

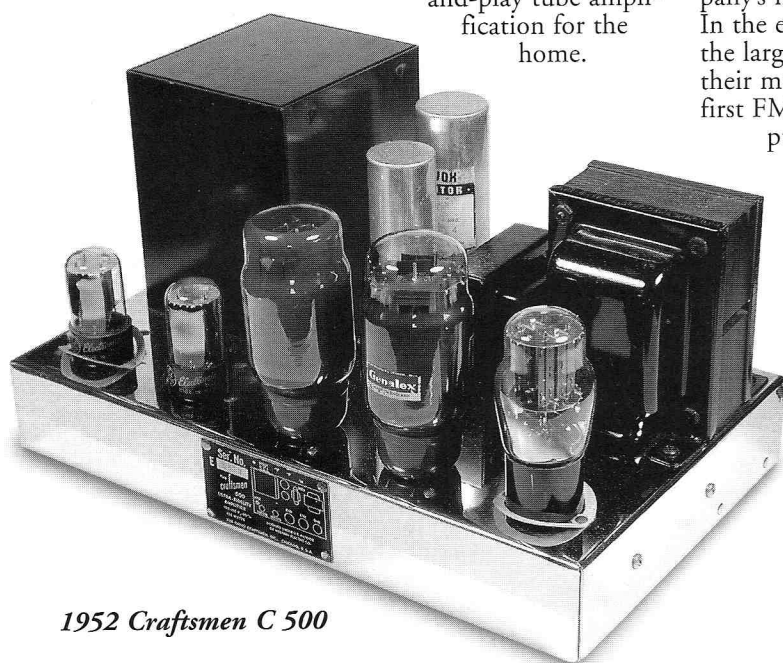
Radio Craftsmen C500 Amplifiers #2 Vintage Hi-Fi Series

By Charlie Kittleson ©2003 All Rights Reserved

In the mid 1940s, many GIs who served in the European Theater experienced live classical and chamber music for the first time in their lives. This created an interest in the finer things in life, such as fine music reproduction in the home. Unfortunately, most home radios and 78 RPM records offered very little in the way of high-fidelity reproduction. Typical radios of that era had type 6F6G, 41 or 42 tubes in a cheap output stage driving a low quality output transformer and a low fidelity 6 to 10-inch electro-dynamic speaker. Most sets had a frequency response of 100 to 5,000Hz--pathetic by today's hi-fi performance standards. Many of the lower quality "high-fidelity" radios and phonographs had cheesy-sounding falsified bass and attenuated highs. And in the 1940s, after two decades of generally higher quality sets, manufacturing standards fell to a new low due to materials scarcity and the advent of "value engineering."

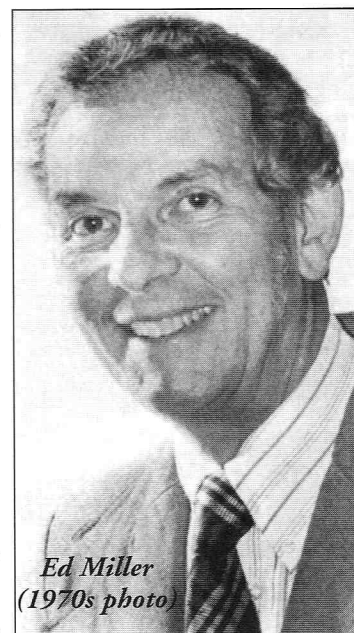
Most existing tube amps were mainly PA grade with low quality output transformers. There were few, if any, high quality tube amplifiers or preamps designed for fine record reproduction. Many music enthusiasts opted to build their own tube amp based on the 1947 D.T.N. Williamson article originally published in *Wireless World*. However, most people did not have the skills or the time for DIY, so a

new market was created for plug-and-play tube amplification for the home.



