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CARVER SILVER SEVEN MONO AMP

Manufacturer's Specifications

Rated Power Output: 375 watts into 8 ohms, 20 Hz to 20 kHz, at 0.5% THD or less.

Power Output at Clipping: 475 watts rms into 4 or 8 ohms, 510 watts into 1 ohm.

Power Bandwidth: 18 Hz to 40 kHz, referred to maximum output of 475 watts.

Frequency Response: Flat from 1.5 Hz to 100 kHz.

Noise: 110 dBA below rated power.

Energy Storage: 390 joules.

Output Tubes: Fourteen KT88/6550A tubes per channel.

Dimensions, Including Feet and Bases: Main chassis, 13 in. W × 9½ in. H × 18 in. D (33 cm × 24.1 cm × 45.7 cm); power supply, 10 in. W × 9½ in. H × 18 in. D (25.4 cm × 24.1 cm × 45.7 cm).

Weight: 145 lbs. (65.8 kg), including granite bases.

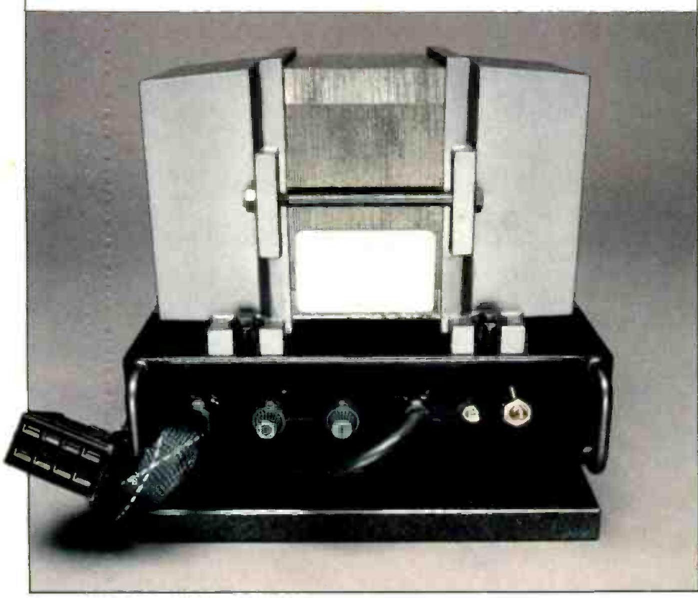
Price: $17,500 per pair.

Company Address: P.O. Box 1237, Lynnwood, Wash. 98046.

For literature, circle No. 90

Here we have some serious amplifiers, folks! These beauties, the Silver Sevens, are the biggest tube power amps that I have ever had my hands on. They are Bob Carver's crack at making the world's best power amplifier.

