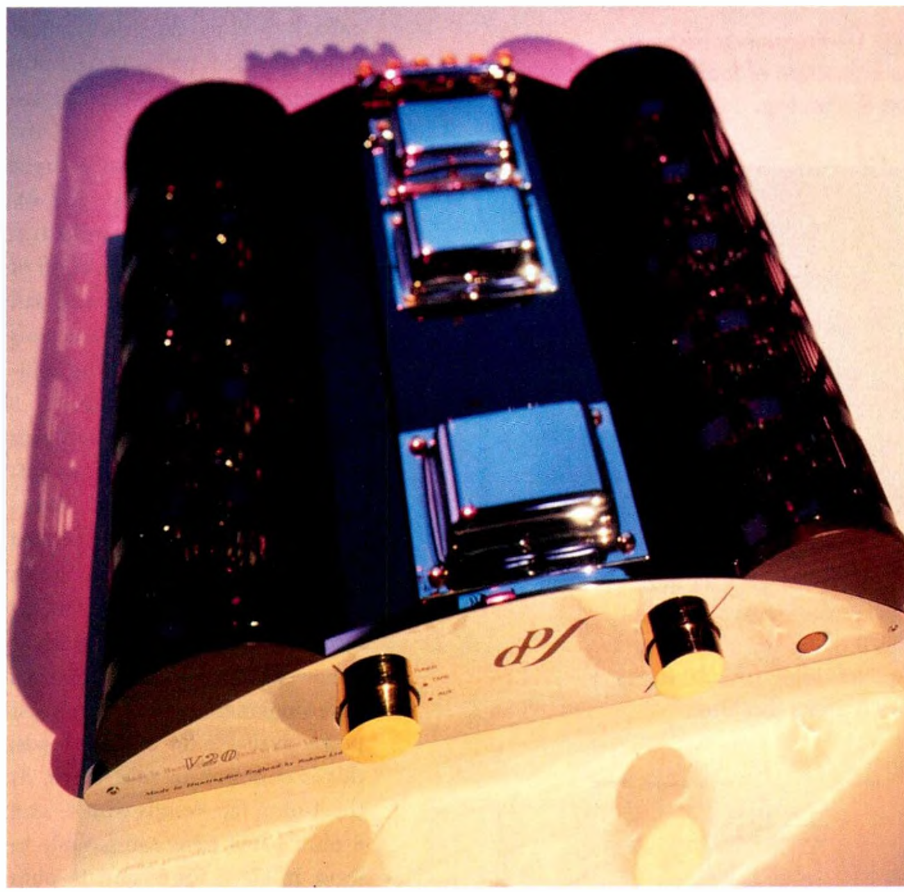
BASCOM H. KING

E.A.R. V20 INTEGRATED TUBE AMPLIFIER

Tim de Paravicini, chief designer for E.A.R. (formerly Esoteric Audio Research), comes up with highly sophisticated amplifier circuits that have earned my high regard. I have used and tested several amps from this British company; almost all of them made their rated power at 20 kHz with less than 0.1% total harmonic distortion—rare in tube amplifiers.

The E.A.R. V20 resembles the top of a V-type auto engine, with its tubes arranged in two angled banks, and is said to have been inspired by the V-12 engine in de Paravicini's Jaguar. Each bank contains one channel of the stereo amplifier's circuitry; three transformers (one power and two output) are placed between the banks, where a car's carburetor or fuel injectors might be. The V20's unusual appearance is also the result of its circuit configuration, which is probably unique: Instead of a few hefty output tubes, it has ten 12AX7 small-signal tubes in each channel's output stage.

THE E.A.R. V20 SOUNDED REALLY SPECIAL, AND I LIKED IT FROM THE MOMENT I TURNED IT ON.



