

An idea that started life as a home-made Christmas gift has earned a place in engineering history.

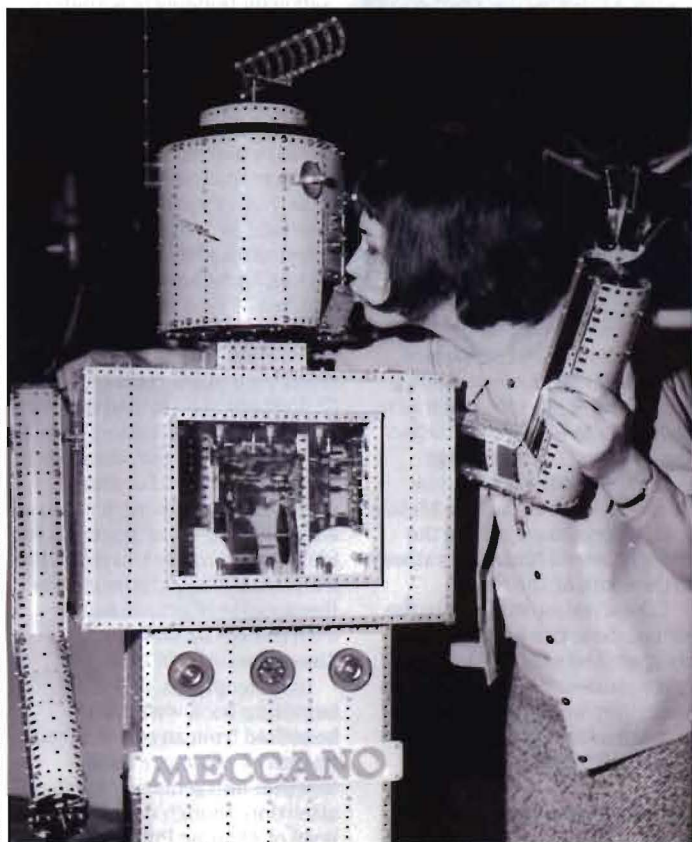
The Eccentric Engineer

by Justin Pollard



TOY TECHNOLOGY

THE INSPIRATION FOR GENERATIONS OF ENGINEERS



ONE HUNDRED and fifty years ago, one of the most important figures in modern engineering was born – a builder of cars, bridges, aeroplanes, trains, houses, factories, tanks, cranes and just about anything else that can be built. But you won't find his creations across rivers, at airports or in stations, but under the Christmas tree.

It wasn't an auspicious start in engineering for Frank Hornby. Brought up in a relatively poor family in Liverpool, he was never going to find the funds for university and probably wouldn't have got in in the first place as he hated school. Aged 16 he left to take up the role of cashier in his father's provisioning business. Frank did

not lack ambition, having been a devoted follower of the great 19th century self-improver Samuel Smiles and his exhortation: "Every human being has a great mission to perform, noble faculties to cultivate, a vast destiny to accomplish."

Hornby's destiny wasn't to lie in bookkeeping, however, but in toys. In 1899 he began making small tin-plate toys for his children. These sheet-metal cranes and trains were not an unusual feature on Christmas morning in many households, but as the century turned Hornby had one, brilliant idea. What if, rather than making toys, he made a set of parts that could be joined together in any form the owner fancied? So he set

Competition

What's this Meccano man up to? The wittiest caption emailed to engtechmag@theiet.org by 17 January 2014 wins a pair of books from Haynes.

about cutting out a series of copper strips, half an inch wide with holes drilled every half an inch. These could then be bolted together, have wheels and pulleys attached and be turned into just about anything.

By the end of the year he had put together a kit; all he needed was a great name. That name, as the 1901 patent reads, was 'Improvements in Toy or Educational Devices for Children and Young People'. The real name he came up with was *Mechanics Made Easy* and the seven shillings and sixpence set even received endorsements from professor of engineering and the inventor of the variable pitch propeller, Henry Hele-Shaw.

