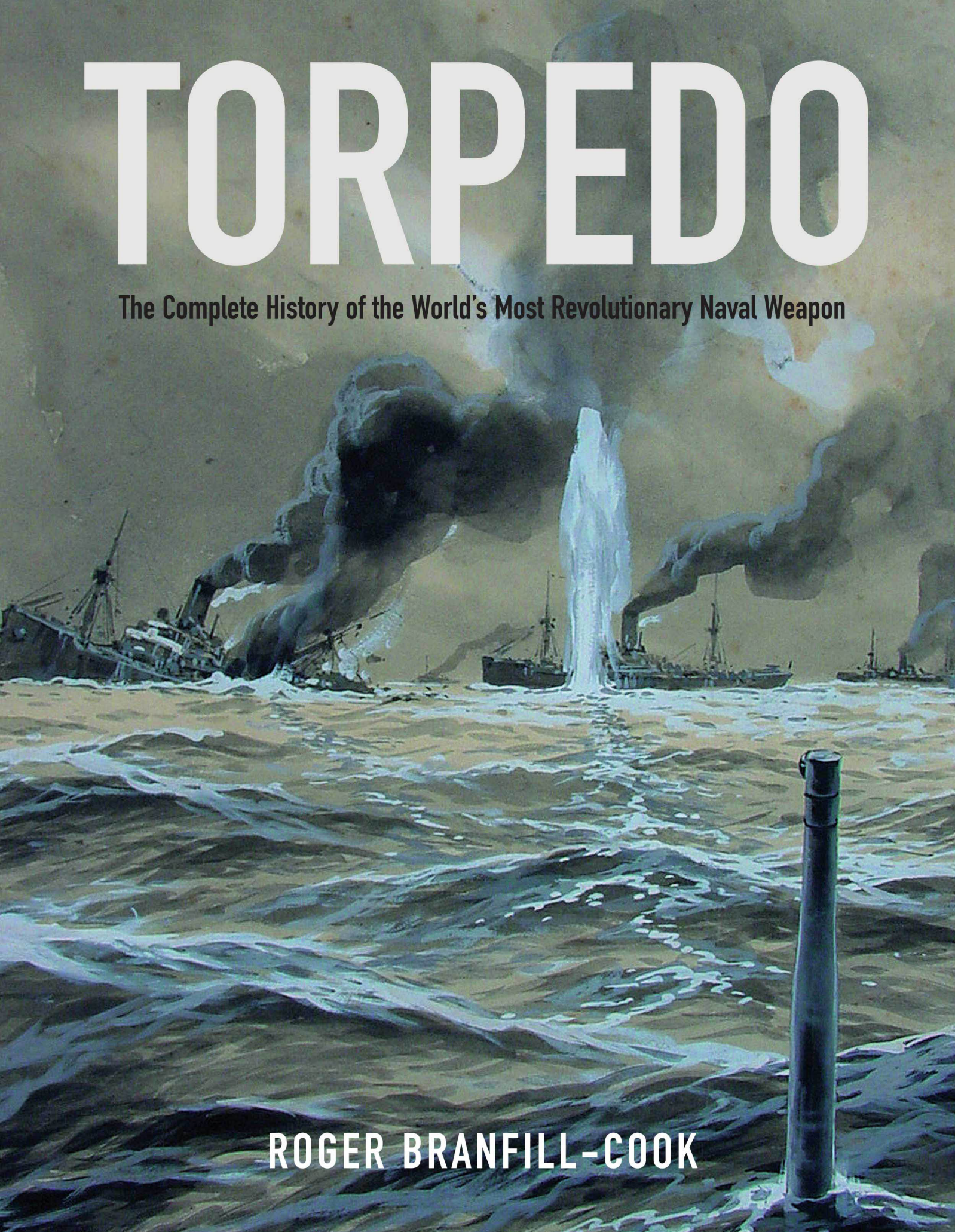
TORPEDO

The Complete History of the World's Most Revolutionary Naval Weapon



ROGER BRANFILL-COOK

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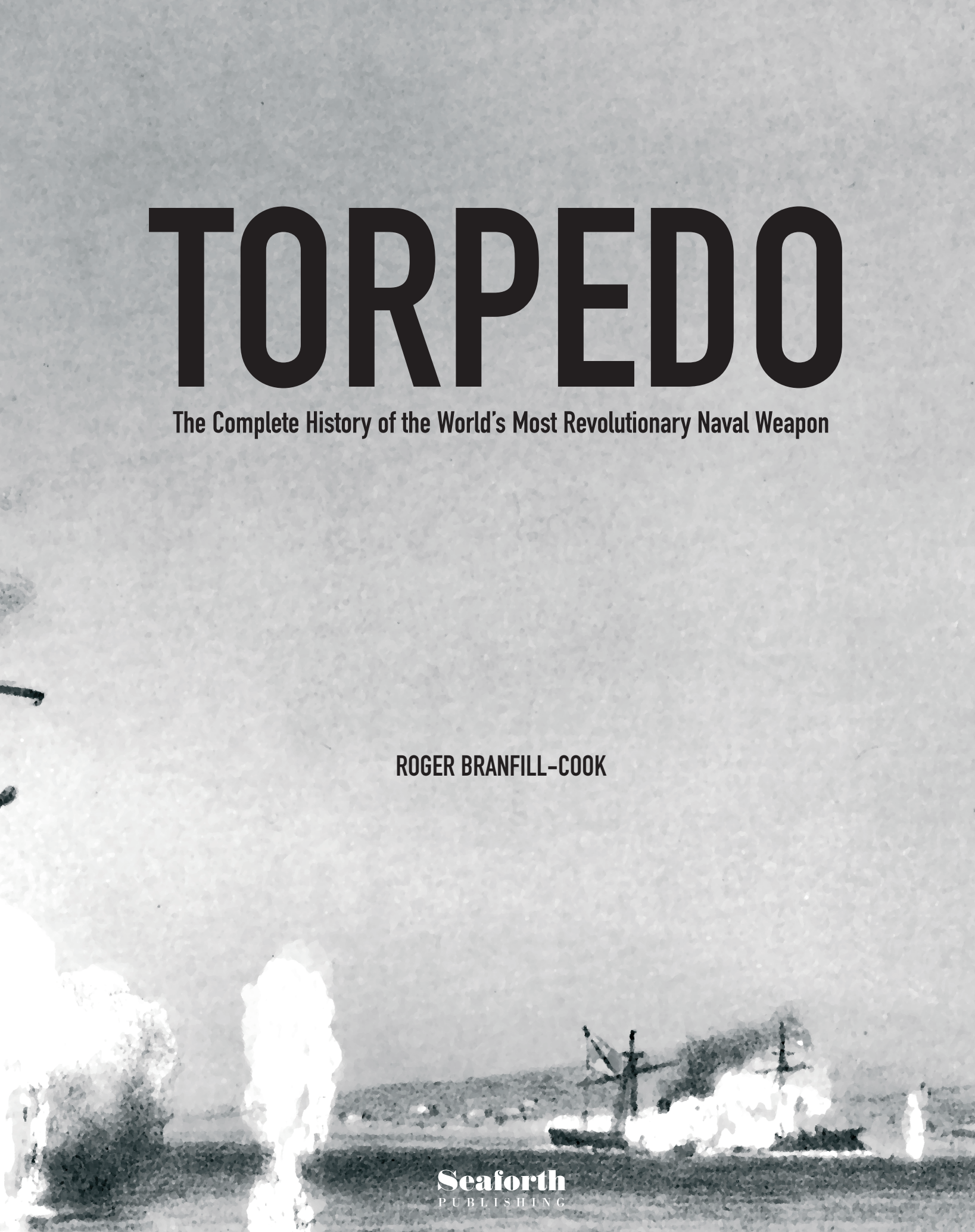

