reproduction. Back then, it wasn't easy for somebody to attain this. When I made my first amplifier, I went to a home of a friend whose father had a sheet metal shop, and he bent me up an amp chassis. I used a hand drill to drill the holes for hardware and used a Greenlee punch for the tube sockets.

I spent more time drilling holes in the chassis than soldering components into the circuit. I thought that there must be some easier way to do this. I saw that Heath was selling kits by mail order and they seemed to be doing a good business. I thought that there was no reason why there can't be a kit of parts that would make it easy for somebody to assemble an amplifier and save some money over having a factory assembled job.

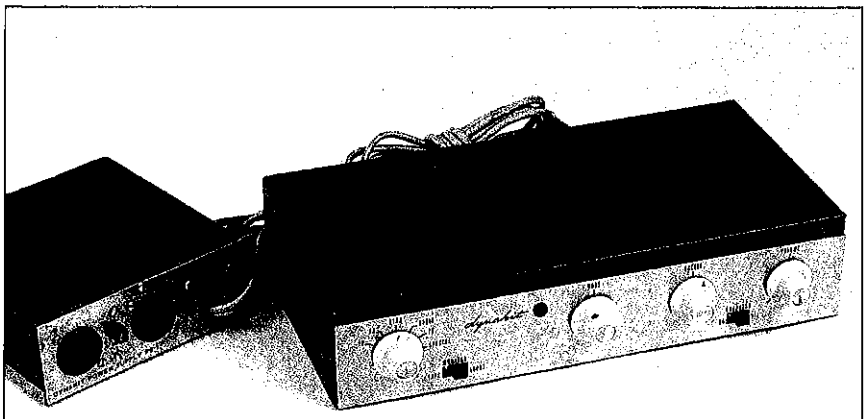
So with this thought in mind, I looked for suppliers who could take care of the printed circuit and chassis for me. I subcontracted all these things so it didn't take many people to run the business. With just a handful of people I had a small business operating without the difficulties and headaches of having a large workforce and the people to take care of it.

We had a little company where everybody did a little of everything and it was profitable. When I sold the com-

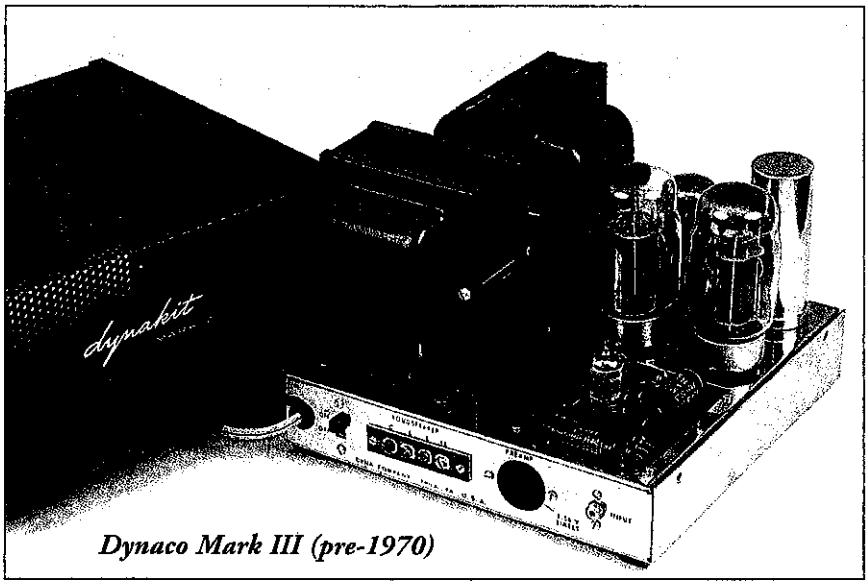


Dynaco Mark II

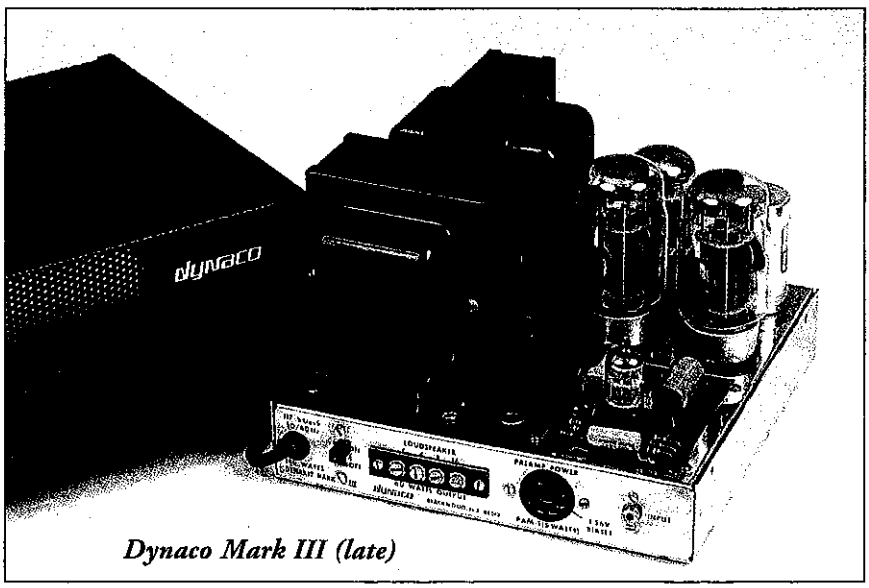
1957 Dynaco Ad



Dynaco PAM-1 (with power supply)



Dynaco Mark III (pre-1970)



Dynaco Mark III (late)

pany in 1968, we had 150 employees and were still subcontracting a good part of the production. I estimate that the total number of people working on Dynaco products must have been about 300 people.

What were your first amplifier and preamp products back then?

We had an amp that we called the Mark I, but it never went into production because it needed some modifications before it got too far. So that became the 50-watt Mark II. The Mark II was then superceded by the 60 watt Mark III that cost $10.00 more but offered the freedom of 4, 8 and 16-ohm speaker taps and the new KT88 output tubes.