An integrated amplifier, the V20 has a five-position signal selector, an illuminated pushbutton power switch, and a volume control. On the rear panel are five pairs of high-quality phono connectors for signal inputs, another pair for the tape output, an IEC power-cord socket, and a fuse holder. The gold-plated five-way binding posts for speaker connections (common, 4-ohm, and 8-ohm terminals for each channel) are at the rear of the top panel; 16-ohm operation requires a small change in the internal wiring, which could be done by a dealer or "by anyone who knows how to use a soldering iron," according to E.A.R.'s distributor in the United States.

Inside the V20's unusual housing, the construction is relatively simple and conventional. Within the one-piece welded chassis are the transformers and a circuit board that holds filter caps and rectifiers for the high-voltage and negative supplies. Another board, behind the rear panel, connects the input and output jacks; the selector switch and volume control are connected to it via small daughterboards and are operated by long shafts from the front panel. (The shaft extension of my review sample's volume control was slightly bent, making the associated daughterboard flex when I turned the control.) The audio circuitry and tube sockets are on two large boards, one per channel, mounted on standoffs beneath the tubes.

Measurements

On many tests, the E.A.R. V20's two channels performed almost identically. Data will therefore be presented only for the left channel unless otherwise noted.

The E.A.R. amp's frequency response is shown in Fig. 1 for open-circuit, 8-ohm, and 4-ohm loads and with the NHT dummy speaker load, all on the 8-ohm output taps. The output variation for 4-ohm and open-circuit loads on this tap is within ±0.7

Rated Output: 24 watts per channel, 20 Hz to 20 kHz.
Rated IM Distortion: Less than 0.5%.
Dimensions: 16½ in. W x 5⅜ in. H x 17⅜ in. D (42 cm x 13.5 cm x 44 cm).
Weight: 48½ lbs. (22 kg).
Price: $4,595.
Company Address: 1624 Sunset Ave., Santa Monica, Cal. 90405; 310/396-1919.

Photos: Michael Groen

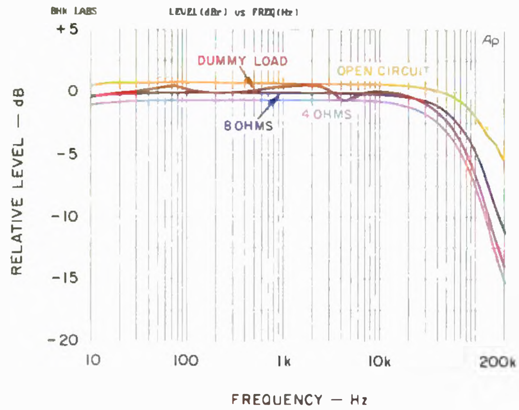


Fig. 1—Frequency response as a function of loading on the 8-ohm tap.

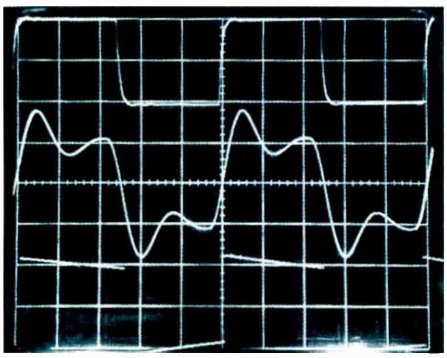


Fig. 2—Square-wave response for 10 kHz into 8-ohm load (top), 10 kHz into 8 ohms paralleled by 2 µF (middle), and 40 Hz into 8 ohms (bottom).