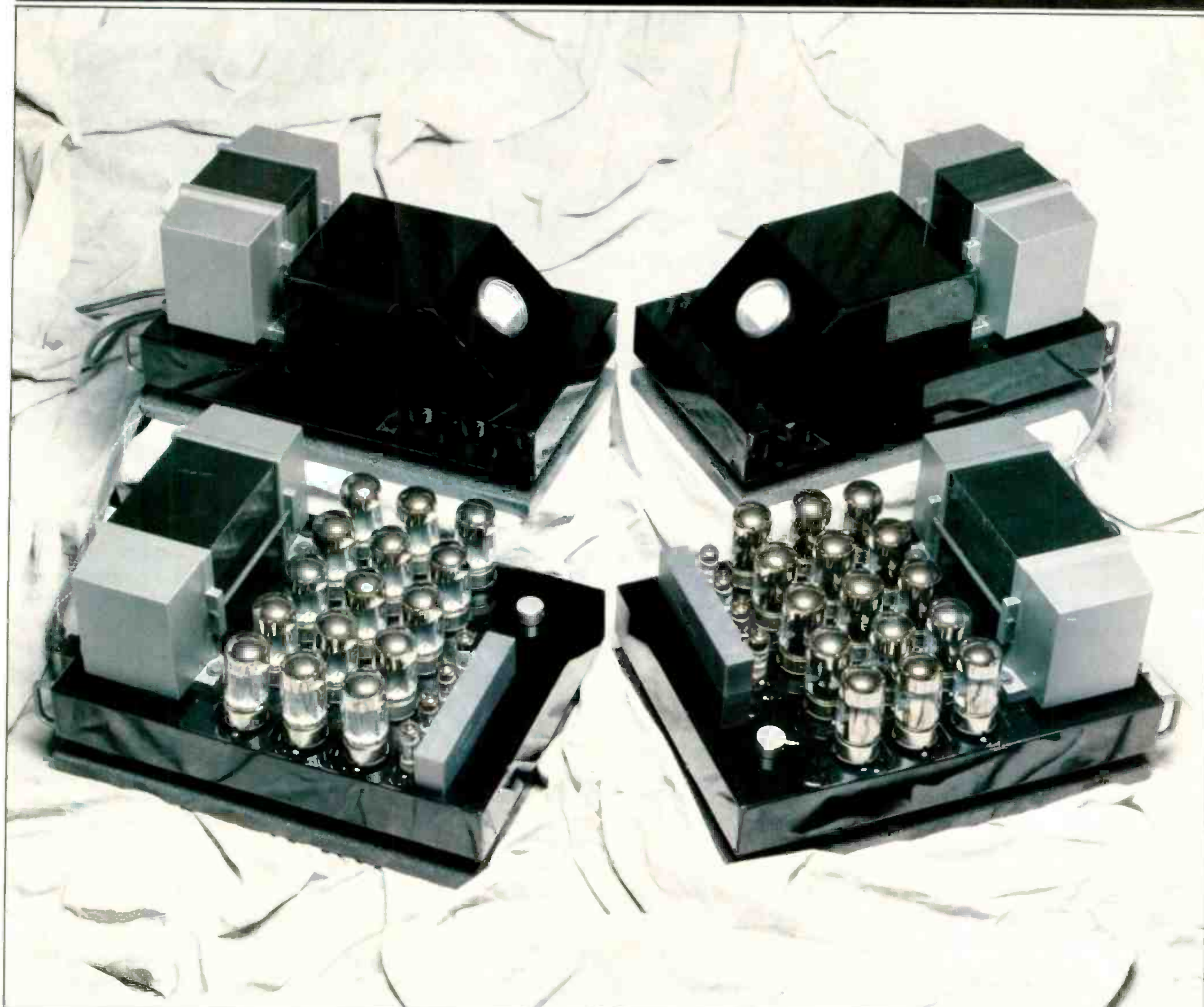
Bob Carver has claimed that he can clone the sound of any amplifier by making another amplifier (usually solid state) match the first amp's transfer function. In at least two instances, he has claimed in other audio publications to have duplicated the sound of other very good, highly regarded amplifiers. In subsequent advertising, he claimed that various solid-state amplifiers from Carver Corp. sounded like these two audiophile reference amplifiers and, of course, were available at a much lower price. In what I consider a brilliant bit of advertising genius, Bob Carver even followed up some rave reviews of his own Silver Seven tube amp by advertising a Silver Seven-t solid-state amp, cloned from the sound of his tube original.



My personal engineering belief is that even though the logic of it looks undeniable, it isn't really possible to make one amplifier duplicate another's sound by keeping the differences between their outputs (for the same input signals) below a certain measured threshold. I give you this as background on the thinking of the person behind the Silver Sevens.

As can be seen in the photograph, four pieces make up the Silver Seven system, two mono amplifiers and two power supplies. The size of each amp's output transformer certainly looks appropriate for a power level of some 300 to 400 watts. The power transformer, on the other hand, does not look equally up to the task of supplying power for a circuit that puts out nearly 400 watts continuous, but it won't ever have to in music service. I see a parallel with Bob's original Phase Linear 700 solid-state amplifier in the sense that its power transformer had poor regulation but did allow for some enormous power bursts (and pretty good steady-state power too!).

Taking a closer look, each amplifier chassis has an input level control on the top surface, next to the input tubes. In front of these tubes is a solid piece of aluminum that serves as a nice-looking nameplate and provides a radiating sur-



face for transferring some of the input tubes' heat to the air. At center stage are 15 power tubes, 14 of which are used in the output stage and the odd one serving as a series-pass element in a screen-grid regulator for the output stage. And then, of course, there is that impressive hunk of output transformer!

On the rear surface of the amplifier chassis are a four-terminal output barrier strip (with provision for matching 1-, 2-, 4-, and 8-ohm loads), two signal input jacks à la Tiffany (one direct, the other capacitor-coupled), a connector for the cable from the power supply, fuses for the total cathode currents of each bank of output tubes, and a control for adjusting the quiescent current of the output stage.

