The Watch Face: Lume

TECHNICAL
By Adrian Hailwood
Aug 5, 2019
Share Article:

Delve into the history of dial design and the elements that make up some of the most famous watch faces of our time.

Contents hide

Part 2: Lume

A watch is only as good as its ability to tell you the time. This means that early watches, however finely made or accurate, were at best part-time timepieces. Before widespread public and domestic lighting, dark meant

dark and passing hours might be marked by a chiming clock if you were rich enough, or close enough to a church. In 1680 Daniel Quare created repeating watches that could tell time in the dark to the nearest quarter of an hour, but it would be a further 70 years before time to the nearest minute would be possible and even then, these marvels of miniaturisation were only available to the privileged rich.

Glow in the Dark

The substance that put the ‘time’ into night-time was discovered by Marie and Pierre Curie in 1898. Radium is a curious element, always warmer than its surroundings due to the radiation it emits, but what suited it to watchmaking was the fact it glowed and could be used to impregnate the hands and dials of watches and clocks making them glow at night. Luminous paint was invented in 1902 by William J Hammer who first mixed radium with zinc sulphide, but he failed to patent his creation and lost out to George Kunz at Tiffany & Co., who did.

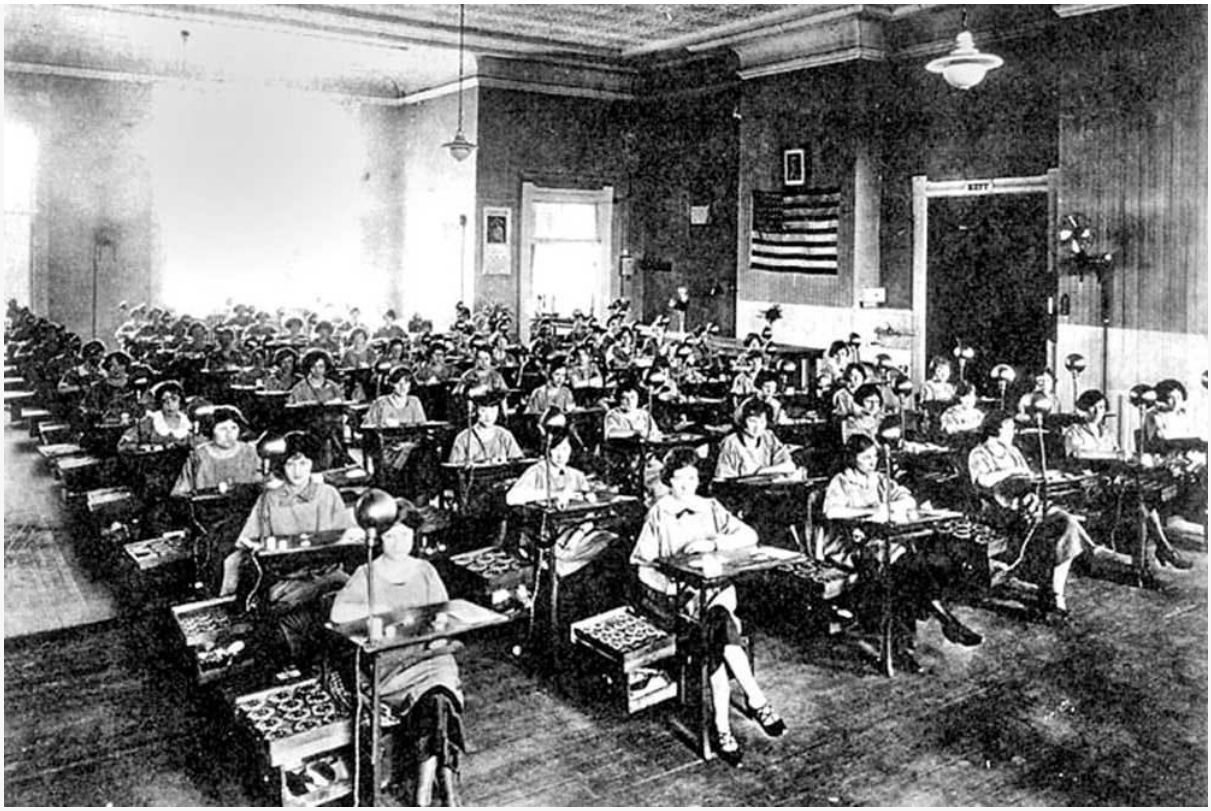
Marie and Pierre Curie

Radium Days

Despite the hazardous effects of Radium being identified only 2 years after its discovery, the early years of the 20th century saw an outbreak of ‘Radium Fever’, as with previous discoveries such as magnetism and electricity it was touted as a health-giving cure-all. Radium-laced toothpaste, face cream and even underpants were sold, all with disastrous effects. Early use of radium paint was most prevalent in Switzerland where, to quote Ross Mullner – author of ‘Deadly Glow’, “There were so many radium painters in that country that it was common to recognize them on the streets even on the darkest nights because of the glow around them: their hair sparkled almost like a halo.”

Radium condoms, one of many radium-based consumer products that touted miracle health properties of the radioactive element

The USA began using radium paint in 1914 bringing its toxic effects to the workplace. In the case of the 'Radium Girls', women who worked at 3 dial making facilities, they were told that the luminous paint was harmless by their managers and so, in addition to painting each other for fun, they pointed their brushes for fine work by licking the bristles and in doing so ingested lethal amounts of radium. Using brushes, a technique derived from ceramic painting, was not common in Europe, where glass pens or wooden styluses were used. The companies involved denied liability and suppressed medical evidence accusing some of the victims of contracting syphilis. Eventually the women proved their case and also the fact that the management knew of the risks, from strict protective measures being taken during paint manufacture. Radium continued to be used until the 1960s but with safety procedures being followed, work-place contamination ended.



