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Issue 14

The Classic Electronics Reference Journal

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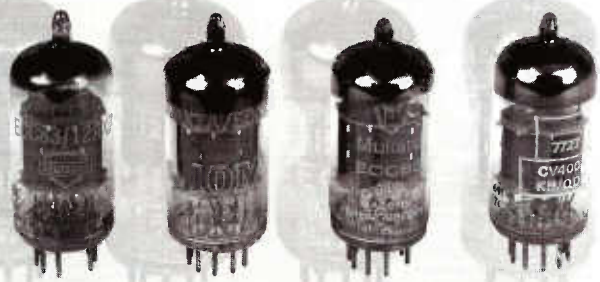
12AX7 Special Edition

Ultimate 12AX7 Shootout

52 Versions Tested



Jolida JD603A

CD Player with a Glass Heart

David Hafler Interview

The Acrosound Years

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February 17, 1999

Mike Matthews
Sovtek/New Sensor Corporation
NYC, NY

Dear Mike,

Thanks again for sending us the new 12AX7LP tubes for evaluation. VTV conducted both listening and electrical tests on the tube.

John Atwood, VTV Tech Editor, took the 12AX7LPs to his One Electron Laboratory and used a Tektronix 570 curve tracer to evaluate the tube's electrical characteristics. John noted that the tube is very linear and has great looking curves, indicating a well-made tube. Compared to the Sovtek 12AX7s of the past, he felt that your new tube is significantly better. In fact, John commented that its quality approaches the famed Telefunken ECC83 smooth plate.

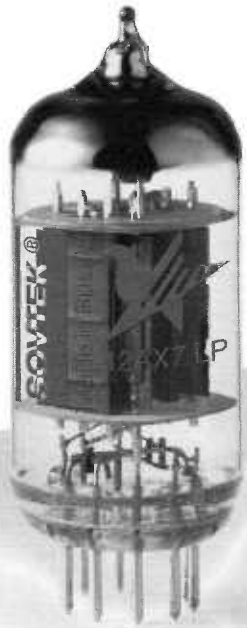
Next, we gave the 12AX7LPs to Roger Coon, a well-known record collector and a major audiophile in the San Francisco Bay Area. Roger is a very critical listener and has "golden ears," plus, he recently completed a 12AX7 listening test for a future issue of VTV. He notes: "large, full soundstage, very musical with nice detail." He compared it to the sound of a Mullard CV4004 box plate 12AX7, but not quite as detailed. In short, Roger was impressed with your tube.

Then I listened to the 12AX7LP in a variety of tube preamplifiers and amplifiers. You have a very musical, smooth and involving tube. It is easy to listen to for long periods of time, like a quality tube should be. This will be a great tube for both hi-fi and guitar amp applications. I think it sounds a lot like a vintage Brimar 12AX7.

Compared to anything else out there in the 12AX7 market, with the exception of some primo NOS stuff, I feel that the Sovtek 12AX7LP is the best sounding one on the market at this time. In conclusion, you have a winner here!

Thanks again and best regards.

Vacuum Tube Valley
Charlie Kittleson
Editor of VTV



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Coming In the Next Issue of VTV:

- David Hafler Part II
- 9-Pin Dumpster Pentodes
- Assemblage SE 300B Review
- 12AX7 Hi-Fi Listening

And More!

Western Amplification and Tube Technology Society to Form

A new society, (WATTS), dedicated to the advancement and enjoyment of vacuum tube amplification is forming in Northern California. Its sole purpose will be to provide a forum for builders, listeners, manufacturers and technicians interested in tube amplification of music. Nominal annual dues will be collected from members who will have access to association meetings and events. Non-members will be welcome, but will be subject to entrance fees.

The group will have structured quarterly meetings, held on Sunday afternoons and consist of a general session and other tube events. These events may include: tube product demos, tube and amplifier listening sessions, amp clinics, guest speakers and a bi-annual tube swap meet. A survey will be taken to determine future meeting topics and group structure.

The initial kickoff meeting will be held at Sunset Car Audio, 1701 Santa Rosa Ave., Santa Rosa, CA. (Baker Ave. exit Northbound on Rt. 101) on October 15, 2000 from 1PM to 4PM.

Meeting details will be announced on **www.vacuumtube.com**. *Please do not call or email us as we will not take telephone or Internet inquiries.*

VTV Subscription Rate Increase

The cover price of individual copies of Vacuum Tube Valley will increase from $9.00 per issue to $10.95 per issue, effective with Issue #14. Subscription rates will increase from $36 to $40 for 3rd class and $49 for First Class US, $52 for Canada, $60/Europe and $68/Asia/World.

No More 6922s & 7308s

There is now a severe shortage of NOS quality 6922s and 7308s. The sole source of new 6922s is Sovtek. This tube, while noted for its reliability and low microphonics, has some sonic deficiencies.

VTV recommends that OEMs should change their circuit designs or that they pay the development costs to a tube manufacturer for a better 6922. End users have an option to modify their equipment to accept better tubes that are available for less money. This includes the 6N1P (still being made). Plentiful and still cheap NOS tubes that are still suitable for audio include: 2C51/5670, 5687, 6021, 5963, 5965, 6385 and 6350.

New 300B from Electro-Harmonix

The new 300B EH has an improved grid, eight course directly heated filament, 40 watt plate dissipation and excellent stability. This improved tube has top-quality construction and ultra-long life. The attractive tube now has a ceramic base and is available singly or in matched pairs. Suggested retail price is $156 per tube.

For more information contact Electro-Harmonix: Phone (212) 529-0466; FAX (212) 529-0486; www.ehx.com

New 300B EH

Vacuum Tube Valley is published quarterly for electronic enthusiasts interested in the colorful past, present and future of vacuum tube electronics.

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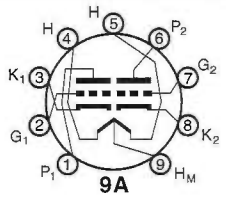
12AX7: Twin Triodes Forever



By Eric Barbour

This article is intended to serve as an update for the 12AX7 summary which appeared in VTV #1 back in May 1995.

History Update

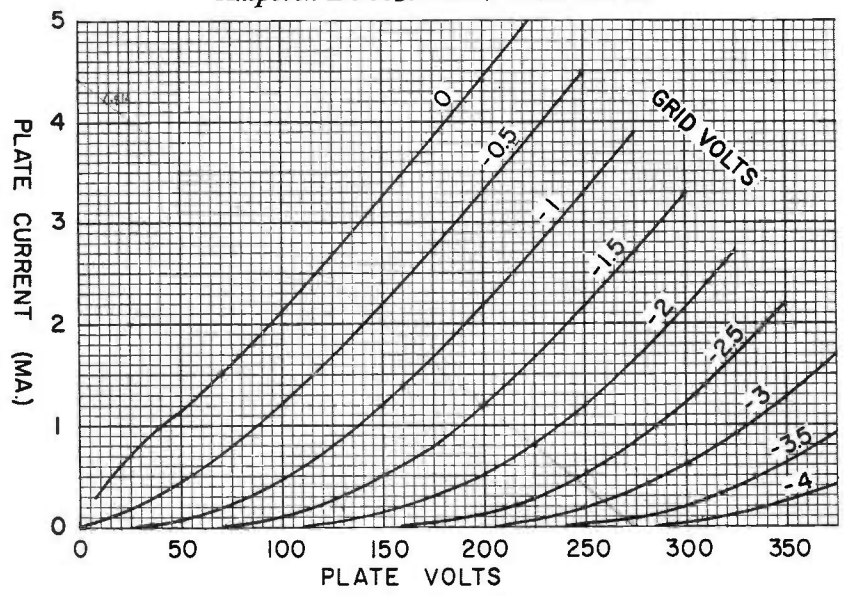
It has been confirmed that the 12AX7 was introduced simultaneously by RCA and Sylvania in March 1948. Sylvania was probably the sole manufacturer at the time, with RCA being the engineering developer. This was a commonplace arrangement until the 1980s--many "RCA" tubes were engineered by RCA, but were actually manufactured by Sylvania or GE under contract. 12AU7, the medium-mu variant, was introduced simultaneously, and used mostly common parts except for the grid (yes, that's right--not much physical difference except in the grid windings!). These two dual triodes became the most popular electronic amplifiers of their period. For example, the Philbrick Researches Inc. K2W of 1952 was the first really successful operational amplifier on the market. It used two 12AX7s.

Most audio equipment after 1956 used 12AX7s as gain devices, in preference to the previous heavy use of pentodes like the 6SJ7 or octal dual triodes like the 6SL7GT and 6SN7GT. Famous pro-audio products, such as Pultec and Teletronix processors and the Ampex 351 tape recorder, relied on 12AX7s. And 12AX7s practically took over hi-fi preamps made by Brociner, Dynaco, Eico, Fisher, Grommes, Harman/Kardon, Heathkit, Knight, McIntosh, Marantz, Newcomb, Pacemaker, Radio Craftsmen, H. H. Scott, Tech-Master and most other OEMs of the period. 12AX7s can be found in the driver stages of power amplifiers made by most of the above firms. The number of guitar amplifier models that use 12AX7s in their preamps cannot be estimated--the 12AX7 is the standard guitar-amp gain stage.

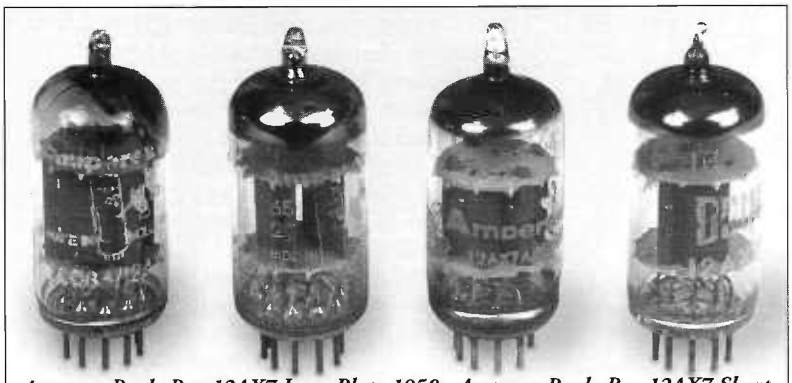
Because of restrictive laws in the UK regarding country of origin for military and government electronics, British tube manufacturers did quite well in the 1940-1980s period. The BVA (British Valve Association) was perhaps one of the most ruthless anti-competitive business cartels in recent history. The MOD (Ministry of Defense) was the largest customer of BVA members. British "Specials" of the 12AX7/ECC83, such as the CV4004 and M8137, were made to very high standards, and bear high NOS prices today. Such tubes often came with molded plastic protectors stuck over their pins, to keep them from being bent in shipment. The presence of such a pin-holder is a sign of a genuine classic Mullard or Brimar tube, or of a top-quality MOD item. Production of such tubes ceased in the 1970s. The pin protector was revived recently by Richardson Electronics for their costly "Bugle Boy" brand.

One problem with 12AX7 types has always been microphonics, especially in avionics and instrumentation (where microphony could cause death or injury). Telefunken solved this in 1958 by introducing a unique tube, the ECC803S. Unlike all other 12AX7s, it used a type of grid construction used on RF preamp tubes such as the 6DJ8--the so-called frame grid. Rather than winding ordinary grid wire onto two soft metal posts, very fine wire was wound onto a stamped molybdenum frame. This lends rigidity and helps produce a tube which is much less prone to microphony and mechanical vibration. It also gives a tube with high transconductance, an advantage in low-noise service. Tele ECC803Ss have been out of production for many years and are very scarce and expensive today. Note that a Teslovak ECC803S was recently marketed by JJ Electronics (Cadca, Slovakia)--its construction is frame-grid style, making it the only other known version of the 803S.

Amperex ECC83/12AX7 Plate Curves



The premium versions 7025 and ECC83 were often the result of cross-branding. Very picky customers for NOS tubes today do not realize how chaotic the industry was in the past (and still is today). In the 1970s Sylvania made tubes bearing all three designators at once: 12AX7, ECC83, and 7025.



Amperex Bugle Boy 12AX7 Long Plate 1950s, Amperex Bugle Boy 12AX7 Short Plate 1965, Amperex 12AX7 1970s, Brimar 12AX7WA 1970s

Versions of Today:

Today, there are only three factories known to be making 12AX7 or 12AX7-like dual triodes: JJ/Teslovak of Cadca, Slovakia; Ei of Nis, Serbia; and Reflector of Saratov, Russia (maker of the current "Sovtek"products). The demand for 12AX7s worldwide is believed to be in excess of 1 million units per year, nearly all of them going into guitar amps. The above factories are not well-capitalized, and are said to be having trouble meeting the enormous market demand. Ei is known to have large unfilled contracts for 12AX7s, whereas their factory was believed damaged during recent NATO air raids. Svetlana Electron Devices is working on a 12AX7 for release in mid 2000, primarily at the behest of a major guitar-amp OEM.

The once-popular Chinese 12AX7 is now known to be defunct. It was made at the Sino factory in Beijing, not Shuguang as previously reported (The Shuguang factory is having trouble at this time). Reports that the old tooling would be placed back into production have not been confirmed; no such tubes have appeared on the market to date.

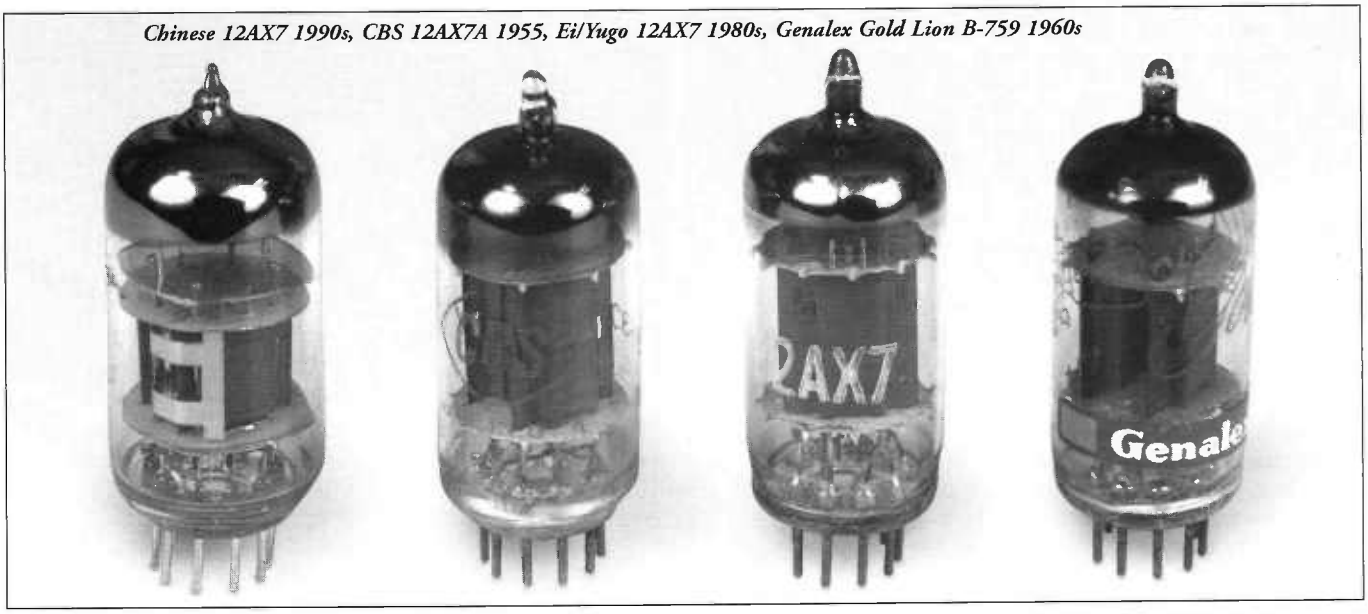
JJ/Teslovak makes an ECC803, alleged to be a super-premium type with low microphony, in addition to the regular ECC83. As the ECC803 is more difficult to find, we were unable to verify this. Their standard ECC83 does appear to have frame grids, and looks physically like a 6DJ8. Note that some dealers still refer to them as "Tesla" tubes, and the samples I have seen carried the old Tesla logo. JJ (from the owner's initials) is a spinoff from the mostly-defunct state electrical-equipment firm Tesla. JJ ECC83s are reported to have relatively low microphony and variable electrical consistency.

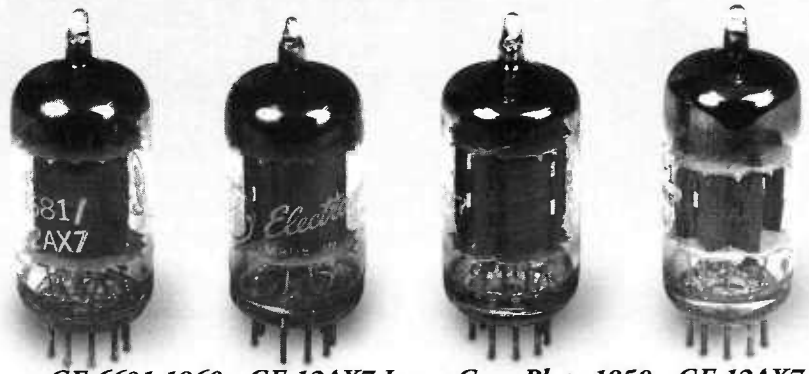
The other current East European version is the Ei 12AX7. It looks much like the old Amperex (Philips) ECC83, as it is apparently made on old tooling from Philips. It is often said to have microphonic tendencies (an assertion not supported by my own tests). Scarcity and a Western embargo on Serbian products prevent its widespread use. Otherwise it is a good tube and worth looking into for high-linearity applications.

Sovtek has made seven (that's right, SEVEN) variations; WA, WB (both formerly made under contract by Voskhod Kaluga, currently believed to be bankrupt and out of business), WXT, WXT+, WXT+ "Premium Select", and the recent LP and LPS (the latter having a coiled heater, like the 7025). The WXT and WXT+ appear physically identical. *(According to New Sensor, the WXT and WXT+ have been discontinued).* Electrical parameters seem to be little different from version to version, except for the new LP/Ss, which have larger plates and appear to have better cathodes and better quality control.

Please do not be confused by the various modern suffixes, such as WA, WXT and so on. Before 1980, a suffix on a tube number meant a special version, tested and qualified to some standard or meeting an unusual specification (such as 12AX7A being suitable for hi-fi with controlled hum and noise characteristics.) Today, these suffixes tend to make less difference. If a decent tube is all that's needed,

Chinese 12AX7 1990s, CBS 12AX7A 1955, Ei/Yugo 12AX7 1980s, Genalex Gold Lion B-759 1960s





GE 6681 1960s, GE 12AX7 Large Gray Plate 1950s, GE 12AX7 Large Gray Plate 1963, GE 12AX7WA Ridge Plate 1985

any of the Reflector/Sovtek types will do the job.

In the 1995 VTV #1 article, I tested a number of assorted 12AX7 types for distortion and microphonics. The list of results tended to confirm the feelings of audiophiles, vintage hi-fi collectors and recording engineers. Classic Mullard, Telefunken and Amperex/Philips tubes from before 1970 usually had outstanding performance, and (as it happens) sound qualities. Current production is much more erratic, though improving, thanks to the complaints of end-users.