There were speakers that specified a 4-ohm output including the AR speaker. However, the AR speaker required a high powered amplifier because it was very inefficient. We brought out an amplifier that did an excellent job into the AR speakers and the two coupled with each other very nicely. This turned out to be a great marketing arrangement because we could go to hi-fi shows and share the expenses. They sold speakers and we sold our amplifiers with no conflict of interest (laughter), but with complementary activity.

How did you initially market the Mark II and the PAM I preamp?

In 1955, we were making about 1,000 Mark IIs per month. That was fantastic business at that period. We had the demand for a preamp, but it wasn't quite ready. I had this preamp design which I had been carrying in my head for a long time. I did most of my circuit designing by thinking it over, rather than by breadboarding it. The circuit used a feedback tone control arrangement that would be very simple and wouldn't require many tubes. I tried it and it worked and I arranged production. We used outside people to help style it.

Just about the time we were ordering parts, I noticed a peculiar kind of noise coming from it when it was turned up all the way. The prototype unit didn't have the noise problem. I tried everything that I could think of for weeks, and tried to pin the problem down. I even had Stewart Hegeman come in from New York to analyze the noise problem. He took a look at it and couldn't find the answer (laughter). I finally resolved the thing by taking the

preamp apart, piece-by-piece and interchanged them between my breadboard unit and the pre-production unit. I found that the low-noise resistors were noisier than anybody could have anticipated. They were just no good. It took me all that time to find it because they were consistent. They had the same harsh, rushing, waterfall kind of noise. That delayed shipping by several months at a time when the demand was really high. So when we started shipping, we had back orders for a couple thousand units.

Who did your sheet metal work back then?

Well, it started with a company called Dalco. This gentleman had migrated from Europe, who was a competent production man. He did a good job on stuff and his prices were good. After I found him, he did 95% of all of our work.

Who made your circuit boards back then?

A chap named Art Leibchur was working for a company called Avionics and broke off from them to set up a business for making printed circuits. I just found him in the classified pages of the phone book and started using him. He made some prototypes for me for the first hi-fi exhibit we had and then he made everything after that.

Who manufactured the Dynaco output and power transformers?

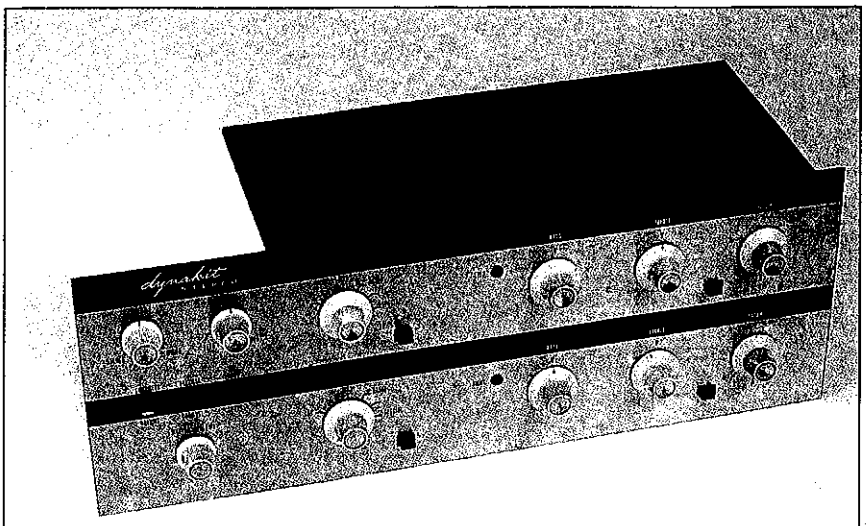
When Dynaco got started I knew of a company called Tresco that was located about 6 blocks from our factory. I was going to wind the transformers myself but I didn't like the idea of tying up money, buying new equipment, and the headaches of production. I went to visit the principals at Tresco and told them what I expected them to do. They made up samples for me according to my design. They sounded good and had pricing that was a very good deal for me. Eventually, I ended up buying 20% of Tresco. They supplied me everything I needed for years afterward and I turned out to be their biggest customer.

What was the very first Dynaco output transformer?

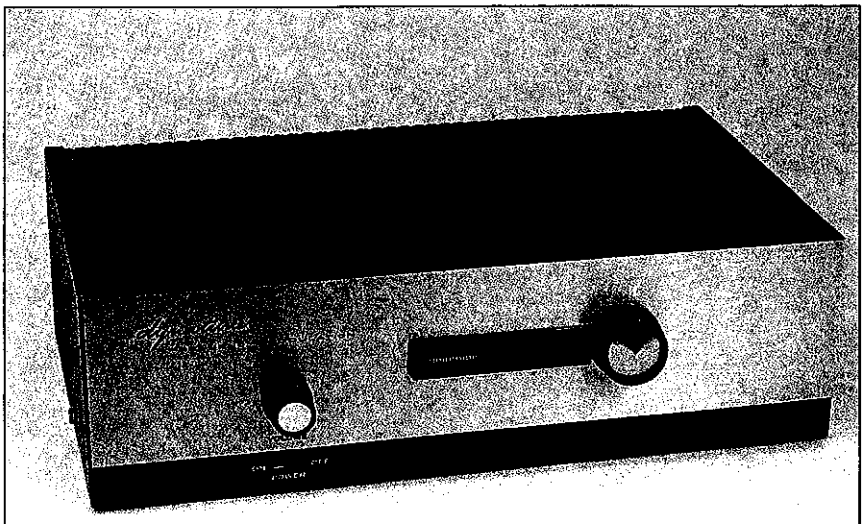
The A430 was first and the A431 just added the 4-ohm tap.

The A431 was your design?