Profits remained small, partly because Hornby had to get others to manufacture his parts and they found it difficult to keep up with demand. Rescue came in the unlikely form of the meat importer for whom he now worked, David Elliot. He gave Hornby some empty office space and the two went into business together. In 1907 Hornby took over production and took out a trademark in the name Meccano.

There has probably never been a toy so influential to future generations of engineers, if we exclude the humble building brick, and the toy that could be made into anything gained rapidly in popularity. But Hornby wasn't finished yet. Keen to tell the world about his invention, he and his eldest son began to set up a series of offices abroad as well as licensing the idea to Märklin in Germany. Since 1891, Märklin had been making model trains so Hornby began importing their clockwork motors for his construction sets. This gave Frank another idea. The first Hornby train rolled off the production line in 1920.

Now a model railway needs more than trains and track. As any decent train modeller will tell you, you need the landscape – the hills, the houses, cars and shops. So in 1933 that is exactly what Hornby started making – a range of die-cast trackside accessories, and another legendary brand was born. Dinky toys had the advantage for those less agile with a spanner of being ready assembled and painted. The down side was that these early models suffered from the scourge of the die-cast collector, zinc pest – a progressive and untreatable crumbling of the casting due to lead impurities in the zinc alloy.

Meccano, Hornby trains and Dinky toys made Frank Hornby a wealthy man. His great inventions live on, with the most famous iteration of his train set, the 'Dublo' system, first hitting the shelves in 1938 and becoming a regular feature of every child's dream Christmas morning ever since. *

CAPTION PRIZES BAG A BOOK



This month's competition winner will receive copies of the 'Dan Dare Space Fleet Operations Manual' and the 'McLaren M23 Owners' Workshop Manual', two new titles from the ever-expanding range of Haynes Manuals (haynes.co.uk). Winner of our November 2013 issue competition is Jim Waterton with: 'After a winter of piste-bashing in the Sierras, a bit of salt-raking at Salton makes a nice change.'



Denunciation, torture and imprisonment couldn't quash Sergei Korolev's enthusiasm for rocket science.

The Eccentric Engineer

by Justin Pollard



AEROSPACE

THE TURBULENT LIFE OF THE MAN WHO GOT SPUTNIK INTO SPACE



THE NAMES of most of the pioneers of the Space Age are writ reasonably large and rightly celebrated. Even Werner von Braun managed to step out of the shadow of his Nazi past to take his place as one of the men who got us to the Moon. But this was not the case for the American team's Cold War counterparts in the Soviet Union.

The Soviet regime always took the view that its pioneers should remain anonymous during their lifetime, nominally to protect them from enemy agents but also handily ensuring they didn't get too big for their boots and enabling them to be 'reassigned' if they did. So while von Braun became known in his lifetime as one of the great rocket men, his counterpart in the Soviet Union remained known even to many in the industry simply as 'The Chief Designer'.

Of course The Chief Designer did have a name, Sergei Korolev, and it's a name that should perhaps be heard more, for his journey to the stars was truly extraordinary. Korolev did not have an easy start in life. His parents separated when he was just three, apparently due to

financial troubles, but his mother took the drastic step of telling her young son that his father had died. His education was interrupted by the Russian revolution forcing him to study at home, malnourished and suffering from typhus, until he got a place studying carpentry in a building trades school.

It wasn't the ideal start for a rocket engineer, but carpentry got him interested in building gliders and this got him onto a course at the Bauman State Technical University in Moscow, where he was supervised by legendary Soviet aero engineer Andrei Tupolev. By 1930 he'd earned his pilot's license and started thinking about the potential of liquid-fuelled rocket engines. Just four years later he published his seminal 'Rocket Flight in the Stratosphere'.