1952 Craftsmen C 500

The growing home audio market attracted several entrepreneurs such as Avery Fisher, Hermon H. Scott, Harry Ashley (EICO), Frank McIntosh, Saul Marantz and many others. John Cashman, formerly an executive with Hallicrafters Radio Company, saw the opportunity for selling home audio and television equipment and founded Radio Craftsmen in 1947. Cashman located the Craftsmen factory in a two story brick building at 4401 North Ravenswood Ave in North Chicago near the "EL" commuter-train tracks. They were in the same neighborhood as E H Scott Radio Laboratories, the premier radio manufacturer for the elite and wealthy in the 1930s. Also nearby were the Haldorssen and Stancor electrical transformer plants.



Ed Miller
(1970s photo)

Ed Miller was one of the first engineers to work for Craftsmen. Ed received his electrical engineering degree from the University of Cincinnati in 1943 and was a radio hobbyist with a strong interest in FM technology. During his career, he worked for Stewart-Warner, US Navy Ordinance as a laboratory engineer, and in General Electric's research labs. He joined Radio Craftsmen of Chicago, Illinois in 1947 as an electrical engineer. Within a few years, he was promoted to vice president and director of engineering. He was the driving force for the company's manufacture of high-fidelity tuners and amplifiers. In the early-to-mid-1950s, Radio Craftsmen was among the largest producers of FM tuners, with Fisher Radio as their main competition. The RC-1 was Radio Craftsmen's first FM tuner. It, along with the matching 10-watt RC-2 push-pull 6V6 power amplifier, were made on beautifully chrome-plated chassis.

Another famous audio pioneer who worked for Radio Craftsmen was Sid Smith, who did most of the design work on the C 500 amplifiers. Sid went to work for Ed Miller in early 1950 and immediately started working on amplifier and transformer design. In April of 1951, he completed the design of the RC-10 AM/FM tuner preamp which was extremely popular. In addition, he designed the C 400 - 6V6 PP amp, the C 10 am/fm tuner and the 5- watt 6W6 amp designed for use with the chrome-plated Craftsmen TV chassis.

When I interviewed Sid in 1997, he mentioned that he began work on the C 500 amp design in 1951. The goal was to come up with a

design that had stable output with feedback. A significant component of the C 500 was the output transformer design. Sid told me that Herb Keroes of Acrosound taught him how to spec out a transformer for a given circuit. Eventually, the design was finalized and Stancor was chosen to produce the output transformer.

Sid left Radio Craftsmen in 1954 and went to New York to pursue a career as an opera singer. Between rehearsals and performances, he answered a help-wanted ad for a draftsman. It was of course, Saul Marantz who was looking for a draftsman. The rest, as they say, is history. Sid later designed the Marantz Model 2, 5, 8, 8B and 9 amps, Model 3 crossover, Model 6 stereo adapter, and the 7C audio consolette. He was also involved in the design of the fabulous Marantz Model 10 and 10B FM tuners along with Dick Sequerra and Saul Marantz.

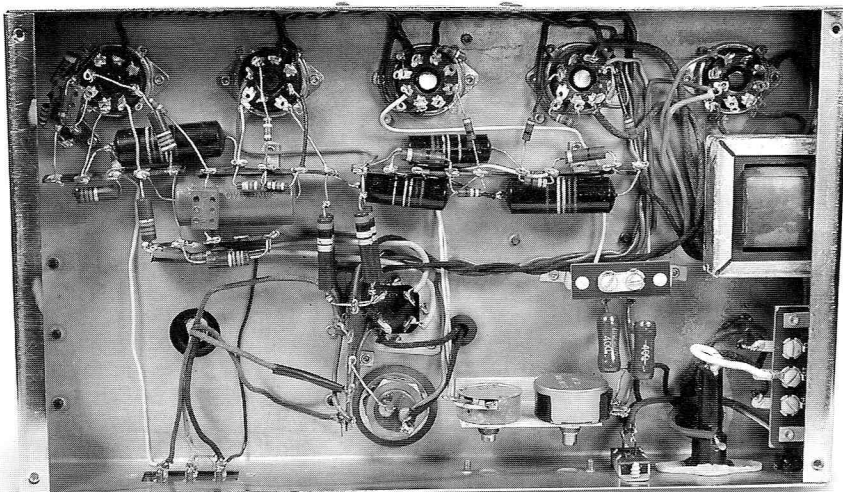
Craftsmen C 500 (\$99 suggested retail)