Radium dial painters

Recalling the Strontium

Even with safety measures in place it was clear that radium was dangerous stuff. Alpha and beta particles were contained within the watch, but radium also produced gamma rays which could penetrate the case and decayed to highly carcinogenic radon gas. The 1960s saw a shift from radium to something less dangerous and with a shorter half-life, partly for the health of the wearer and partly for the health of the phosphor in the luminous paint that was being rapidly degraded by the alpha emission. Strontium was considered a useful candidate, a pure beta emitter with a 28-year half-life, the phosphor in the paint would stay healthier for longer and it was cheaper than radium. Strontium has its own health issues though, absorbed into the bones if ingested, it causes bone cancer and leukaemia. Strontum-90 was present in fall-out from nuclear testing in the 1950s and the public outcry in the US when milk was contaminated lead to a ban on its use.

Strontium-90

Over in Switzerland, strontium was used on dials by a number of manufacturers including Rolex. It also found its way into the Bakelite bezels of the early 6542 causing them to be recalled and changed for anodised aluminium. Later dial details added by Rolex such as ‘underlines’ show that the replacement dials had been checked to be ‘strontium-free’.

Ps and Ts

Promethium and tritium were the next candidates for use as low-grade radiation sources. The ‘Circle P’ indicating its use can be clearly seen on Seiko quartz chronographs supplied to the British MOD and promethium notably found its way onto the hands and dials of the US Navy Tornek-Rayville Blancpains, leading to an alarming radiation warning being engraved on the case back. Promethium is a stronger exciter than tritium making the dials and hands brighter, but with a half-life of only 2.6 years, it doesn’t last long. Great for watches that will be serviced routinely but not so good for the civilian market. (Ironically, promethium decays into samarium, a weak alpha emitter with a half-life of 106 billion years…)

Seiko ‘Circle P’ chronograph issued to British RAF pilots

Tritium, the ‘Circle T’ on British MOD watches, performs more usefully, with a half-life of 12 years and a low-energy beta particle emitter, it was used widely through the watch industry. With public concern over radioactivity, the tritium content has been reduced over the years. A simple ‘T’ indicates the presence of tritium, but this was later replaced with ‘T<25’ showing that the emission was less than 25 mCi (millicuries) and, finally, the ‘T Swiss Made T’ that signifies emissions below 7.5 mCi.