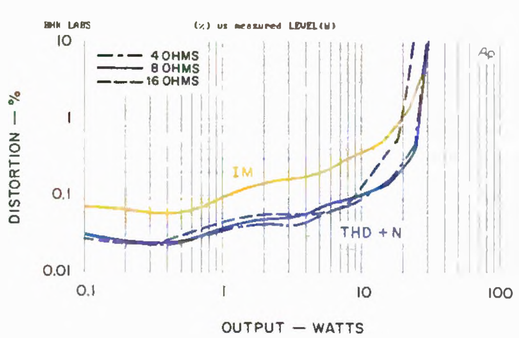


Fig. 3—THD + N at 1 kHz and SMPTE-IM distortion vs. power output, measured at 8-ohm tap.

dB of the 8-ohm load throughout the audio range; for the NHT dummy load, the variation is about +0.5, –0.75 dB. That's quite reasonable for a tube amplifier. The curves for open-circuit, 4-ohm, and 2-ohm loading on the 4-ohm output taps were similar but were farther apart because the relative output impedance was slightly higher (i.e., the ratio between 4 ohms and the 4-ohm tap's impedance was slightly lower than the ratio between 8 ohms and the impedance on the 8-ohm tap). The variation with the dummy load was about half that for the 8-ohm tap.

Square-wave response at 10 kHz (Fig. 2) is very well behaved with an 8-ohm resistive load on the 8-ohm tap. Adding a 2-microfarad capacitance to the load causes some overshoot and ringing, but it is quickly damped. (With the capacitance added to the load, the frequency response had a slight peak at roughly 33 kHz.) The 40-Hz square wave has a mild tilt, which relates to the V20's rolloff of 0.35 dB at 10 Hz. Rise and fall times were about 4.9 microseconds at ±5 volts out when driving an 8-ohm load via the 8-ohm tap.

Total harmonic distortion plus noise (THD + N) at various impedances, and SMPTE-IM distortion for 8-ohm loading, are plotted against level in Fig. 3. The amp's THD + N is almost unaffected by load up to about 10 watts. At higher power levels, 8- and 4-ohm loads have similar effects, but there's less power available for 16-ohm loads; this is common in tube amps. At the 4-ohm tap, results with 4- and 8-ohm loads were comparable to those in Fig. 3 for 8- and 16-ohm loading.

How THD + N varies with frequency at several power levels is shown in Fig. 4 for 8-ohm loading on the 8-ohm outputs. Distortion doesn't rise much at high frequencies, which is worth noting, but it does rise somewhat in the bass, particularly at full power.

A spectrum analysis of the harmonic distortion and noise residue for a 1-kHz signal at an output level of 10 watts (Fig. 5) is not so pretty. Despite the output stage's Class-A operation, the harmonic series is quite complex, with high-order products that don't decrease much at higher frequencies. Nevertheless, except for the third harmonic (which has the greatest magnitude), THD is about 0.023%; that's pretty low. (Including the third harmonic would raise THD to about 0.06% or 0.07%.) It's debatable how easy it would be to hear distortion that has such a harmonic structure and magnitude, and it turned out not to be annoying. At 1 watt (not shown), distortion was lower, less complex, and decreased more rapidly with rising frequency. The main reason for the 10-watt spectrum's complexity is that the designer opted for a circuit topology that requires driving the output tubes into grid current in order to attain the desired output (see "Technical

Associated Equipment Used

Equipment used in the listening tests for this review consisted of:

CD Equipment: PS Audio Lambda Two Special and Sonic Frontiers Transport 3 CD transports, Sony CDP-707ESD CD player, Panasonic DVD-A310 DVD player, Genesis Technologies Digital Lens anti-jitter device, and Classé Audio DAC-1 and Sonic Frontiers Processor 3 D/A converters

Phono Equipment: Kenwood KD-500 turntable, Infinity Black Widow arm, Win Research SMC-10 moving-coil cartridge, and Vendetta Research SCP2-C phono preamp

Additional Signal Sources: Nakamichi ST-7 FM tuner, Nakamichi 1000 cassette deck, and Technics 1500 open-reel recorder

Preamplifiers: Sonic Frontiers Line-3 and First Sound Reference II passive

Amplifiers: Arnoux Seven-B stereo switching amp, Quicksilver Audio M135 mono tube amps, Manley Labs Stingray stereo tube amp, and deHavilland Electric Company Aries single-ended mono tube amps