The first of the larger Craftsmen amps was introduced in late 1951. Dubbed an Ultra-Fidelity Amplifier, the C 500 was a 10-watt RMS, pure Class A Williamson-type design. To quote Craftsmen's original ad copy:

"Ultra-Fidelity is a new concept in audio amplifier performance previously found only in the research laboratory. With an Ultra-Fidelity amplifier, harmonic and other types of distortion either approach the point of vanishing or are truly negligible over the entire range from 20 to 20,000 cps. In order to maintain excellence throughout this range, the complete frequency range of an Ultra-Fidelity amplifier must be considerably wider than the audio range. The Craftsmen 500 amplifier now brings Ultra-Fidelity from the research laboratory to the home.

The use of an Ultra-Fidelity amplifier eliminates completely the audio power amplifier from being a source of distortion in a home music system. In addition to this, an Ultra-Fidelity amplifier, because of its excellent damping characteristics, can reduce transient distortions in the speaker system. These outstanding performance characteristics may be clearly and practically demonstrated to the listener by providing low listening fatigue and by recreating an intangible effect of "presence" approaching concert-hall realism.

The C 500 circuit direct-coupled the first AF stage (one-half of a 6SN7) to a split-load phase inverter (the other triode of the 6SN7) which was RC coupled to a 6SN7 push-pull driver. The driver was RC coupled to a KT66 push-pull output stage. Matched pairs of British



C 500 under chassis

KT66 tubes were used because they had higher triode output capabilities than 807s or 6L6s. They were also chosen because of their lower plate impedance. Feedback was taken from the 16-ohm tap of the output transformer and was fed to the cathode of the first 6SN7 triode through a 68pf capacitor and a 4.7K resistor for approximately 20dB of negative feedback. Basically, a subtly refined Williamson design.

The following quote from a 1954 Craftsmen product brochure describes how well the C 500A amplifier handled phase and transient response:

"Since an analysis of the wave-shapes encountered in music and speech shows a preponderance of sharply peaked and steep-sided wave fronts, high fidelity audio equipment must be capable of duplicating these wave-shapes faithfully and without originating additional transient signals. Excellent square-wave response has been accomplished in the C 500 by following video amplifier design techniques that require an excellent phase response characteristic as well as a good frequency response far beyond the audio spectrum. In this amplifier, the excellent phase response showing less than 15 degrees shift at the extremes of the audio range has made possible almost perfect duplication of square-waves as low as 20 cps or as high as 20,000 cps with practically no transient tails or ringing that might mar musical reproduction."

The large potted output transformer was meticulously designed by Sid Smith for best square wave performance, maximum fidelity and superb frequency response. It featured interleaved windings, 25mHy leakage inductance, 120Hy primary inductance and full output power from 10Hz to 50KHz. Core materials and windings were made with the finest available materials and utmost quality control. According to Sid, Stancor made this transformer for

Craftsmen. There were two versions of the transformer, one with square corners and a later one with rounded corners (made primarily by Stancor, and in some cases by other firms.) Over 12 years ago, John Atwood (former VTV Technical Editor), evaluated dozens of classic tube amplifier transformers and compared their performance to each other. The Craftsmen C 500 output transformer tested with minimal ringing and outstanding frequency response, yielding superb square wave response.

Beefy and well designed, the C 500 power supply had two filter chokes and a 4uf @ 500V oil cap to filter the high voltage (445 VDC) to the center tap of the output transformer. A dual 40uF @ 500V electrolytic capacitor provided filtered DC to the front-end of the amp. The power transformer was similar in specification to a Stancor PC8412 with a secondary winding of 840V center tap rated at 145mA. Most of these original power transformers failed, due either to poor quality or shorted filter capacitors. Most C 500s I have seen have had the power transformer replaced with a PC8412 or Chicago PV-200. Finally, a 5V4G rectifier tube provided the DC rectification.

Cosmetics of the C 500 were quite appealing with a beautifully chrome-plated chassis, attractive engraved nomenclature tags and aesthetically-pleasing component layout. According to Hal Cox, a Bay Area hi-fi historian, Craftsmen was inspired to chrome plate their chassis by nearby E. H. Scott Radio Company, who made beautiful chrome-plated radios during the 1930s and early post-war period.