Rad-free

In 1941 as Japan entered WWII Kenzo Nemoto launched his company supplying luminous paint for military dials. Over the years Nemoto & Co mirrored the wider world's progression through a range of radioactive sources, using, first radium, then after 1960, promethium. In 1993 the company developed a ground-breaking luminous compound they christened Luminova. Base on strontium-aluminate, this wonder material was not only radiation-free but was brighter and more long-lasting than any previous zinc-sulphide based paint. Luminova does not self-generate light in the same way as a radioactive paint but it is the next best thing and both safer and cheaper. Luminova has been developed and improved since 1993. It is made and distributed by Seiko as their LumiBrite compound and in Switzerland it is Super Luminova (it is probably made for Rolex as Chromalite too, but Rolex aren't saying).

The direction things are glowing…

As watch brands search for novelty and individuality, lume cannot just glow, it has to glow in an interesting way. For a long time, Luminova has been available in a variety of colours and grades, each providing a different intensity of light from dark red as the worst, to C3 as the best.

There is much debate as to the efficacy of the classic green glow of C3 and the blue tint of Rolex's Chromalite, which all seems to come down to when you look at it. Walking into a dark room on a bright day your eyes with be in photopic mode, prioritising colour perception. In this case green lume will seem brighter. In the middle of the night, when your eyes have adjusted, they will be in scopic mode, prioritising tones, and here the blue lume wins. It's not all about the brightest lume though, brands are now developing lume in their corporate colours or to achieve distinct effects. A modern master of the luminous arts is James Thompson at Black Badger. Initially adopted by the watch fraternity as a maker of cool luminous rings, he is now putting luminous components into watch cases and dials. Brands such as Schofield, Sarpaneva and MB&F have all added a touch of Black Badger glow. In his latest collaboration with De Bethune, Thompson has worked with Super-Luminova's manufacturers to create a material that has the brand's iconic dark titanium oxide blue under regular light and also glowed the same dark blue at night. With such spectacular effects now possible, night-time is no longer when a watch goes to sleep but when it comes alive.

De Bethune DB28 GS Grand Bleu features unique lighting system created in collaboration with James Thompson of Black Badger Advanced Composites

'The Science Bit...'

Although Radium glows blue in the dark, it is not very bright. It is its property as a radioactive particle emitter that was most widely used on dials and hands with these particles causing other ingredients in the paint to glow by a process known as radioluminescence. The glowing component is known as a phosphor although, confusingly, phosphorous is not a phosphor and emits light by a different chemical reaction known as chemiluminescence.

Radium produces alpha and beta particles along with gamma rays. These particles excite zinc sulphide to create that typical green glow of radium

lume. The alpha particles also break down the phosphor much quicker than beta particles so after a few years the glow fades to nothing. Don't be fooled, with a half-life of 1,600 years the radium in the paint is still emitting like crazy but there is no phosphor left to interact with it. UV light may elicit a brief glow but there will be no lasting effect. The alpha and beta particles are contained under the watch crystal and the gamma rays are too weak to be a problem, but care must be taken with loose dials or dust from fragile luminous paint, as ingestion can be dangerous.

Later replacements for Radium such as Strontium, Promethium and Tritium have half-lives of between 28 and 2.6 years meaning that a fading of their efficacy in vintage watches is as much due to the decay of the radioactive source as a breakdown of the phosphor.

Modern luminous paint is photoluminescent. It does not create light independently, rather it is like a photon battery. It needs to be charged with light, which is then released slowly over time. Many factors affect both the brightness and duration including the colour of light emitted, the efficiency of the paint and the thickness of the application.


REVOLUTION
THE ROLEX OYSTER PERPETUAL: STELLA FOR THE PEOPLE
WEI KOH'S COMPLETE AP PERPETUAL CALENDAR GUIDE
SPEED: GEORGE BAMFORD ON THE NEW DEFENDER
THE REVOLUTION WATCH AWARDS 2020