It would seem that things were taking a more normal trajectory for Korolev by this time. He'd met and married a fellow aviation engineer and had a daughter and was now chief engineer of the state-sponsored Jet Propulsion Research Institute. But any semblance of normality disappeared in 1938 when Stalin

Competition

What might Sergei Korolev be saying in our picture? The wittiest caption emailed to engtechmag@theiet.org by 14 February wins a pair of books from Haynes.

began the Great Purge. Korolev was quickly denounced by two colleagues, allegedly for slowing down work at the Institute. If they hoped this would give them a leg-up in the business, they were sorely mistaken. They were both executed.

Korolev was arrested by the NKVD, tortured, forced to confess and sentenced to ten years in a gulag. With an almost desperate naivety he continued to write to Stalin explaining that there must have been some mistake, but Stalin of course wasn't listening. Eventually, with a new head at the NKVD and a growing realisation that killing all your best engineers in gulags might not be helping national development, Korolev was moved from the gold mine to a Moscow prison for intellectuals where his services could be used by the state while he was 're-educated'. Working on aircraft design for the war effort, he managed to get himself transferred back to a group developing rocket propulsion, a subject in which the Soviets now badly lagged behind Germany, having purged all their best engineers.

It wasn't an ideal working environment. His boss had previously denounced him and he was still a convict, but the resilient Korolev seemed to take it in his stride. Finally, in 1944 he was released. A lesser man might have been unwilling to help a country that had treated him so badly, but not this one. Korolev joined the scramble to secure German rocketry know-how, reverse-engineering captured Vengeance weapons and then working towards Stalin's goal of developing long-range missile systems to carry nuclear warheads. This he achieved in 1957 with his R-7 Semyorka design, the first intercontinental ballistic missile.

The story of a man who designed a weapon of mass destruction for a state that had repeatedly tried to kill him might not seem like a particularly heartening tale, but Korolev was thinking of greater things. To him, the R-7 was a means of reaching space and in 1957, the International Geophysical Year, US President Eisenhower said his country would put an artificial satellite in orbit. Against strong resistance from the military and political leaders, Korolev persuaded Khrushchev that beating the Americans would be a bloodless victory in the Cold War. On 4 October of that year, Sputnik 1 was launched on Korolev's modified R-7 and the space race began. *

CAPTION PRIZES BAG A BOOK



This month's competition winner will receive copies of the 'Dan Dare Space Fleet Operations Manual' and the 'McLaren M23 Owners' Workshop Manual', two new titles from the ever-expanding range of Haynes Manuals (www.haynes.co.uk). Winner of our December 2013 issue competition is Godfrey Evans: 'Just think – another arm's width and I could have swung both cats!'.



Not many ancient rulers celebrated their achievements on the same scale as Rameses the Great.

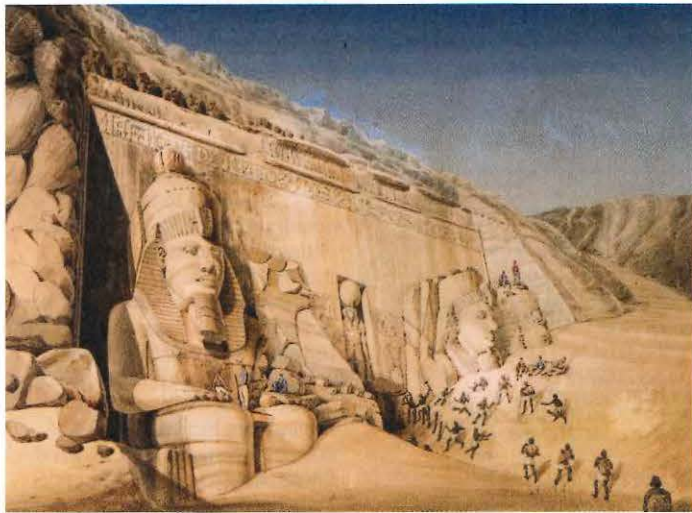
The Eccentric Engineer

by Justin Pollard



HISORICAL ARCHITECTURE

THE MOUNTAIN DEDICATED TO ONE PHARAOH'S GLORY



WE'VE LOOKED at a lot of modern engineering recently in this column, so I thought it might be time to get back to the originators of the big engineering statement. Ancient Egypt was a land of extravagant architectural gestures but few Pharaohs came close to Rameses the Great (c1303-c1213 BC) when it came to proclaiming his glory in stone, and nowhere did he do this better than in the temples he built at Abu Simbel.