Each power supply has a meter that monitors the total B+ current drawn by the amplifier's output stage. This meter is mounted on the slanted front surface of the filter-capacitor housing. On the rear surface of each power supply is a connector for the a.c. line cord, two fuse-holders, a standby/operate switch, a main power switch, and an interconnect power cord, captive to the power supply, that terminates at the amplifier chassis. One of the fuses is for total B+ current drawn from the high-voltage supply, and the other is an a.c. line fuse.

The finish on these amplifiers is a beautiful, hand-rubbed black lacquer and really looks good. Granite mounting slabs and rubber dampers go under each of the amplifier and power-supply chassis.

Internal construction of the amplifier unit is all point-to-point wiring via the pins on the tube sockets and via terminal strips mounted to the chassis where needed. No p.c. boards are used in the amplifier chassis. All bus interconnecting wires are made of sterling silver! (Hence the "silver" in Silver Seven.) Numerous Wonder Cap polypropylene capacitors are used in the signal circuitry in bypass and coupling applications. The general level of parts quality used is of high order, although I was puzzled by the use of

There are no p.c. boards in the amplifier sections, just point-to-point wiring including sterling silver bus interconnects!

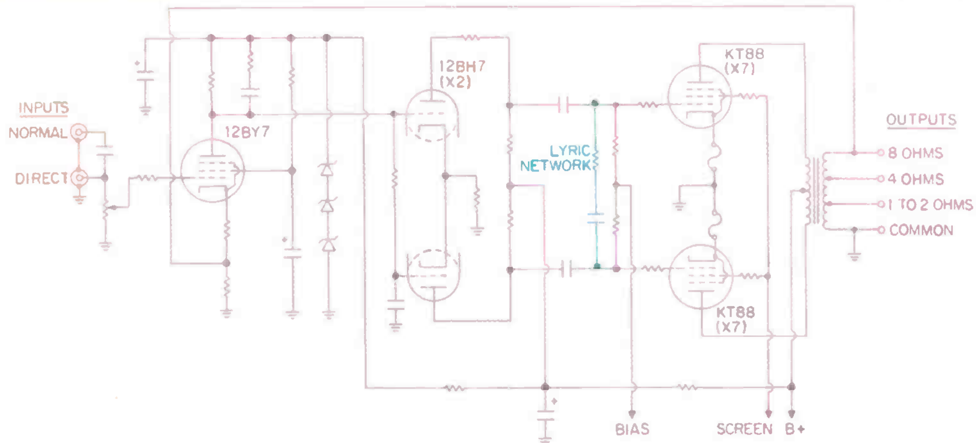


Fig. 1—Simplified schematic of the Carver Silver Seven amplifier circuits. The highlighted network is added by the amp's distributor, Lyric Hi-Fi; see text.

some ceramic capacitors in the signal circuitry. The power supply does utilize p.c. boards in two areas—one for the high-voltage rectifier diode assembly and the other for the turn-on/turn-off delay circuit. Workmanship and wiring quality are first-rate in the Silver Sevens, as well they should be for such an expensive product.

Circuit Description

The circuit topology of the Silver Seven is much like that of other tube amps that I have reviewed recently. (See Fig. 1 for a simplified diagram of this topology.) In the Carver circuit, the input stage is a 12BY7 video-amplifier tube connected as a pentode. Its screen grid is fed through a dropping resistor and is bypassed to ground by an electrolytic capacitor bypassed with a 0.01-μF polypropylene capacitor. The B+ supply for this first stage is regulated with a shunt zener-diode string bypassed by electrolytic and film

capacitors. The plate output of the first stage is direct-coupled to one grid of a 12BH7 twin-triode tube operated as a long-tailed-pair phase inverter. Another such tube is paralleled for increased drive capability. No provision is made for push-pull balance, as is done in many such phase-inverter circuits. The Carver design uses plate resistors of fixed but unequal value, which is necessary in this type of phase-inverter circuit due to the use of low-gain triodes to obtain equal outputs. Push-pull output from the plates of the phase-inverter stage is capacitor-coupled to the control grids of the two banks of output tubes. Each grid is fed through a 6.8-kilohm "grid-stopper" resistor from the common-phase drive line.