1954 Craftsmen C 500A



Each of the 500-series amps carried a stamped serial number on the front identification tag. Sid told me that C 500 amps began with the serial number E 1001 and production ended with E 6XXX or thereabouts with the C 500A amplifier. So essentially, that means that between 5,000 and 6,000 C 500s and C 500As were built. Craftsmen amps were extremely popular and were featured in custom, built-in systems shown in many 1950s audio-ophile books and magazines.

INSTALLATION and SERVICE INSTRUCTIONS

THE craftsmen 500A ULTRA FIDELITY AUDIO AMPLIFIER

ELECTRICAL SPECIFICATIONS

POWER OUTPUT: 15 watts maximum.

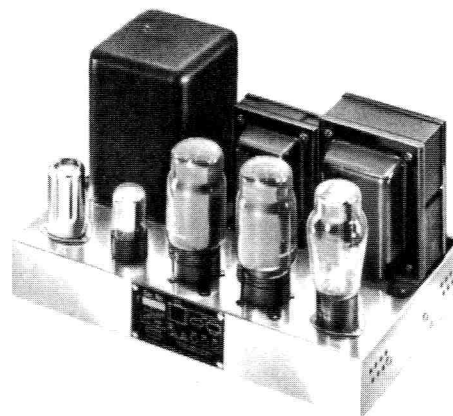
FREQUENCY RESPONSE: +0.1 db., 20 cps. to 20,000 cps.
+2 db., 5 cps. to 100,000 cps.

POWER RESPONSE: 12.5 watts, +1 db., 10 cps. to 50,000 cps.

PHASE SHIFT: +15 degrees, 20 cps. to 20,000 cps.

TOTAL HARMONIC DISTORTION: Less than 0.1% at 10 watts at mid-freqs.

INTERMODULATION DISTORTION: Less than 0.5% at 10 watts (40 & 12,000 cps.: 4/1)



HUM AND NOISE LEVEL: 90 db. below rated output.

SENSITIVITY: 1.5 volts, rms. input for rated output.

OVERALL GAIN: 70 db. (470,000 ohm input resistance)