Loudspeakers: B&W 801 Matrix Series 3 speakers used as subwoofers with Dunlavy Audio Labs SC-III speakers; Tannoy Churchill speakers

Cables: Digital interconnects, Illuminati DX-50 (AES/EBU balanced); analog interconnects, Vampire Wire CCC/II and Tice Audio IC-1A; speaker cables, Kimber Kable BiFocal-XL and Madrigal Audio Laboratories HF2.5C

Like most earlier E.A.R. amps, the V20 is a fully balanced design using a unity-coupled output stage, but it differs from the company's previous amps in the design and coupling of its stages and in the way negative feedback is applied. The V20 has five stages, all but one of which use 12AX7 dual-triode tubes.

From the selector switch, the signal passes through the volume control to a differential-amplifier input stage, which uses one section of a 12AX7 for each signal phase. A triangle of resistors interconnects the two cathodes and a negative supply. The triangle provides a high resistance between each cathode and the negative supply (thereby setting the tube's operating current) and a smaller resistance between the cathodes (which sets this stage's gain). This first stage acts as a phase inverter to provide balanced signals to the following stages. The first and second stages are RC-coupled, with resistors across the coupling capacitors adding a touch of DC coupling to help maintain low-frequency stability after overall loop feedback is applied.

Like the first stage, the second and third stages are configured as differential amplifiers that use half a 12AX7 for each signal phase. The coupling between these stages is the same as that between the first and second stages. All of the voltage swing to drive the output stage comes from the output of the third stage. Its plates are RC-coupled to the input of the fourth stage, with no DC coupling.

The fourth stage is not the output stage, however. It is a cathode-follower driver, with the paralleled elements of a 12AU7 dual triode handling each signal phase. This stage provides additional driving current to the output stage via direct coupling between the cathode follower and the output stage's control grids.

The additional current from the cathode follower is needed because the output stage employs what designer Tim de Paravicini calls "enhanced triode operation." He originally applied that phrase to one of his prior amplifiers, in which signals went to the beam power output tubes' screen grids instead of their control grids. (I suspect the term "enhanced" is by analogy to FET circuits, which are said to operate in enhancement mode if they don't pass current until a positive bias is applied to their control elements and to operate in depletion mode if they pass current freely until a negative bias is applied. Tubes normally operate in depletion mode, though the term is rarely applied to them.) That prior amp had its control grid grounded so that current would not flow until a positive bias was applied to its screen grid.

To get "enhanced triode operation" from actual triodes, which have no screen grids, you have to make their control grids fairly positive with respect to their cathodes. This takes a lot of drive current, because it lowers the tube's input impedance; in the V20, that current comes from the cathode-follower stage. This helps get the 12AX7s (normally used as voltage amplifiers that deliver only a few milliamperes of current) to produce enough current to drive speaker loads.

Even that high-current operating mode does not, of course, make a single 12AX7 the equivalent of a standard output tube. Therefore, the V20's output stage has ten 12AX7s—twenty triode sections—per channel. Ten triode sections in parallel handle each phase of the output signal, acting like a pair of composite triode output tubes per channel.

The output stage is unity-coupled, like that in McIntosh tube power amplifiers. In such a circuit, half of the load is in the output tubes' plate circuit and the other half is in their cathode circuit. This amounts to quite a bit of local feedback and results in lower distortion in the output stage.

A unity-coupled output stage requires a very large drive voltage at maximum output—more than half the stage's output voltage into the output transformer. To get this high drive voltage with low distortion, the plate circuits of the third and fourth stages are supplied from a dynamic power source that moves with the signal, rather than a steady DC voltage, by means of a technique called bootstrapping.