The output tubes are operated as pentodes with fixed bias. (Fixed bias is used in most tube power amplifiers.) In this mode of operation, the output tube cathodes are grounded, or nearly grounded, through small current-sampling resistors; a negative voltage of appropriate value (usually −35 to −45 V) is applied to the grid-leak resistors for the two push-pull output tubes (or to the two banks of output tubes in the case of push-pull, parallel-connected stages like this one). Earlier versions of the Silver Seven had a two-position bias switch labelled "Low" and "High." These positions allowed total output stage currents of about 200 to 250 mA and 500 mA, respectively. The reviewed samples have a screwdriver-adjustable pot on each amplifier chassis so that you can vary total output stage current from about 200 to 500 mA. Incidentally, the incoming bias from the power supply is zener-regulated to about −48 V. As received, the amplifiers were acjusted for about 250 mA, and that is how they were set for all my measurements (except where otherwise noted).

The odd 15th output tube is connected as a triode (screen grid connected to plate) and functions as a series-pass element in a circuit that supplies regulated voltage to all of the screen grids of the output tubes. A third 12BH7 is used as the error amplifier for this screen regulator. (In earlier versions of the Silver Seven, it was paralleled with the

With hybrid electrostatic speakers, the Silver Sevens produced an incredible sense of space, tonal honesty, and resolution.

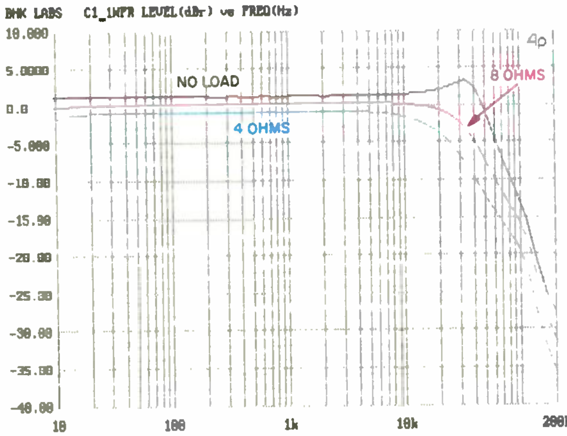


Fig. 2—Frequency response at the 8-ohm tap with various loads; see text.

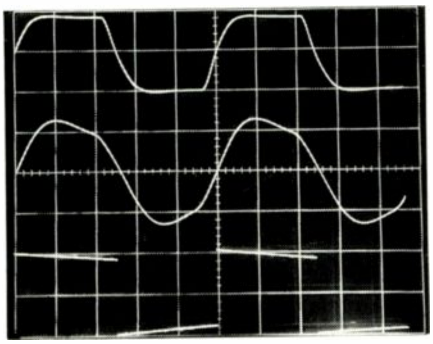


Fig. 3—Square-wave response at 8-ohm tap for 10 kHz into 8-ohm resistive load (top), 10 kHz into 8 ohms paralleled by 2 µF (middle), and 40 Hz into 8 ohms (bottom). Scales: Vertical, 5 V/div.; horizontal, 20 µS/div. for 10-kHz traces, 5 mS/div. for 40-Hz trace.

phase-inverter section of the amplifier circuit.) The regulated voltage to the screen grids is about +330 V; B+ to the center tap of the output transformer is a hefty +660 V.

Overall negative feedback is taken back to the first stage's cathode from the 8-ohm tap of the output transformer's secondary winding. The Silver Seven's output-stabilizing RC network is more complex than the usual resistor and capacitor in series across an amplifier's output. Here, there are two such networks, one connected from the output transformer's 8-ohm tap to ground and one from the 4-ohm tap to ground. Several hundred ohms of resistance are also connected from the 8- to the 4-ohm output.

In the power supply, the high-voltage secondary of the transformer is rectified by a full-wave bridge and fed into a capacitor input filter that consists of two 2,000-µF, 450-V capacitors in series, for an effective capacitance of 1,000 µF at 900 V. Each diode arm of the bridge is physically two diodes in series, and each of the two diodes is bypassed with a 470-kilohm resistor and a 0.01-µF, 1-kV ceramic capacitor. Next in the B+ line is a filter choke of some 32 mH (a relatively small value for tube amplifiers' high-voltage supplies). This filter choke terminates in another series-connected capacitor pair of 2,000-µF, 450-V capacitors. In a long-term sense, the net capacitance of this supply is 2,000 µF; in the short term, for high-frequency transients, its effective capacitance is 1,000 µF because of the isolating properties of the series filter choke. Another secondary winding is rectified by a full-wave bridge and is RC-filtered to form a regulated bias supply for the output stage. A heater winding, putting out about 18 V a.c., powers the filaments of the output tubes in a series-parallel arrangement consisting of three tubes in series in each of five parallel strings. For openers, this is some 150 watts of filament dissipation before we even begin to talk about plate dissipation!