DAMPING FACTOR: 32:1

OUTPUT INTERNAL IMPEDANCE: 0.5 ohm on 16 ohm tap

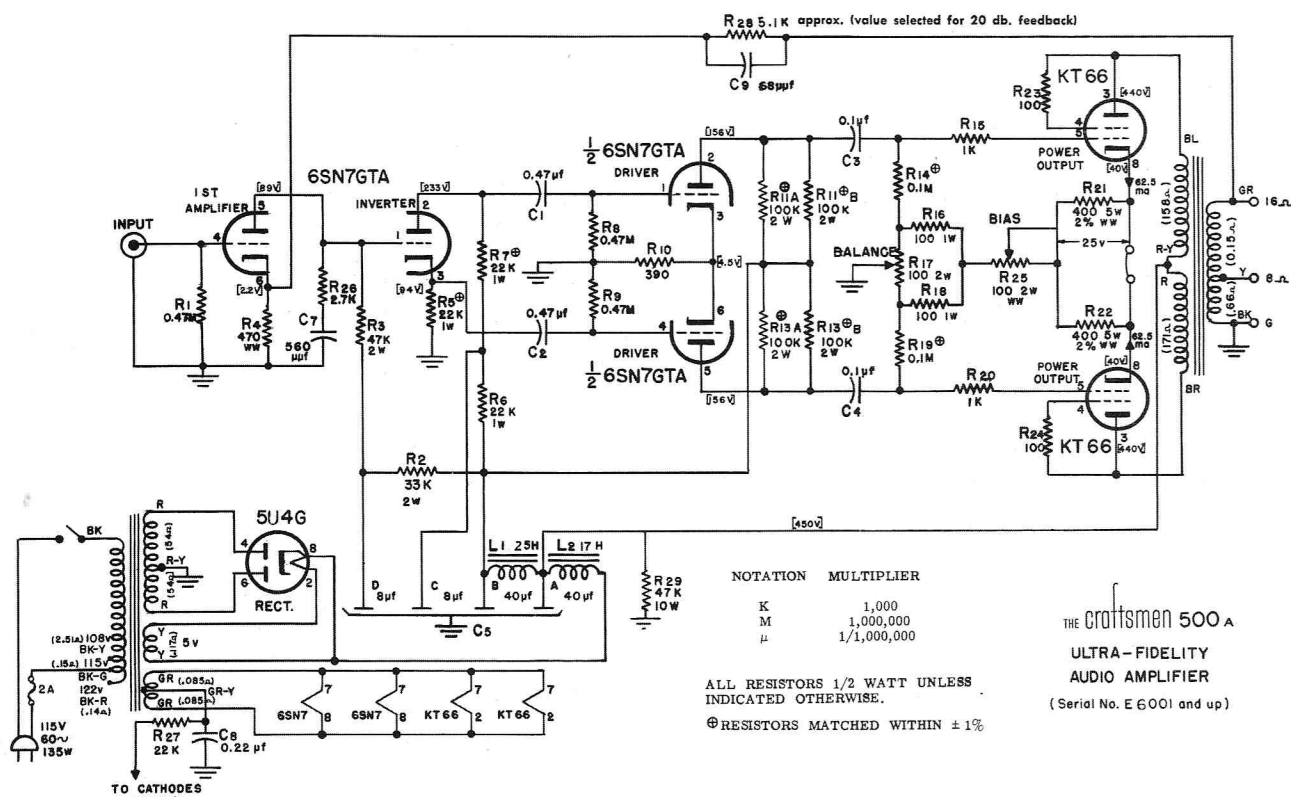
OUTPUT LOAD IMPEDANCE: 8 and 16 ohms nominal

POWER CONSUMPTION: 105-125 volts, 60 cps., 125 watts

TUBE COMPLEMENT: 6SN7GTA amp. & inverter, 6SN7GTA push-pull driver, (2) KT66 power output, 5U4G rectifier.

OVERALL DIMENSIONS: 8 in. x 13½ in. x 7½ in. high

SHIPPING WEIGHT: 25 lbs.



Craftsmen C 500A (\$99 suggested retail)

In late 1953, Craftsmen introduced the C 500A, an upgraded model of the original C 500. Generally, the circuit was similar with the same tube complement except for the 5U4G rectifier that replaced the original 5V4G. Plate voltage was upped another 10 volts and the 4uF oil cap was eliminated. The dual 40uF @500V can-type filter cap was relocated under the chassis. A larger 25Hy filter choke was added to the top of the chassis. Damping factor was increased to 32 and output power rating was increased to 15-watts RMS. The output transformers used were mainly the rounded-edge Stancor types with the same specifications and ratings as the C 500 amplifier. The power transformer was changed to a beefier one that was the equivalent of a Stancor PC8414 with 1128V center tap at 150mA rating.

Specifications of the C 500A were +0.1db from 20 to 20kHz with total harmonic distortion of less than 0.1% at 10 watts.

Craftsmen C 550

By 1954, the home hi-fi market was getting crowded. Altec, EICO, Fisher, Grommes, Heathkit, McIntosh, Marantz, H.H. Scott and dozens of other companies were all producing tube mono integrated and power amplifiers. In addition, less efficient speakers such as the AR-1 (often paired with Janzen Electrostatics) and others were showing up in the marketplace. 15 watts was no longer enough for many bookshelf speakers of the period. Craftsmen answered the call with the C 550, an uprated amp producing 30 watts RMS. This amp was designed by Bob Grodinski who took Sid Smith's place as design engineer of

amplifiers at Craftsmen in 1954. An Ultralinear output transformer took the place of the original larger C 500 iron. It is not known who made this transformer, although it is most likely Stancor as it is similar in specification to the Stancor A-8072 Ultralinear replacement output transformer. This amp also used a B+ delayed turn-on via a slow warmup, 60 second thermo-relay tube to preserve the cathodes on the KT66s.