The output transformer has two identical center-tapped primary windings. One winding connects to the plates of the composite output tubes; its center tap goes to the main high-voltage plate supply. The other primary winding, whose center tap is grounded, is connected to buses that link the cathodes of the output tubes and, via resistor networks, the cathodes of the second, third, and fourth stages. Each signal phase has its own cathode bus; the ten paralleled tube halves handling that phase are connected to the bus via capacitor-bypassed self-bias cathode resistors. This setup yields two signals of equal amplitude but opposite phase at each end of the two primary windings; the signals in both windings have the same phase and amplitude. In addition, the V20 amplifier couples signals of the same phase and amplitude via capacitors to improve circuit operation at high frequencies, an enhancement to the unity-coupled topology devised by de Paravicini.

The dynamic supply voltages for the third and fourth stages' plate supplies come from the output transformer's plate windings. Each of the third stage's two plates is fed from the end of the winding that carries the same signal phase from the output stage plates. This provides a constant plate-to-cathode voltage for the cathode-follower driver tubes. It also provides a dynamic constant-current load for the third stage's plates, thus enabling that stage to provide the large signal-voltage swing the output stage requires.

The second and third stages' cathodes are also connected to their respective phases' cathode buses via resistors. This provides an inner negative feedback loop back to the third stage and a global loop back to the second stage. The global loop sets the overall gain of stages two through five. The first stage is not included in any multistage loops. No feedback is taken from the output transformer's secondary.

The V20's output stage is said to operate in Class A. However, I feel it should be considered Class A_2, as grid current flows (by design) for a considerable portion of the signal cycle.

In the power supply, the transformer's main high-voltage secondary drives a full-wave voltage doubler circuit that delivers +350 volts to the center taps of the output transformers' plate windings. An auxiliary rectifier circuit supplies –200 volts to two voltage dividers that feed the grid circuits of the cathode-follower stage's driver tubes. These dividers set the operating point (quiescent current) of the cathode-follower tubes and the output stage. The first stage's cathode resistors receive –125 volts derived from the –200-volt supply. Each channel's +350-volt supply is further decoupled and filtered to feed the first and second stages' plates. All tube heaters are AC-powered, via a separate power-transformer secondary winding for each channel. *B.H.K.*

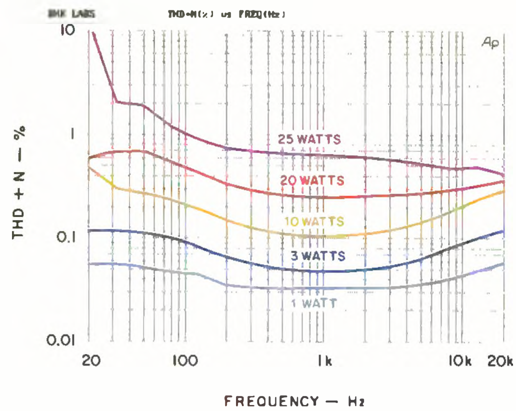


Fig. 4—THD + N vs. frequency.

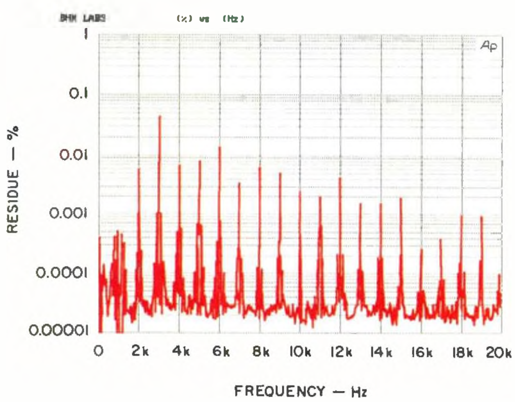


Fig. 5—Spectrum of harmonic-distortion residue for a 1-kHz signal at 10 watts out into 8 ohms.

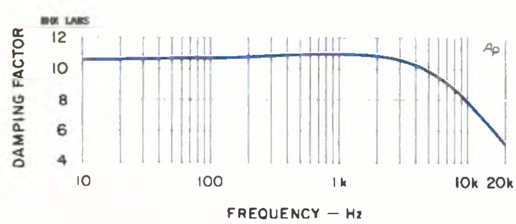


Fig. 6—Damping factor.