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FRONTISPIECE: The Battle of Pachoca, 6 May 1877, the first time a locomotive torpedo was fired in anger: launched by the British ironclad frigate *Shah*, the torpedo missed its target, the rebel Peruvian turret ship *Huáscar* (see page 170).

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Contents

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Wherever possible the illustrations included in this book are credited to their originators or to the institutions which hold them for future generations. I have been collecting and reading books on naval subjects for over fifty years, which means that many of the authors whose works I quote left us many years ago. Others are still alive, but not even the editors of their last works can trace them.

When information has been discovered on the Internet, and the original source is either not stated or was unknown, I have not hesitated to reproduce the appropriate illustrations, lest they be lost to our common pool of knowledge with the disappearance of the website. If any of the authors and artists whom I have been unable to contact, even after extensive enquiries, see their work included in this book, it is with the aim of giving them full credit, and referring readers to find and browse their books with the same pleasure that they have given me.

I must record my sincere thanks and appreciation to the following who have aided me in putting together this encyclopedia. Without their contributions the work would have been the poorer.

Hallvard Aasdalen, Bjørn Bakkhe and Kjell J Glosli for help with the Oscarsborg torpedo battery.
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And my especial thanks go to my editor, Robert Gardiner, for his help and encouragement.
Roger Branfill-Cook,
Ivoiry

Introduction

The torpedo was the great leveller of the age of the ironclad, and the principal weapon of the U-boat forces that nearly secured victory for Germany in both world wars. Winston Churchill said that during the whole of the Second World War the only threat he really feared was the U-boat offensive in the Atlantic. In the Pacific, the torpedo was the weapon used by the US Navy to sink the majority of Imperial Japan's warships and virtually all of her merchant fleet between 1941 and 1945, isolating her island garrisons and strangling the Home Islands themselves. It was torpedoes which sealed the fate of the *Bismarck*, crippled the Italian battle fleet at Taranto, sank most of the battleship casualties at Pearl Harbor and finally put down the largest dreadnoughts ever built.

For all the immense investment in large-calibre guns and thick armour, apart from the three British battlecruiser losses at Jutland (which were almost certainly the result of poor ammunition-handling procedures), of all the dreadnought battleships and battlecruisers, only *Hood* and *Kirishima* were sunk by heavy gunfire alone. Ironically, both were British battlecruiser designs. On the other hand, in both world wars, torpedoes launched either by the enemy or by their own side – to scuttle them – sank no less than twenty dreadnoughts. They were, in order of sinking: *Lützow* (scuttled), *Svobodnaya Rossiya* (scuttled), *Szent István*, *Royal Oak*, *Conte di Cavour*, *Littorio*, *Caio Duilio*, *Barham*, *Oklahoma*, *West Virginia*, *California*, *Repulse*, *Prince of Wales*, *Hiei* (scuttled), *Scharnhorst*, *Musashi*, *Fuso*, *Yamashiro*, *Kongo* and *Yamato*.

Up until the dramatic introduction of the Fritz-X guided armour-piercing bomb which sank the *Roma*, bombers had the ability to damage a capital ship on the high seas, free to manoeuvre and able to defend itself, but not sink it. Only the torpedo could guarantee immobilising and even sinking a battleship at sea. But despite the introduction of anti-ship guided missiles in the latter part of the Second World War, and their modern descendants today, the torpedo remained, and still remains, the ship-killer par excellence.

Hundreds of warships and tens of thousands of merchant ships have been sunk by torpedoes, or were so severely damaged that they were knocked out of action for months, if not years. In the modern age, the torpedo continues to be the major arbiter of potential naval actions worldwide, some 150 years after Robert Whitehead's invention first took to the water.

When my publisher asked me to compile this encyclopedia of the torpedo, my first reaction was that the subject matter is immense. To tell the whole story in all its minor details would take a multi-volume work running to several thousand pages, which few would purchase and even fewer read in its entirety.

As I began collating information, I quickly came to realise that a large amount of technical and historical detail is already available, if one only knows where to search. The detailed technical history of torpedo development has been well covered by those authors to whom I pay due acknowledgement. In addition, a vast store of technical, historical and photographic information is salted away in the various national and naval archives, truly an Aladdin's cave for those who wish to delve deeply into the specifications of any particular model of torpedo. I must pay tribute to the dedicated and often underfunded archivists and museum curators, who are the guardians of knowledge for present and future generations.