Additional features on the C 550 included the use of a single terminal board to mount most of the capacitors and resistors. One choke in the power supply was eliminated and the power transformer was downsized to an 820V center-tap rated at 140mA.

Repair and Restoration

C 500s are very simple in design and easy to work on. The point-to-point wiring and open chassis make it easy to replace any component. They are built like classic cars from the 1950s, lots of heavy iron and chrome.

The power transformers on a 500 is usually blown and replaced with an aftermarket unit. If you get a 500 with a blown power transformer, there are close replacements available from Hammond or Schumacher. They will be cosmetically different and most likely smaller, but will do the job. Or, you can get the original transformer rewound.

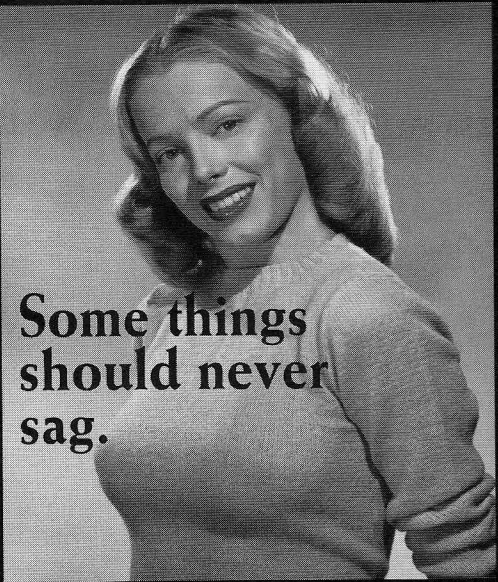
Chrome chassis have a way of attracting dust. When the dust gets caked on, then damp or wet, the chrome will rust. Many dusty old Craftsmen amps wound up being stored in damp garages or basements. If you are lucky, you may find one that has good chrome.

The coupling caps can easily be replaced with whatever you choose. I have used everything from old Sprague Vitamin Qs, to Audicaps to ICMWR Illinois metalized polypropylene caps. You have to experiment around to find out what your preferences are. The electrolytics should be replaced, but the 4 uF@600V tubular oil cap only on the C 500 (not the C 500A) will generally test OK. Do not add more than 50% additional electrolytic capacitance value, because it can rob from the mid and high frequency response and overtax the rectifier tube.

How Do They Sound?

The C 500 is one of the finest sounding early 1950s tube amps. Use of KT66s in triode connection, beefy 6SN7 front-end, along with an outstanding output transformer make for superb 3-dimensional realism. Even by today's standards, the C 500 is clear, sweet and has superb musical performance. They match perfectly with speakers designed at the same time, such as efficient Tannoys, Bozaks, Altec 604s, Klipschorns, EV and University component speakers, etc. They are perfect for any horn-type speaker setup. You can even use them for bi-amp or tri-amp horn systems.

The Craftsmen amps are very solid and excellent-sounding amps. The only weakness is the power transformer which is generally replaced. Note that the C 500 puts out about 10 watts and the C 500A puts out about 15 watts due to higher plate voltages.



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The Beginning of the End

By 1955, the home audio market was getting crowded with over 60 companies, large and small, producing tube amps, tuners, etc. Craftsmen was having problems with their distribution system that was mainly retail outlets and mail order houses like Allied Radio, Lafayette Radio, Newark Radio, etc. They briefly tried to bypass the retail dealer and catalog houses and sell directly to customers by mail, but this attempt failed and they went out of business in late 1955. The Radio Craftsmen business and name were sold to a company in Los Angeles later that year. They concentrated on integrated amplifiers such as the Solitaire and receivers such as the Stradivarius of the "flat" design. This company's products were cheaply made and they later failed.

By that time, Sid Smith had left the company for Marantz and Ed Miller started Sherwood with a group of engineers from Elrad, a coil manufacturer in Chicago. Sherwood was the name they chose, as it was the name of the suburb that Ed Miller lived in. We will cover the story of Sherwood in a future issue of VTV.

Thanks to Hal Cox of Mill Valley, CA, John Eckland of Palo Alto, CA and Earl Yarrow of Newman, CA for their assistance with this article.

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