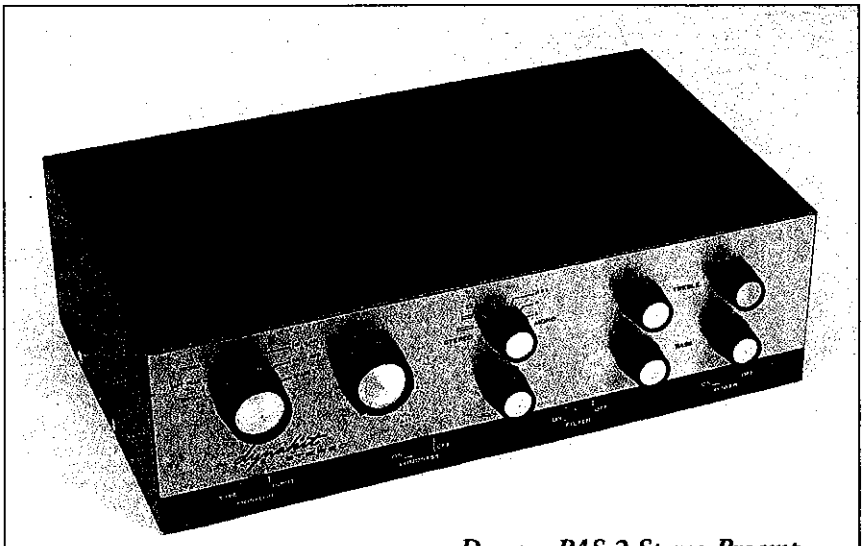
Yes, but I used the same long-tongue EI arrangement that Herb Keroes had used with the Acrosound design. It used a long,



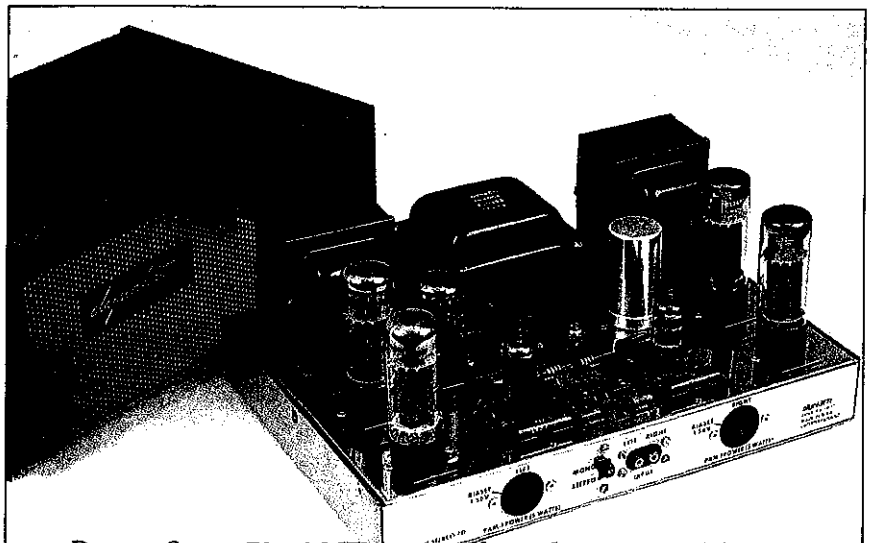
Dynaco PAS-1 (2-PAM-1s and DSC Stereo Adapter



Dynaco FM-1 Mono Tuner

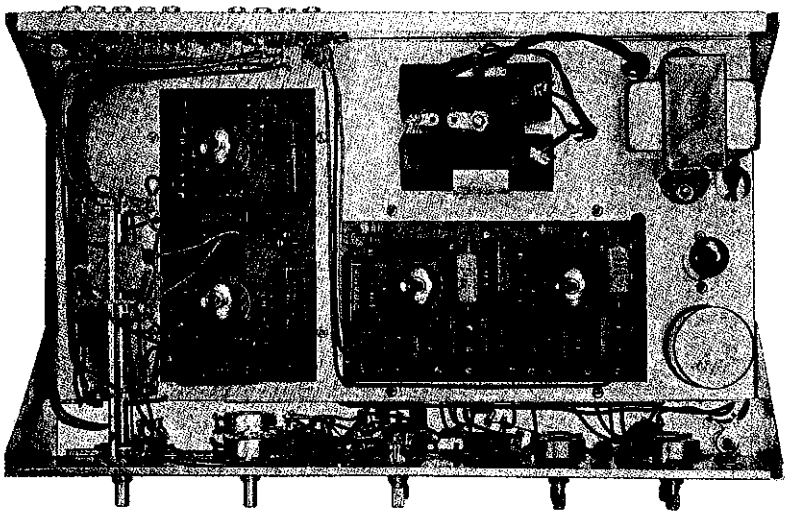


Dynaco PAS-2 Stereo Preamp



Dynaco Stereo 70 - 35 Watts per Channel Stereo Amplifier

Dynaco PAS-3 Stereo Preamplifier



Dynaco PAS-3 Chassis Photo From Owner's Manual

narrow coil.

What about the winding arrangement in those transformers. Are they different than the Acrosound?

Oh yes, they are definitely different. I had a patent on the Dynaco transformers.

Is that patent still in effect?

No, the patent was only good for 17 years.

What were some of the unique winding features of the Dynaco design transformers?

The Dynaco design had something that was very rarely done, I had not seen anybody do it in output transformers. It inverted part of the winding. The coil was spun in the opposite direction and windings were put in parallel, criss-crossed sections. It is a little hard to describe. It was interweaved through a parallel connection rather than series connection which I had not seen other transformers use.

So the transformer had four winding sections. The first and third were wound in opposite phase and inserted backwards in order to make it work out. The secondary came in between the first and third or second or fourth sections. This is hard to describe without drawing a diagram. You could probably find that patent very easily if you wanted to look it up. It shows that both series had parallel arrangements. Both of them were unique with that step over.

What core material was used in the transformers?

I don't recall. Tresco brought this in for our use.

You also came out with some potted versions of those transformers that were kind of the deluxe line. Were they a better grade of transformer or was it just cosmetics?

Well actually there weren't any standard end-bells available for the larger sizes, 60 watts and above. These included the A440 and A450 models. They looked good and I guess the end-bells didn't look as nice as the sheet metal cans. They were not the same as the deep-drawn cases that we used with the Acrosound transformers.