Then there is that universal trove of knowledge, the Web. Here one can browse long into the night, lured by links which lead off into hitherto unknown territories. But the Web is to be treated with caution: the amateur nature of the Web means that all too often contributors repeat the errors of authors who should have known better, not having had the time or the opportunity to return to the original sources. Web articles are often contradictory, and sometimes downright incorrect. What saves the Web is that with the presence of a site moderator one can correct such errors by quoting original sources. But the biggest weakness of the Web is its transitory nature: when the webmaster passes on, or loses interest, the information disappears. That is why I have used details published on certain specialist websites in my encyclopedia, with the aim of not only preserving the information, but also recognising the unpaid efforts of these enthusiasts.

Wherever possible, I have used current photographs to illustrate certain items, preferring even shots taken through display cases to official photographic records from archives. My aim is to encourage readers to visit every museum and heritage site they can, from the surviving ships themselves to the magnificent artefacts such as the huge cutaway model of the Austro-Hungarian battleship *Viribus Unitis* in the Vienna Military Museum.

Because of the wide scope of the subject, I have deliberately restricted myself to the mobile, fish or

automobile torpedo and its derivatives. The original definition of a 'torpedo' was applied to an underwater explosive device for coast defence, which became the naval mine; this is in itself a vast subject, which lies outside the scope of this work, although the hybrid Mark 24 'mine' and the hybrid Mark 60 Captor will, however, be found here.

I have included several photographs and drawings of torpedoes, but the examples are far from exhaustive. There are hundreds of different types, but in reality they all share certain basic characteristics: a metal cylinder, of varying length and diameter, made of steel or bronze; an early pointed nose, changing to a less acute point, then a blunt rounded shape, finally ending with a metaplat (flattened nose) in the most modern types; whiskers and exploder can be found protruding from the nose of many types, and although practice heads did not, of course, carry exploders, divers must beware of later torpedoes, which carried an inertia exploder internally, in the upper or lower part of the nose; at the opposite end, first one, then two propellers, initially two-bladed but then increasing to three, four and six blades, before disappearing completely. The earliest stabilising fins ran along the top and bottom of the cylinder, but these soon disappeared, leaving two horizontal tail fins and two vertical: the Whitehead Fiume factory put the tail fins behind the propellers, the Royal Laboratories ('RL') version had them before the propellers.

There are very few divergences. If you come across a torpedo with an oval cross-section instead of round, you have a Brennan. If the torpedo has two propellers set side by side at the tail, it is almost certain to be a Howell.

Due to the large number of different torpedoes, specifications are generally omitted from the narrative, so readers who require technical details of a particular model of torpedo or a range of torpedoes from, say, a specific country, should look in the tables in Part V.

In my research, I found very little published information on the wide variety of torpedo delivery vehicles and launch systems, and I have done my best to provide what I freely admit is a basic introduction to this topic. Again, the issue of anti-torpedo defence has been previously addressed here and there, but I have tried to tie up the various threads of a struggle which is still ongoing.

In bringing the whole story together, I have tried to give a broad, yet still detailed, overview of this important subject, to serve as a general reference work for naval enthusiasts and historians.

In conclusion, I must pay tribute to the work of the late Edwyn Gray, the undisputed expert on early torpedo development. Gray spent years tracking down the most obscure inventor and the most unfeasible patent application, in order to write his two major reference works listed in the Bibliography. After his death his extensive research files were donated by his widow to the RN Submarine Museum in Gosport. In compiling this encyclopedia, I have surfed widely in his books for my précis of the early development of the fish torpedo, but I wholeheartedly refer the reader to the works of Edwyn Gray for fuller details.

Part I

The Inventors and their Torpedoes, Successful and Imaginative

CHAPTER 1

Robert Fulton and his Infernal Devices, 1804–1813

In the nineteenth century the name of Robert Whitehead was generally synonymous with that of his invention: in the press of the day, torpedoes were referred to not by their designation or manufacturer, but as 'Whiteheads'. However, the story of the torpedo itself does not begin with Robert Whitehead, but instead with that prolific genius, Robert Fulton, some sixty years earlier.

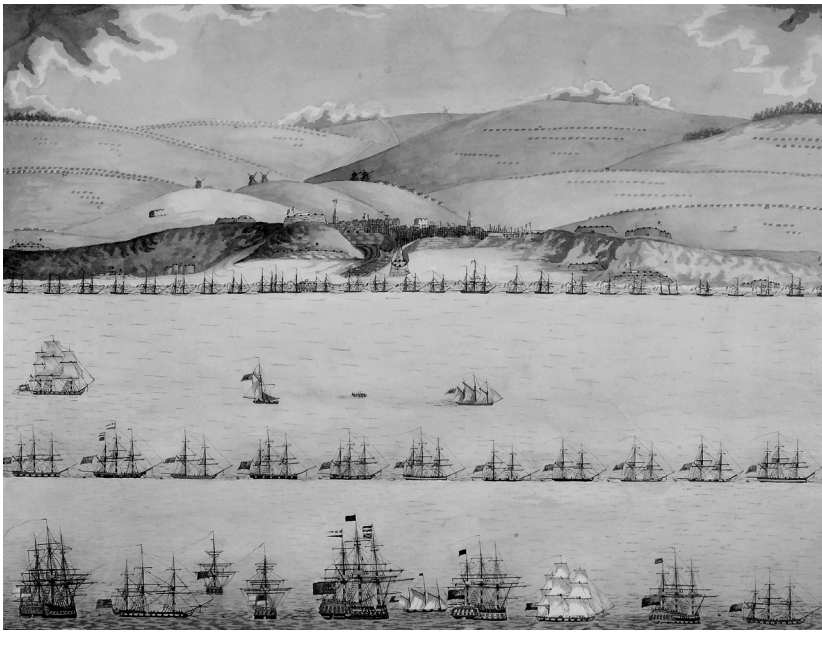
In the course of his short but fruitful career, Robert Fulton designed canal dredging equipment, a steamboat tested on the Seine on 9 August 1803, and the *North River Steamboat,* the first successful passenger-carrying steam vessel, in 1807. During the Anglo-American War of 1812, he designed the first steam warship, *Demologos*, which was not completed until after his death, and was then renamed *Fulton* in his honour. Before he died, he had proposed a submerged cannon which he christened the *Columbiad*, designed to fire projectiles into the vulnerable underwater hull of an enemy vessel. He was, of course, conversant with the attempt by his fellow American, Bushnell, to destroy British warships using his primitive submarine boat the *Turtle* during the Revolutionary War. He was also aware of the reasons why Bushnell had failed. And he took up the name 'torpedo', which Bushnell had used to describe his explosive devices.