What is most extraordinary about these buildings is that they were not constructed of the usual quarried and dressed masonry but were instead cut from the living rock of a sacred mountain. The mountain was effectively transformed into a temple. Into the vertical face of the rose-red sandstone, two buildings were excavated – the Greater Temple for Rameses and the Smaller Temple for his wife Nefertari.

The doors to both of these were flanked by colossal statues. At the entrance to the Greater Temple sat four seated images of Rameses (the upper part of one has since collapsed due to earthquake activity) wearing the double crown of Upper and

Lower Egypt, each 20m high and weighing around 1,200 tonnes. Above this sits a frieze of 22 Sun-worshipping baboons, while over the door an image of the falcon-headed god Ra-Harakhte holds the hieroglyphic symbols that, together with his image, make up Rameses' throne name – User-Maat-Re. As is traditional in Egyptian art, next to the pharaoh's gargantuan legs stand knee-high statues of Nefertari, the Queen mother and the king's first two sons and six daughters.

Between these huge statues is a doorway into the cliff face where a series of rooms have been excavated from the rock. Immediately inside is the Grand Hall, its 17m-high ceiling supported on eight pillars carved with the standing image of the pharaoh. On the surrounding walls are carved reliefs of Rameses' favourite scene, the Battle of Kadesh, at which the Pharaoh claimed he personally defeated the whole Hittite army after his own troops fled. This was, in truth, an exaggeration.

Through the grand hall lies another room with more peaceful scenes of Rameses and Nefertari making offerings to the gods,

Competition

What might these workers be saying as they unearth Rameses' temple complex? The wittiest caption emailed to engtechmag@theiet.org by 7 March wins a pair of books from Haynes.

which leads to a vestibule and three chapels. In the middle chapel, staring out from the gloom of the deep interior sits a row of four seated statues of Re Herakhte, the deified Rameses, Amun-Re and Ptah.

Excavating all this by hand using only copper tools is, of course, impressive in its own right, but what makes this feat of engineering astonishing is that the whole temple is aligned so that on just two days a year (20 October and 20 February) the rays of the Sun penetrate this inner sanctum, illuminating all the gods – except Ptah who, as god of the underworld, remains always in the shadows.

The Smaller Temple is equally unique. Flanking the door are 10m-tall statues of Rameses and Nefertari, who, unusually, is the same scale as her husband. It is also the first Egyptian temple dedicated to the wife of a Pharaoh, indicating the extraordinary position held at court by the woman who Rameses called 'The One for Whom the Sun Shines'.

The temple is dedicated to the Queen and the goddess Hathor, and the first hall inside is supported on six pillars whose capitals bear the face of Hathor. Beneath these on the pillars themselves are carved images of Nefertari playing the sistrum, a percussion instrument sacred to the goddess. The walls here are no less martial than the Greater temples, depicting Rameses in battle with Nefertari looking on. Three doors from the hall lead to a vestibule, which leads to the sanctuary. Here, amid scenes of Rameses and Nefertari, the Hathor cow is shown in high relief, emerging from the rock of the mountain.

Work on the temples began around 1284 BC, the inauguration being carried out by Rameses and his wife on their journey into Nubia in 1255 BC. By then construction was finished and the colossal statues were probably vividly painted, as were the interiors. Rameses' monumental achievement must have seemed set to last forever.

