Alkaline and Zinc Carbon Batteries

"Heavy duty" is a meaningless marketing term. Those batteries are good old carbon-zinc. Just like the ones that leaked and ruined all you cool toys in the 50s. "Heavy-duty" was invented back then to imply a better grade of carbon-zinc batteries.

For almost all applications, alkaline are better than carbon-zinc.

"Heavy duty" and alkaline batteries only have slightly different chemistries, and slightly different open circuit voltages. Both are very close to the established 'label voltage' of 1.5v for the carbon-zinc wet cell (Leclanché, 1868) and later the carbon-zinc dry cell (Gassner, 1888). By comparison, the cell voltage of a lead-acid battery is ~2.0v, and NiCad cells run about 1.4v

However, there are significant differences in practice - mostly length of life (Alkaline last 4-9 times as long), current discharge properties (alkaline supply more current for longer), voltage drop-off with use ("Heavy duty" drop off gradually as they are drained; alkaline keep a higher voltage until they are nearer their end of life, and then drop off) etc. Sometimes a device requires a certain voltage to operate, and the gradual voltage drop-off of a "heavy duty" cell causes it to fail even when it has significant charge left in it. Therefore, a heavy duty battery that 'died' in 10 minutes in one device, may still work fine in others

The term "heavy duty" is a misnomer. It was "heavy duty" in the 60s when I was born (and probably well before) but only in comparison to the older cells. Today, it should be called "pathetic underachiever" but somehow the makers are slow to make the change.

The "regular duty" dry cell was basically a Leclanche cell that mixed the electrolyte into a slurry with black manganese dioxide instead of using a plain liquid. The electrolyte was a slightly acidic mixture of ammonium chloride [and some zinc chloride], and actually had an 'open circuit voltage' of 1.55v, that settled close to 1.5v under load.

The anode (- end) is actually the zinc casing itself (hidden under steel end plates for durability and a protective paper shell) The cathode (+ end) is a carbon bar, inserted into the electrolyte, and sealed with insulating wax, to make both sides of the cell accessible from the outside, without shorting out the cell.. Some of the zinc in the casing is consumed during use, so a heavily discharged dry cell may 'break through' and leak if left in the circuit.

(The terms cathode and anode may seem reversed here. That's because battery designers use + and - relative to the cell chemistry, not the voltage supplied by the battery - or so I've read. It still seems silly to me.)

The 'heavy duty' battery changed the primary electrolyte to zinc chloride resulting in a slightly higher open cell voltage (~1.6v), and held its voltage better under load, as well as having a longer life (more pronounced under heavier loads than light loads)

Despite the way the term is used in advertising, alkaline cells are actually chemically carbon-zinc cells with a somewhat improved [predictably, more alkaline] electrolyte. They have a slightly higher open cell voltage, more storage capacity, and less voltage drop during the main part of the discharge curve, but most of its benefits actually come from improved construction.

The casing of an alkaline cell is just protective. The Anode is a gel of zinc and KOH (a potent alkali) inside a polyester cylinder in the middle of the battery. The gel is connected to the external - terminal by a brass spike. The cathode is a shell of carbon+manganese dioxide slurry between the polyester cylinder and the outer casing

Alkaline cells can last 4-9 times as long as "heavy duty" cells (depending on the application) and have a better discharge curve (they lose less voltage as they are discharged, then drop of more at end of life]. They can't be recharged (they tend to explode) while the heavy duty cells could be mostly recharged a few times. Standard and heavy duty rechargers were common in the 1970s, though recharging was always recommended against by the manufacturers, because of the risk of leakage/bursting after erosion of the zinc casing, and lost profit from erosion in new battery sales.

However, the Renewal cell (Rayovac) is actually a carbon-zinc cell that is designed to be recharged 25-100 times (using a microprocessor-based recharger). A NiCad battery can be recharged 1000 times ideally but its chemistry has a lower open cell voltage of about 1.4v, which is fine for many applications, but won't work in others. (Carbon zinc cells don't reach 1.4 until they are mostly dead) Since few people recharged NiCad's that often except in specialty uses like laptops, and NiCad's had other issues, the Renewal was considered a viable alternative to NiCad.

NiMH [Nickel Metal hydride] rechargeable cells have more capacity than NiMH but have an open cell voltage of ca. 1.2 v - not suitable for many applications. For this reason many devices specify alkaline cells (heavy duty should work, due to the similar open

cell voltage, but they'll have a much shorter life

Motorcycle, car and UPS batteries use 3 or 6 lead acid cells (2v each) in series to achieve their rated voltage of 6v or 12v; the rectangular 9v "transistor" battery contains six 1.5v batteries in series inside it. You may have never seen a "B" cell, because in the US, it was a stacked series of cells that added up to 45-90v, and was used for vacuum tubes. It's called a B cell because "B voltage" was an existing term in vacuum tubes. In Asia, however, there was a B cell that was about as long as a D cell, but narrower than a C cell. Kind of like a supersized A cell. I have one, but it's been dead for 20 years.