And so it was, during a visit to France, that he decided to offer his services to the French government. In December 1799 Napoleon had returned to Paris from his triumphs in Italy, and he immediately began planning an attack on England. It was on the 12th of the same month that Fulton proposed to the French to build a submarine to help them in their war effort. His offer was refused but he built the submarine anyway, named it the *Nautilus* and successfully tested it in the Seine on 13 June 1800. However, the problem of designing a suitable weapon for his submarine – the same as had put an end to Bushnell's experiment – led Fulton to concentrate instead on underwater explosive devices.

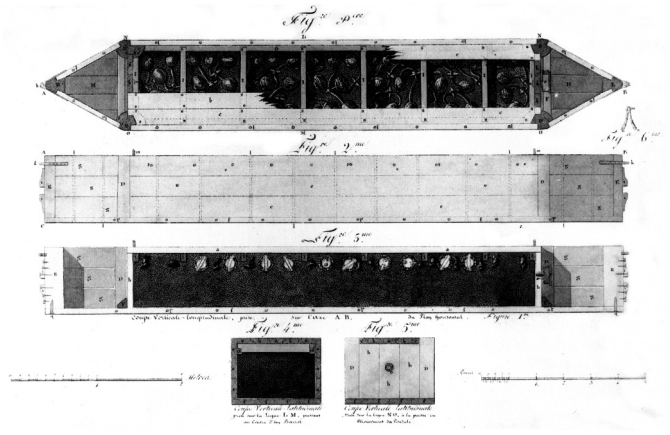
In 1803 he showed his steam launch to Napoleon; this would, if developed, have given the French a major advantage in launching a cross-Channel invasion. However, the innovative Fulton fell foul of one major obstacle: in military matters Napoleon was at heart a conservative. He had even rejected the first practical breech-loading rifles firing self-contained cartridges offered by Pauly of Paris, preferring to put his faith in the old-fashioned muzzle-loading flintlocks. He would never be prepared to risk sending his army to sea based on unproven schemes by Fulton. Disappointed by the attitude of the French, Fulton did what every self-respecting armament salesman would do, and crossed to the other side.

The British were aware that at sea they had the upper hand, but the margins were slim, for at any moment adverse weather or faulty strategy might allow the French army to debouch onto the beaches of southeast England. In such a scenario the British were none too confident of success; far better to prevent the invasion before it could be launched. By 1804 Napoleon was amassing his '*Grande Armée*' on the heights above Boulogne, and the French navy was busy building invasion barges. The British tried without success to stop them using conventional tactics and technology, but the coastline was difficult to approach and French defence works were just too strong. They needed an advantage, an edge, and Fulton proposed to give them just that.

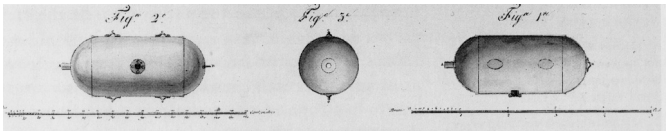
Although Fulton later claimed that the British response was lukewarm at best, in fact he was supported



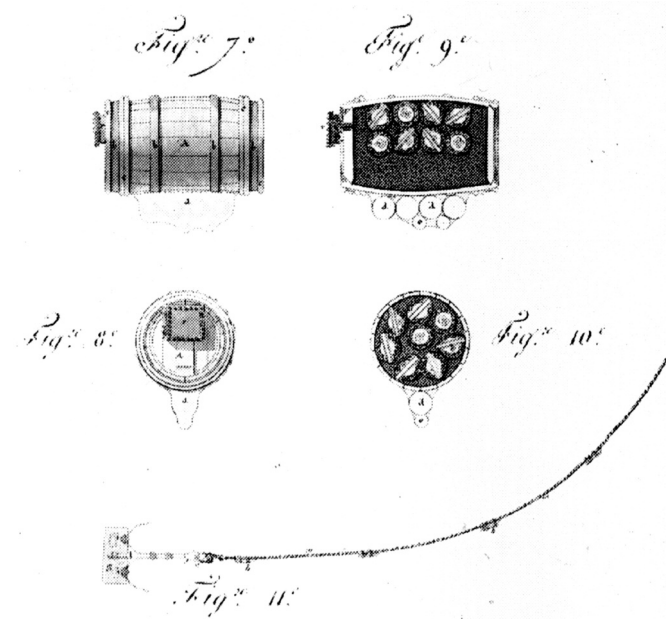
The French defences facing the British in October 1804: a line of British warships moored bow to stern prepares to bombard the port. The Grand Army is camped on the heights, and the principal target, the boats of the invasion fleet, are moored against the shoreline, covered by guns and mortars ashore. (© National Maritime Museum, Greenwich, London, PZ6989)



Here is what appears to be one of the 'large coffers'. It measured around 21ft (6.4m) long. At the right-hand end in the drawing is an attachment to enable it to be towed into action.



The second drawing shows what appear to be copper casks. These are probably the 'small coffers'. Fulton had used copper as the external skin of his submarine *Nautilus*, and also for constructing 'submarine bombs' during his stay in France.



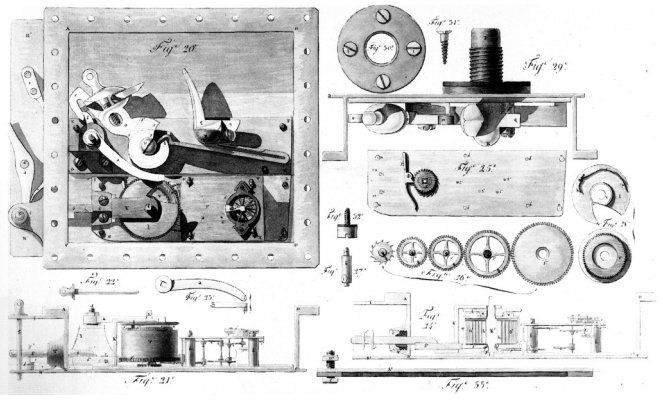
Here we have the 'hogsheads'. They are described as being the size of a forty-gallon cask. They have weights, probably iron cannonballs, attached to their underneath to ensure that they float one way up, otherwise the priming powder could fall from the pan in the fuse. The drawing at the bottom presumably shows a hogshead being towed into position.

by the highest echelons of government, who ensured that considerable resources were put at his disposal. He was given the cover name of 'Mr Francis' and some of the Royal Navy's most enterprising officers were seconded to the enterprise.