Were you involved in all the designs of the transformers, such as the A470 for the Stereo 70, or the Z565?

Those were just derived from the basic

unit. The A430 was the starting unit and to make it smaller or make it larger was just a matter of changing the wire sizes, turns ratios and the size of the lamination stack. They were straightforward measurements and calculations. Tresco, based upon our specifications, designed the power transformers.

Did you use any other transformer vendors or imports?

The only thing that was made overseas, when I was still there (up until 1968) were some of the chokes.

Did you design the whole kit process?

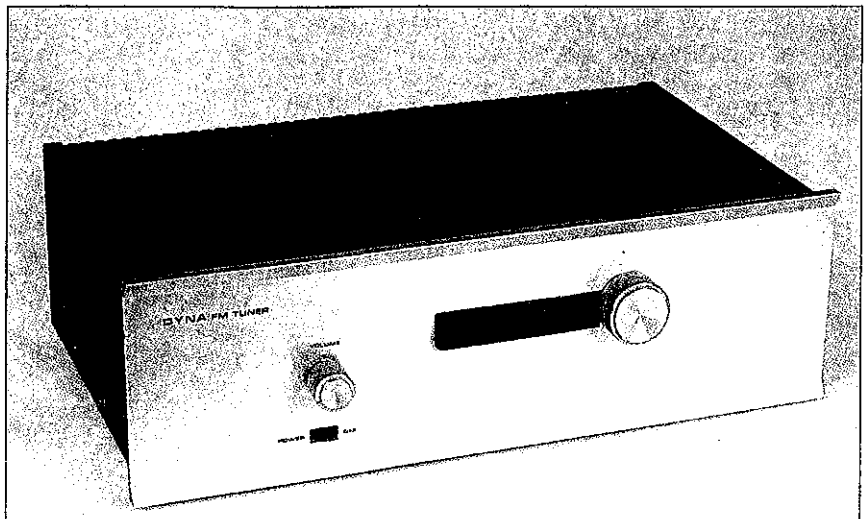
The first ones I did myself completely. After that Bob Tucker got involved. He was very good at thinking of what problems a customer might have and trying to eliminate them. Anything that we were going to put out, he field tested it very thoroughly. He assembled them himself to write the manual. We also used people, who were not skilled, to assemble the kits under Bob's watchful eye. He could see where they ran into problems and make adjustments. The manual was an important part of the kit, of course. I think we had it down to at least as good as Heath and better than EICO and other kit companies.

Was Stewart Hegeman involved in the design of the FM3?

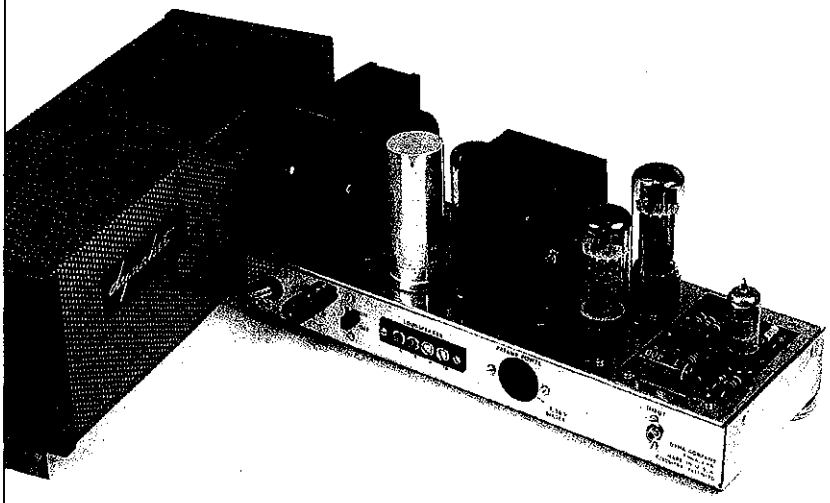
Yes, he worked on the FM-1 and the FM-3. We had a deal with him where he got paid, I don't remember exactly just how it worked out, but it made him a nice sum by the time it was finished. Unfortunately for us, we had to bring somebody else aboard to finish it up because Stewart was a guy that never finished a design.

Who designed the other units like the PAS3, the SCA35?

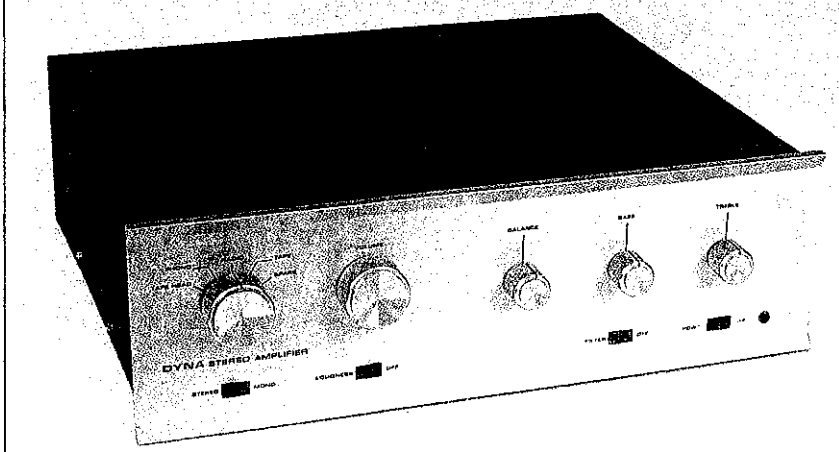
I was involved in all of the tube designs. Ed Laurent did most of the conversions from preamp to integrated amps. He did a good part of the mechanics. Actually, for practical purposes, I was chief engineer and in an administrative sense, Ed did mechanical design and stuff like that. I was involved in everything since I had started the company when I was the first person in it. I knew how to do everything that was done inside the company. I knew how to keep the books. I knew where to buy the components and it was a one man oper-