Part of the 18-V winding's output is half-wave rectified to supply d.c. power to the turn-on/turn-off time-delay circuit. This circuit delays the application of B+ to the output stage for several minutes after power on, by switching the B+ with a series relay. The filaments and B+ to the front-end circuitry come on at power turn-on. At power turn-off, this relay drops out immediately to prevent any surges or "blaps" from reaching the speakers as the front-end supply decays. The standby switch is in series with the relay coil and serves to reduce power consumption by removing plate power from the output stage. This is useful if the amplifiers haven't been used for a short while, because you don't have to go through the whole warm-up cycle. One nice touch which contributes to component longevity is the use of a few surge resistors in the primary circuit of the power transformer. These devices exhibit relatively high resistance when cold and, accordingly, reduce inrush current considerably at turn-on. As the current through these devices warms them up, their resistance drops down to a few ohms, allowing essentially full power into the transformer.

Measurements

Boy, what a grunt it was, moving these amplifiers from my house to my lab for measuring! This was especially so, as I left the Silver Sevens on their granite bases and rubber isolators. In testing, I measured the S/N of both units, Serial Nos. 00113R and 00113L (hereafter referred to as R and L, respectively) to check for any significant difference in behavior. The data plotted is for amp R, which, as it turned out, performed slightly better.

As is my custom, I measure gain and sensitivity early on, as they're the easiest to do. (I like to work into these things.) The gain of these amps was higher than the usual 26 dB or so; it came out to about 35.2 dB on the 8-ohm tap with an 8-ohm load. Corresponding IHF sensitivity was 49.3 mV. Gain with the 4-ohm tap loaded by 4 ohms was 31.6 dB, closer to the norm.

When I cranked up the plate current, the spacious and detailed but slightly edgy sound became more open, lush, and musically true.

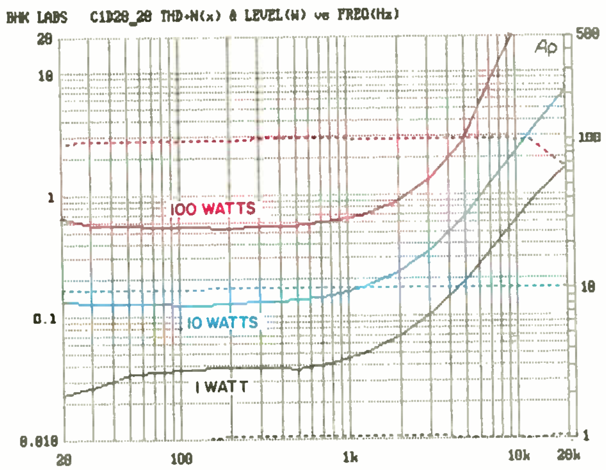


Fig. 4—THD + N vs. power and frequency for 8-ohm load on 8-ohm tap. Dashed curves are actual power output vs. frequency at the indicated levels; read power from right-hand scale. The slope of the 100-watt dashed curve was caused by an uncorrected drop-off of the test signal.

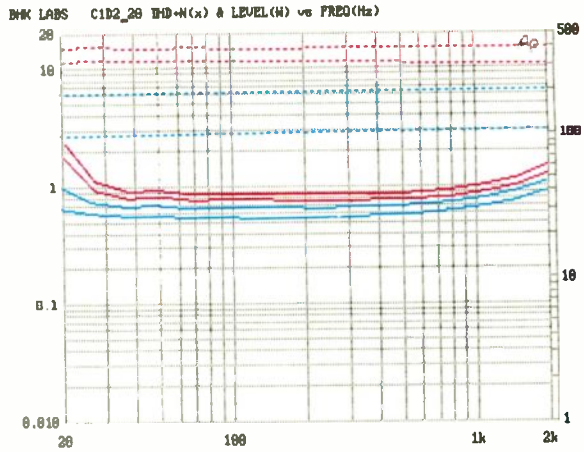


Fig. 5—Same as Fig. 4 but for higher power levels (375, 300, 200, and 100 watts, from top to bottom) and for frequencies only up to 2 kHz.