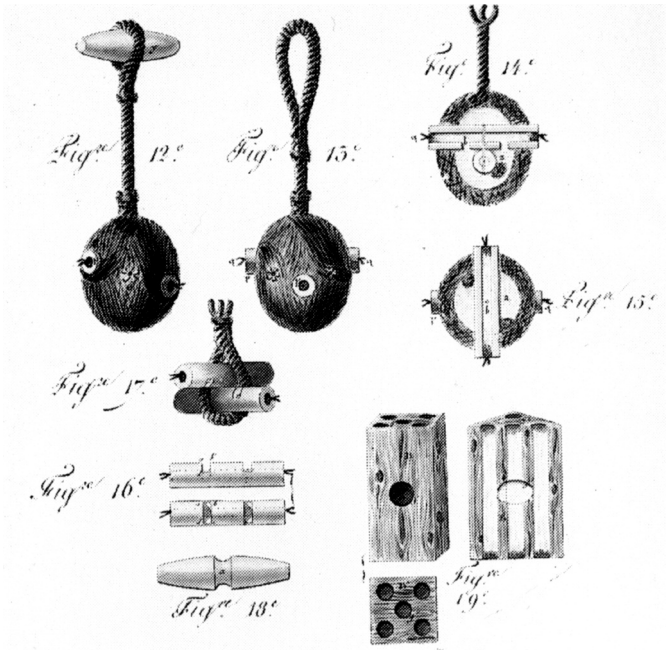
Following on from his experiments in France, he designed several novel devices for attacking the invasion barges, which like many unconventional weapons before them were generically dubbed 'infernal devices'. For the first planned attack on Boulogne in August 1804, Fulton produced '5 large coffers, 5 small, and 10 hogsheads'. Happily, a folder exists in the National Maritime Museum containing drawings of his inventions, ironically drafted by a Frenchman, a certain Monsieur Garriguer, who sent them to Monsieur Guillemard, navy engineer at Rochefort. The artist would appear to have had first-hand access to some of Fulton's devices, which had failed to explode as planned.

These 'infernal devices' were packed with 'incendiary balls' and the space between them filled with gunpowder. They were to be exploded by means of a clockwork delay fuse which tripped a flintlock action, all contained in a waterproof box. The prewound and cocked fuses were to be activated by withdrawing a pin, and the operators were tasked with returning each pin as proof that the devices had been correctly armed.

It appears that Fulton had designed what, in modern terms, are designated sub-munitions. As the shock from exploding black powder would usually be effective only within a limited radius, the sub-munitions could spread mayhem over a wide area, setting fire to sail and cordage and timber alike. One can only hope that Fulton had tested these devices before sending men into combat to risk their lives with them. One basic drawback would appear to be



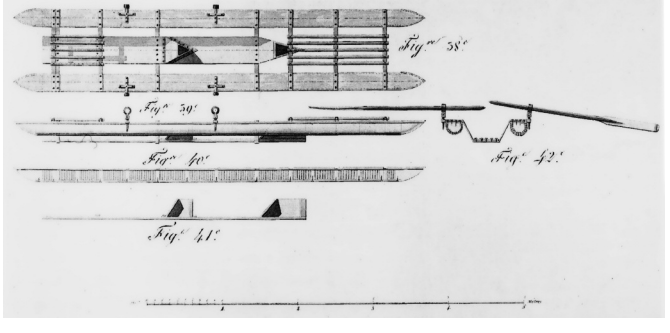
One of the intricate clockwork fuses. One has to wonder why the original used as the basis of the drawing had not actually tripped. Perhaps it was a trifle too complex for 100 per cent operational reliability.



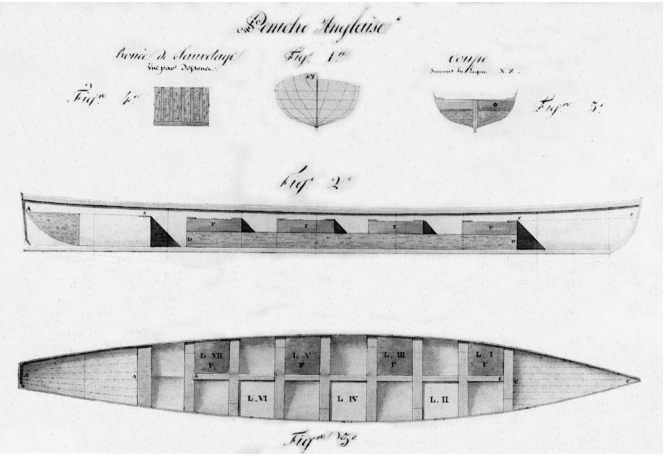
Here are the 'incendiary balls' contained in the gunpowder filling.

ensuring that the incendiary balls actually caught fire as they were ejected, and were not simply blown to pieces.

To deliver his 'infernals' into the ranks of the French, Fulton conceived a stealth craft, a small catamaran to be sculled by a crew of two, dressed in black and wearing masks (like the current image of a ninja). It is unlikely that Fulton himself designed these, but in trials they proved 'barely discernable at 25 fathoms (46m) and invisible at 35 (64m) even from halfway up the rigging'. The payload was to be carried on the gratings fore and aft. Since these flimsy craft would be completely incapable, in any tideway, of towing the large coffers and even the hogsheads by the efforts of only two men, their weapons must have been the small copper cylinders. That would leave the large coffers and the hogsheads to be towed into release position by oared cutters, allowing them to drift down, joined together in pairs, under wind and current towards their intended victims.



The lightly-built catamaran, with supports for the two rowers, and two pairs of sculls.