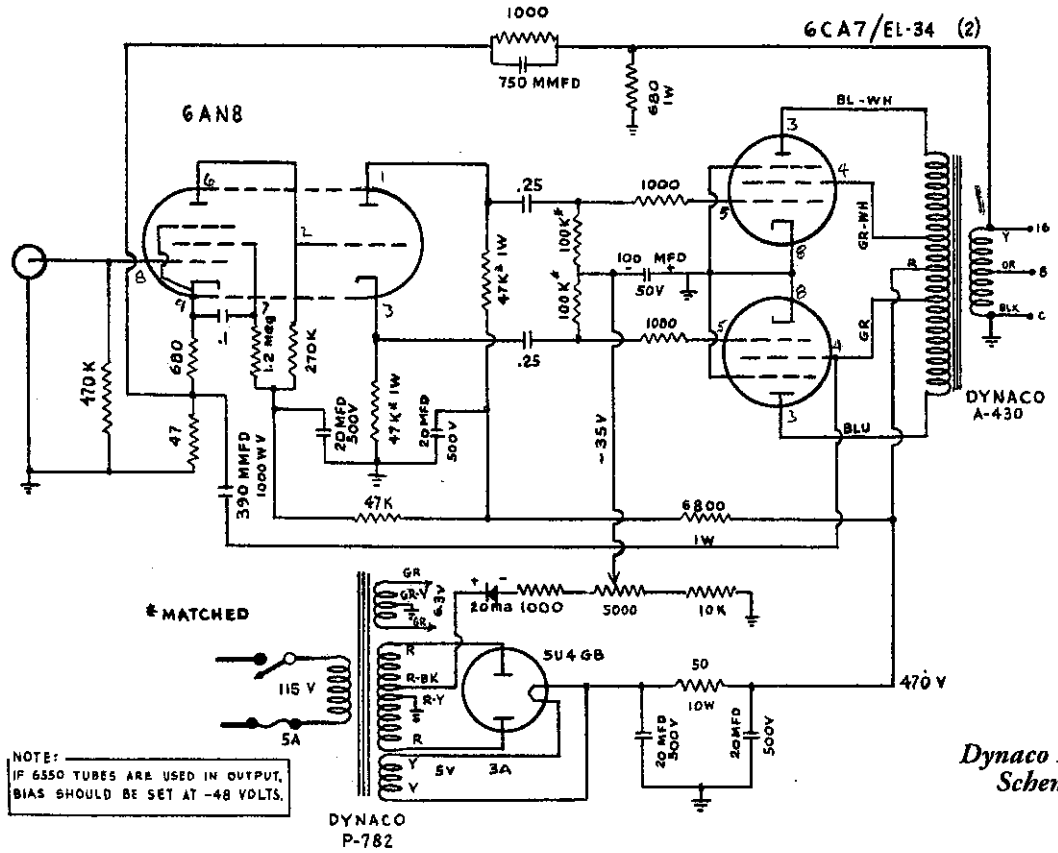
Dynaco FM-3 Stereo Tuner



Dynaco Mark IV 40 Watt Mono Amplifier

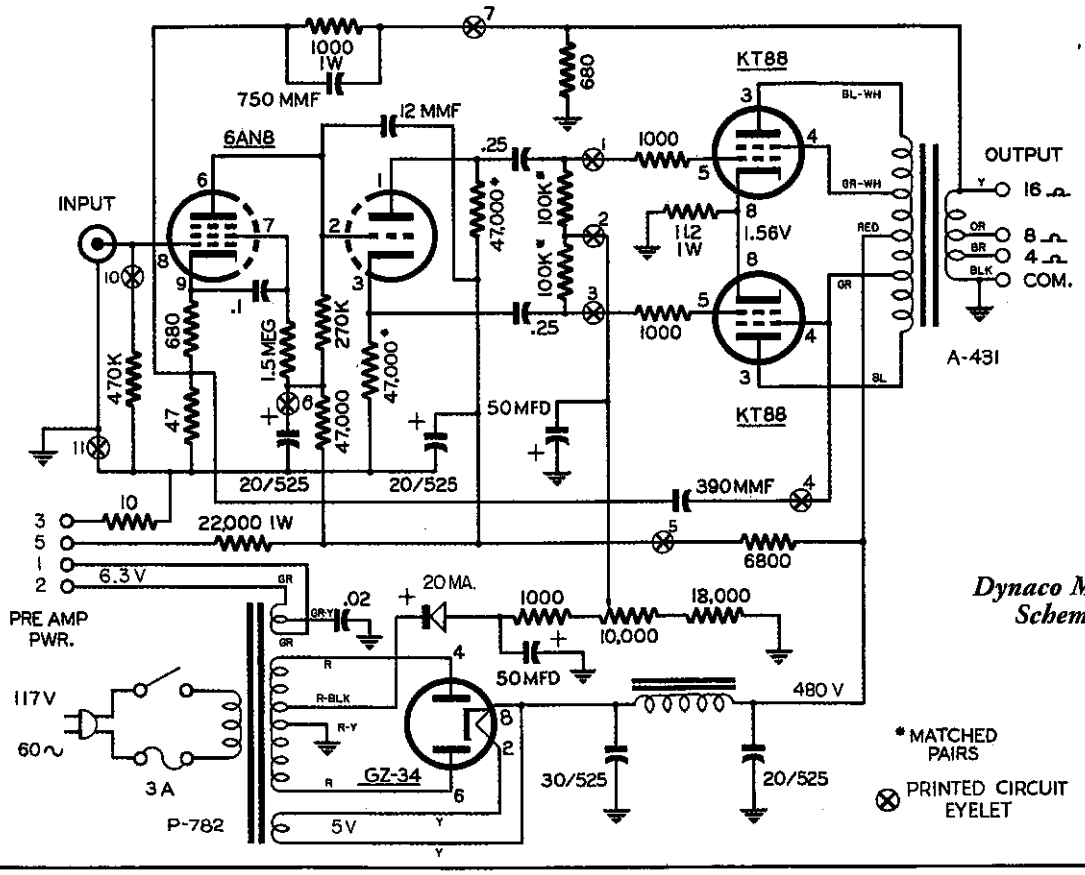


Dynaco SCA-35 Integrated Amp



Dynaco Mark II Schematic

DYNAKIT MARK III 60 WATT POWER AMPLIFIER



Dynaco Mark III Schematic

ation for quite awhile. One man with assistants, let's say. It was only gradually that I was able to delegate some of the work over to other people. At the time when I left, I think the organization had gotten to where we had a quality control man and other specialists.