But Rameses' great good fortune – his extremely long reign – would also prove his curse. Outliving most of his sons, his legacy was a series of weak rulers under whose leadership control of Nubia slipped away. Rameses' greatest temple became just a distant memory and without the support of a central administration the buildings themselves ceased to function and their staff were dispersed. Soon the sands of the Western Desert were encroaching around the monuments engulfing them and hiding them from sight for over 2,000 years. *

CAPTION PRIZES BAG A BOOK



This month's competition winner will receive copies of the 'Dan Dare Space Fleet Operations Manual' and the 'McLaren M23 Owners' Workshop Manual', two titles from the ever-expanding range of Haynes Manuals (haynes.co.uk). Winner of our January 2014 issue competition is Martin Pate: 'You go ahead



without me, darling. I don't think they'll let me through the airport metal detector this time!'

In the midst of the Cold War, money was no object when it came to getting your hands on the opposition's technology.

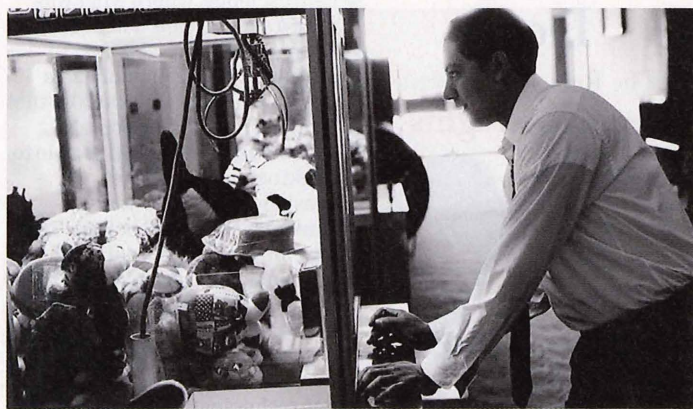
The Eccentric Engineer

by Justin Pollard



DEFENCE

THE SECRETS BEHIND WORLD'S LARGEST ARCADE GAME



DO YOU remember those claw grab machines on the end of the pier? How easy it was to manoeuvre the claw over the desired toy or teddy only for it then to slip out of the machine's surprisingly weak grasp. Still, at least it only cost you a few pence. In 1974 it cost the CIA \$800m (that's a modest \$3.6bn today).

To be fair the CIA weren't after a teddy. They had their eyes on a Soviet Golf II Class SSB strategic ballistic missile submarine, the K-129, which had disappeared in April 1968 somewhere in the Pacific. The Americans knew this because they had seen the Russian fleet scramble to find the boat, which they failed to do, and because they then found it themselves when their hydrophone network triangulated in on a deep-sea implosion that marked the final fate of the sub.

Since then they had also seen the wreck thanks to the splendidly named USS Halibut, a submarine fitted out to search for and photograph just this sort of thing, and what they saw looked very tempting. The only problem was the wreck was lying in nearly 5km of water. How could they get their hands on it?

In truth the problem was stickier still. This submarine wasn't really theirs so they'd not

only have to get it but they'd have to get it without anyone else, particularly the Soviets, noticing. And so they decided to build the biggest, sneakiest claw grab ever constructed.

The Hughes Glomar Explorer, as the ship was called, had a cover story of being designed to prospect for manganese nodules on the sea floor but was actually built to fish for K-129 in one the CIA's most secret operations of the Cold War, Project Azorian. Looking like a perfectly ordinary drilling ship from the outside, a major portion of its hull could open underwater to reveal a vast internal 'moon pool' through which a grabbing claw, known affectionately as Clementine, could be lowered on a pipe string similar to those used in oil drilling.

Once directly over the wrecked sub, the steel claw would then close around it and draw it up into the bowels of the Glomar Explorer without anyone outside being any the wiser. The US would have a treasure trove of Soviet nuclear technology, code books and data, which the Soviets wouldn't even know they'd lost.