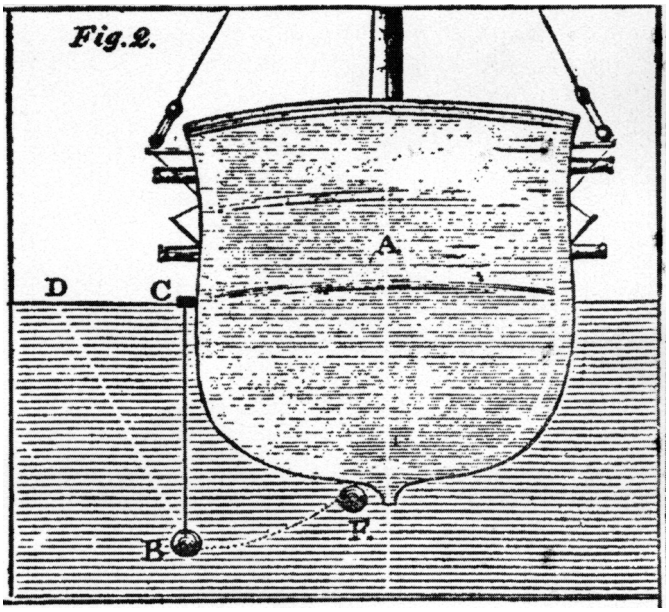


To ensure the recovery of the catamaran teams, there was even a lifeboat, with extra buoyancy from compartments filled with cork, to enable them to survive under small-arms fire from the defenders.

With such emphasis on stealth, it is disappointing to note that the British attack, when it went in against Boulogne on the night of 2 October 1804, was clearly anticipated by French Rear Admiral Lacrosse. To add to the lack of subtlety, the British sent in no less than four fireships, towed by armed launches. Into the middle of all this, Fulton's stealth teams paddled their catamarans at a snail's pace. Despite the considerable efforts expended, the results were disappointing. Only one French pinnace was sunk, her crew of fourteen men being killed in the explosion of a fireship they were boarding. There were no casualties on the British side, so the lifeboats appear to have worked as planned.

On 8 December an attempt was made to destroy Fort Rouge, guarding the entrance to the port of Calais, using one fireship and two catamarans, one of which missed the fort and the other of which failed to explode. This time there were no casualties on either side. A third attack was launched, against Boulogne, on 1 October 1805, but this time employing improved versions of Congreve's incendiary rockets (which were to produce the 'rockets' red glare' over Baltimore seven years later), and this time the French were taken by surprise and fires started ashore.

Fulton's fiendish devices were towed into action by Captain Seccombe in a boat rowed by eight men, plus the coxswain, who placed the devices so as to lie on port and starboard sides of a French gun brig anchored in Boulogne Roads. A boat from HMS *Immortalité* commanded by Lieutenant Payne did the same. On withdrawing, the two officers were disappointed to see that the explosions on each side of their two target vessels appeared to have had no effect. The next morning Fulton was at a loss to explain why the infernal devices had not, as intended, destroyed

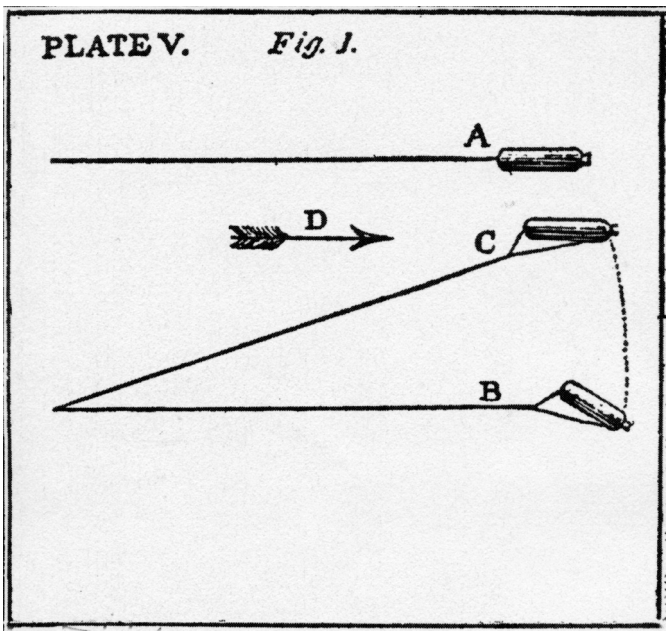


Fulton's explanatory drawing of the under-keel explosion from his treatise *Torpedo War and Submarine Explosions.*

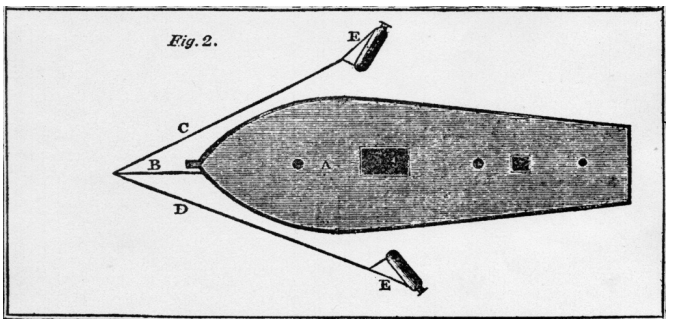
the French brigs. Later reports in French newspapers confirmed that the explosions had only produced a shock effect and canted the vessels to one side, without damaging them.

Fulton set his analytical mind to work, and realised that if the explosion took place alongside the hull, the blast effect would rise vertically beside the ship. What was needed was a means of ensuring that the explosion took place under the keel. He envisaged the shock wave of a solid body of water being displaced upwards against a small part of the ship's bottom, which would give way, the explosion having the same effect as if the vessel had been thrown bodily upwards some 20 or 30ft (6 or 9m), and then dropped back down onto a rock 3–4ft (90–120cm) in diameter. He had invented the modern ship-breaking under-keel explosion almost 140 years before it was first used in action.