Let's talk a little about some of your design philosophy. You used the 6AN8 and 7199 as driver tubes. What were your criteria in using those tubes?

The normal criteria to choose any tube. Low noise is one. Most people don't realize that you have hum in some of these things just because of the internal construction of the tube. What we found was that Sylvania 7199 had less noise than the RCA. We would pick tubes on the basis of noise or distortion if we found a difference in distortion. I think it is very difficult how you pick tubes because you are balancing one thing against another.

Did you use a combination driver tube to keep costs down?

The combination driver tube was done initially because it was space saving and saved costs without sacrificing anything.

What about output tubes. What were your selection criteria?

There are differences because some output tubes require higher voltages. So to have a decent safety margin you have to allow for the fact that you can't use the maximum voltage all the time. Hum was usually not a problem, but distortion levels were an important characteristic.

What were your favorite EL34s?

We used Mullard EL34s, because the Mullard salesman got to us first and he got friendly with the engineers, people who would have some say. They were aggressive sales people.

In the Mark III amps, you used the Genalex KT88s?

When the KT88 was first designed, Genalex came to me with samples of the tubes and they looked ideal. It handled more power than the Tung-Sol 6550s and we knew they were good tubes, so it was a natural. Also the KT88s had lower levels of distortion than others that we had used previously, but that was in a range below audibility.

During the mid to late 50s, which was kind of a golden era, if you will, of hi-fi in this country, were you influenced by any other designers, when you were producing your kits? Was there anybody that had major influence on you?

No, in fact I think it's the other way around. I had major influence on them (laughter).

I would say so too (laughter)!

Actually, when I think about it, things that I did as routine back in the 70s were still not adopted by the bulk of practitioners; Little tricks of the trade, like how to bypass input shielding in preamps, stuff like that. People who had been in the business and making designs for years and years still had not picked up those little things.

Were you impressed with any other manufacturers equipment back then, even though it might have cost more?

There wasn't anything I saw that cost more, that would contribute to the sound. I think that I was able at that time to pretty well convince most people that our equipment was the best. And when I say the best I don't mean the most expensive. I think we were ahead of the whole industry in terms of being able to produce a low distortion and accurate amplifier. Some people made it more expensive and sometimes they used more expensive components that were more than necessary. Some designers had their own wild circuit ideas, some of which worked in the field and many of them really didn't do anything special. I felt there was not a direct correlation between price and quality. This is especially true if you define quality as accuracy.

The Dynaco Stereo 70 was probably the most popular tube stereo amp. When did you start thinking about building a stereo amp? What motivated you to get into this?

The first demonstration of stereo records were in the late 1950s. The stereo tape recorders of the era were not very successful. Plus, there wasn't any reason to change equipment because there was very little binaural program material to be played. There was very little emphasis in promoting it in the 50s. But when the first records came out it, it gave consumers a chance for an easy conversion to stereo and gave retailers an opportunity to raise the price.

What year did you come out with the Stereo 70?

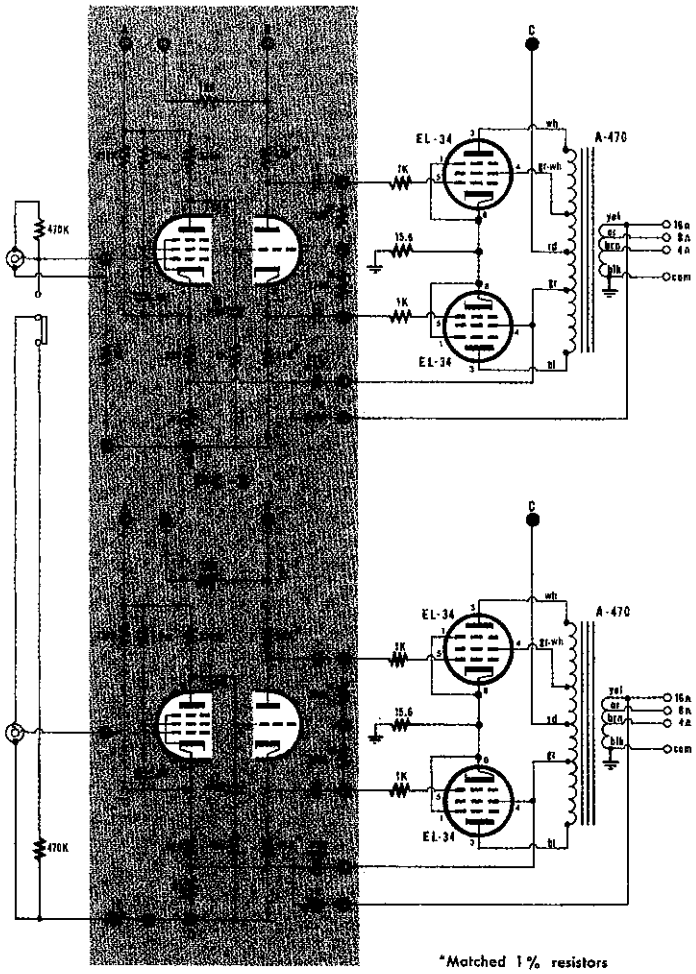
The Stereo 70 came out in late 1958 or early 1959. However, first we had the stereo adapter so that you could hook up two PAM-1 preamps to two Mark III amplifiers. I guess this got us into stereo earlier. That was a way of salvaging what was in the market already and selling consumers another preamp to line up with what they already had. It was a practical approach and it worked. The stereo tuner, I guess, came along in the early 60's.

Did you sell more Dynakits than assembled units?