New Warnings

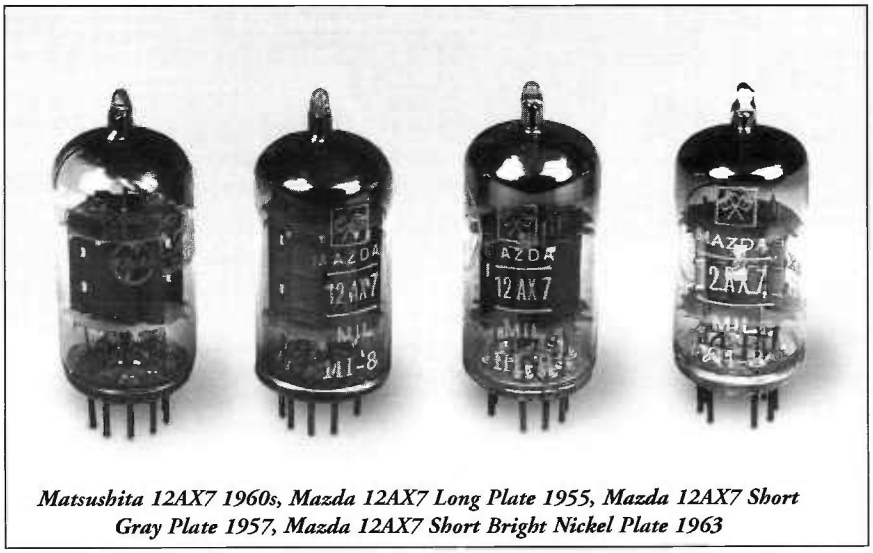
Beware of rebranded 12AX7s. This was a common practice throughout this century, and easy to do since the brand markings on most tubes are made with a water-soluble ink. Today, it is sometimes seen as a way to mislead a customer and collect a higher price for a lesser tube. Many rebranded tubes of the 1960s and 1970s were actually made in Japan. Raytheon often bought tubes from Japanese and Korean firms and rebranded them. Usually it's easy to tell a Japanese receiving tube from the style of the type lettering frosted onto the glass, if it is still visible. Hitachi, Matsushita and Toshiba are known to have made 12AX7s, plus the 12AU7, 12AT7, 12AY7, 5751 and 7025. The quality of Japanese tubes remains doubtful, although they are out of production and becoming scarce.

Many cheap tubes are still being labeled with classic brands. More than ten years ago, Tungsram 12AX7s from Hungary were labeled "Mullard Made In Britain"; these still appear for sale occasionally. A factory in India made 12AX7s in the 1960s and 1970s, at very low cost. These were also relabeled. And only a few years ago, some rejected CV4004s from who-knows-where were stamped with the Mullard logo and sold as super-tubes. These are easy to spot as they came in a red Mullard box--a color scheme which the real Mullard Ltd. never actually used.

The Telefunken diamond logo, and various Amperex logos, have been pirated frequently. Currently the Amperex "Bugle Boy" brand is owned by Richardson Electronics, which uses it on military-surplus and some imported tubes. Unlike some other firms, they are honest about what they are doing, and are carefully burning in and selecting the tubes before sale. A few dishonest dealers are printing Tung-Sol, Telefunken, Mullard and Amperex brands on whatever 12AX7s they can get on the open market, regardless of quality. Note: the current crop of counterfeit tubes are often branded **"Foreign Made"** and are in fake, reprinted Amperex, Mullard or Telefunken boxes, made to look "old." (Often, I get calls and e-mail at Svetlana from audiophiles and pro-audio engineers who seem determined to hold modern tubes to the tight specs shown in old tube manuals. These pathetic souls usually become angry when I inform them that the world has changed!!)

Classic Substitutes

Not many direct substitutes exist for the 12AX7. It doesn't help that large numbers of users (and even technicians) are confused about the proper application of preamp tubes. Although the "9A" base pinout is as close as the industry ever came to a standard, many people have plugged in a tube with a totally different pinout or function, resulting in damage to the amplifier or preamp. Following are some possible drop-in substitutes for 12AX7s and their kin. These will work without socket rewiring, but they should be used carefully. If you have another type, seek out an experienced tube-audio tech before plugging the tube in.



Matsushita 12AX7 1960s, Mazda 12AX7 Long Plate 1955, Mazda 12AX7 Short Gray Plate 1957, Mazda 12AX7 Short Bright Nickel Plate 1963

5751

The 5751 (mu 70) was introduced by GE in 1949. This was intended to be a member of the so-called "ARINC" special series of tubes for use in aircraft electronics (ARINC=aircraft, industrial and control). It was further discussed in VTV issue 1. Like other specialized tubes, it was too expensive for consumer electronics. Virtually all of its production was used in military and critical industrial applications. Among the few audio devices to use it are Conrad-Johnson high-end products of the 1970s and 1980s: the MV-50, MV-75, MV-75A and Premier One power amps, plus the Premiere Three preamp.

Today, some tube-audio users have found that 5751s can often be used in place of 12AX7s in preamps, giving lower voltage gain yet much improved distortion and microphonic performance. This is true in MOST circuits--some preamps which rely on feedback, such as the classic Dynaco PAS-2 and PAS-3 stereo preamps, can have their electrical performance upset by the use of 5751s. And the 5751's heater draws slightly more current than that in a 12AX7, 175 mA versus 150 mA. Nevertheless, damage to the equipment is unlikely. If you are uncertain, an experienced technician must be consulted.Variations include 6851, CV4017 and CV8312. Old-stock mil-grade 5751s made in the 1980s are currently easy to find. Using 5751s in new designs would be risky, as production is unlikely to resume in the future.

12AD7

Introduced by CBS-Hytron and Sylvania in 1955. Supposed to be a low-noise, low-heater-hum-induction, low-microphony version of the 12AX7, predating the 7025. Not popular in America or Europe, it apparently was widely used in Japan. Many Akai, Roberts and Sony tape recorders used and specified 12AD7s, and were originally equipped with Japanese-made versions of the type. I was confused by its near-universal use only in Japanese equipment, until John Atwood found the original Sylvania advertisement from November 1955. 12AD7 appears to be electrically identical to the original 12AX7, with one exception: the heater draws 12.6 volts at 225 mA, versus 150 mA for the regular 12AX7. As usual, the heater is center-tapped for 6.3v use, whereupon it will draw 450 mA versus the normal 300 mA. If possible, check with the equipment manufacturer or an experienced technician before using 12AD7s in 12AX7 sockets. 12AD7s are quite scarce today and will never be made again.

12AT7

This is often seen in guitar amps as a phase inverter or reverb driver, yet it was NOT originally an audio tube! The 12AT7 was intended as a VHF cascode amplifier for TV and radio. FM tuners of the 1950s and 1960s used it either as an audio amplifier or as the RF stage, or even both. Many experts recommend against its use in hi-fi due to poorer linearity. It was known as the ECC81 in Europe, and nearly all the companies that made 12AX7 types also have made versions of the 12AT7. In the 1960s it rivaled the AX7 in popularity for industrial and military applications. While plug-in compatible with the standard 12AX7, it's characteristics are different. However, it will not damage the circuit. Whether it is worth using in your audio equipment is dependent on personal taste. Variations of the 12AT7 include the 6060, 6201, 6679, 7728, A2900, B152, B309, B739,CC81E, CV455, CV2016, CV3508, CV4024, CV5212, CV8154, E81CC, E2164, ECC801, M8162 and QS2406. Ei is said to still be making 12AT7s, though its eclipse by the 12AX7 makes it risky for use in new designs.

12AY7/6072A

This was an early low-noise audio preamp tube, introduced by GE in 1949 and often found in 1950s Fender guitar amps. It is much lower in gain than a 12AX7 or

AMPEREX TUBE TYPE 12AX7/ECC83

The 12AX7/ECC83[1] is a miniature, high-mu twin triode, each section of which has an individual cathode connection. The construction of the 12AX7/ECC83 is such that noise and microphony are reduced to a minimum. Hum is reduced by the use of a coiled tungsten heater. A center-tapped heater permits operation of the tube from either a 6.3 volt or a 12.6 volt heater supply.

The 12AX7/ECC83 is particularly suited for use in resistance - coupled voltage amplifiers such as those used in the preamplifier and input stages of Hi-Fi amplifiers, phase inverters, multivibrators and numerous industrial control circuits where high voltage gain is desired.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode	Coated, unipotential		
	Series	Parallel	
Heater Voltage, AC or DC	12.6	6.3	volts
Heater Current[2]	0.15	0.3	amps
Direct Interelectrode Capacitances	With Shield[3]	Without Shield	
Grid to Plate (each section)	1.7	1.7	uuf
Input (each section)	1.8	1.6	uuf
Output (section 1)	1.9	0.46	uuf
Output (section 2)	1.9	0.34	uuf

MECHANICAL

Maximum Overall Dimensions	
Length	2 3/16 inches
Seated Height	1 15/16 inches
Diameter	7/8 inch
Mounting Position	any
Base	Small button, 9 pin RETMA #9A

[1] The 12AX7/ECC83 is a direct, high-quality replacement for other brands of the 12AX7.

[2] When used in equipment which employs series - connected heaters, a current-limiting device must be inserted to limit the current when switching on.

[3] With external shield (RETMA #315) connected to cathode of section under test.

1

12AX7/ECC83

MAXIMUM RATINGS (Each Section)

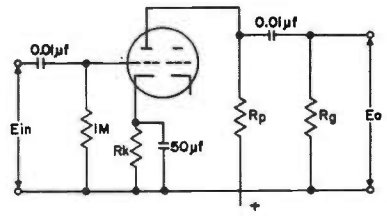
Design Center Values

Zero Signal Plate Voltage	550	volts
Plate Voltage	300	volts
Plate Dissipation	1.0	watt
Cathode Current	8	mA
Grid Voltage	−50	volts
Grid Voltage (Grid current = + 0.3 uA)	−1.3	volts
Grid Resistance[4]	2	megohms
Heater to Cathode Voltage	180	volts
Heater to Cathode Resistance	20,000	ohms
Heater to Cathode Resistance[5]	150,000	ohms

Typical Operating Conditions

Class A Amplifier (Each Section)

Plate Voltage	100	250	volts
Grid Voltage	−1.0	−2.0	volts
Amplification Factor	100	100	
Plate Resistance (approx.)	80,000	62,500	ohms
Transconductance	1250	1600	micromhos
Plate Current	0.5	1.2	mA



Rp = 0.047 MΩ
Rg = 0.15 MΩ

CLASS A RESISTANCE-COUPLED AMPLIFIER, EACH SECTION

[4] With self bias.

[5] In phase inverting circuits.

2

1965 Amperex 12AX7 Data Sheets

5751, so it is not a plug-in replacement for those types. Again, consult a technician if you are uncertain. The 6072A, a super-premium version, has recently found new life in condenser microphones and microphone preamps, even though it has not been manufactured since 1988. Rumor has it that an unknown Chinese factory recently made a run of 6072As for tube microphone use.

7729

This super-tube is believed to have been made only by GE and CBS/Hytron in the 1960s. Often it is found bearing the names of instrument manufacturers, such as Beckman. A true 7729 has gold pins. This tube was intended for very critical applications, probably for use as a differential amplifier in instrumentation. 7729s are said to be excellent in sound quality, yet extremely scarce and very unlikely to be manufactured again.

Other Types

There are a few obscure types that are very similar to the 12AX7. These include the 12BZ7, 12DF7, 12DM7, 12DT7, 6681, 7729, and the European/Japanese 6L13, B339, B759, CV492, CV4004, CV8156, CV8222, E83CC, E2164, ECC863, and M8137. Industrial tubes were usually meant for long life and/or for operation in a cutoff condition for long periods (in digital computers); such a tube may also suffer from very high distortion or other sonic artifacts. The user is ultimately responsible for trying and determining the suitability of these tubes for the audio application. This also applies to tubes which will work in a 12AX7 socket but are definitely not intended for high-quality audio, including industrial and computer tubes like the 12AV7, 12AZ7 and a few others. A 12AU7 or equivalent can also be plugged into a 12AX7 socket, with very low gain and/or high distortion being the result. Still, the choice is ultimately up to the equipment owner.

Acknowledgements

Many thanks to Kevin Deal of Upscale Audio (www.upscaleaudio.com), Upland CA (909-931-9686), for his assistance. Also thanks to New Sensor Corp., New York, NY, for providing sample 12AX7s. Special thanks to Ludwell Sibley and John Atwood for assistance with facts.

This article was adapted from a feature in the October 1997 issue of Pro Audio Review.

The Ultimate 12AX7 Shootout: Guitar Amps

By Charles Kittleson and Ron Veil

The 12AX7 and its European cousin the ECC83 are unquestionably the most popular audio tubes in the world. There have been well over 200 varieties and versions of this tube produced since its inception by GE, RCA and Sylvania in 1948. It is believed that over 40 factories worldwide produced a 12AX7/ECC83 at one time or another. It is still being produced by JJ/Tesla, Ei, Reflector and in late 2000, Svetlana. There have been ongoing rumors that the Chinese 7025STR will be reintroduced by Magic Parts in the near future, but we have been unable to confirm this.

We have chosen to conduct a listening test of several common types as well as a number of exotic and rare types. This test is exclusively for guitar amp applications, but in the next issue of VTV we have a 12AX7 shootout for hi-fi applications. To add even more validity to the test, we did it blind, thereby eliminating the "audiophile" effect: (the more expensive it is, the better it sounds.) All of the tubes were placed in the amp without any of the evaluation panel knowing which tube was being played.

Identifying 12AX7 Types

There are several differences in shape and coloration of 12AX7 plate structures. We will attempt to identify the major differences as follows:

1. Long or Large Plate: The early design long plates were typically made in the 1948-early 1960s period. RCA, Tung-Sol, Raytheon, Telefunken and Mullard made these as well as many other manufacturers. Ei and most recently Sovtek reintroduced this plate structure. They can be colored black or varying shades of gray. Beware when purchasing these, especially US made versions, as they are prone to being microphonic.

2. Medium or Short Plate: The shorter plate design came later in the 1960s, probably in response the long plate's problems with microphonics. Most of these are 12AX7A, ECC83 or 7025 designations made by RCA, GE, Mullard, Philips and others.

3. **Box Plate:** Mullard introduced these in the early 1950s as either an ECC83, CV4004 or M8137. The plates are wider and thicker than other 12AX7 types and are typically colored medium to dark gray.

4. **Ridge Plate:** This design came in the late 1950s and was probably an offshoot of a military design. Most 1960s and later Sylvania and some GE12AX7As are typically made this way. The GE ridge plate 12AX7s have slightly shorter and wider plates than Sylvania types. The ridge does not necessarily make them less microphonic.

5. **Misc. Plate Structures:** The Sino/Chinese 12AX7 and the Sovtek/Reflector 12AX7WA/WBs have distinctive-looking plate structures. There are probably a few other non-standard-looking plate structures out there as well. Since the late 1950s there have been so many plate structure variations that it would be impossible to list them all here.

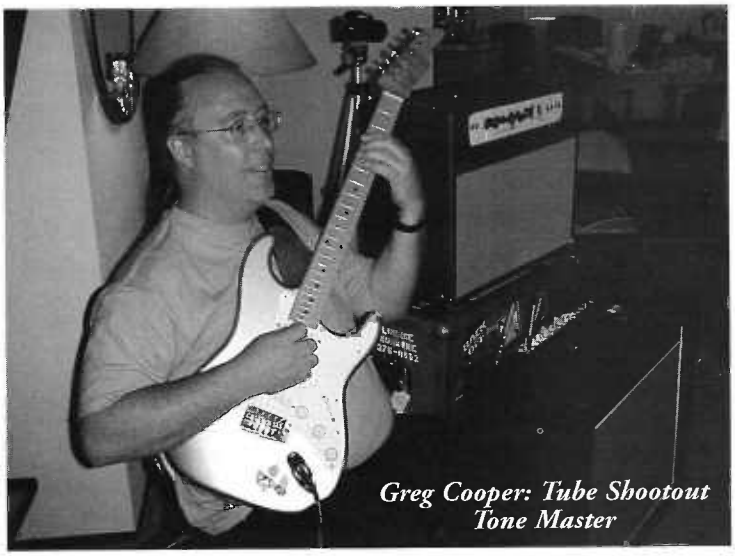
6. **Black, Chrome or Gray Coloration:** Most 12AX7 plates are made of nickel and colored gray. Raytheon, RCA and Western Electric, to name a few manufacturers, used a black carbide coating on some of their tubes in the 1950s to reduce noise. There seems to be a "cult of the black plate" group of tube enthusiasts who feel that any black plate tube is magical. We will leave it up to you to decide if their theory is valid. Mazda, Radio Technique, Siemens (often marked Telefunken) produced some chrome-plated (actually, just untreated nickel) 12AX7s in the early 1960s.

7. **Smooth or Ribbed Plates:** Most 12AX7/ECC83 plate structures have horizontal and/or vertical ribs of various sizes and shapes stamped into them from the tooling. This was probably done to increase the strength of the structure.

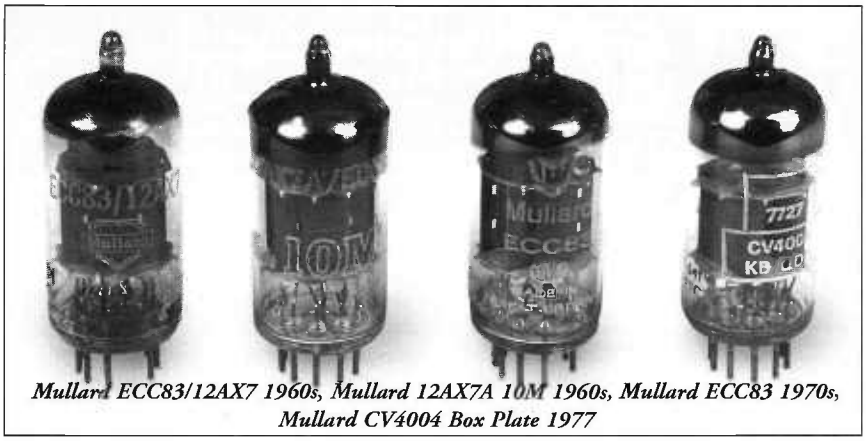
However, Telefunken introduced a smooth plate version of their 12AX7/ECC83 in the early 1960s. These tubes have a smooth outer surface, and are reported to sound better than their ribbed plate version. We have found this to be true in some, but not all applications.

Location, Crew and Equipment

For the second time, our host for the tube shoot-out was Ron Ott of Pleasanton, California. Ron graciously opened his home to us for our seven-hour evaluation. Our listening crew consisted of Greg Cooper, a talented San Francisco guitar virtuoso who laid down the tone; Phil Loarie; a guitarist from Berkeley; Ron Veil, San Francisco guitar tech extraordinaire; Terry Buddingh, a noted tone junkie and writer for both **Bass Player** and **Guitar Player** (Miller-Freeman Publications); Ron Ott, builder of King Amps and



Greg Cooper: Tube Shootout Tone Master



Mullard ECC83/12AX7 1960s, Mullard 12AX7A 10M 1960s, Mullard ECC83 1970s, Mullard CV4004 Box Plate 1977

East-Bay guitar amp tech; and Charlie Kittleson, VTV Editor and guitarist.