As anyone who has tried to get a teddy from a machine on the pier can tell you, this sounds great in theory but is damn hard

Competition

What would this holidaymaker think of the Hughes Glomar Explorer? The wittiest caption emailed to engtechmag@theiet.org by 16 May wins a pair of books from Haynes.

in practice. Up until this date the deepest recovery of a sunken ship had been from 75m. The K-129 lay in nearly 5km of water and weighed 2,000 tonnes. Most crucial to the operation was going to be the claw, designed by Lockheed Missile and Space Company, which had to be able to stay oriented over the wreck.

While the ship was equipped with two automatic station-keeping systems it would still pitch and roll with the swell, so the claw had to be isolated from that movement using a motion-compensated and gimballed work platform. From this position its steel claws would reach around the sub's hull to capture it and then the whole rig would be lifted up towards the surface. While still submerged, a system of docking legs would then be lowered through the hull of the Glomar Explorer to attach to and stabilise the claw and load, which could then be drawn up into the ship's secret interior.

Even after the vast claw was built, the CIA still had to get it into the ship without anyone noticing so, never ones to shy away from a major engineering problem, they commissioned the world's largest submersible barge, the Hughes Mining Barge I. With the Lockheed claw loaded on-board, this barge was then submerged onto stabilising piers built on the seabed and the Glomar Explorer manoeuvred above it from where the grab could be taken into the ship's moon-pool.

The Glomar Explorer arrived at the wreck site in the mid-Pacific on 20 June 1974 in conditions of utmost secrecy. Not that that stopped two Soviet Naval vessels from dropping by to see what was happening. In fact, for all their secrecy, the Soviets had been

tipped off about the plan but simply didn't believe that it was possible so the CIA might have been able to save themselves the cost of a submersible barge.

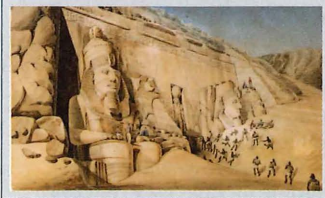
Meanwhile 'Clementine' was lowered over the wreck and attached itself to a substantial portion. Exactly what happened next is not so easy to tell as the CIA are quite a secretive bunch, but at some point during the lifting operation some of the steel teeth on Lockheed's claw sheared off and two-thirds of the recovered submarine broke away and plummeted back down to the seabed. To be fair, the mission was not a complete failure and one section of the sub was recovered, complete with nuclear torpedoes and various undisclosed other materials, but two-thirds of the prize slipped through their fingers forever.

It can't have been much different to the disappointment felt on an end-of-pier grab machine every day. But unlike those machines, this one cost \$800m a go and so the CIA decided not to play again. *

CAPTION PRIZES BAG A BOOK



This month's competition winner will receive copies of the 'Dan Dare Space Fleet Operations Manual' and the 'McLaren M23 Owners' Workshop Manual', two new titles from the ever-expanding range of Haynes Manuals (haynes.co.uk). Winner of our March 2013 issue competition is Alan Crowther: "Right lads; let's get this finished before the tide comes in."



In an unlikely family, a top secret wartime mission was perhaps the most unlikely thing a Marx brother did.

The Eccentric Engineer

by Justin Pollard



INVENTIONS

THE MAN WHO LEFT HOLLYWOOD TO BE AN ENGINEER



IT'S RARELY a good idea to drop an atomic bomb but it's never a good idea to accidentally drop one, so when it comes to holding such things in place you want a very serious-minded engineer. Or Zeppo Marx.

Herbert Marx, known as Zeppo to his friends, was, along with Gummo, one of the two lesser known Marx brothers, eclipsed somewhat by Groucho, Harpo and Chico. At least when it came to comedy. That didn't prevent Zeppo from starring in the first five Marx brothers films, including 'Duck Soup', although he was the one usually stuck with the straight role and, when the studio wanted to reduce costs by reducing numbers, he was the brother to be shown the door.

