The Black Gate story

You'll find 'audiophile grade' parts in most serious hi-fi products, but how much difference can they really make? Listening trials on Black Gate capacitors gave some astounding results

WORDS MARTIN COLLOMS

Ticking away in the background — you might even say on the outer fringes of audio design — is the question of how the actual audio building blocks sound; the components themselves, not the made-up equipment or the circuits. We are talking about resistors, amplifying and rectifying devices, capacitors and wound components, transformers and inductors not to mention connectors and wiring.

An electronics designer uses these parts to craft the circuitry and layout of an audio product. Even now, in certain academic circles, the existence of sound quality differences between technically well-behaved amplifiers is disputed. Yet others contend that not only do the design and form of theoretical and practically-expedited circuits matter, but the specific components or parts also have their own sonic characteristics.

Many such parts are customised through experience, and their unique build and specification aspects are utilised in proprietary audio ranges. Companies such as Naim and Audio Note exemplify such attention to detail. To give just one example, substituting a given, selected power transformer with one of nominally equivalent size, voltage and power will probably *not* generate an equal sound quality for the unit built using it. In elevated audio circles, there is rather more to a transformer spec than the standard figures for regulation and volt-amperes.

It's some years since reviews of component sound quality were published in *HFN/RR* and there is understandably a limited following for such material. But since then, in audiophile design circles, one particular branded range of parts has been gaining a cult following for sheer sound quality.

If true, this is an important finding because the industry is finding that the supply of traditional higher-quality discrete audio compatible parts is declining. This is due to the inexorable advance of surface-mount technology and to the predominance of larger, more complex integrated circuits, and as a result the opportunity for design creativity in audio product through the considered selection of electronic parts is diminishing. So it's hoped that this review/feature article may help to alert more

audio designers to the possibilities, and generate broader international recognition of parts of real quality.

Black Gate is the name of the range of capacitors that has attracted our attention. Kazuo Ishi, a Japanese inventor, patented a new way of making electrolytic capacitors back in 1978. Today, Black Gate capacitors are marketed under the Rubycon brand by Jelmax, the established Tokyo-based capacitor company, which makes a large number of these types under license. As far as the UK is concerned, Black Gate capacitors are available through the importer, Audio Note.

I last looked at such a passive component when reporting on the patent by Denis Morecroft of DNM for his 'T' network capacitor for power supply reservoirs (the UK licensed manufacturer is BHC Aerovox). With a test power amplifier chassis in place it was possible to compare that new three-terminal design with a variety of conventional two-terminal devices [*HFN/RR*, Aug '97]. In these 'T' network components the emphasis was on the internal electronics of the capacitor and a way was sought to maximise the performance of the device by separation of charge and load paths combined with a reduction in high frequency impedance.

Capacitor designers are painfully aware of the limitations of various types, for example the odd and varied properties of the film dielectric in the case of the plastic capacitors. Other aspects include the conductive layer — is it an ethereal vacuum deposition or perhaps solid metal foil? For electrolytics, a wayward construction of aluminum foil is used with a deeply etched oxide insulation, paper or fibre separators; the whole bathed an electrically slow and complex conductive goo.

Generally the goo or electrolyte has a closely-guarded composition and is ionic electrolyte, the standard way of achieving an electrical barrier connection to the oxide layer on the foil. It's been known for a long time that this electrolyte is imperfect, and among other details of construction, it may well dominate the electrical performance (distortion, bandwidth, loss factor), and by association, the sound quality. For those not in the know already, I point out that the humble electrolytic power supply reservoir can significantly contribute to amplifier sound quality. Causing much vexation, such differences can't be found in the most searching measurements of the amplifier itself.

It was time to put some actual components to the test, and what better choice than the ongoing developments in Black Gate technology?

CHERRY-PICKING

I can't hope to do justice to Black Gate as a totality so I've cherry picked from the range, mainly dipping into the stores at Audio Note for my selection. My task was complicated by early reports that a significant running-in period was required (several days) which, unfortunately, turned out to be true. Certainly, there were first impressions that gave a helpful clue, but a day or two were needed at minimum to gauge the result. For these tests I set up an amplifier of known quality, mounted on an open 'breadboard' (actually a maple chopping board) to allow relatively easy substitution of the capacitors in a range of positions. Later I also experimented with a trusted compact disc player, which it would not be fair to name.

I have experimented with small, medium and large decoupling capacitors (standard 470µF/50V, 470µF/16V, 22µF/50V and 47µF/25V) as well as standard power reservoirs (10,000µF/80V, 4700µF/ 35V and 220µF + 220µF/350V 'Heart of Muse'). Then came the Black Gate NH type non-polarised at 100µF/160V, 4700µF/35V, complemented by the NX type of completely symmetrical non-polars (470µF, 16µF, 22µF/50V, 20µF/50V, 22µF/6.3V, 0.47µF/50V, and the delightful 0.1µF/50V). Finally, I checked out the bi-polar high current crossover capacitors (4.7µF, 6.8µF/50V).

The Black Gate capacitors are certainly very, very expensive and consequently I was hoping for some significant advance over normal types. However, I couldn't possibly have predicted the magnitude of the sound quality changes I heard. The changes were so dramatic that I made multiple repeat comparisons over many days.

Do note that they are not a 'fix all' solution — you can't just throw them at a design. Each type and value needs to match the requirements of the specific circuit as well as being compatible with existing types of capacitor or other Black Gates when used. While parallel combinations of Black Gates were generally foolproof, adding Black Gates to conventional capacitors could actually make things worse. For example, even one of the best 100µF 'N' types added to a 10,000µF Nichicon reservoir didn't help matters, while a 0.47µF 'NX' really did lift the combination significantly when used as a reservoir bypass.