Equipment used in our tone test included a 1966 Fender Super Reverb amplifier with four-10 inch ALNICO CTS speakers (1973 vintage), a new cap job using Sprague Orange Drops, new Sprague Atom electrolytic caps, 12AT7 Telefunken and 12AX7 Bugle-Boy (tested for low microphonics), and a pair of RCA Black Plate 6L6GCs with a GZ34 Mullard. Our guitar was a beautiful Tyler Stratocaster finished in deep metallic gold with Fralin pickups. We tried to come up with a guitar/amp combination that was the most common and used or heard by most musicians in their career. That is why we chose the Stratocaster and Super Reverb over other guitars and amps. Also, time limitations and busy schedules weighed into the equation.

For the evaluation, we electrically tested almost 300 12AX7s to find the best quality ones for this evaluation. In order to separate the wheat from the chaff, we used a George Kaye Small Signal Tube Checker (212-779-3713). This useful device ($550) is able to test each section of the tube for noise, microphonics, gain and output. All the tubes evaluated in this test were selected for the best possible electrical and mechanical conditions. Kevin Deal of Upscale Audio (www.upscaleaudio.com), was very helpful in providing many of the rare and exotic 12AX7s for this test. In addition, John Eckland and John Atwood provided more samples.

George Kaye Small Signal Tube Tester

The actual position of the test 12AX7s was at V-2, the first audio tube in the reverb and tremolo channel. To calibrate our ears, we started out with a mid-sixties RCA 7025, which came stock with the Super Reverb. All tone controls were in the middle (flat) position and the settings were kept constant. We played in the clean mode with just a touch of reverb to add dimension.

Some Observations

1. Some guitarists and audiophiles seem to favor the older "long plate" 12AX7 types by GE, RCA, Mullard, etc. These were initially introduced in the late 1940s and throughout the 1950s. We tested several samples, both NOS and good used. Inevitably, many of the NOS samples we tested were microphonic in one triode, which rendered them unusable in this test.

2. Many other NOS tubes had their defects as well. Some were microphonic, others had noticeably unbalanced sections or noise. When buying high-priced tubes from tube dealers and sellers on eBay, be sure that either the tubes are fully tested and/or that you can return the tubes to the seller if they are found to be defective. NOS stocks are depleting rapidly, so the quality of remaining stock is likely to be less than the best.

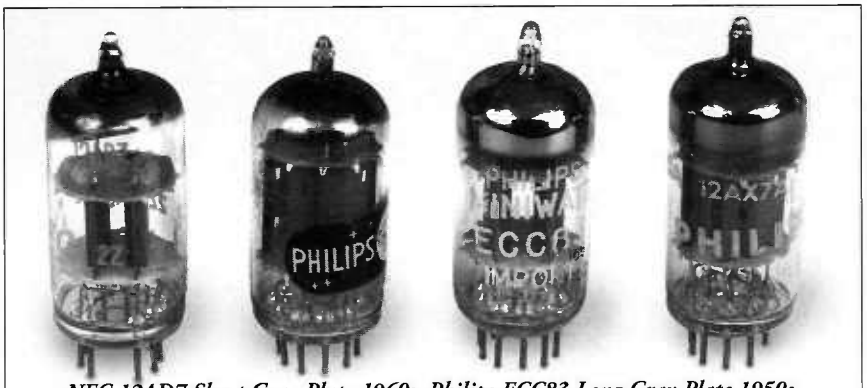
3. Most tube companies sold some of their tubes to other manufacturers who rebranded them with their logo. An example would be RCA buying 12AX7s from GE, putting the RCA logo on them and boxing them in RCA boxes. Another example would be Amperex buying tubes from Mullard and putting the Amperex Bugle Boy logo on them. It is impossible to trace who made what tube when, but we will try to identify the actual source of 12AX7s tested whenever we can in this article. Note that Philips Electronics actually owned the Amperex and Mullard factories as well as at least 20 other tube factories in Europe and Asia. We are planning to publish a very informative article regarding date coding and factory origin on Philips tubes in the near future.

Tube Rating System

We subjectively rated these tubes on a scale of 1 to 100. The number was based on the following factors: dynamic response, coloration and tonal character. The higher the number, the better we liked the tube. If there was at least a 5-point difference between tubes, it was considered a meaningful difference. However, 2 points is not considered that significant. Lower number tubes (0-50) lacked character, were flat or unbalanced sounding. Medium numbers (51-75) were average or slightly better than average sounding and would be acceptable based on cost considerations. Medium high numbers (76-89) were very good to excellent performers that would work great in most guitar amp applications. Highest numbers (90-100) are the very best performers. These tubes had awesome sonics and produced tonal

coloration that bordered on magical. We divided the tubes into two general groups: new/current production and new old stock (NOS) tubes.

Note: As with any audio shootout, your individual results may vary from ours, depending on your ears, guitars, amplifiers, tubes and speakers. We encourage you to experiment with tube sonics on your own to determine the guitar tone best suited to your musical tastes. Also, a caution to hi-fi enthusiasts, the results of this test may not be the be-all/end-all for your application. We will have a more detailed hi-fi evaluation in the next issue of VTV.



NEC 12AD7 Short Gray Plate 1960s, Philips ECC83 Long Gray Plate 1950s, ECC83 Philips Miniwatt 1960s, Philips 12AX7 Dutch 1970s

New Production 12AX7s (mu 100)

Ei Long Flat Gray Plate Yugoslavian (1990s)

This was a nice, balanced tube with lots of treble sparkle. If you want a tube with high-end magic and lots of treble bite, this is the one! Other than that, response was relatively warm in the bass and mid range. Note that Ei tubes can go microphonic at a faster rate in combo amps, so a better application would be a piggyback Marshall or something similar. Overall Tone Rating: 81

JJ/Tesla ECC83/12AX7 1999

The Tesla 12AX7 looks like a frame grid 6DJ8 RF tube. It had strong bass and the mids were balanced and warm with great harmonic texture. However, some of us thought that the highs, even though they were detailed, sounded a slight bit brittle. Note that the Tesla is not always recommended for combo-type amps due to excessive vibration that causes the tube to become microphonic faster than normal. Overall Tone Rating: 81

Sovtek 12AX7WA

The earlier style Sovtek had sweet mids with bite and extended highs with reasonable detail. However, the bass response was not as balanced sounding as the RCA 7025 and lacked some sonic detail. Overall, this was a good sounding tube, but some of the earlier Sovtek 12AX7s had a shorter life expectancy than their newer types. Overall Tone Rating: 64

Sovtek 12AX7WB

This version of the Sovtek 12AX7 had even balance, was sweet and silky with chimey highs. Color this one warm and responsive. Overall Tone Rating: 80

Sovtek 12AX7LPS

One of Sovtek's latest offerings, this tube had strong, chunky bass and mids. The sound was noted to be clean and musical with nice warmth, especially in the mids. Sonic presentation was balanced, but the highs were a slight bit bright. Based upon the availability, tone and reasonable price, this tube qualifies for a Best Buy. For best performance in your amp, buy this tube from reputable dealers who test the tube for low noise and microphonics as well as transconductance. Overall Tone Rating: 83

Svetlana 12AX7 Large Gray Flat Plate 1999 (prototype)

The new Svetlana 12AX7 will be available from retailers in the third quarter of 2000. Our samples were 1999 engineering prototypes that resembled smooth plate Telefunken 12AX7s on steroids. We have heard that the production version of this tube will be slightly different. Our initial samples of the Svetlana 12AX7 tube had great sonic projection in the mids and highs. We thought the mids really rocked and were very musical, but the bass was a mildly recessed. This would also be a great tube for hi-fi amplifiers. It will also work well in Marshall amps; in fact, Marshall is already using the Svetlana 12AX7 in most of their new guitar amps. Overall Tone Rating: 82

New Old Stock 12AX7s (mu 100)

Amperex 12AX7 Bugle Boy Long Gray Plate 1958

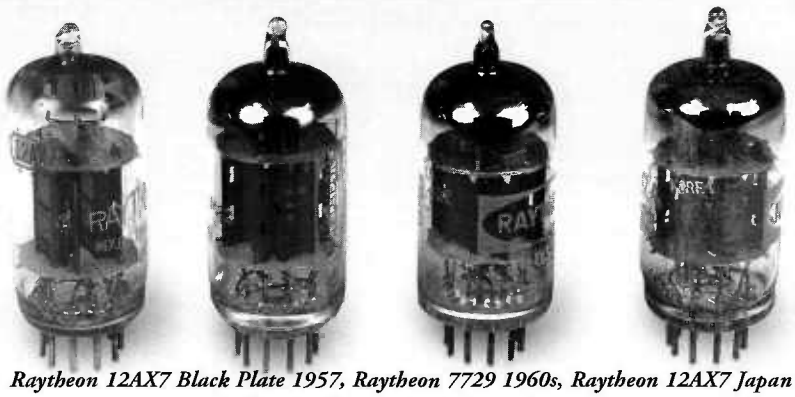
The late 1950s Bugle Boy was sweet and detailed all over the place. To most reviewers, it sounded very articulate and dynamic. This tube broke up into mild distortion a little earlier than others. Color this one warm and sparkly. Overall Tone Rating: 90

Amperex 12AX7 (rebranded GE ridge-plate 1974)

Richardson Electronics purchased Amperex from Philips Electronics in 1972. After this date, Amperex-branded tubes were marked with the elongated orange globe logo. Apparently, the Bugle Boy logo was then discontinued until fairly recently. The GE branded Amperex we tested had good detail, was slightly warm with sweet, rich highs. Color this one sparkly with big tone. Overall Tone Rating: 82

Brimar 12AX7WA Long Gray Plate 1970s

The 1970s Brimar had a strong and chunky bass, sweet and rich mids, and strong, extended highs. The tube's tonal character was warm and musical. Dynamic response was even with a sparkly top end. This would be a great tube for Fender style and most British style amps. Overall Tone Rating: 84



Raytheon 12AX7 Black Plate 1957, Raytheon 7729 1960s, Raytheon 12AX7 Japan 1960s, Raytheon 12AX7A Korea 1970s

CBS 12AX7 Long Gray Plate 1955

The 1950s CBS tube had great bass response, was balanced and responsive throughout the musical spectrum. CBS bought Hytron, so this tube likely came from the Hytron factory. This was a very smooth and musical tube and would sound excellent in most amplifiers. Overall Tone Rating: 90

Chinese 12AX7 Short Gray Plate 1990s

Because this tube is typically quiet and has low microphonics in selected versions, many guitar amp OEMs used it during the 1980s and 1990s. Unfortunately, it is now out of production, but was made by the millions, so finding NOS should not be difficult. The tube had a balanced dynamic response. It was warm and musical with good detail. Color this one chimey, detailed and musical. Overall Tone Rating: 80

GE/JAN 12AX7WA Long, Wide Gray Plate 1963

The early 1960s wide gray plate GE was a balanced-sounding tube with good detail. It was warm and musical, slightly punchy, and had sparkly highs. This would make a sweet blues guitar tube. Overall Tone Rating: 83

GE/JAN 12AX7WA Short Ribbed Gray Plate 1980s

This one had flat response and was musical and sweet sounding. It would be good tube for blues and/or jazz playing. These tubes are widely available from NOS tube dealers. Overall, this was a top-rated performer in this test. Overall Tone Rating: 87

GE 6681/12AX7 Long Gray Plate 1960s

Mid-frequencies seemed to be enhanced, but overall detail was quite good. Gain was a little higher than average for this ballsy-sounding tube. Tonal coloration was on the warm side, but was balanced. We thought this tube would sound great in most vintage Fender-style amplifiers. Overall Tone Rating: 84

Matsushita ECC83/12AX7 Short Gray Plate 1960s (Japanese copy of a Mullard)

The Japanese Mullard copy had slightly more gain than average. This tube was very dynamic, open and 3D sounding. It is definitely a recommended tube for many guitar applications. Overall Tone Rating: 80

Mazda ECC83/12AX7 MIL Long Plate 1955

This tube had above-average gain with deep, strong bass. The highs were sparkly and glassy with excellent musical detail. Color this one the better side of warm with sparkly magic. Overall Tone Rating: 88

Mazda ECC83/12AX7 MIL Short Plate 1957

The 1957 Mazda was warm, detailed-sounding tube with deep bass. The mids were OK, but the highs were a bit bright sounding. Overall Tone Rating: 66

Mazda 12AX7 MIL Chrome Short Plate 1963

This was one of the sexier looking tubes with attractive bright nickel anodes. The gain was slightly below average, but the highs were silky-smooth. This was a lively sounding tube with even response and a detailed, warm sound. It would be a great tube for either blues or jazz music. Overall Tone Rating: 94

Mullard CV4004 Gray Box Plate 1970s

This tube was flat sounding in the mids and bass and the highs were slightly harsh. However, the panel thought that this tube would make a better hi-fi tube. Overall Tone Rating: 58

Mullard 10M Series Short Gray Plate Gold Pins 1960

Mullard's 10M was musical and warm with a nice, chunky bottom. The mids were boosted and warm, but the highs were a little hot for some tastes. This tube may work fine in some Marshall amplifiers. Overall Tone Rating: 75

Mullard 10M Series Short Gray Plates 1970 (Gold printing and no gold pins)

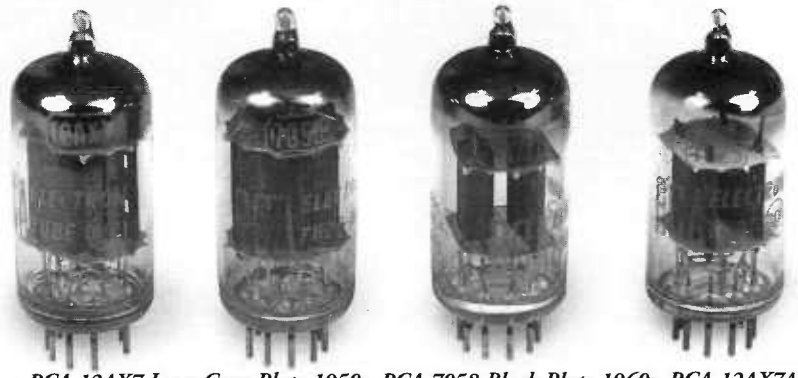
The bass was balanced and strong. The mids were pronounced, but detail was nothing special. Highs were neutral sounding and nothing special. This one might make an excellent hi-fi tube. Overall Tone Rating: 55

Mullard ECC83/12AX7 (marked GE) Short Gray Plate 1963

This was a tube with very good detail and with overall balanced sound. However, the highs were slightly edgy. Overall Tone Rating: 78

Mullard ECC83/12AX7 Short Gray Plate 1970s

The 1970s Mullard had very detailed bass with musical mids and super smooth top end. This would make a great hi-fi tube. Overall Tone Rating: 84



RCA 12AX7 Long Gray Plate 1950s, RCA 7058 Black Plate 1960s, RCA 12AX7A Sort Gray Plate 1970s, RCA 7025 Short Gray Plate 1960s

NEC 12AD7 Short Gray Plates 1960s

Introduced by Sylvania in 1955, the 12AD7 was a special low-noise 12AX7 for audio use. It was mostly used by Japanese OEMs. This was a neutral, kind of average-sounding tube. We all thought that it did nothing magical and was kind of flat and boring-sounding. Overall Tone Rating: 45

Philips Miniwatt ECC83 Long Gray Plate 1950s

The bass was strong and balanced, however the mids sounded uneven and scooped. We noted the highs to be edgy and bright sounding. This was not an exceptional tube, and only slightly better than average for this test. Overall Tone Rating: 58

Philips Miniwatt ECC83 Short Gray Plate 1960s

It had modest detail, warm and sweet sounding, but highs are a little bit edgy. This tube has a distinct flavor, and is kind of funky-sounding. The bass response was less than average with this tube. Overall Tone Rating: 78

Philips ECC83/12AX7/7025 Short Gray Plate 1970s

The late production British-made Philips was slightly warm and not the slightest-bit edgy. This one had ballsy bass and midrange was slightly emphasized, being warm and sparkly. On the whole, this was a good sounding guitar tube. Overall Tone Rating: 75

Philips ECG/JAN 12AX7 1980s

Due to the military scrapping most of their tube gear, these tubes have been available on the market for a few years at reasonable prices. We noted this bottle to have a nice balance throughout the musical spectrum. The bass was strong, mids were rich and detailed and the highs were lively and extended, albeit a slight bit edgy. These are cheap right now, so get them while you can. Overall Tone Rating: 81

RCA 12AX7A Long Gray Plate 1950s

The classic RCA sound with nice detail and predictable dynamics. Highs were very smooth with a sweet musical punch. This had a classic 12AX7 sound with warm and sparkly coloration. Overall Tone Rating: 85

RCA 12AX7A Short Gray Plate 1960s

This vintage RCA tube had good musical detail with nice dynamics. The mids were warm and detailed. Highs were good, but had a slight edge that might work for a dark-sounding amp. Note that these were not as detailed as the RCA 7025. Overall Tone Rating: 77

RCA 7058 (12AX7) Long Black Plate 1950s

This was a warm, midrange-tilted tube. Bass response was strong and highs were very well defined, but some thought the highs were a little harsh. The 7058 was a long black plate version of the RCA 12AX7 and was used in demanding instrumentation applications. Overall Tone Rating: 79

RCA 7025 Short Gray Plate 1960s

This tube was original equipment in the 1966 Super Reverb amp we used in the test. We noted the tube to be very dynamic as well as rich, silky and sparkly. With an even, tight bottom and a clear, warm top, the RCA 7025 was a near perfect balance for the Super Reverb circuit and 4-10" speakers. Get these while you can, as they are getting scarce. Overall Tone Rating: 88

Raytheon 12AX7 Long Black Plate 1950s

An awesome, but extremely rare tube with superb micro-dynamics and exquisite musical detail at all frequencies. We thought this tube performed noticeably better than the RCA 7025. This little bottle had nice tonal complexity, but was still smooth and sweet sounding. Overall, the Raytheon black plate was a top performer. Please note, this version is extremely rare and can be microphonic in one of the triodes. Our sample was super-quiet and very balanced. As a side note, the early 1950s Raytheons were considered to be the quietest 12AX7s in their day. In fact, Daniel von Recklinghausen chose them as phono and first audio tubes in the H. H. Scott hi-fi amps until Telefunken started its push into the US markets in the late 1950s. Overall Tone Rating: 98