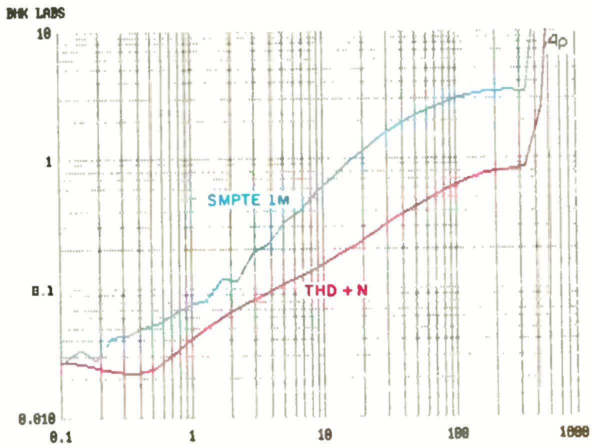


Fig. 6—SMPTE IM and THD + N vs. power output for 8-ohm load on 8-ohm tap.

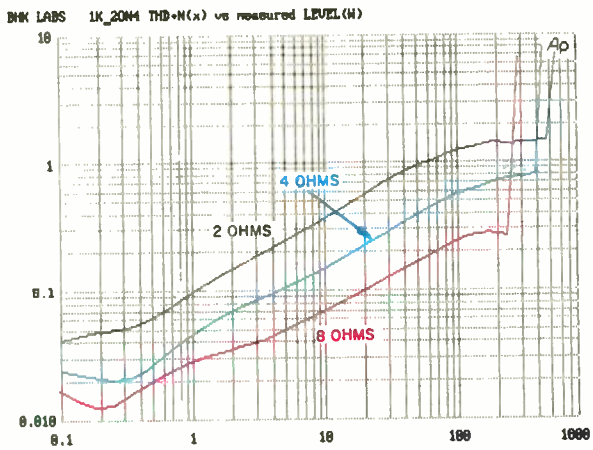


Fig. 7—THD + N vs. power for various loads on 4-ohm tap; see text.

Next, frequency response was checked at the customary 1-watt output level. Figure 2 shows responses at the 8-ohm tap with no load, the normal 8-ohm load, and a load of 4 ohms. Plotting the curves this way gives you an insight as to how low the output impedance was (the lower the output impedance, the less the change in level as a function of load) and how the high-frequency response (damping) varied with load. With 8-ohm loading, the high-frequency response is nicely damped but is 3 dB down at about 30 kHz, a bit low for "good" high-frequency bandwidth. Low-frequency response for open-circuit and 8-ohm loading looks excellent. With 4-ohm loading on the 8-ohm tap, you can see the beginnings of a low-frequency roll-off. This is because the reduction in open-loop gain caused by the higher loading reduces the feedback, which then no longer compensates as well for the transformer's low-frequency roll-off.

The high-frequency response of Amp L was down more than that of Amp R, reaching its cutoff point (3 dB down) at about 22 kHz for an 8-ohm load. With an open-circuit load, Amp L's response was up about 1 dB at 10 Hz.

Square-wave response is shown in Fig. 3. In the top trace, at a frequency of 10 kHz, the damping is excellent; just a trace of overshoot is present. Rise- and fall-times are on the order of 12 μS. Paralleling the 8-ohm load with a 2-μF capacitor yields the 10-kHz response in the middle trace. Again, ringing is reasonably low. In the bottom trace, response to a 40-Hz square wave, low-frequency tilt is not as low as I have seen in some other tube amplifiers.

The incredible solidity, as well as tonal rightness and warmth in the lower midrange, continue to captivate my attention.

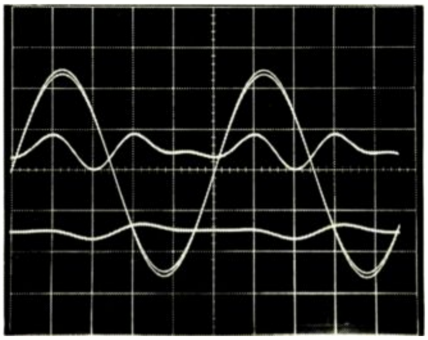


Fig. 8—Output and distortion residue at 10 watts out into 8 ohms, for output stage current of 250 mA (smaller output trace and upper residue trace) and 500 mA (larger output trace and bottom residue trace).