So strong was the Black Gate effect that existing 0.1µF polypropylene decouplers on supply lines had to be removed from the circuit as they were found to audibly degrade the BG performance even of a 47µF 25V standard polarized type used with no other high frequency decoupling.

If the standard Black Gate electrolytics were exceptional — rated typically 50% better than conventional electrolytic — the 'non-polar' types were extraordinary

If the standard BG electrolytics were exceptional, in my view surprisingly so — rated typically 50% better than conventional electrolytic — the 'non-polar' types were quite extraordinary. Chosen for the right value and position, the sound quality of my audio test units were transformed by the addition/substitution of BG non-polars. Moreover, this capacitor series as a whole proved just as effective in the digital areas of an experimental D/A converter as in its analogue sections, compared to those of the test amplifier.

Cobwebs over the soundstage that you hadn't realised were there were now swept away. Substantial gains were also present in every aspect of sound quality. The difference was so great that we were forced back to cross-check the non-BG types and also to refer back to known reference grade audio products to make sure that we were not fooling ourselves.

RUNNING IN

When you are very familiar with how a product sounds, it is often surprisingly easy to detect subtle changes between electronic components used in it. This is even more obvious when the product is both very short and simple and very good.

I had already observed running-in phenomena with other components, the most obvious being a moving-coil loudspeaker. Nevertheless, amplifiers, CD players, *etc*, may be observed to run in over a period of time, usually no less than several tens of hours. Sometimes the rate of improvement will be slow, almost imper-

Value for money? Black Gate capacitors cost typically eight times as much as basic alternative types

ceptible, and several weeks may pass before you realise the sound has got better. Assessing these changes is made easier by a valued stock of long-term, well run-in reference products.

While in general Black Gates sound pretty good out of the box, the potential performance ceiling is so high that the process of improvement during running in can appear to go on for many tens of hours!

Take the 10,000μF/80V high current reservoir, performing well in the power supply of the test solid-state amplifier. First trials showed it was certainly the best of its type, compared with top grade alternatives including 'T' network, Elna and Great Supply. Nevertheless, on a value basis the BGs did not at first appear to be worth eight times that of the other types.

And then they ran in. As the days went by the Black Gates gradually and inexorably built on their lead to a point where their contribution to sound quality was such that a return to those other well-regarded reference capacitors resulted in amazement, confusion and finally great disappointment. Certainly this big BG reservoir is very expensive (about £90 each in singles), but in a circuit which can fully exploit its potential, there's no other device of this type which can make such a contribution to performance.

THE TECHNOLOGY

Aspects of Black Gate capacitor technology are protected under trademarks as well as seven patents for Germany, Japan and the USA. First released in 1978, the technology began with an advanced modification to the electrolyte, namely the inclusion of very finely-divided graphite. Chemically neutral, the particle size is appropriate for the exploitation of tunnelling, a fast and virtually lossless conduction mechanism which is far superior to the ionic movement of the standard electrolyte.

Musical notes appear to hang there, in time and space, of near perfect entity and with breathtakingly natural instrumental and reverberant decay

With this dramatic conduction improvement, self-noise and distortion are reduced by between 10 and 300 times depending on type (and cost!) and the ESR, or unwanted internal impedance, is improved right across the board, by a factor between 2 and 10 times, over the frequency range, and especially over a wider range of temperature. Normal ionic conduction is known to be rather temperature-dependent and many audio electrolytic capacitors sound and measure at their best at a respectably high temperature such as 40° centigrade, a factor in the sometimes-encountered extended warm-up effect.

The top Black Gate models have extraordinarily low measured distortion, for example at 10kHz, 200mV drive, reading –148dB for the NX non-polar series (1500μF/15V) compared with an average of –88dB of distortion for three standard non-Black Gate types of equivalent rating.

I am not saying that –88dB of capacitor distortion is directly audible in any case, but the figures do give a clue to the properties of Black Gate NX. Special test equipment, itself upgraded with Black Gate capacitors, was required to define that noted distortion improvement of some 50dB or 300 times.

So comprehensive are the advantages at this extant point of exploration, that it's hard to know where to begin. Referenced to the benchmark of the best non-BG capacitors, the soundstage of the test amplifier was remarkably expanded in width and depth, yet focus is still more solid. Images hang in space, set in floodlit pools of acoustic ambience. Subtleties which were previously just hinted at are now firmly and expressively delineated. Every point in the audible frequency range is clarified, sharpened, resolved. Rhythm and timing are redefined. Musical notes appear to hang there, in time and space, of near perfect entity and with breathtakingly natural instrumental and reverberant decay.

Colorations which were previously blamed on circuit behaviour and on specific active devices were now seen to be largely the fault of the old capacitors that were in use, and these errors were almost banished by installation of a few Black Gates. If these comments seem extreme I offer in my support the experiences of several other listeners, some hard-bitten and difficult to impress. In general they were shocked by the magnitude of the changes I could make in the test system with these capacitors, and when the combination of parts was felt to be in balance, agreed that the overall improvement was not the usual 10 or 20% resulting from the insertion of a new and better review amplifier, but rather a complete order of magnitude.

Taken overall, and when used in circuits which are capable of exploiting the Black Gate advance to the full, the gain in sheer sound quality is roughly and simply proportional to the cost of the Black Gate part. Even the lowest-cost types are rewarding, while the top components in my view change the rules for high-quality audio equipment design.