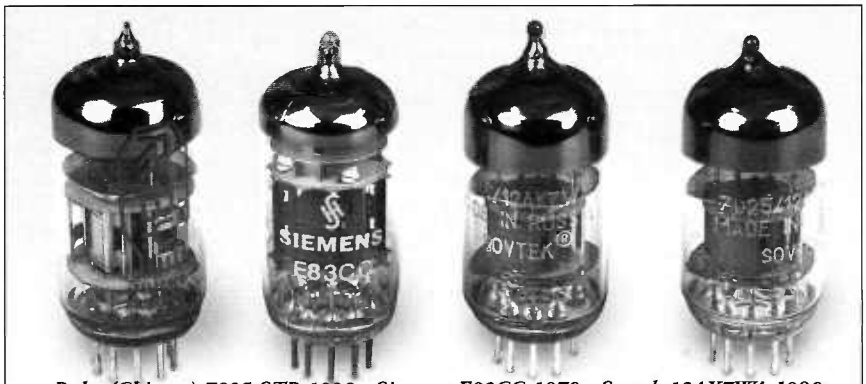
Raytheon 12AX7 Short Grey Ridge Plate (Sylvania-type copy made in Korea 1970)

Surprisingly, this little bottle was dynamic and warm with nice musical detail. Highs were sweet and punchy with no edge. Raytheon ceased manufacturing their own 12AX7s in the early 1960s and went to Korea and Japan for these tubes. They are clearly marked as to country of origin. Overall Tone Rating: 81

Raytheon 7729 Long Plate Gold Pins 1960s

This little bottle was very musical, dynamic and detailed. Great for blues, especially in a bright-sounding amplifier, as the highs were ever-so-slightly rolled-off. This tube has strong bass, lots of sparkle, is detailed and textured. If you play jazz guitar, this tube will amaze you with

its tonal richness. Not recommended for rock music because it overloads slightly when the strings are whacked. Don't get too excited about finding this tube at your favorite tube dealer, as the 7729 is probably the rarest of the 12AX7 types ever made! It was also labeled GE and was made for super-critical instrumentation purposes in the early 1960s. Overall Tone Rating: 92



Ruby (Chinese) 7025 STR 1990s, Siemens E83CC 1970s, Sovtek 12AX7WA 1990s, Sovtek 12AX7WB 1990s

Ruby 7025STR Short Chrome Plate Chinese 1990s

Another surprise, this tube was lively and musical with a tight bass and warm, sparkly top. The tube's gain was noticeably greater than average. Overall presentation was defined and balanced, but a little brighter sounding than the RCA 7025. Magic Parts is apparently trying to re-introduce this tube in the near future. Some tube dealers may have a few original ones in stock. Overall Tone Rating: 85

Siemens E83CC Ruggedized Short Gray Plate 1970s

The bass response was not as deep as the RCA 7025 and the mids were a little scooped. However, the highs were strong and detailed. This was a bright-sounding tube that would work well in dark-sounding amplifiers. Overall Tone Rating: 55

Sylvania 12AD7 Short Black Plate 1950s

This unusual bottle had nice, lush lows, mids and highs. It had above average gain, but was not edgy. Overall, this was a sweet, musical tube. This tube was originally used in Japanese tube-type tape recorders in the late 1950s and early 1960s. A few dealers currently have these in stock at reasonable prices. Overall Tone Rating: 80

Sylvania/JAN 12AX7WA Short Gray Ridge Plate 1961

This tube was responsive, dynamic and musical with good detail. The treble and mids were sweeter than later Sylvania 12AX7s. A few NOS dealers have these at reasonable prices. Overall Tone Rating: 85

Sylvania/JAN 12AX7 Long Ridge Gray Plate 1970s

This tube had flat response, with good bass and mids. Upper mids and highs had lots of color but could be a little hard sounding. Overall Tone Rating: 76

Telefunken 12AX7 Long Gray Ribbed Plate 1960s

The earlier ribbed Tele was a ballsy tube with strong, punchy bass, warm and sparkly mids and a chimey top. This was a smooth and musical tube for this guitar application, but may not perform the same in all amps. As many tube hi-fi enthusiasts know, this can be an excellent preamp tube for home audio. Overall Tone Rating: 83

Telefunken 12AX7 Long Gray Smooth Plate 1960s

Telefunken produced what is believed to be one of the finest 12AX7s ever made. They used premium materials, superb craftsmanship and excellent quality control. The result was a 100,000 hour rated 12AX7 that was quiet, had extremely low microphonics, and sounded excellent. Telefunken 12AX7s were used extensively in 1950s and 1960s hi-fi and pro-audio applications. It is not known whether they were used in any guitar amps as original equipment.

This one sounded completely different than the ribbed plate Tele. The bottle was extremely dynamic and very musical. This tube was alive with great tonal control, sweetness, and had a balanced presentation. Note that this tube may sound bright in some bright-sounding amps like Marshalls. Overall Tone Rating: 91

Tung-Sol 12AX7 Long Black Plate 1950s

The Tung-Sol had chunky bass, but the mids were slightly scooped out. Overall detail was warm and rich, but the tonal presentation was not balanced. Fender used the Tung-Sol in 1950s Tweed amplifiers as original equipment. Overall Tone Rating: 74

Tung-Sol 12AX7 Long Gray Plate 1960s

Our sample of the Tung-Sol gray plate was very open sounding with deep, rich bass. Color this one big, warm and musical. The mids and highs just "sang" to us. This bottle has very big dynamics with a sparkly 3-D sound. It was original equipment on many US manufactured guitar amps in the 1960s including Fender, Gibson and Magnatone. Overall Tone Rating: 94

Tungsram (Hungarian) ECC83/12AX7 Gray Plate 1970s

The Tungsram had smooth, warm bass and mids that were balanced-sounding. The treble had exceptional extension and had a magic sparkly characteristic. This tube is still available from some NOS tube dealers at reasonable prices, so don't wait too long! Overall Tone Rating: 87

Westinghouse 12AX7 (1970s Japanese)

We noted this tube to have a good balance as well as being responsive and dynamic. Bass register was heavy and the mids were warm and musical. Overall Tone Rating: 75

5751s (mu 70)

GE/JAN 5751 Gray Plate 1960s

The GE had a little less bass than the RCA 5751, but is still warm and musical. Highs were nice and sweet as well. Overall Tone Rating: 75

GE/JAN 5751 Five Star Series 1962

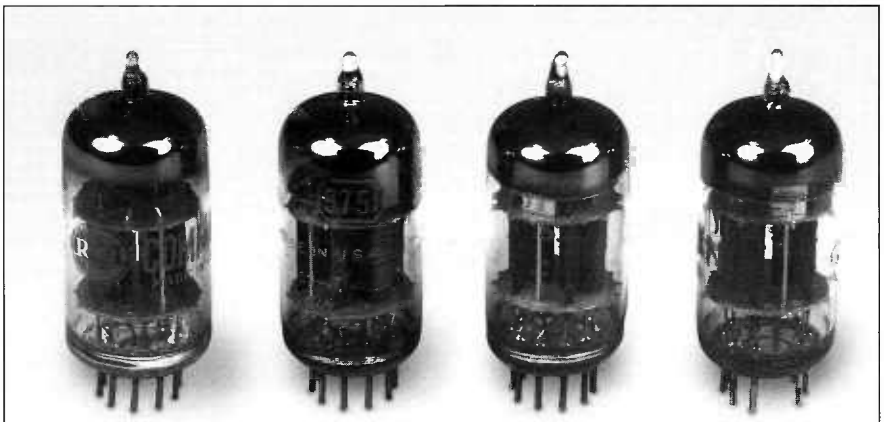
This one was a musical and sweet little tube. A great tonal device for jazz music as it seemed to"swing." Overall Tone Rating: 79

RCA Command Series 5751 (1957)

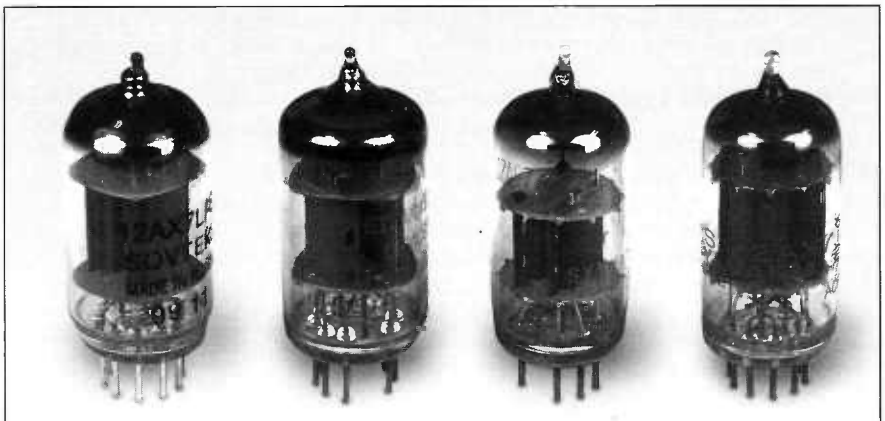
Because they have a lower gain, many players prefer the smooth, warm response of the 5751s. The RCA Command Series 5751 was used extensively in avionics and other military applications because of its sturdy build and ability to withstand heavy G forces in the field. The RCA sample was even, warm and smooth, but it had less dynamic response than a typical 12AX7. Overall Tone Rating: 75

RCA 5751 Short Black Plate (marked HP) 1959

Another balanced sound, smooth and rich with detailed highs. This one was more sparkly than a typical 5751. Overall Tone Rating: 83



RCA Command 5751 1950s, RCA 5751 Black Plate 1957, GE Five Star 5751 1960s, Sylvania Gold Series 5751 1960



Sovtek 12AX7LPS 1999, Svetlana 12AX7 1999, Sylvania 12AD7 1956, Sylvania 12AX7WA Ridge Plate 1961

Sylvania 5751 Gold Series (Gold Plated Pins) 1960s

This one was less warm than any of the other 5751s in this test. Tonal coloration was OK, but highs were a little edgy. Overall Tone Rating: 60

United (GE) 5751 Short Gray Plate 1970s

Again, this was a balanced, even sounding tube with solid bass and singing mids and highs. Color this 5751 lively, musical and rich sounding. Overall Tone Rating: 79

Our Favorite 12AX7s

Yes, all of the 12AX7s sounded different. Some sounded significantly different than others. Every tube has a tonal color and it is up to you, the artist, to paint a tonal image in your preferred style. As mentioned earlier, these tubes were all super select grade and you are not likely to obtain this quality unless your tube seller is equipped to do some extensive testing. Remember, the leftover NOS stock quality is not as good as it was five years ago, so be very cautious when plunking down your hard-earned cash.

Please note: our tone tests were done with a small sampling of the rare tubes that were available; and your sonic results may vary, depending on your tubes, their vintage and individual production batch. Also, if your favorite tube did not do well, don't feel upset. Tube rolling is not an exact science and the most meaningful results are achieved when you can do this in the comfort of your own home or studio with your tubes and equipment.

Amperex (Holland) 12AX7/ECC83 Bugle Boy Long Gray Plate 1958

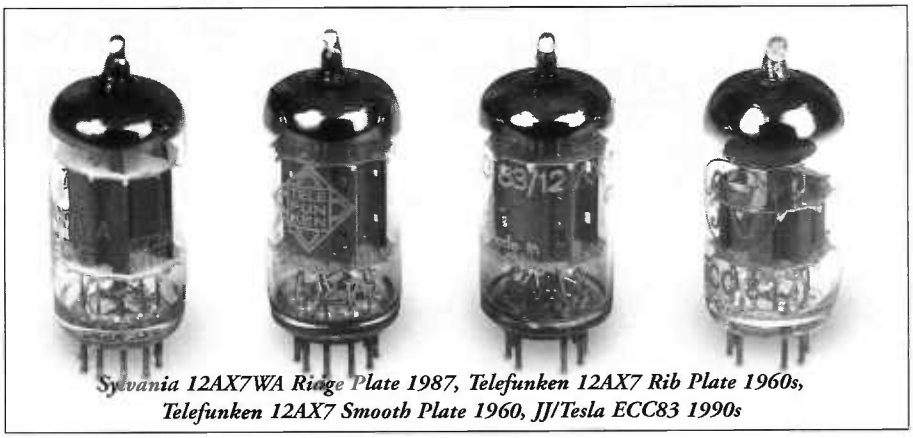
We did find a non-microphonic early Bugle Boy 12AX7. With outstanding tonal complexity and warm detail, the tonal coloration was quite pleasing. This is another tube that is getting hard to find and may be impossible to find in quantity. Do not confuse this with the short plate versions from Amperex or Mullard that came out later, as they are a different animal.

CBS Long Gray Plate 1955

CBS's mid-fifties 12AX7 sounded great. It had nice dynamics and articulate voicing. It comes in a black, white and red box with a CBS logo on the tube in white. Later versions of the CBS may sound completely different, so be sure of what you are getting.

Mazda 12AX7 MIL Chrome Short Plate 1963

The Mazda tube was a real sweetheart. Its dynamics were excellent and tonal coloration was silky-smooth. Most gui-

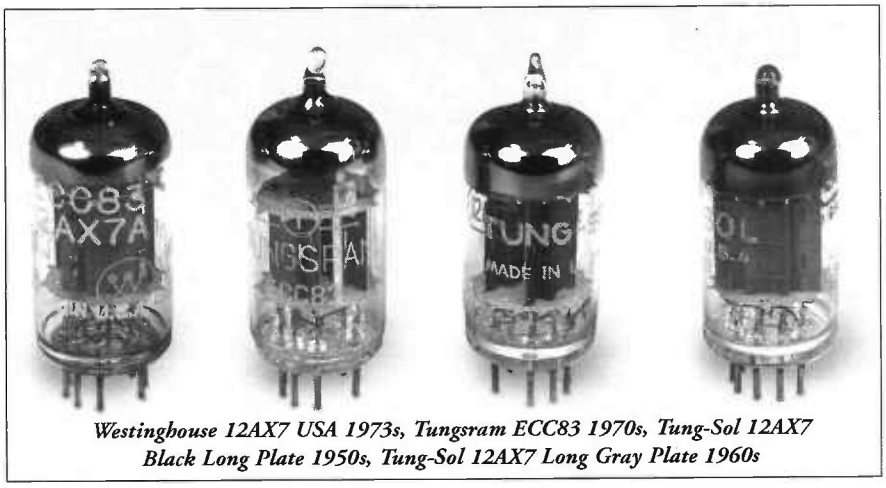


Sylvania 12AX7WA Ridge Plate 1987, Telefunken 12AX7 Rib Plate 1960s, Telefunken 12AX7 Smooth Plate 1960, JJ/Tesla ECC83 1990s

tarists would love the sound of this little tube in their Fender Blackface type amps. It is currently available from a few tube dealers, so shop around. It may be a little pricey, but is worth it.

Raytheon 12AX7 Long Black Plate 1957

This super rare tube was magical, in that it did everything beyond perfect. Dynamics and micro-detail were astonishing and noticeably better than any other 12AX7 in the test. It was unanimous amongst the reviewers that this was their favorite tube. Be aware that this tube is extremely rare (Kevin Deal says don't call on these) in NOS and can be microphonic in one triode if not carefully selected.



Westinghouse 12AX7 USA 1973s, Tungsram ECC83 1970s, Tung-Sol 12AX7 Black Long Plate 1950s, Tung-Sol 12AX7 Long Gray Plate 1960s

Raytheon 7729 1960s

The 7729 was probably the rarest tube in this test, but it sounded great! Dynamic, detailed and rich, it would be an exceptional tube in blues or jazz music. The midrange bordered on magical! Do not bug Kevin or other NOS dealers for this tube, as it is unobtainable.

Sovtek 12AX7LPS 1999

The new Sovtek 12AX7LPS qualified as **Best Buy** in this test. It sounded as good or better than a number of NOS tubes at a fraction of the price. It can be a solid performer in most musical instrument applications. Be sure your tube dealer tests and selects for low microphonics and noise. Selected tube prices may be a little higher, but you will be assured of quality sonics and best reliability.

Svetlana 12AX7

When it becomes available in Q3 of 2000, the Svetlana 12AX7 will be another excellent tube at reasonable prices. From the looks of this tube, it will be very reliable and have low microphonics. Sound quality will be exceptional as well, based upon previous listening sessions in both guitar and hi-fi applications. The Svetlana 12AX7 will unquestionably be another **Best Buy**.

Telefunken 12AX7 Smooth Plate

This was an awesome tube that can still be found in used, but good condition. It was used extensively in Fisher and Scott tube hi-fi equipment from the 1960s.We have found used Telefunken 12AX7s that were 40 years old, yet tested like new and were quiet. The smooth plate version had a more balanced sound than the rib plate and had great upper-mid to treble response. As mentioned, it can sound a little bright in some amps, so experiment before going full bore.

JJ/Tesla ECC83/12AX7 1990s

This tube is currently available at reasonable prices from many tube dealers. It had a nice warm midrange and sparkly treble. The best application would be in a piggyback amplifier to increase tube life and keep microphonics to a minimum.

Tung-Sol Long Gray Plate 1960s

Another legendary performer, this tube was responsive, dynamic and musical. If tone is your game, the Tung-Sol 12AX7 should be in your arsenal. A very limited quantity are still available from NOS dealers, but don't wait too long!

That's a Wrap!

That's all for now folks. We hope you had fun and learned something from this article. Hopefully, you can find some of these tubes for your amps and play some wonderful music through them. Note that this test is not the gospel and it is up to you to find out what sounds best to your ears.

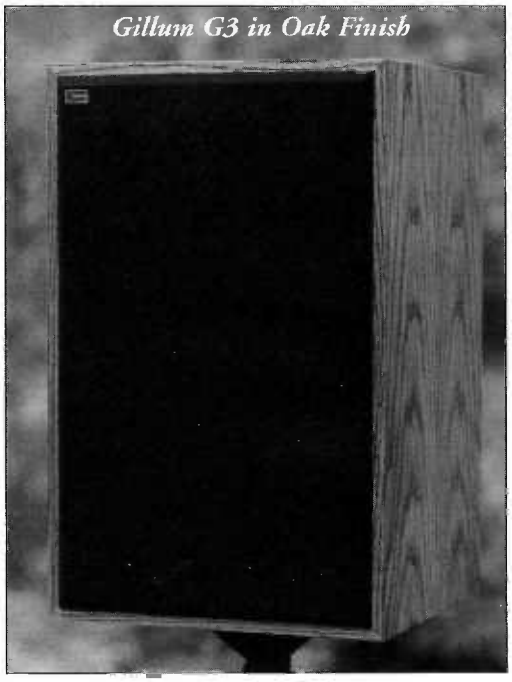
We would advise any readers who are interested in obtaining any of the NOS 12AX7 reviewed in this test not to wait too long before purchasing your favorites. Remember, there are more tube amps on the planet that use 12AX7s than at any other time in history. Demand will soon outstrip supply of this limited resource and some NOS examples will not be available at any price.

Clean, Clear and Tube Friendly

The Gillum G3 Loudspeaker

By David Bardes

Designed and built by Gary Gillum, former Klipsch engineer, the Gillum G3 speakers are a rare find for vacuum tube enthusiasts. Clean sounding and 97 dB efficient, these speakers look much like the Klipsch Heresy. So much so that an audio hobbyist might dismiss them as a knock-off. Don't be fooled! The similarity ends with the general size and configuration. I'm sure Gary tires of the comparison. So let's get beyond that, OK?