The kits were more popular in the beginning. In the later days, the kits became less popular because people didn't mind spending the extra few dollars for an assembled unit. Then there's always a little fear from people who put kits together that they were not getting the best results. There was always a market for assembled ones at any price level but we did it at a competitive price level.

Did the kits present much of a problem from a technical support standpoint?

No, because we debugged the assembly manuals to the point where they didn't make incorrect assemblies. But there were always a few people who just never could make something work because they couldn't solder point A to point B. We had a very inexpensive service policy, I think we only charged either $5.00 or $10.00 to fix any kit problems. We had two service techs at the factory handling kit issues and other service jobs. These guys handled up to a thousand pieces of service work in a month sometimes.



*Matched 1% resistors

VOLTAGE TEST POINTS

Pin #	Any EL-34	GZ-34	Either 7199
1	1.56	—	*
2		435	*
3	410	—	*
4	415	360 ac	
5	−32**	—	
6	−32**	360 ac	1.0
7		—	0
8	1.56	435	*
9	—	—	*

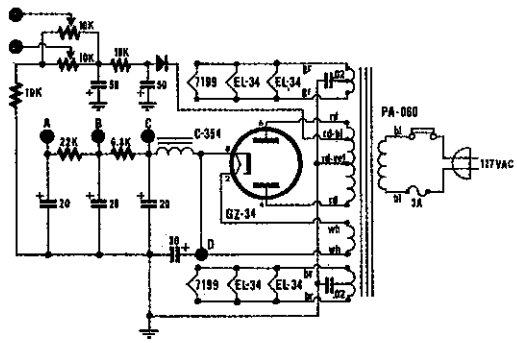
6.4 ac

6.4 ac

*Measurements at these points vary from tube to tube and do not indicate whether performance is normal.

**Measurements at these points can only be made with a vacuum tube voltmeter. The two tubes in a pair should have identical readings.

Capacitor lug		Selenium rectifier		Printed circuit
A ■	305	Bottom (+) lug	50 ac	Eyelets #3 and #18
B ▲	375	Top (−) lug	−65 dc	370 volts dc
C	415			
D ◠	435			



Dynaco 70 Stereo Schematic

What was your dealer markup?

On the kits they were getting one-third. On the assembled product they were getting 40%. They usually cut the price a little so they weren't making all of that.

Would you say that mail order sales companies like Allied, Lafayette, and Radio Shack were some of your biggest customers?

Yes they were. At the very beginning there were few retailers who were interested because they couldn't afford to promote an unknown brand. Allied Radio didn't want anything that wasn't advertised and promoted.

Was your relationship with AR continued through the late 50s?

I first met Edgar Villchur in 1953 or 1954 when he introduced the AR-1 speaker at the early hi-fi shows. We maintained a perfectly good relationship and I joined them in terms of promotion. AR rented a space in Grand Central Station in New York, for product demonstration purposes. Anybody who walked through the station and had time to kill between trains could go in and hear some AR and Dynaco working together. We paid AR for half of that, of course. Even after AR came out with their own amplifier, we still had a close relationship.

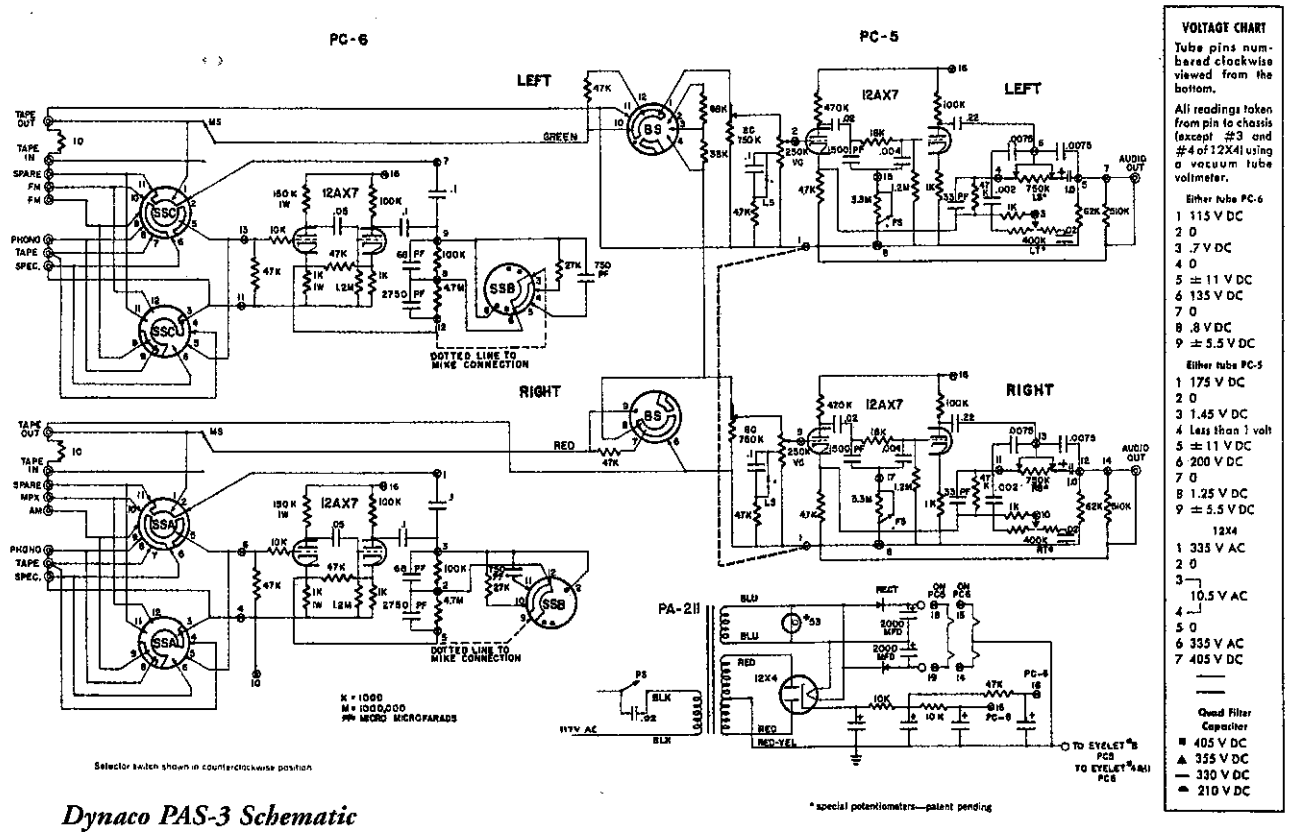
What brought about the development of Dynaco loudspeakers?