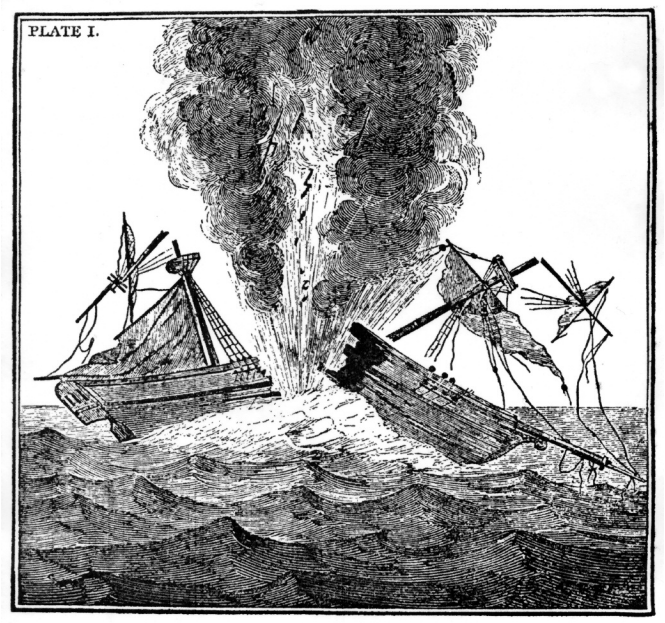
Nevertheless, he still had to work out how to ensure that his torpedo passed beneath the bottom of the ship to finish up next to the keel instead of merely lying alongside. He kept to his original plan of towing two torpedoes joined together, then releasing them either side of the target vessel's anchor chain. However, instead of simply attaching the joining rope to the centre of the torpedo tail as at 'A' in the above drawing, he arranged the rope so that each torpedo was attached at an angle by a bridle, as in 'B' and 'C'. The action of the tide, represented by the arrow 'D', could then be used to swing one or both torpedoes



The revised method of attaching the torpedoes.



The modified torpedoes as they were deployed against the *Dorothea*. 'B' is the anchor cable.



The spectacular end of the *Dorothea*, the very first vessel to be destroyed by an underwater explosive device.

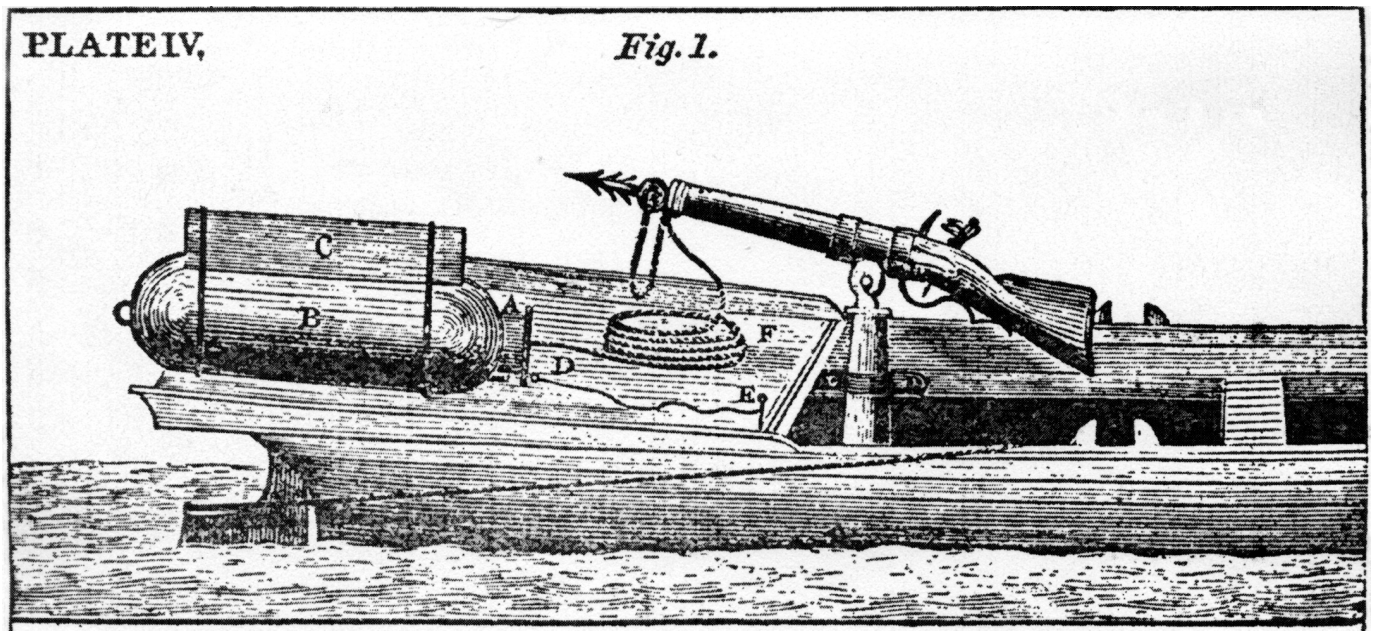
towards the ship and draw it up against the bottom of the hull, where the clockwork fuse would detonate it.

Back in England, to maintain confidence in his towed torpedoes, Fulton put on a demonstration on 15 October 1805 using his new bridle torpedo attachments, in which an old brig, the 200-ton *Dorothea*, was attacked by rowboats towing two of his modified devices, one of which was filled with 180 pounds (lbs) (82kg) of powder, to be set off by an eighteen-minute delay fuse. After the boats' crews had practised the operation several times, the real attack went in, and the two torpedoes, joined by 70ft (21.3m) of rope, were released to catch on the *Dorothea*'s anchor cable. During this manoeuvre one of the observers, Captain Kingston, was heard to declare – presumably on the basis of Fulton's failure at Boulogne – that if the torpedo were placed under his cabin while he was at dinner, he should feel no concern for the consequences.