Gillum G3 in Oak Finish

The G3 is a chunky floor-standing bookshelf speaker made popular in the 60s and 70s and is comfortable on short speaker stands 8 to 15 inches high. It is available in a durable black finish or in wood veneer. It sports a 12" woofer, a horn loaded compression midrange driver and horn tweeter. It weighs in at a hefty 50 lbs (25kg). A two-slot barrier strip on the back accepts bare cable or spade connectors. These speakers are serious pieces of hardware, and they have a no-nonsense feel about them.

Carefully removing the rear-panel revealed a crossover using quality poly caps, coils, and an autoformer. Gary prefers the autoformer over the use of L-pads or resistors to match drivers. A significant benefit to this attenuation is that the midrange and tweeter are coasting even when powered by huge amps at painfully loud volume levels. At normal volume levels, these drivers produce very little distortion.

We tried the G3s on a variety of amps, from a fashionable 45 SET, to an EL34 PP amp, and several in between. All the tube amps we tried were an excellent match for the G3s. They were efficient enough for the 45 amp to play loudly with lots of headroom, and far more than rugged enough for the push-pull amps to fill a large room with very loud music.

These speakers are amazingly revealing, dynamic and open sounding. Properly positioned, they provide a deep and a realistic soundstage. Bass response is taut, realistic, and deep. They have a bright lively sound that makes many other speakers sound slow and soggy. In one recording we heard prominent midrange coloration on a female vocal, no doubt we thought, due to the midrange horn. Nope, it was the recording. Well-recorded vocals are natural and uncolored with the G3s.

This is all to the good, but care must be taken to match these speakers with the right equipment. Solid-state amps, pedestrian CD players and the like will take the G3s well past bright and into "nails-on-chalkboard" territory. At $1260 a pair, it is not likely that these speakers will get matched up with the cheap stuff, but should they meet lesser audio gear, these revealing speakers will show no mercy and take no prisoners!

Positioning these speakers in your listening room can fine-tune the sound. Because of the directivity of the horn drivers, a moderate degree of toe-in is required to get that great soundstage. This same directivity allows the speakers to be placed close to the back wall or into corners for better bass performance. We ended up with the speakers on low 8 inch stands close to the rear wall, and toed in about 30 degrees. We would match the G3s up with a top-notch analog system where smooth electronics can play clean, clear and loud. The results would be stunning. Even with our CD front end, we were enjoying a new level of realism with the G3s.

Specifications: (supplied by manufacturer)

Bandwidth: 50Hz-17.5kHz +/- 1 4dB

Sensitivity: 97 dB SPL, 1 watt/1 meter

Impedance: 8 ohms minimum

Maximum Power Input: 125 watts peak program material

Beamwidth: Approximate coverage angles between 6dB down points from on axis. Average of 500Hz - 8KHz octaves. Nominal: Horizontal 100 degrees, Vertical 110 degrees

Enclosure type: Horn type midrange and tweeter with direct radiator woofer

Drive Components: 12" (30 cm) woofer (proprietary by Eminence), 20 inch (5 cm) voice coil diameter midrange compression driver by EV, one inch (2.5 cm) voice coil diameter tweeter compression driver by EV

Crossover: Balancing type network with crossover frequencies of 750 Hz and 6.5 KHz

Dimensions: Height 23 3/4" (60.3 cm); Width 14 1/4" (36.2 cm); Depth: 13 5/8" (34.7 cm)

Shipping weight: 55 lbs. (25 kg)

$1260 in Black Lacquer (Plus shipping)

$1575 in Matched Walnut or Oak Veneer (Plus shipping)

Gillum Loudspeaker Systems, P.O. Box 123, Ridgdale, Missouri 65739-0123 (417) 334-7428

PP SV83 Amplifier Project

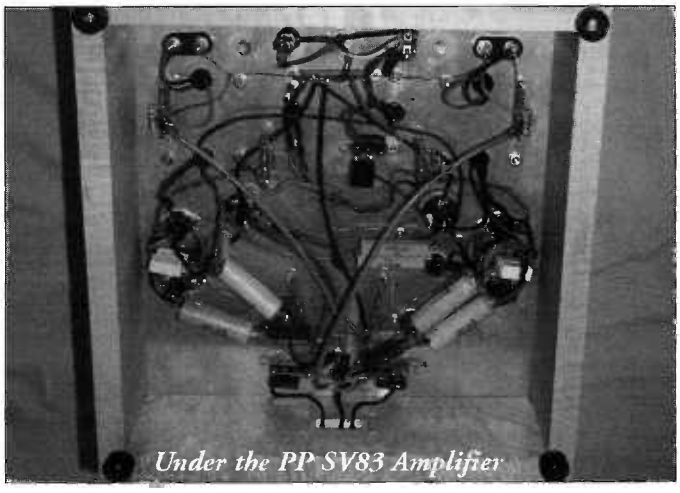
Based on Dynaco ST-35 Outputs

By Chris Beck

After listening a good while to my SE SV572-10 amps, based upon Eric Barbour's design in VTV Issue #5, it's time for a little change of pace here. I started out my venture into tube audio a few years ago with a used Dynaco SCA-35 integrated amp. It was modified (tone controls removed, better caps, etc.) and sounded pretty good. However, the phono stage was mediocre and the amp wasn't very quiet (hiss and hum). Therefore, the amp sat unused in the basement. Not a very respectable existence for a vintage amp. So, I got the idea to use the transformers from the SCA-35, which are identical to the ST-35, and build a "clone" of the ST-35 using the ST-35 circuit.

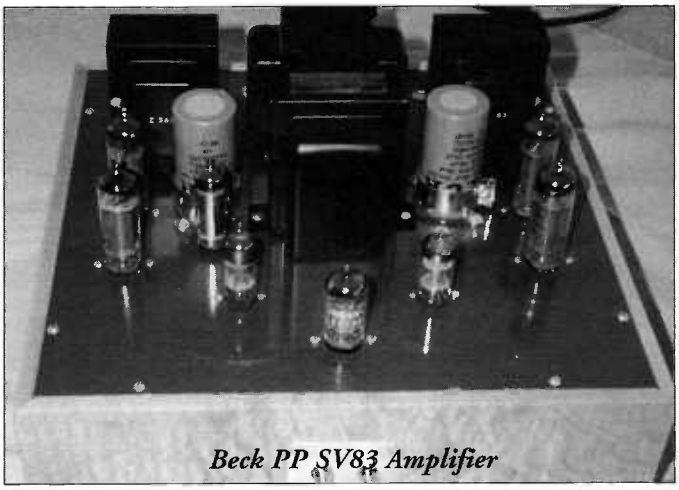
Circuit Description

A lot of the problems with my SCA-35 were caused by the 7199 tube. It is a good device, but can get noisy with age. Replacements are quite expensive and getting hard to find. Dynaco also made an amp called the ST-35, which was the amp only version of the SCA-35, with one important difference. Instead of the 7199 pentode/triode input tube, it uses the 7247 tube (also called a 12DW7). This tube is half of a 12AX7 with half of a 12AU7 in the same envelope, for the voltage amp and phase splitting duties, respectively. This keeps all the triode nuts happy, besides being a better tube. Now, the only problem is that 7247s are also rather scarce and expensive. Both the 7199 and 7247 (12DW7) are still being made, but the Sovtek 7199 is marginal, not being a true 7199, and the Ei 7247 is probably never to be seen again from Serbia.



Under the PP SV83 Amplifier

Fortunately, we can use common 12AX7s and 12AU7s to mimic the duties of the 7247. In my design I've chosen to use a 12AX7 for the input (1/2 for each channel) and a 6C4 in each channel for the phase splitting, which is just 1/2 of a 12AU7 in a 7-pin envelope. For the output tubes, the ST-35 uses the EL84/6BQ5 tube. They are run in the Ultralinear connection with the screen taps from the famous Dynaco Z-565 output transformers. Now, for a little twist, I am going to use a slightly different tube from Svetlana, the SV83. This is a tube originally designed for video amplification and is highly linear. It has the same 12 watt plate dissipation rating as the EL84 and higher transconductance (15,000 micromhos). The caveat is a screen grid rating limit of 200 volts. This limit does not allow the tube to be operated in Ultralinear connection or triode connection with more than about 250 volts. The ST-35 beats it's tubes with around 360-370 volts, so plug in SV83's and they will fail. The solution, you ask? Pentode connection, using a regulated screen supply via a trusty 0A2 gas tube.



Beck PP SV83 Amplifier

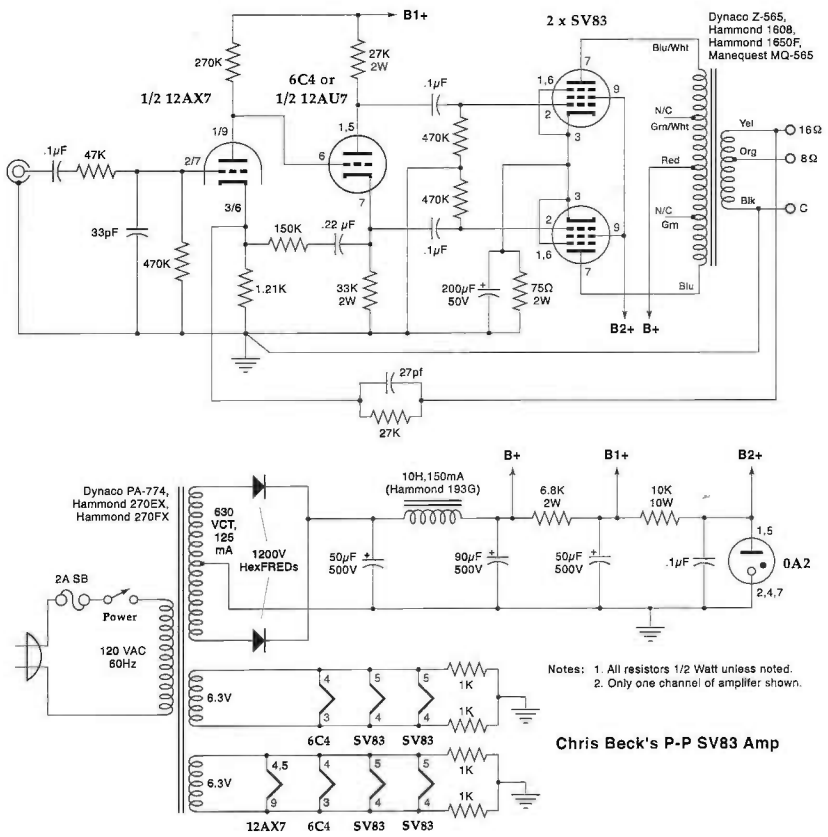
The Svetlana Web Page (www.svetlana.com) has both the data sheets for the SV83 and Application Note #29 for data on wiring in a screen supply with very few parts. Many very highly regarded amps of the past used true pentode connection, including all H. H. Scott amplifiers, the Grommes 260 and some Altec PA amps.

The overall circuit duplicates the original ST-35 with the following changes: 1) regulated screen voltage supplied to the SV83 tubes, and 2) the addition of a 10H choke to the power supply replacing a fixed resistor formerly in the schematic. I did this to provide better filtering and regulation in the supply, and I like lots of iron on an amp!

Construction

The amp is built entirely on a .080" thick 6061-T6 aluminum plate, 12" x 12". I drew a layout of the holes and cutouts on AutoCAD and used a full size template to locate the holes for center punching. At the very least, hand draw a layout on graph paper before proceeding to make sure everything fits. All holes were drilled with a selection of Uni-Bits at slow speed in a drill press. I used a

thick pine board underneath the part being drilled to provide backup for the bit and reduce chattering. The enclosure is made from some 1" thick curly maple, miter jointed and finished with natural color stain. I recessed the chassis plates flush using a Bridgeport mill. The bottom plate is .045" thick aluminum. Having the amp assembled to the top plate makes modifications and testing much easier than having to fish around inside a box. I used an acrylic metallic green spray paint for finishing. It's a nice color and dries quickly, unlike the Hammerite I used on the SV572 amps. I can't wait a month for the paint to fully cure before I bolt anything to the plate. Wiring was completed on a few terminal strips attached near the tube sockets.



Parts

For parts selection on this amp I used commonly available parts from Mouser Electronics, Triode Electronics, and Digi-Key. I used HEXFRED diodes in the power supply with LCR multi-section caps, a really old Thordarson choke (something the ST-35) never had, Xicon carbon film resistors, Xicon metallized polypropylene caps, vintage 22 ga. cloth covered solid core wire, and some other miscellaneous parts from Antique Electronic Supply. Tubes are Tesla 12AX7, GE 6C4WA, RCA 0A2, and Svetlana SV83. See the schematic for other possible transformers you can use to build this amp.

Measurements

Power output at clipping is about 7.5W and the input sensitivity for full output is .71V RMS. Bandwidth at full power is -3dB at 23Hz and well past 20kHz. The THD of the amp is well under 1% THD until clipping. 1000Hz square waves looked really good. The output stage biases at -4V on the cathodes of the SV83s, using a 75 ohm, 10W resistor and a low ESR Panasonic bypass cap. Each SV83 is running at about 380V and 25mA, for a little over 9 watts plate dissipation. This should assure long life for the tubes.

Listening Impressions

So how does it sound? Great!! This amp is far above my original SCA-35. The sound is very clean and detailed, without the harsh grit and grain I'm used to in push-pull amps with lots of feedback and solid state rectifiers. Bass is tight and the highs are nicely extended. The HEXFRED diodes and choke really give the amp the sound of a tube rectified supply, but without the extra heat and complexity. On my horn speakers, the amp doesn't have quite the "life" of my SV572-10 amps, but the sound is still excellent.

Final Thoughts

Overall, I am very happy with the amp. It will make a fantastic addition to a small bedroom or office system, or as I have it, as a rig for the basement workshop, where it is used for quite a few hours a day. As the amp uses common tubes that are widely available and inexpensive, I don't worry about burning up precious NOS tubes. I can retube the amp for under $30. The builder also has a wide variety of transformers available in case there isn't a spare SCA-35 sitting around. Hammond makes power transformers, chokes, and output transformers that can be utilized with good results, and Magnequest makes an exact reproduction of the Z-565 Dynaco output transformer. See the schematic for these notes.

Chris Beck is a manufacturing engineer for Gardner Bender, Milwaukee, WI. He graduated from Embry-Riddle Aeronautical University with a Bachelor of Science in Aeronautical Engineering. His system includes a Stan Warren modified Sony CD player, AR ES-1 TT with Mayware arm and Shure M97xE cartridge, homebrew Ultrapath preamp with a Steve Bench designed phono stage. Speakers are an Edgarhorn System 100 with biamped subwoofers, and custom vacuformed ABS 300Hz round mid horns.

Thanks to Tom McNally for providing the original Dyna ST-35 schematic and to Eric Barbour of Svetlana for technical help and advice throughout this project.

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?

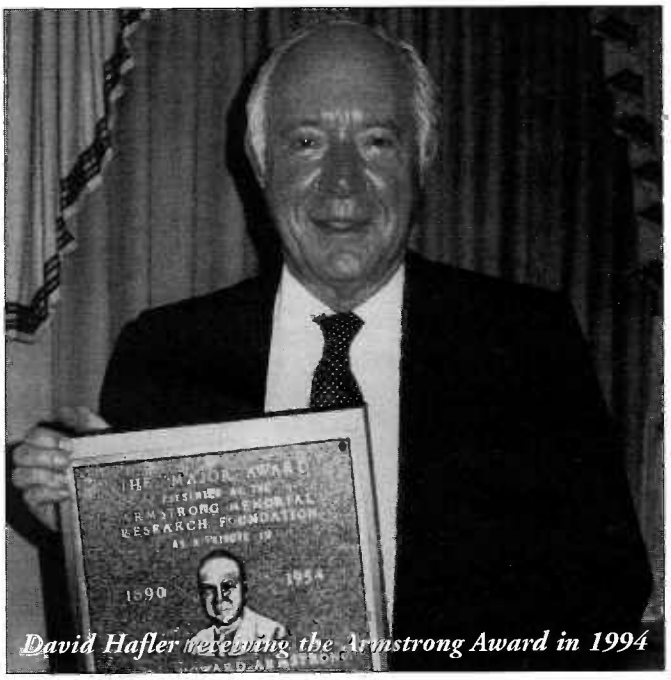
Yes, bass reflex, of course, and they had this bass boosting function. They were used with a Bogen PA system and it sounded magnificent. They had only the one FM station in Philadelphia at that time which was mostly experimental. But I had never heard anything sound that good, except the real thing.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



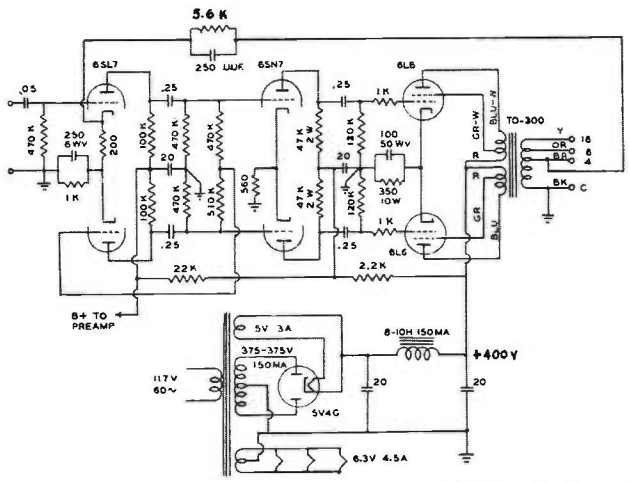
David Hafler receiving the Armstrong Award in 1994

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.

T0-270

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.

T0-335

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, 6L6
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

Direct Reactance Drive Amplifier

Driver with Emphasized Detail

By Jack Elliano

This is another one of Jack Elliano's innovative circuits. As VTV Technical Editor, I can't always agree with Jack's physical explanations for his designs. However, I am leaving them here in their original state for VTV readers to ponder. His amps sound very good, though.
John Atwood, Technical Editor

This circuit was designed and submitted to VTV in June 1999.

Introduction and Theoretical Discussion

In the infancy of tube amplification, the direct coupling arrangement was introduced with the Loftin-White amplifier. Word was that it saved the cost of a capacitor. Many direct coupled circuits have been published since then, even one with a gas regulator tube as a voltage offset coupler between stages. This used argon or neon gas in the audio path. It can't be too bad, you can already hear nitrogen and oxygen wriggling around in front of your speakers.

The standards are set by the conventional amplifier circuits such as input sensitivity, tube types, output load impedances and acceptable distortion measurements. But where are the standards for low level amplification and amplitude linearity? If the amplification of low level detail was ever written about, I've never seen it. Low level detail is what is lost with most conventional circuitry. One example is that mylar-based dielectric capacitors have an electrostatic barrier or a low voltage level, where charge and discharge cannot happen. It may be due to the dielectric material and conductor electron transfer. These types of capacitors have difficulty transferring voltage variations of levels less than .1 volts. Paper based dielectric capacitors can have a smaller dielectric constant and can pass more minute voltage variation.

Another example of design problems is the improper selection of tube amplification factors within the circuit of an amplifier. The transfer characteristics and operating points of each tube can lower sonic detail due to the nonlinearity of amplification at different grid signal levels. The detail is still there, but not at the same level as the rest of the signal, so it may be inaudible.