I always thought the speaker market was a good one. First, it is an easily produced item with a high profit margin. Also, when somebody buys one of your products, chances are you could sell them a complimentary product if he was happy. I always thought that we were going into the speaker business, not to manufacture speakers drivers, but to buy raw speakers, breadbox them and handle it from there on. I was going to Denmark regularly to handle Dynaco's distribution of B & O products. So we knew a lot of people in Denmark who were in the audio field. There was a small company called Seas who did a nice job and had good quality. We found their prices were reasonable and we started to have them make speakers for us.

Later, people split off from Seas and formed their own company, in order to continue production of our product. I think we outgrew Seas at that point. We were selling 1,000 speakers a week during the late 1960s.

Who designed the A25 speaker?

A fellow named Skoning who still has some custom speaker business. Another fellow came along with the idea



Dynaco PAS-3 Schematic

for stuffing fiberglass in the bass reflex port to make the bottom-end more damped. The way he did it worked well and we paid him a percentage for the first 10,000 speakers or some such value, I can't remember now the exact details. So he took the credit for designing it even though he and Skoning actually worked out the parameters jointly. It came down to two final speaker designs. The two of them looked alike and had essentially the same specs but they sounded entirely different. The one I picked turned out to have an aluminum voice coil instead of a copper voice coil, so it had a good low bass response and a nice sparkle at the high end.

How many A25s do you think Dynaco sold?

Bob Tucker once told me they had passed the one-half million mark. He kept track of those kinds of things.

While we are talking about production figures, let's go down the list of the tube products. What are your estimates of tube equipment production figures?

I did make a couple of notes based on what I knew about production figures up until I sold the company in 1968. These are more approximations than exact numbers:

Mark II - 30,000; Mark III - 85,000; Mark IV - 55,000; Mark VI - 1,000; PAM 1 - 120,000; Stereo 70 - 250,000; ST-35 - 65,000; SCA-35 -80,000; PAS-2 and PAS-3 - 500,000 (combined); FM-1 and FM-3 - 200,000 (combined) (*NOTE: for more descriptive information on Dynaco Equipment, refer to VTV #1 p 5-7*)

Even though I sold the company in 1968, I stayed on as an advisor through 1971. The above numbers do not reflect production figures during that period. *(Note: David estimated that the total number of Stereo 70s made through 1977 is over 400,000; PAS-2/3s >600,000 and Mark IIIs >125,000)*

Did you sell many products overseas?

Yes, because most people didn't do any business overseas at that time. A lot of the overseas business went to McIntosh, who did a good job because their high price made it a very attractive item in the Japanese market. We sold more units than McIntosh did, but they sold more dollars into that market because their prices were so high.

You had a fairly good market in Japan then?

For a while there Japan did very well for us, buying 5,000 units at a clip.

What about Europe?

We set up our own distribution company in Europe and did well, we got about 20% of our business out of Europe. At that time that was very, very good because, let's face it, most American companies did very little in Europe and especially in Japan.

What was your favorite Dynaco amplifier?

I guess the Stereo 70 because it worked well, was inexpensive and was adequate for three-quarters of all people. The remaining quarter needed higher power, mostly because they played it loud or because they had inefficient speakers, like electrostatics.

So your favorite loudspeaker would probably be Dynaco, right?

Yes, I did think they were great speakers for the time and price.

In VTV #4, we did a vintage speaker article and listening evaluation. Our listener panel found that the A25 was one of the best-sounding vintage bookshelf speakers, so that still holds true today.

I agree. Also, as a general class of speakers, I like electrostatic designs, but you need a lot of power to handle them properly.

What were your first solid-state amplifier and preamplifier?

The Stereo 120 and the PAT-4, which were brought out in the mid-1960s.

Why did you decide to go into transistors?

People were clamoring for them. They wanted them. I would say, in terms of listening, there wasn't any essential difference between tubes and transistors. If there was a difference it wasn't because of tubes versus transistors, it was because they may have been trying to drive wrong size speakers, with the wrong size amplifiers.

We have quite a few readers who would disagree with you on that, David! Who designed the transistor equipment?

Ed Laurent and his technical staff did much of the design. Then Erno Borbely, who we imported from Norway, was also involved in the design and final details. He was a very

careful and methodical guy. A lot of the new things, I would personally suggest and tell them to "try this."

So you were making both tube and solid-state equipment in to late 1960s?

Yes, but the tube stuff was fading down at that point.

After you left Dynaco in 1971 as an advisor, how long did they continue to make tube gear?

I would say to approximately 1977 or so.

When and why did you decide to sell Dynaco?

I reached a certain age where I decided that being a workaholic was getting old. When I first started Dynaco in the mid-1950s, I had two full-time jobs and two part-time jobs all running at the same time. When somebody had to do all the legwork, it turned out to be me.

Was the fact that the Japanese audio companies had significant volume in the US hi-fi market a consideration in your decision to sell Dynaco?

The Japanese thing came a little later. They did a good job and sold product at realistic prices. They started out kind of weak and ended up very strong.

Who bought Dynaco?

Tyco Laboratories bought it from me. Tyco had the idea that anyone who took a business course at Harvard could manage any type of company anywhere. They felt like it was always the same only the details varied.

What are your thoughts about what is occurring in consumer audio today?

You are not going to like my feelings, I'm afraid. There is a big rip-off going on. Companies are selling extra high-priced equipment that has no benefit except a high profit to the company that sells it. I don't think that many of these fads that come along are true advances.