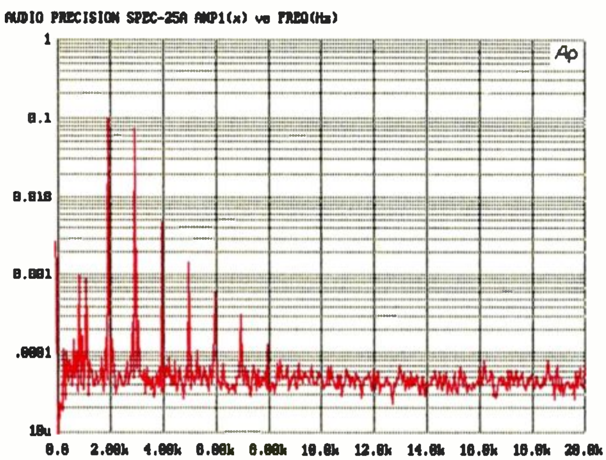


Fig. 9—Spectrum of residual distortion for 1-kHz signal at 10 watts into 8-ohm load on 8-ohm tap, with output stage current of 250 mA; see text.

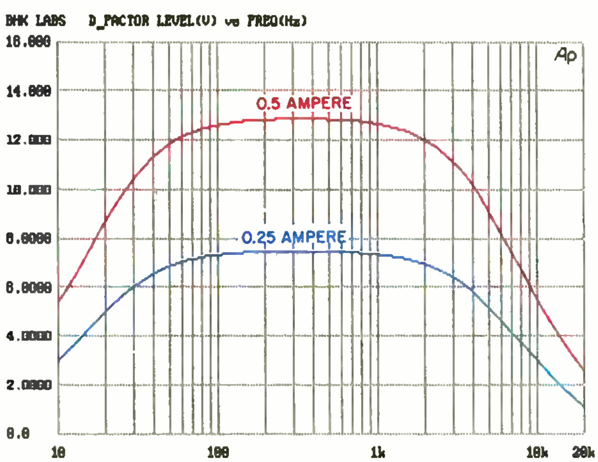


Fig. 10—Damping factor vs. frequency for two levels of output stage current.

Lyric Hi-Fi, exclusive distributor for the Silver Seven, adds a network to help the amplifier achieve the sound quality they desire. This network, however, causes the output to slew at higher frequencies and power levels. I therefore separated the data for THD + N as a function of frequency and power into two plots. Figure 4 shows THD + N over the full range from 20 Hz to 20 kHz for power levels up to 100 watts. For distortion at higher power levels, I restructured the measurement to cover only the range from 20 Hz to 2 kHz, as shown in Fig. 5. I did so because it is not really useful to show these results beyond the point where slewing raises the distortion. In Fig. 5, it can be seen that THD + N remains low at low frequencies at full rated power (375 watts), a testament to the appropriateness of the output transformer's size. (Amp L had a bit more distortion at the frequency extremes than shown here.)

Total harmonic distortion plus noise at 1 kHz, and SMPTE IM distortion, are shown in Fig. 6. Results are typical for tube amplifiers in that distortion generally increases with power. To see how distortion and power output might vary with loading, THD + N at 1 kHz was plotted versus power for 2-, 4-, and 8-ohm loads on the 4-ohm tap (Fig. 7). As expected, distortion is lower for loads of higher impedance, and maximum power is higher for loads of lower impedance.

Figure 8 shows the waveform and residue of harmonic distortion at an output of 10 watts for output stage idling currents of 0.25 and 0.5 ampere. The top residue trace and the smaller of the superimposed output traces is for a current of 0.25 ampere, at which distortion measures 0.12%. The slightly larger output trace is for the higher current, 0.5 ampere (output stage gain is decidedly a function of idling current); the distortion residue for this current, 0.037%, is shown in the lower residue trace. The dominant harmonics appear to be second and third. A spectrum of the distortion residue for an idling current of 0.25 ampere is shown in Fig. 9. There are some higher order harmonics, but their amplitudes are low and decrease rapidly as distortion order increases. At the higher output stage current, the higher order harmonics disappear more quickly into the noise floor.

Table I—Output noise. The IHF S/N ratios were 88.0 dB for Amp R and 86.5 dB for Amp L.

	Output Noise, nV	
Bandwidth	**Amp R**	**Amp L**
Wideband	255	395
22 Hz to 22 kHz	229	380
400 Hz to 20 kHz	138	158
A-Weighted	111	135

Output noise levels are listed in Table I. Notable in these amplifiers is their relatively low wideband noise for a design with such high signal gain.