Not that this really bothered Zeppo. While some engineers may dream of running away to Hollywood to become a movie star, he dreamed of running away from Hollywood to become an engineer. And that's exactly what he did. The precise origins of his Marman Products company are a little shrouded in mystery. What we do know is that Zeppo had a gift for mechanics

and was the brother charged with keeping their first car on the road, having worked for a Ford dealership in the 1920s. This was an amateur interest at first, expressed in no more than his possession of a well-equipped machine shop where he would tinker when not acting as a theatrical agent (along with Gummo) representing his more successful brothers.

What happened next we only really have Zeppo's word for. He claimed that while breeding thoroughbred horses with Barbara Stanwyck – one of many sideline businesses – he was introduced to the president of the Douglas Aircraft Corporation who asked him to machine some parts for the DC3 aircraft. This might seem unusual but the work, in the run up to the Second World War, was 'sensitive' and the man from Douglas didn't trust most commercial machine shops. Zeppo agreed and hired a studio propsman from the RKO studio to come and do the work.

At this point the story becomes yet more peculiar. According to the Marx brother, he was working in the shop when a

Competition

What might Zeppo's brothers have to say about his invention? The wittiest caption emailed to engtechmag@theiet.org by 9 July wins a pair of books from Haynes.

destitute man walked in and asked him if he could construct a new type of clamp that he'd invented. Terms were agreed, royalty rates set and the clamp was made. At this point Zeppo apparently realised that this was a unique design that could be used to solve a number of engineering problems, notably how to connect high-pressure fuel lines in aircraft. Now he was a part-timer in the aircraft parts manufacturing business he could see an opportunity.

By this time the Second World War had broken out and such things were in high demand so Zeppo handed over the theatrical agency to Gummo and set up his own engineering firm – the Marman Products Company – poaching large numbers of props machinists from RKO Pictures. The pressure-resistant clamp, now known as the Marman clamp, was not useful only as a fuel line connector. As it could be manufactured in almost any size, it could be employed to secure cargo on aircraft. It was at this point that some 'men from the ministry' with a very particular need for secure clamps appeared.

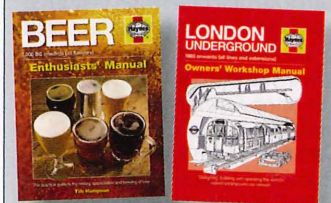
They were charged with finding a system for holding what was then the world's most secret and most deadly weapon in the bomb bay of a B29 Superfortress. Holding and then releasing the atomic bomb 'Little Boy' was perhaps one of the most mission-critical jobs a clamp could do and the experts had concluded that Zeppo Marx's Marman clamp was the one for the job.

On 6 August 1945 the Enola Gay set off on its fateful mission to bomb Hiroshima, carrying Zeppo's device. Another flew with 'Fat Man' on the Bockscar to Nagasaki. In an unlikely family it was perhaps the most unlikely thing a Marx brother did.

By the end of the war Zeppo's company was expanding, making over 200 items including small motorbikes, but the clamps remained its greatest achievement. Marman types have and still do hold together the upper stages of many rocket payloads, and John Glenn trusted his life to the one which held his Friendship 7 to the Atlas rocket that made him the first American in space.

By this point, however, Zeppo seems to have tired of running a machine shop. He sold the company for a considerable fortune in 1955 and tried his hand at numerous unusual businesses, including owning a fishing trawler and some orange groves. His love of engineering never quite left him. By the time of this death he was the proud owner of three patents including a wristwatch that could measure your pulse and set off an alarm if it became erratic – the forefather of wearable health devices. *

CAPTION PRIZES BAG A BOOK



This month's competition winner will receive copies of 'The Beer Enthusiasts' Manual' and 'London Underground Owners' Workshop Manual', two new titles from the ever-expanding range of Haynes Manuals (haynes.co.uk). Winner of our May 2014 issue competition is Derek Pate: 'A third of a nuclear submarine for \$800m is a lot cheaper than trying to win one of these teddy bears.'