A typical push-pull amplifier, whether operated in class A or B, when played at extreme low output levels, will lose detail. This is due to the current movement from zero flux at crossover of the core materials nonlinear operation at this level (bottom of BH curve). In comparison, a single-ended core will not distort as long as it is operated well below saturation. The low level detail is now only encumbered by the coupling efficiency of the design. With the flux resting at the linear portion of the BH curve, the signal appears as imposed oval movements.

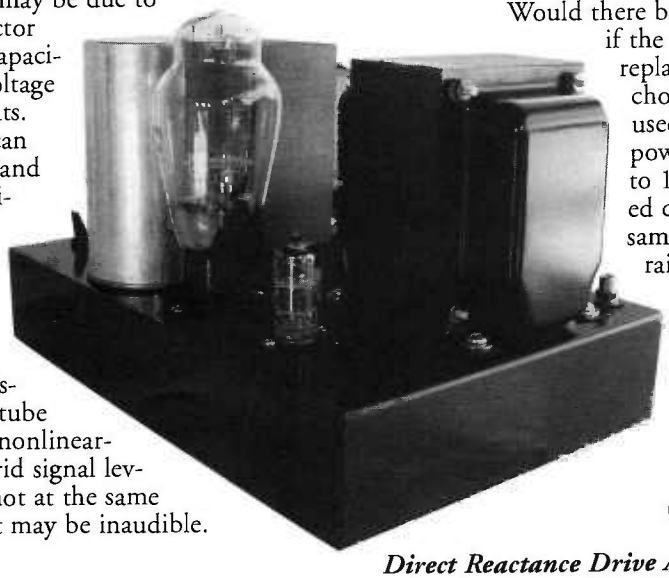
Direct Reactance Amplifier Design

The amplifier circuit we are presenting here not only adheres to the top standards, but is a combination of direct and impedance coupling. In addition, attention is given to the amplification of low level portions of the signal. In order to achieve detailed amplification, the design must have a minimum parts count and coupling devices have to be low-loss. The first thing to do now is to select a driver tube that has a gain of 40 or better and a low enough plate resistance so we have no Miller Effect problems. This tube must also have the ability to drive a 300B grid. The Western Electric 417A came to mind first. This coupled to a 300B added up to a fair arrangement. The conventional direct coupled circuit with an Ultrapath-type output stage (explanation later) was built on a breadboard. With the use of a few adjustable power supply sources, the circuit began to develop.

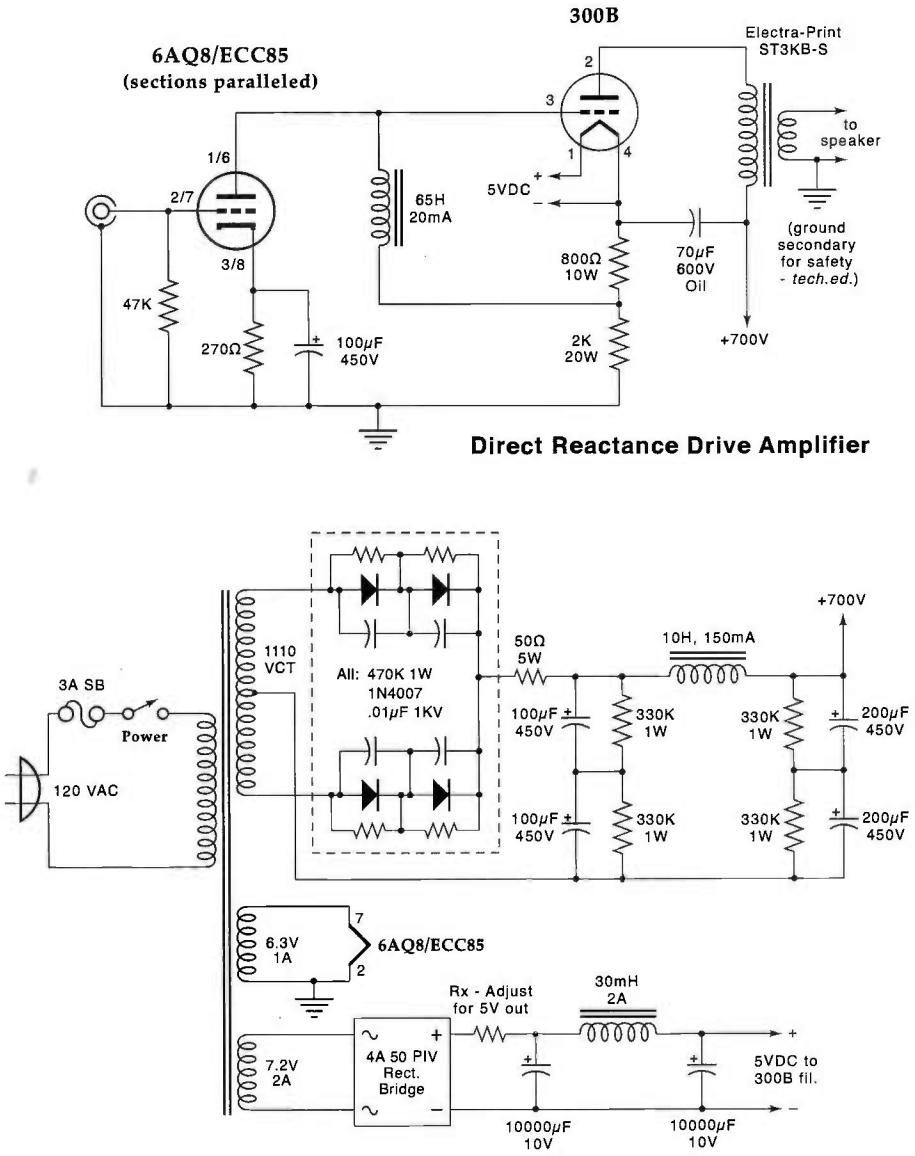
In direct-coupled circuitry, a common resistor, from driver plate and output grid, is usually used. This arrangement has only to deal with the Miller Effect of the output tube and is relatively free of problems. This new circuit was used to drive a cathode follower output. It was developed for Edgarhorn Speakers and Euphonos audio power amplifiers. High driver outputs were obtained with this type of coupling. The cathode followers needed this.

Would there be an increase in efficiency if the common resistor was replaced with a reactor or plate choke and no capacitor was used? In this amp, the output power increased from 6 watts to 13 watts with the readjusted driver plate voltage the same as before. Well, that raised a few eyebrows. We were pleased with our new, simple and efficient amplifier, but what made this happen and why did the choke do this?

Back to the books again to dust off the synapses (neuron interconnects to



Direct Reactance Drive Amplifier



Direct Reactance Drive Amplifier

you guys on the East coast). In circuits containing only reactance, no energy is consumed. Reactance is the expression of the opposing effect of the voltage generated from self induction. Self induction is the opposition to a change in the value of current. Also, the higher the frequency, the greater the reactance, since the greater the change of current, the more opposition the coil offers to the change. An analogy is like feeding a baby something it hates--he spits it out at the same rate you shovel it in. This acts as a constant-current device or an infinite impedance, very much like a Mu stage. The efficiency also comes from having the driver plate voltage stay relatively stable when working into an infinite impedance. The reactor we chose was 65H, 20mA DC. We trimmed it with 80% nickel laminations to bring up the inductance at low levels. The static inductance went up to 100H. It appears that this added inductance rapidly disappears as signal level is increased. The effect, indicated by the few experimenters that have used nickel core material, resulted in a blending of the music. This is still under experimentation and investigation.

This arrangement, so far, is very efficient with no voltage level barriers, interworking with operating points or nonlinear inductors (inductors with no current passing) and direct coupling. It can't get better than that! For the driver tube, 6AQ8 was thrown at me, and I caught it. The tube thrower said "use this, it has a gain of 57 and, if paralleled, it will offer a low drive source impedance." This stuff does go on here - really! The tube improved the sensitivity, about 1.4V to full output, and lowered the distortion to .75%. Lower cost, more abundant source of glass and life is wonderful!

OK, OK the Ultrapath output stage, why? (see "The Ultrapath Line Amp," VTV issue #10, p.11) Answer, this is about detail and the same theory here is even more important due to the higher value resistance on the output tube cathode from ground. Returning the signal path from the transformer to the cathode instead of the power supply to the cathode will offer better detail. Maximum coupling of all variations is accomplished. The set of resistors at the 300B cathode is a combination of its bias and the voltage divider for the 6AQ8. This arrangement offers a handshake of all components so they all ride together with external voltage variations. Since the 300B is in class A, current variation is minimum.

The power supply is diode rectified. Yes, I know this is a no-no, but in this case, no audio passes through the power supply. Why run the electric bill up with a tube rectifier? The large caps on the output side of the filter offer good storage and stability. The in-rush voltage upon power-up will cancel across the warming 300B due to the charging of the cathode return cap. This circuit is as conventional as they get, and regulation is not needed. Regulation is, in essence, an "anti amplifier" and must have voltage error present to work. The error RC lag can affect the lower frequency that may appear at the power supply, as in other types of circuitry.

The output transformer, a ST3KB-S, is the latest model developed for Euphonos Audio Group, except for one item: the secondaries are wound with *pure silver wire.* This is most important, we think, as a detail enhancement. Silver wire, as far as we understand, is much more sensitive to flux variations than copper wire. A silver wire secondary, being the receiver of the variations given by the primary, will create current from lower levels unlike copper. Also, as far as we understand, the atomic reason for this is that the silver atom has two more outer shells or electron orbits with 18 more electrons than copper wire. The electrons furthest from the nucleus will have the most energy and therefore need the least amount of energy to be moved. Electrons moved by a magnetic field act like gyros when they are moved. Demonstrations of Hall effect devices made from silver and copper conductors will show differences in current. A silver wire primary winding also offers better efficiency as the transmitter, as its field intensity may be stronger than copper wire with the same current. It is a fact that even running a current through a beer can will generate a magnetic field. So for practical reasons, we will limit this component to just silver secondaries.

Results Are In!

The measurement results were, 13 watts full output, 1.4v input, frequency response was limited with the output transformer to about -1dB 10Hz to 40kHz and distortion at mid-power was .5%. The total of all improvements within this amplifier to enhance detail will not be heard if speakers with efficiency less than 98 dB SPL are used. It all has to do with the air wrigglers you own. The more efficient the speaker, the better the detail. We have used the Edgarhorn (105dB/w) exclusively for years and found them to be the most revealing of the good, bad, and the ugly that we've heard. The detail with the Ultrapath line amp supplying the signal was most noted with the high end and the extreme low end. The music came from pure black with the sound of the studio noise floor. We heard the movement of feet, charts and coughs. Believe it or not, it appeared to give us the ability to examine the recording at a level such that, we were not listening to the music anymore. All that were present at the audition of the amp agreed that it did not matter, and that any emphasis of detail is welcome. Maybe one step more to realism has been accomplished. Real live sound can have some unpleasantness to it. I once heard a live singer belch.

The photo shows this amplifier built as a monoblock to convey its simplicity. To avoid interaction with common cathode returns, we recommend building this amp as a monoblock. We invite you to build these for yourself for your listening pleasure.

Jack Elliano is an audio designer and owns Electra-Print Audio, a custom audio transformer builder located in Las Vegas, Nevada (702) 396-4909

Jolida JD-603A CD Player

CD Player with a Glass Heart

By David Bardes

If you are of the opinion that all CD players sound the same, my guess is that you are only auditioning these players at the chain stores, or you don't yet have the right gear in your listening room. CD players can and do sound different. And the differences are not subtle!

This review was originally going to be a small round-up, giving us a chance to listen to several CD players with tube analog sections. Unfortunately, the other brands we requested to review never rolled in, so I won't be able to give you an idea of their relative sound. This also left me with the puzzle of what to compare this player to. Enter my own CD player, the Marantz CD-63 SE. I thought I was being extravagant when I purchased it several years ago at $400. It sounded better than other CD players I auditioned, even a few that cost a couple hundred bucks more.

Not being able to leave well enough alone, the cover was soon removed and a lot of stock parts were replaced with shiny audiophile parts. A quick look at the specs showed that my Marantz performed better on the test bench with dynamic range and signal to noise ratings much higher than the Jolida. Yes, I was confident that my hot-rodded player would give the Jolida a tough time.

The JD-603A is a smart looking center-drawer, single CD player that comes in a dark gray case with silver buttons and a multi-colored fluorescent display. Several well considered features make this player a pleasure to operate. I liked the front-mounted, separate volume pots for the

Jolida JD603A Specifications (supplied by manufacturer)

Sampling Frequency: 44.1KHz

Frequency Response: +/- 0.1dB, 20Hz to 20Khz

Signal to Noise Ratio: Better Than 90dB

Dynamic Range: Better Than 85dB

THD+N Distortion: Less than 0.1%

Channel Separation: Better Than 80dB (1KHz)

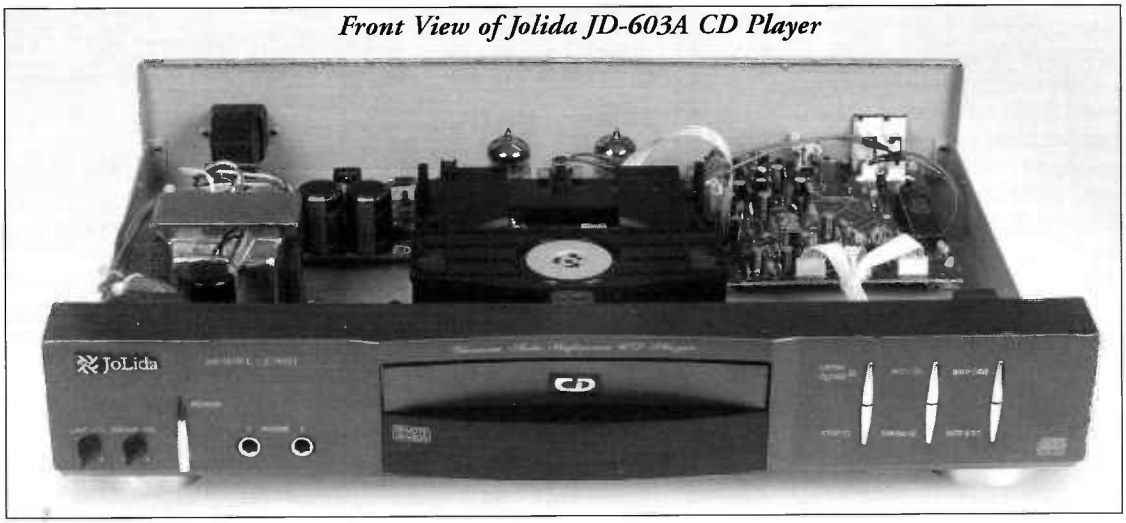
Line Output Voltage: Greater Than 2V +/- 1 dB

Power Consumption: 20 Watts

Price: $550 USD Plus Applicable Tax and Shipping

Jolida, Inc.,
10820 Guilford Road
Annapolis Junction, MD 20701
(301) 953-2014 Phone (301) 498-0554 FAX

Front View of Jolida JD-603A CD Player

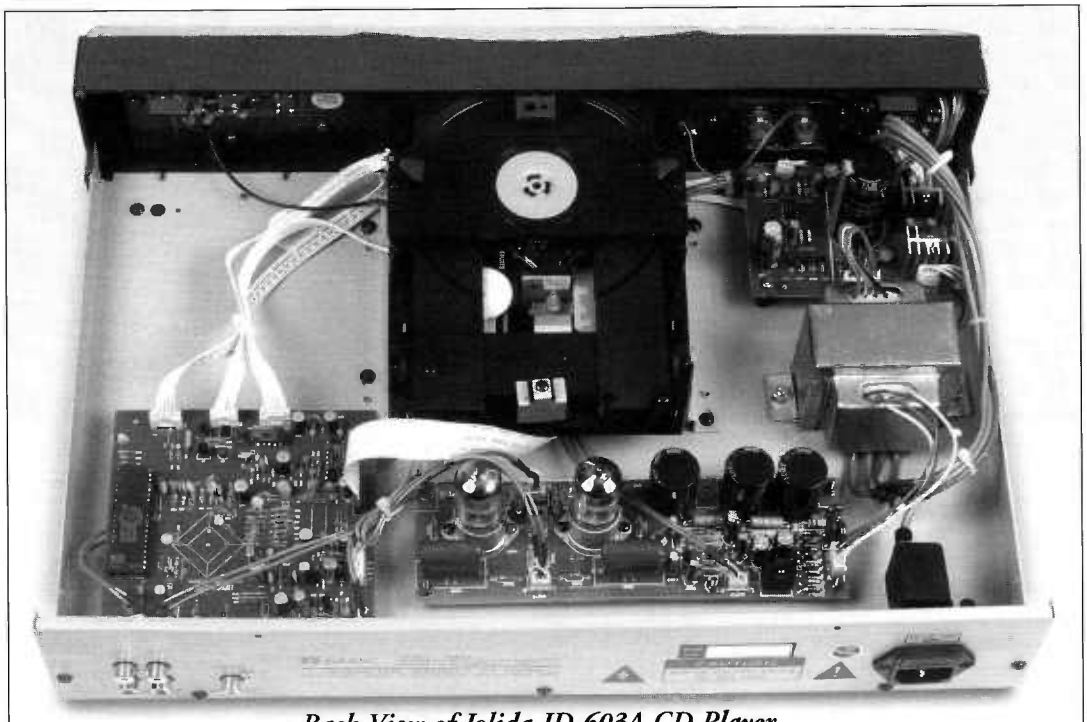


headphone jacks (2 jacks! also front mounted), and RCA outputs for those folks who have a CD only system. A second set of RCA outputs are included that bypass the volume control as well. Both coax and toslink optical outs complete the back panel. A remote control is also included. If I were to change anything about the usability of this CD player, it would be to make the display size a little larger. It's difficult to read from across the room. A peek under the hood revealed a roomy and well laid out interior. Separate circuit boards for digital, analog, and control functions surrounded the center mounted Sony transport. Positioned under the vents in the top piece were two shielded Chinese-manufactured 12AX7s. The output section had its own voltage regulation stage. In addition, the 12AX7s were actually used as a gain stage directly to the output and not as a tube buffer stage like some competitive models. The digital board used a high quality Philips chip set. A couple of large high- quality coupling caps were also present in the analog stage. The chassis construction was nothing special, and no braces or attempts at vibration damping were evident.

The sound? Well, the Jolida ate my CD player for lunch! Crestfallen, I listened to a much larger soundstage, smoother mids and cleaner highs, and just plain more music coming through the speakers. I consoled myself with the belief that at least my CD player had better bass, what with those "so-big-I-had-to-mount-them-sideways" PS caps I'd installed. Then I replaced the Chinese X7s with some JAN/Philips ECG 12AX7s in the Jolida and the big bass advantage disappeared. I wish now that I had done some more tube rolling, but even with the stock Chinese tubes installed, the Jolida was clearly more musical. It is also apparent that the quality and choice of tubes also has a big effect. Those Jan/Philips ECG tubes sounded bigger and more dynamic than the Chinese tubes.

Extended listening found little to complain about. At times I did hear some hum, including one headphone listening session, but I think this was other gear in my system. Perhaps the Jolida might be a bit sensitive to hum. In any event, the Jolida always sounded relaxed and articulate. When I switched my player back in, the music was gritty and strained.