Damping factor versus frequency is shown in Fig. 10 for output stage currents of 0.25 and 0.5 ampere. As can be seen, distortion level and gain are not the only things that change with output stage idling current. What is of note in these curves is that the damping factor decreases in the low

Probably the most realistic and best amps I have heard, the Silver Sevens surely are a contender for the title of world's best amplifier.

end below about 100 Hz, in addition to the quite common fall-off in the high end of the spectrum. This reduction in damping factor at low frequencies is most likely due to the relatively short interstage time constant in the coupling between the phase-inverter stage and the output tube's grid-drive lines. This time constant is usually kept short to raise its roll-off point so that it will not coincide with that of the output transformer and output stage. The net result is that the amount of feedback is reduced at low frequencies, with a consequent increase in output impedance.

Dynamic power output of the Carver Silver Sevens was a very impressive 540 watts with 8-ohm loading on the 8-ohm tap; this works out to a dynamic headroom of about 1.6 dB. Power at visual onset of clipping was 460 watts, for a clipping headroom of about 0.9 dB. With a 1-ohm load on the tap for 1 to 2 ohms, and using the tone-burst signal for dynamic headroom, I measured a peak current of ±30 amperes, which is equivalent to a burst power of 450 watts.

Current draw off the a.c. line was 3.6 amperes at an output stage current of 0.25 ampere and about 5 amperes when the output stage current was up to 0.5 ampere. That's 10 amperes for the pair of Silver Sevens just idling! Believe me, this heats up a room quite noticeably after the amplifiers have been on awhile.

Use and Listening Tests

Signal sources used to evaluate the Silver Sevens included an Oracle turntable fitted with a Well Tempered Arm and a Spectral Audio MCR-1 Select moving-coil cartridge, a Magnavox CDB-560 CD player feeding a Wadia 2000 decoding computer, a Nakamichi 250 cassette recorder, a Nakamichi ST-7 tuner, and a Technics open-reel recorder. A Vendetta Research SPC-2B MC phono preamp was used for playing records. The outputs of the Vendetta and the other high-level sources were selected and volume-controlled with my reference selector switch and switched attenuator unit. Other power amplifiers on hand during the review period were a Berning EA-2101, a pair of Cary Audio monoblock CAD-50SLs, EAR 519s, an Infinity HCA, and a pair of EAR 549 mono tube amps. Speakers used were pairs of the Siefert Research Magnum III, Martin-Logan Monolith III, and Spica Angelus plus experimental two-way systems loaned to me by Arnold Nudell.

I first listened to the Silver Sevens on the Siefert Research speakers. The first music I heard was Mahler leider with piano and male voice. I was stunned at how big, full, and real the sound was; the speakers never sounded so good. Using the Martin-Logan hybrid electrostatics, I got a sense of incredible space, tonal honesty, and resolution but some hint of edginess and irritation on certain program material. As I mentioned earlier, the amplifiers were preset at an idling current of about 250 mA, and all of the listening thus far had been at this bias setting. Fortunately, I decided to increase idling current in the output stage. (The bias pots permit a total current of about 500 mA, and I cranked them up to this level.) The sound of the amplifiers changed quite a bit with the increased plate currents. What had been a spacious, very detailed, but slightly irritating sound became more open and lush and far more musically believable.

The experimental two-way speakers are astonishingly good. These little systems provide outstanding spaciousness, inner detail and a refreshing upper midrange and high end that are not harsh or fatiguing. I had been enjoying these systems very much with the EAR 549s, but when I switched over to the Silver Sevens, I really appreciated how good both the speakers and the Silver Sevens are. These amplifiers are probably the best and most realistic that I have ever heard. I'm tempted to say that all other amplifiers are pretenders, but that is going a bit too far. There is an incredible solidity to the sound and a lower midrange warmth and tonal rightness that continue to captivate my attention. Needless to say, for me this requires that the plate current be set up to the 500-ampere level. Tube life and reliability may be compromised a bit (even though the approximate plate dissipation per tube, at 25 watts, is still well within rating), but I don't think this will deter anyone with the wherewithal to afford these amplifiers.

Although I haven't heard all the contenders for the title of world's best amplifier, I know the Silver Sevens would be a serious contender and possibly the winner in such a contest. Kudos, Bob Carver. *Bascom H. King*