Highlights"). You might expect such complex distortion to make an amplifier sound irritating, but, as I said, it did not.

I measured interchannel crosstalk with the volume control in two positions, fully clockwise and 20 dB down from maximum (a setting more typical of normal use). At full volume, crosstalk was –90 dB or less up to about 6 kHz, increasing at 20 kHz to 80 dB from left to right and 87 dB from right to left. With the control turned down 20 dB, where crosstalk typically increases, it was still –90 dB or less until the frequency rose a bit past 1 kHz; it then decreased at about 6 dB per octave until, at 20 kHz, it became 66 dB from left to right and 69 dB from right to left.

Damping factor, shown in Fig. 6 for the 8-ohm output, was slightly lower (9.4 at 1 kHz) on the 4-ohm tap. Dynamic power output for 8-ohm loads on the 8-ohm outputs was about 26.3 watts, which corresponds to dynamic headroom of 0.4 dB. Clipping power (i.e., power at the visual onset of clipping, about 1% distortion) was 25.5 watts, corresponding to clipping headroom of 0.26 dB.

Voltage gain into 8-ohm loads on the 8-ohm outputs measured 31.4 dB for the left channel and 31.3 dB for the right. Corresponding IHF sensitivity (input voltage for 1-watt output into 8 ohms) was 76.5 millivolts for the left channel, 77.2 millivolts for the right. Input resistance was about 38 kilohms for either channel.

Output noise varied somewhat with the volume control's position, as it will in any amplifier stage that follows a volume control. For the worse (right) channel, wideband noise was 286.6 microvolts with volume full up, 398.4 microvolts with the control at –6 dB (its worst-case setting), and 273.3 microvolts with it turned all the way down. The A-weighted noise for those settings was 74.6, 110, and 72.5 microvolts, respectively. The IHF S/N ratio was 90.5 dB in the left channel, 90 dB in the right.

The V20 draws 1.6 amperes of AC from idle up to 10 or 12 watts of output per channel; it then increases its draw to 1.84 amperes at full rated power. This suggests that the output stage operates in Class A_2 up to about 12 watts and shifts to Class AB_2 above this level. In contrast to the relatively slow current ramp-up of power amplifiers using conventional, large output tubes, the V20 comes up to its full operating current rather smartly.

Use and Listening Tests

I liked the E.A.R. V20 from the moment I hooked it up and started listening to it. As I swapped it in and out of my system, my appreciation of its qualities only increased. This amplifier sounds really special, in spite of (perhaps because of) its complex measured distortion characteristics.

For most of my listening, I used Tannoy Churchill speakers, whose nominal sensitivity is 95 dB; the V20 drove them very robustly. Dunlavy SC-IIIs, whose nominal sensitivity is 91 dB, also sounded exceedingly good with the E.A.R. amp. The V20 conveyed a sense of transparency, delicacy, air, and detail as well as the best amps I've heard. Bass definition, detail, and punch were also extremely good. I had moments while listening to this amp that made me exclaim, "God, that sounds so much like real live music in front of me!"

The V20 will not be a good choice if you like your music *loud*. Nor will it be the best possible match for speakers whose sensitivity is 85 dB or so, though its 24 watts per channel will suffice for most music played at a reasonable volume.

UNIQUELY, THE V20'S OUTPUT STAGE USES TEN SMALL-SIGNAL TUBES PER CHANNEL.

My review sample worked flawlessly. However, I was a bit concerned that the power transformer and the front panel seemed to get rather hot after the amp had been on for a long time. And I don't know how long 12AX7s can be used as output tubes before audible deterioration sets in. Replacing all the tubes in the output stage will probably cost about as much as replacing a typical power amp's fewer but more expensive output tubes. Despite these concerns, I can recommend the E.A.R. V20 with good conscience to anyone whose system and listening tastes don't make higher power mandatory. I have truly enjoyed having it in my own system. A