It is my hope that the Jolida JD-603A is representative of tube CD players, and that if well designed, they will out perform those similarly priced players armed only with op amp output sections. I have recovered from my wounded pride, and it is with reluctance that I return the Jolida, but I do have a new item on my Christmas list!



Back View of Jolida JD-603A CD Player

Internet Lies and Other Hype

An Editorial Opinion

By Eric Barbour

Why do people use the Internet? Because it can, indeed, be a valuable tool for finding information. However, we have had so many of the Internet's limitations pointed out to us, that we felt our readers should be warned.

Chat Lines and Other Mediums for Misinformation

The major concern is the "advice" passed out to novices in public chat areas. This includes the old Usenet newsgroups (rec.audio.tubes and alt.guitar.amps being two that relate to tube audio directly), some private bulletin boards on websites (such as Audio Asylum, Enjoy The Music, the Fender Discussion Board), and private mailing lists or "reflectors," which are like bulk-email remailers. All of these forums tend to be unstructured, unmoderated and "free," except by mutual agreement of their users.

Seriously, though, beware of any advice you get from the malingerers on such forums! We have seen outright garbage, and even blatant sales pitches, posted as responses to user questions. "Free advice" usually involves hidden costs. The problem is one of human nature, not of the medium's structure. As I discovered many years ago, all you do is put up a public computer chat room, and it starts to attract a broad range of personalities. Unfortunately, a small number of the "alpha males" inevitably hijack the chat room, and force the other users out, or have them serve as sycophants to their own egos. I have seen this happen so many times that I've lost count.

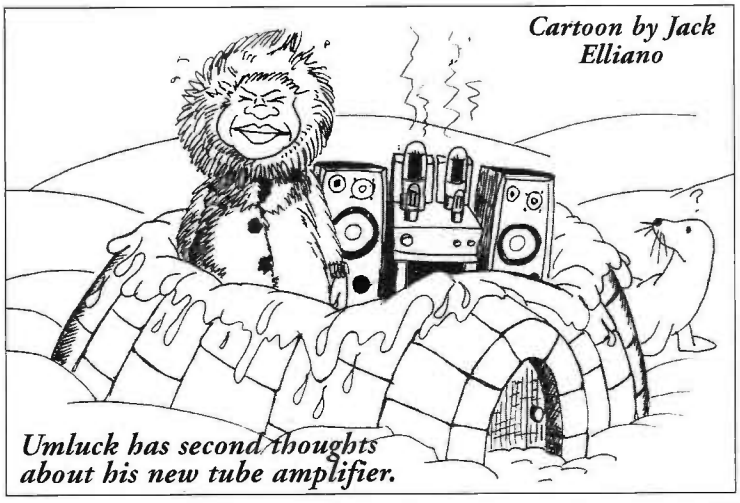
Before the Internet was opened to the public, I observed the same behavior (and was a victim of it) on local private BBSes put up by computer hobbyists. The Internet has simply displaced those BBSes, and become the leading digital sewer for irrational behavior. Look at any such chat area. Regardless of the subject matter or the type of format used, if the area is popular, it becomes a haven for a few sick minds. Inevitably, the bulk of the message traffic is generated by the same hard core of aggressive nerds, hiding behind their computer screens. Always male, usually white, usually between the ages of 25 and 55, and usually numbering only five to fifteen individuals.

Something about a chat area for a hobby seems to bring out the alleged experts: the "legends in their own minds." Because rec.audio.tubes is popular, it has been hopelessly poisoned by idiotic banter between rival factions, with their violent intolerance of outside opinions. These guys seem to be full of advice and opinions, which in many cases is incorrect. I don't have to name any names; just access the recent messages and sort them by poster name. You will find that 90% of the messages came from the same few infantiles. Guitar-amp forums have a few hardcores who, coincidentally, just happen to be highly-opinionated service technicians or parts dealers trolling for business. Call any of them on their blatant self-promotion, and you'd better have an asbestos suit. Not only will they "flame" you back, they will have a few supporters to help them out.

Mailing lists enjoy all this, and more, because membership usually requires the approval of the list owner. The famous "Joenet" mailing list, being very private, has managed to purge itself of all second opinions, leaving a few bratty regulars free to snivel to each other about how they found God by listening to their crude single-ended amps and junkyard horn speakers. On top of that, they actively flog their products to each other and to the unsuspecting novices. (Yes, many of them are OEMs with products to sell.) Ask some of these fellows about a competing product and they will call it "grainy sounding" or "rolled off." (Most novices or "newbies" to tubes are not always aware of this and get sucked into the hype.)

It's even worse on two other mail lists I watch regularly, which deal with analog music synthesizers: Analogue Heaven and Synth-DIY. Say anything on these about vacuum tubes, and watch certain equipment-manufacturer-cum-list-regulars fall all over themselves to criticize you and attack you. Same thing: a few dorks have hijacked these "free" forums, and are squelching all discussion that they disagree with. (For some pathetic reason, these particular lists have come to regard vacuum tubes as nothing but overpriced distortion generators--thanks to the presence of a few old-fart engineers with big egos.) Analogue Heaven has attracted lots of attention; yet I don't know any prominent electronic-music people who can stand to read it. All of them seem to have subscribed to it in the past, and found the maunderings of the resident nerds too much to take.

Sound familiar? It reminds me of a nature documentary about gorillas. The dominant male ape screams, slaps, bites, and hurls dung and rocks. If he keeps it up (and isn't challenged effectively by another ape), he gets the best bananas and the right to mate with all the females. The other male apes are reduced to second-class status.



Cartoon by Jack Elliano

Umluck has second thoughts about his new tube amplifier.

Watch Out! The Cookie Monster Will Get You

A major reason Netscape became such a big deal when it went public: their browser was the first to offer advertisers such "features" as cookies and animated GIF playback. This opened the door to aggressive firms wishing to use websites for banner advertising, involuntary marketing surveys, and research. Cookies are small packages of text information about you, which the browser program maintains on your hard disk at the direction of a given website. A cookie can be very privacy-invasive, especially when combined with "client-side scripting," which allows the website-viewer's computer to run a special program in the background, invisibly to the user. (This is usually in JavaScript, the most common form.) Such a script can rummage around on the computer's hard disk, looking for personal information. Most likely, this is the base reason for the investment-community hysteria surrounding the Internet today.

Remember, there are dot-coms whose business models depend upon surreptitious gathering of personal information by these means. Such methods were being used by DoubleClick and Real Networks (the former via scripts and cookies, the latter via special code buried in their RealPlayer multimedia plug-in) until their "harvesting" of personal information was uncovered by privacy experts. And those may not be the only examples.

It can be difficult to catch such "data mining" in action, since cookies are so often used to hold information such as passwords or other data. Plus, the mined information may be encrypted before it is sent to the harvester's server. Every time you buy something or fill out a form on a website, the seller is probably building a database. This database, being in easily-read formats, can be marketed to other firms, or to government agencies. All this happens without any signal or warning to you! The only way to use many commercial websites, while maintaining your personal privacy, is not to use those websites at all. You might also support some of the websites dedicated to online privacy, including www.anonymizer.com, www.zeroknowledge.com, and www.freedom.net.

Suggestions for intelligent use of the Internet and protecting your personal privacy:

1) Novices who ask for advice or technical help in a public chat areas should ***always get second and third opinions!***

2) ***Beware of chat area malingerers,*** they often do not know what they are talking about. Check the past messages on the area-- most people who post lots of messages per week should be avoided. Incorrect "advice" from these geeks has caused people to make purchases they later regretted or caused tube equipment to be damaged!

3) Do not patronize OEMs and their cyber comrades who hype their favorite products by consistently badmouthing competitors on public newsgroups and chat areas. Such areas are typically a medium for the free expression of individual opinions and not a collective for commercial propagandists siding with certain OEMs.

4) ***Go to the "preferences" menu on your web browser, and disable cookies,*** Javascript, and other client-side script controls. If a website demands a cookie or Javascript to function, avoid that website. Also, avoid websites that use proprietary multimedia software, such as RealAudio or RealVideo. Real's software is VERY intrusive.

5) ***Never respond to or buy anything from spam emails*** or unsolicited email offers for products or services. There are thousands of scam artists on the Internet who are trolling for suckers to rip off. Giving out your personal address and credit information blindly is asking for trouble.

6) ***Avoid filling out forms or surveys on websites.*** Never leave your personal information on public chat areas or newsgroups.

Dot Cons and other Flim-Flam Schemes

A major reason that Internet hype has been so effective: many assertions by "visionaries" that online shopping will put all "brick and mortar" retail establishments out of business. Such hallucinations are based on the idea that a dot-com can have its warehousing and order fulfillment anywhere, thus lowering overhead, and allowing them to undercut the prices which storefront retailers must charge. How many average people are going to change their habits, and let an online grocer choose their produce for them? Or buy a car online, based only on grainy JPEG photos of it? Online shopping can be a boon for shut-ins and the disabled, but it's still nothing more than electronic catalog shopping. The retailer gets to save the cost of printing and mailing catalogs, yet he still can't demonstrate the product to the customer in person.

dot-snot.com

I live in Redwood City, the heart of dot-country. You have to personally witness the asinine behavior of people in the dot-com business to understand the face of real, uncontrolled human arrogance. Go to any restaurant on the San Francisco peninsula during weekday lunch hour, and watch the yuppies shout at each other, wave cell-phones around, complain to the staff, leave a mess, and finally roar away in their huge SUVs, which are always driven as aggressively as possible. And worst of all, these dot snots think the good times will roll forever.

Why don't I get in on the dot-com "gravy train"? The only people who really make money during these "gold rushes" are the insiders. Because I did not go to Stanford or an Ivy League university, and because I do not play racquetball with the "right people," I am not entitled to a piece of the riches. Most likely, neither are you. Don't believe all those vulgar stories about instant IPO millionaires; they are still a tiny minority of the computer-industry population. They went to the right schools and knew the right people, that's all. Most high-tech startups will be failures--even the dot-com variety.

So, if you have your 401K or IRA invested in an Internet-heavy mutual fund, it's time to reconsider your investment strategy. The Internet will be around for a while, but it is going to look a whole lot different in the next few years. And, lots of venture capitalists are going to have egg on their faces! (*This is already happening! Editor*)

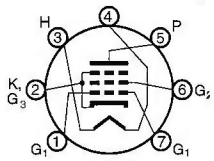
Tube Dumpster

7 Pin Power Pentodes

By John Atwood

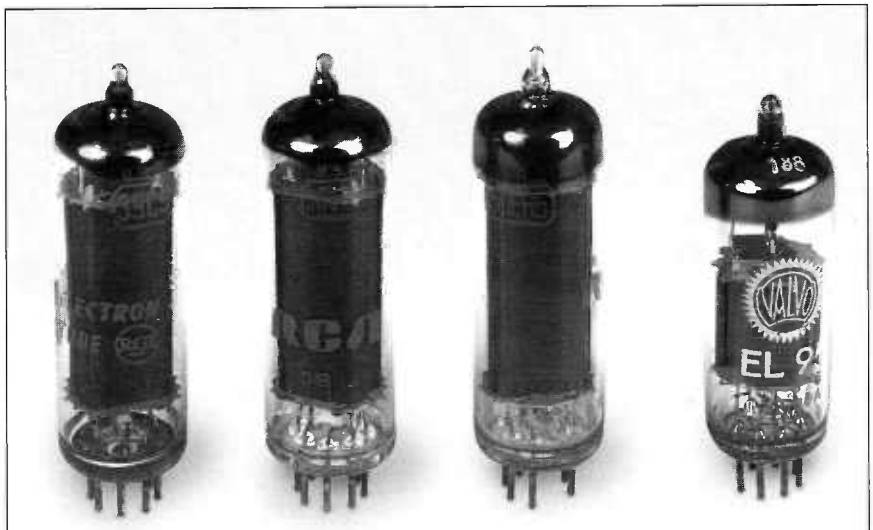
The 7-pin miniature tube was introduced by RCA in 1940 as a series of battery-types for portable radios. During World War 2 the family of 7-pin miniature tubes was expanded to include both miniature versions of conventional octal types (0A2, 2D21, 6AK6, 6AL5, 6AQ6, 6C4) and VHF types that took advantage of the small bulb size (6AG5, 6AK5, 6J4, 9001, etc.). Of these, only the 6AK6 was considered a power pentode, but it was really just a low-power receiving pentode with lower gain. Putting a real power tube in a 7-pin miniature envelope was a real challenge - mainly due to the very high bulb temperatures involved. However, RCA, the dominant American tube manufacturer, realized that the consumer market would be huge after the war, and chose to make the miniature tube the standard for post-war designs. It already had a good set of miniatures developed during the war and in October 1945 released the real workhorses of consumer electronics for the next twenty years: the 6AU6, 6BA6, 6BE6, 12AT6, 12BA6, 12BE6, and the 50B5. Of these, the 50B5, derived from the 50L6GT, was the most difficult and short-lived. It packed almost 15 watts of power dissipation (heater, plate, and screen power combined) into an envelope about one third the surface area of the 50L6GT. This resulted in a maximum bulb temperature of almost 200°C above the ambient temperature - more like a high power transmitting tube than a cheap radio tube! The result was an initial reputation for poor reliability due to outgassing, vaporization of the getter, and electrolysis around the leads.

A more serious threat to the 50B5 and the lower-voltage 35B5 was a fire-safety problem discovered by Underwriter's Labs (UL). Consumer radios of the time were not fused, so had to be "fail-safe" in their design to avoid bursting into flames. The 50B5's pin-out (RMA base 7BZ) has both the cathode and plate leads adjacent to the heater leads. A short between leads or a mix-up of tubes in their sockets in an AC-DC radio could lead to an overload and possibly a fire. In designs where the heater is driven directly from the line but the rest of the circuit is isolated, a short would make the chassis "hot," a severe issue in the days before 3-wire cords. Due to these safety issues, these tubes were redesigned in 1948 to put only the grid leads next to the heater (RMA base 7CV), giving us the well-known 50C5 and 35C5. All 7-pin power tetrodes intended for transformerless designs used this new pin-out. The 6AQ5, derived from the 6V6GT, still kept the old 7BZ base, since it was used only in transformer-powered or car radio designs where shorts to the heater had fewer safety consequences.



The reliability problems were solved in classic American style: throw technology at the problem. Better glass and metal-to-glass seals were developed and better processing reduced outgassing. By the early 1950s, miniature power tubes were both safe and reliable. However, by this time 9-pin power tetrodes were becoming available, and most

Type	Base	Ef	If	Pd max	Ep max	tetrode gm	triode mu	Prototype
6AK6	7BK	6.3	0.15	2.75	300	2300	10.5	6G6G
6AQ5/EL90	7BZ	6.3	0.45	11	250	4100	9.5	6V6GT
6AR5	6CC	6.3	0.4	8.5	250	2300	7.6	6K6GT
6CA5	7CV	6.3	1.2	5	130	9200	11.8	
6DS5	7BZ	6.3	0.8	8	250	5800	14.3	
6EH5	7CV	6.3	1.2	5	135	14600	15.8	
6GZ5	7CV	6.3	0.38	4.3	270	8400		
12ED5	7CV	12.6	0.45	5.6	135	8500		
12FX5	7CV	12.6	0.45	5	135	13500	15.6	
25F5	7CV	25	0.15	4.5	135	5800		
32ET5	7CV	32	0.1	5	135	5500		
34GD5	7CV	34.5	0.1	4.5	135	5700	6.8	
35B5	7BZ	35	0.15	4.5	117	5800	6.8	35L6GT
50B5	7BZ	50	0.15	6	135	7500	6.6	50L6GT
50FK5	7CV	50	0.15	4.5	135	12800		
EL91/6AM5	7BD	6.3	0.2	4	250	2600		
EL95/6DL5	7BZ	6.3	0.2	6	300	5000	16.4	
HL94	7CV	30	0.15	7.5	150	9200		



35C5, 34DG5A, 50EH5, EL95

Type	Base	Ef	If	Prototype
6AS5	7CV	6.3	0.8	35C5
6BF5	7BZ	6.3	1.2	50B5
6CU5	7CV	6.3	1.2	50C5
6HG5	7BZ	6.3	0.45	6AQ5
6HR5	7BZ	6.3	0.45	6AQ5
11DS5	7BZ	11.2	0.45	6DS5
12AQ5	7BZ	12.6	0.225	6AQ5
12AS5	7CV	12.6	0.4	6AS5
12C5	7CV	12.6	0.6	50C5
12CU5	7CV	12.6	0.6	50C5
12DM5	7CV	12.6	0.45	50C5
12EH5	7CV	12.6	0.6	6EH5
12R5	7CV	12.6	0.6	50C5
17C5	7CV	16.8	0.45	50C5
17CA5	7CV	16.8	0.45	6CA5
17R5	7CV	16.8	0.45	12R5
19FX5	7CV	18.9	0.3	12FX5
25C5	7CV	25	0.3	50C5
25CA5	7CV	25	0.3	6CA5
25EH5	7CV	25	0.3	6EH5
35C5	7CV	35	0.15	35B5
35EH5	7CV	35	0.15	6EH5
40FR5	7CV	40	0.1	34GD5
50C5	7CV	50	0.15	50B5
50CA5	7CV	50	0.15	6CA5
50EH5	7CV	50	0.15	6EH5
50FA5	7CV	50	0.1	34GD5
50HC6	7FZ	50	0.15	50EH5
50HK6	7FZ	50	0.15	50C5
60FX5	7CV	50	0.1	12FX5
6005	rugged version of			6AQ5
6095	rugged version of			6AQ5
6669	mobile version of			6AQ5
HL90	7BZ	19	0.15	EL90
PL95	7BZ	4.5	0.3	EL95

new hi fi and TV designs used these types. The 7-pin types dominated the radio and portable phonograph areas and also found a home in TV sets as audio output and occasionally as vertical output tubes.

In Europe, the 7-pin types were never as popular as 9-pin types, and were usually copies of American designs. However, two unique power pentodes were developed there: the EL91 and EL95, both somewhat lower power than the American types.

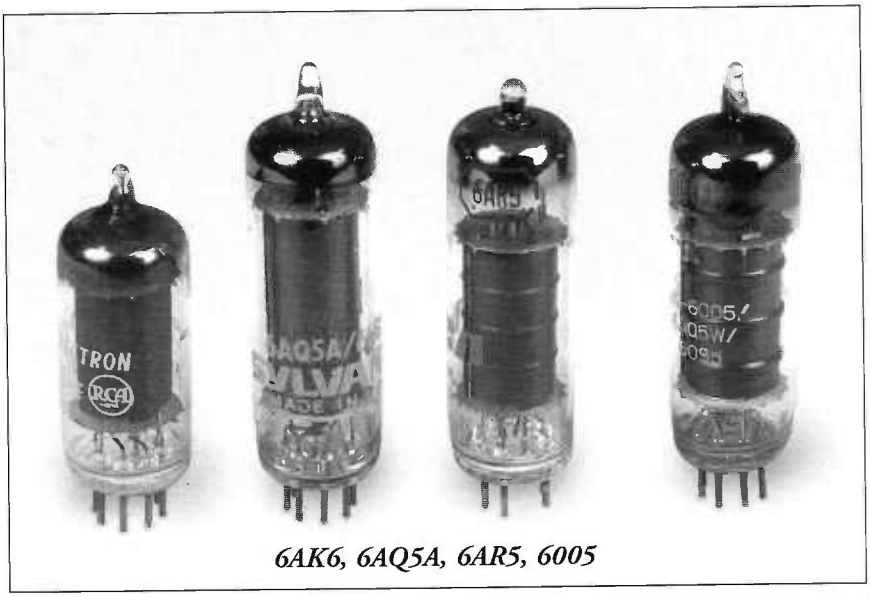
The accompanying tables list the key characteristics of the 7-pin power tetrodes and all the variants from the basic prototypes. Aside from the heater voltage variations, these tubes fall into three major categories: modest performance types derived from octal 6.3V tubes (6AK6, 6AQ5, 6AR5, EL91), derivatives of the low-plate-voltage AC/DC radio tubes (50B5, 6AS5, 25F5, etc.) and later some very high transconductance types (6EH5, 12FX5, 50FK5). The different heater voltages reflect the different heater supply schemes. The 6.3 volt and some of the 12.6 volt tubes were supplied either from car batteries or a transformer. The other types were rated for use in a constant-current series-string arrangement, typically 0.15A for simple radios, 0.3A for larger radios, and 0.45A and 0.6A for television. In the early 1960s, Sylvania brought out 0.1A types that cut 50% off of the heater power of small radios, but these types did not see widespread use.

The triode-connected amplification factor (mu) of 7-pin power tetrodes was measured in the One Electron lab when three or more different samples were available to give statistically valid measurements. The range of measurements were from +/–5% to +/–15% from the average value listed.

So, how can these miniature power tubes be used today? For very low-power amplifiers, the 6AQ5 and 6AR5 are still popular. Transformerless use is discouraged, especially for hi-fi systems where a hot chassis is unacceptable. The easy availability of many of the AC/DC types, especially the 12 and 25 volt tubes, suggest their use with a 12.6 or 25.2 volt filament transformer. For high-quality audio designs, the octal types are recommended over the miniature types, due mainly to lower distortion and higher power ratings.

One of the more productive uses of 7-pin power tetrodes is a triode-connected pass tubes for series voltage regulators. The high perveance of the low-plate voltage types make them well suited for this application. The table lists the triode-connected mu, which can help in the selection of the right tube. The main caution is the low maximum screen-to-cathode voltage, typically 120 volts. In practice, this limit can be somewhat exceeded if the tube is not running at its maximum ratings, but must be kept in mind when designing the regulator.

Was the development of the 7-pin power tubes in the mid-1940s a mistake? The 9-pin novar format is better suited to high-power uses, but was not yet in mass production when the war ended and RCA wanted to miniaturize its tubes. The slight reduction in materials cost was probably not worth the heat and reliability problems first encountered with these tubes. But the decision was made, and a whole generation of American radios and TVs used these little devices.



6AK6, 6AQ5A, 6AR5, 6005

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1. "Tube Lore," Ludwell Sibley, 1996 (available from Antique Electronic Supply).

2. "Reliability Stress and Failure Rate Data for Electronic Equipment," MIL-HDBK-217, 8 August 1962, U.S. Government Printing Office.

3. General Electric Co., "Essential Characteristics," 1974

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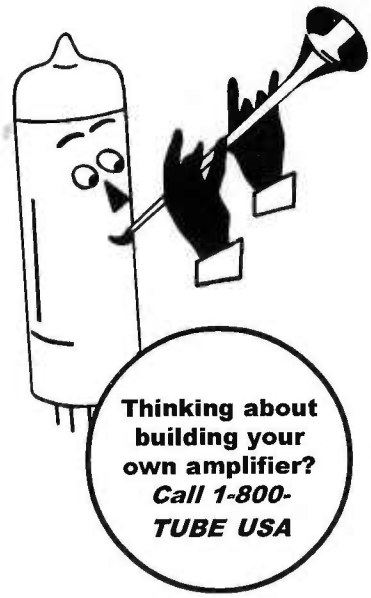

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VTV Corrections:

1. Issue #13, Page 11: The schematic of the Classic 2A3 amplifier should say 330 Volts B+ to the center tap of the output transformer instead of 2.5V.

2. VTV #13, Scott 222 article, Page 16, 1st column, 1st paragraph: The first Scott 222C models used the 7199 as the driver tube, then later switched to the 6GH8 driver tube.

3. VTV #13, Scott 222 article, Page 16, 3rd column, 2nd paragraph: The Scott LK-48 first came with the dark brown colored faceplate. The champagne colored faceplate came later and was never really an option.

4. VTV #13, Scott 222 article, Page17, 1st column, 1st paragraph: The Scott 200, 200B and LK-30 used ECL86/6GW8 as output tubes as opposed the ECL82s that were mentioned in the article.

5. VTV #13, Scott article, Page 16, 2nd column, 2nd paragraph. Later Scott amp chassis had lettering on the chassis to indicate tube placement, etc. It is not recommended that cleaner or polish be used on these chassis as it will remove the lettering.

Thanks to John Byrns of Chicago, Illinois for #2 through 5 above.

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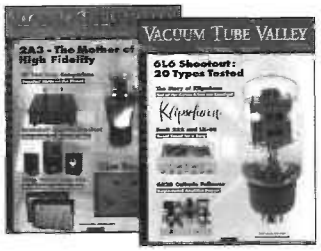

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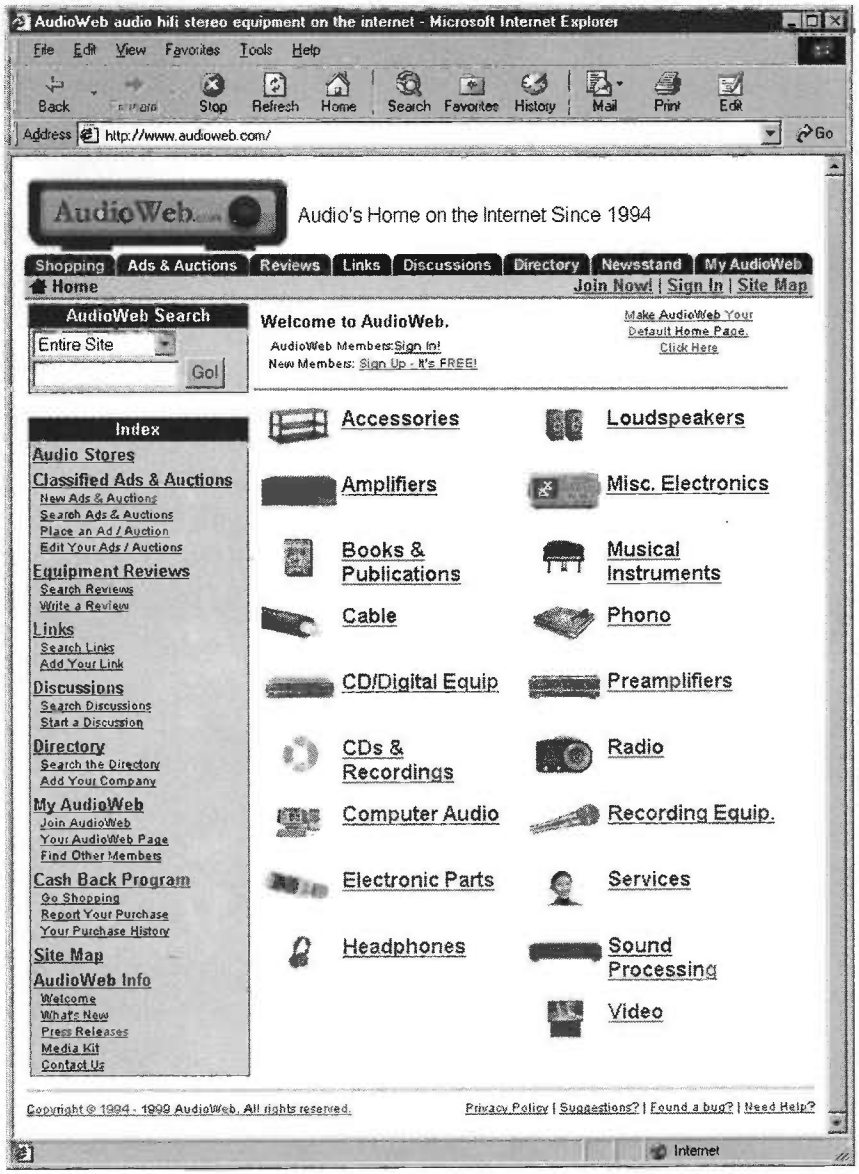

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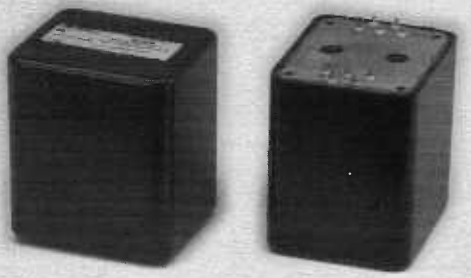

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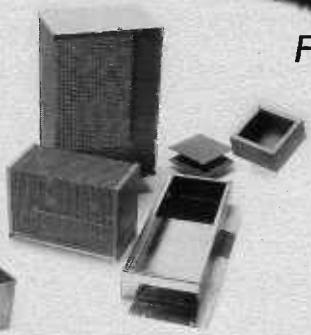

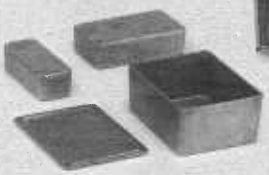

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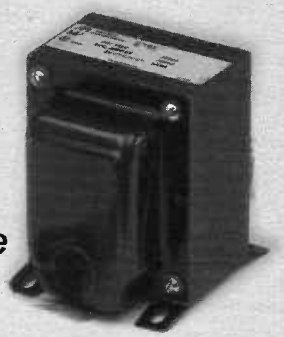

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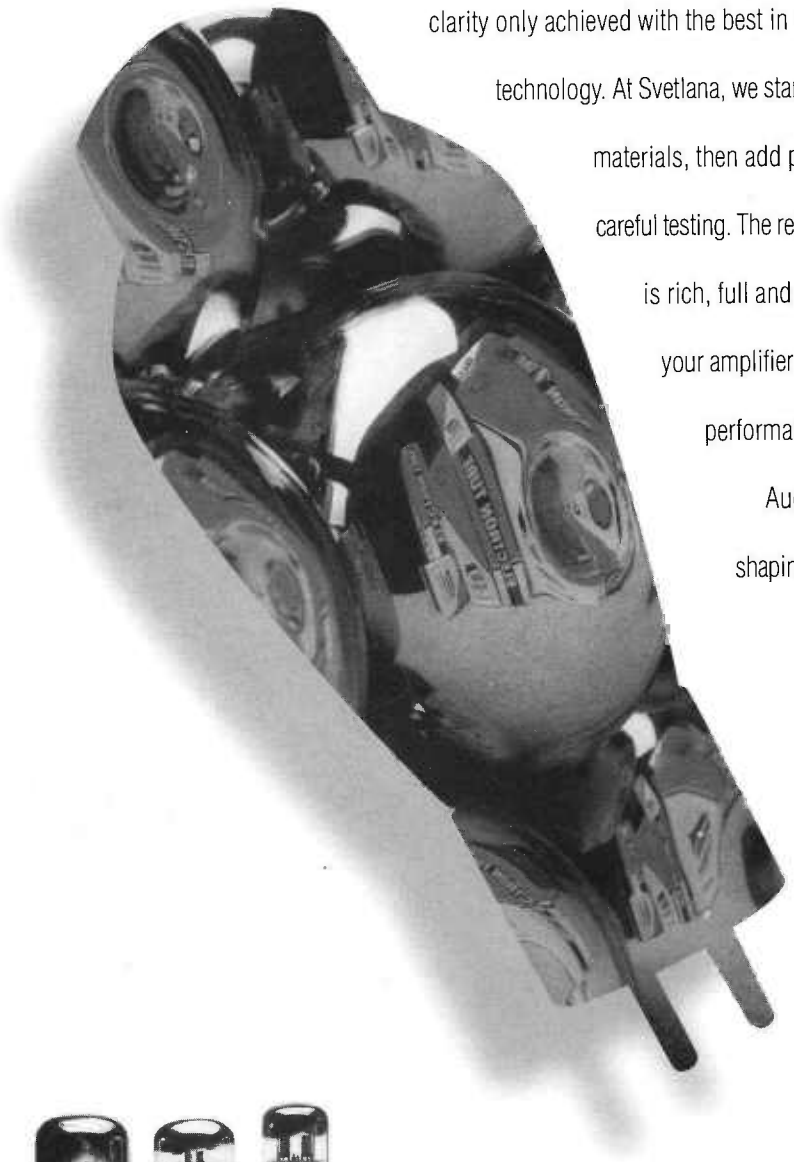

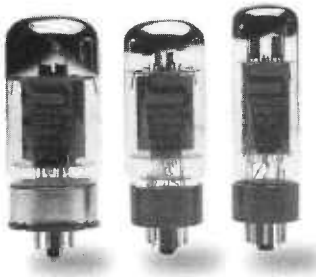

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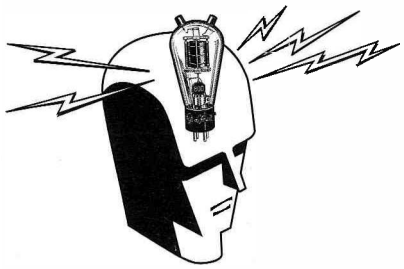

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Vintage Hi-Fi Rebuild Kits

Get Great Sound & Save Bucks!
All kits include all *new* ICMWR signal and bypass film caps, *under-chassis* electrolytics, 1 watt metal oxide low-noise plate resistors, new silicon power supply diodes and schematic. **Kits do not include FP can-type electrolytics.**

Dynaco PAS2/3 $65
Dynaco Mark III $40 (for pair)
Dynaco Mark IV $40 (for pair)
Dynaco SCA-35 $30
Dynaco ST-35 $25
Dynaco ST-70 $35
EICO HF86 $35
EICO HF87, HF89 $60
Fisher X-101, X-202, etc $65
Fisher 400 Receiver $65
Fisher 500C Receiver $75
Fisher 800B, 800C $75
Heathkit W-3M, W-4M $60/pr
Heathkit W-5M $75/pr
McIntosh C-20, C-11, C-22 $100
McIntosh MC30, MC40, MC75 $45 ea
McIntosh MC60 $50 ea
McIntosh MC225, 240 $85
McIntosh MC275 $100
Scott 130 $100
Scott 222, 222B, 222C, D $65
Scott 299, 299B, 299C, D $65

Illinois Capacitors

ICMWR Metallized Polyester (630Vdc rating)

0.001uf	$0.80 ea
0.002uf	$0.80 ea
0.0047uf	$0.80 ea
0.0068uf	$0.80 ea
0.01uf	$0.90 ea
0.022uf	$0.90 ea
0.047uf	$1.00 ea
0.068uf	$1.20 ea
0.1uf	$1.30 ea
0.22uf	$1.60 ea
0.47uf	$2.20 ea
1.0 uf (400V)	$2.50 ea
2.2uf (250V)	$2.75 ea
3.3uf (250V)	$3.20 ea
4.7 uf (250V)	$3.80 ea

Ultra-Tone Silvered Foil in Paper and Oil Capacitors

98% pure silvered foil in kraft paper impregnated with non-toxic mineral oil and petroleum jelly, sealed in epoxy. Silver plated OFC leads with inner foil marked (650Vdc rating)

0.01uf	$14.00ea
0.02uf	$16.00 ea
0.05uf	$18.00ea
0.1uf	$21.00 ea
0.22uf	$32.00 ea
0.47uf	$45.00 ea
1.0uf	$80.00 ea
2.0uf	$110.00 ea

Silver Speaker Crossover Caps with 200VDC Rating

1uf	$45.00 ea
2uf	$75.00 ea
3uf	$95.00 ea
5uf	$145.00 ea

Ultra-Tone Polypropylene Film & Foil Power Supply Capacitors *(Not Silver Foil)*

20uf @ 650V	$25.00 ea
50uf @650V	$45.00 ea
100 uf @650V	$65.00 ea

FREDS (Fast Recovery Diodes)

IXYS 600V 8A	$3.25 ea
IXYS 1200V 11A	$6.50 ea
60V 5 Amp Schottky	$2.00 ea

Illinois Axial Electrolytic Capacitors

Great Value and very dependable.

3.3uf @350V	$1.20 ea
4.7uf @350V	$1.45 ea
10uf@160V	$1.25 ea
10uf @450V	$1.60 ea
22uf@50V	$ .85 ea
22uf @250V	$1.95 ea
22uf @450V	$2.25 ea
22uf @500V	$2.85 ea
47uf @35V	$1.50 ea
47uf @350V	$2.50 ea
47uf @450V	$3.45 ea
100uf@100V	$1.65 ea
100uf @160V	$2.95 ea
100uf @350V	$3.90 ea
100uf @450V	$4.90 ea
2200uf @35V	$2.75 ea

Hovland MusiCaps Polypropylene Foil and Film

High resolution, great-sounding film caps perfect for all types of audio equipment upgrades.

0.01uf @1600V	$9.79 ea
0.022uf@1000V	$9.82 ea
0.033uf @600V	$8.01 ea
0.047uf @1KV	$12.05 ea
0.1uf @600V	$11.52 ea
0.22uf @600V	$14.55 ea
1.00uf @20V	$16.66 ea
2.2uf @200V	$23.83 ea
3.0uf @200V	$28.45 ea

Note: Only the above Hovland values *in stock*.

Tube Sockets

Octal Ceramic Chassis	$3.50
Octal Ceramic PC mt	$3.00
Octal NOS Phenolic	$3.50
9 Pin Ceramic PC	$2.50
9 Pin Ceramic Chassis	$3.00
9 Pin Ceramic GOLD	$5.00
9 Pin Plastic w/shield	$4.00
9 Pin NOS Brn Phenolic	$3.00

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Can Electrolytic Capacitors

20,20,20,20 @475V (Mallory type) $32.00
50+50uf @500V LCR w/clamp $21.50
100,100uf @500V LCR w/clamp $28.00
40,20,20,20uf @500V, LCR w/clamp $32.00

D.H.Labs Silver Sonic Wire

Rated as the best sounding wire for the money by several audio publications.
"This is nothing other than a superb cable. It can be used with confidence with the finest of systems."
Make your own speaker cable & interconnects. Save BIG!!!
Silver Sonic T-14 Speaker Wire $4.00/ft
Silver Sonic BL-1 High Definition Interconnect Wire $3.50/ft
Silver Sonic OFH-20 High Performance Silver/Teflon Chassis Wire $0.95/ft
RCA-2 Gold Tiffany-Style Interconnect Plug $10.95ea
B-1C Gold Banana Plug and Insulator $5.50/pr
BSP Gold Mini Spade Speaker Terminals for Vintage Hi-Fi $1.10 ea

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