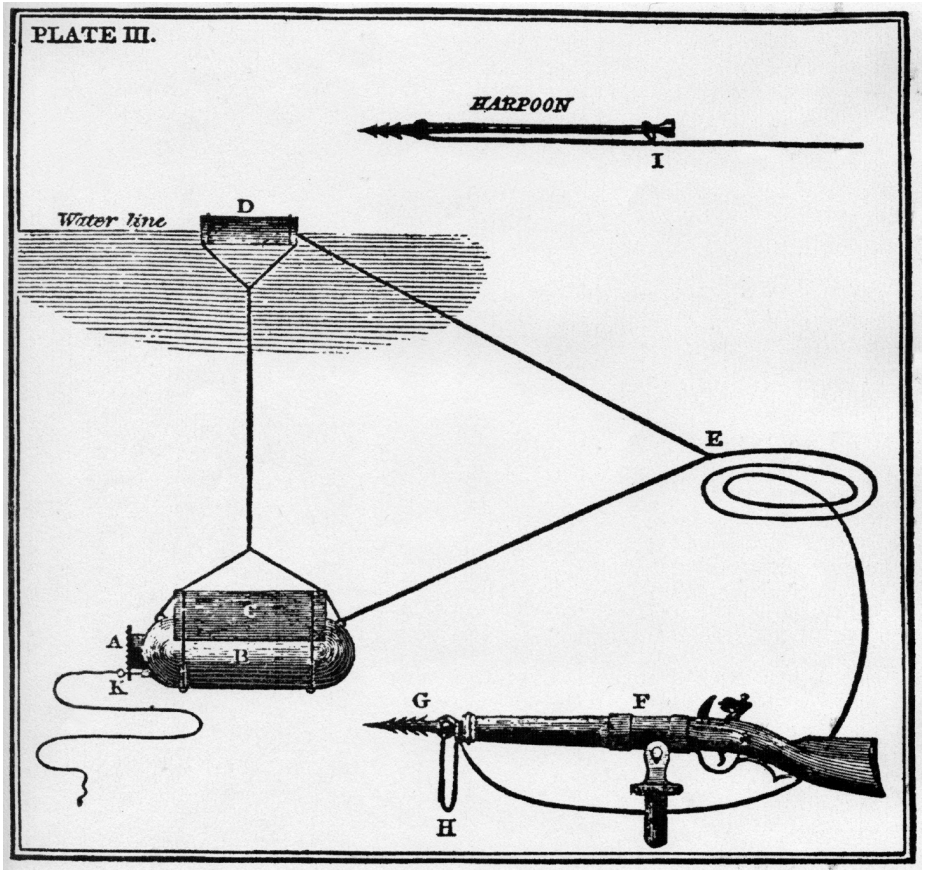
Twenty minutes later, just as Fulton had planned, the explosion beneath her keel lifted the brig bodily some 6ft (2m); she broke in half, and both halves rapidly sank. Fulton described the result as 'in twenty seconds, nothing was to be seen of her except floating fragments'. One is left to imagine that the demonstration drastically changed Captain Kingston's opinion. The one hundred Royal Navy officers and the government officials present were suitably impressed, but just a week later Napoleon's hopes of invasion were dashed at Trafalgar. With the threat removed, there was no further employment for Fulton, and he returned home to the States.

On 20 July 1807 he sank a 200-ton brig off Governor's Island, New York, in front of an audience of some two thousand spectators. He had once more modified the torpedoes, suspending them from floats to keep them several feet below the waterline of the victim. Even so, it took three attempts. On the first, the fuse became inverted, and the priming powder in the flintlock pan fell out, so it did not go off. On the second attempt, the towed torpedoes missed the ship's cable completely, and blew up 100yds (90m) past her, throwing up an impressive column of water 60 or 70ft (18 to 20m) high. On the third attempt, no doubt to everyone's delight, the brig was blown up and broke in two, just like the *Dorothea*.

To make absolutely certain that in future his torpedoes would not miss the target, Fulton proposed a new method of attack. This was described in his treatise on *Torpedo War and Submarine Explosions* published in New York in 1810 (and from which Fulton's drawings in this section are taken). He imagined a clinker-built rowboat some 27ft (8.3m) long, with a beam of 6ft (1.8m), single-banked, with six long oars. For self-defence the boat was to be armed with four blunderbusses, mounted one on each quarter (for reasons of clarity they are omitted from the drawing below). Fulton had read a report in a French newspaper of how back in 1805 the blunderbuss in Captain Seccombe's boat had not only protected them from French musket fire from their intended victim, but had caused the only French casualties in the attack at Boulogne. On the stern of the rowboat was attached a platform, extending out above the rudder and carrying a fifth blunderbuss, but this one was to be loaded with an iron harpoon half an inch (12.7mm) in diameter and 2ft (61cm) long.



Fulton's torpedo-boat design of 1810.



The details of Fulton's harpoon float torpedo.

A greased rope was attached to the harpoon's nose, and also to a ring ('I' in the drawing above) which, when the harpoon was fired, was free to slide backwards along the shaft, coming to rest in front of a base cup. Fulton designed this arrangement to act as a stabiliser for the harpoon, as a result of up to twenty trial shots, in which he claimed to have never missed a target 6ft square (1.8m x 1.8m) set up at between 30ft and 50ft (9–15m) from the gun. Each time, the head of the harpoon was driven clean through timber 3in (76mm) thick.

On firing the harpoon at an enemy ship's timber hull, the greased rope would uncoil, and pull the torpedo body after it. The torpedo was to be armed automatically: a separate rope attached to the deck ('E' in the drawing of the torpedo boat) would be pulled from the torpedo fuse, setting the clockwork delay mechanism in motion. The torpedo itself was to be suspended beneath the surface from a float cork, and the length of the suspension rope was to be adjusted so as to take into account the draught of the vessel being attacked, to ensure the torpedo finished up underneath the keel. Fulton had invented a simple torpedo depth setting.

All this was described in his 1810 treatise, together with elaborate calculations of how much money would be saved by flotillas of his harpoon torpedo boats, compared with the price of building and manning just one 80-gun ship of the line. It was evident from his writing which attacking naval power he intended to protect the United States against, presumably because they had not proceeded with his torpedo designs.

But then he turned his attention away from towed torpedoes, and harpoon torpedoes, and set out plans for moored observation mines. He even devised an automatic system whereby at preset intervals each mine would set its arming lever to 'safe', and would return to the surface for routine maintenance.

Having launched the first successful steam passenger vessel in history, Fulton later turned his attention to helping his country to fend off British coastal attacks during the War of 1812, proposing the use of the spar torpedo – which was actually used in action against British ships – and designing the steam-powered floating battery *Demologos*, to be armed with a battery of underwater cannons. Then, at the young age of forty-nine, he died suddenly as the result of catching pneumonia after saving a friend who had fallen through the ice on the Hudson River. It would be in another American conflict, and almost fifty years later, before his spar torpedo went into action again.

CHAPTER 2

Fulton's Legacy

THE SPAR TORPEDO

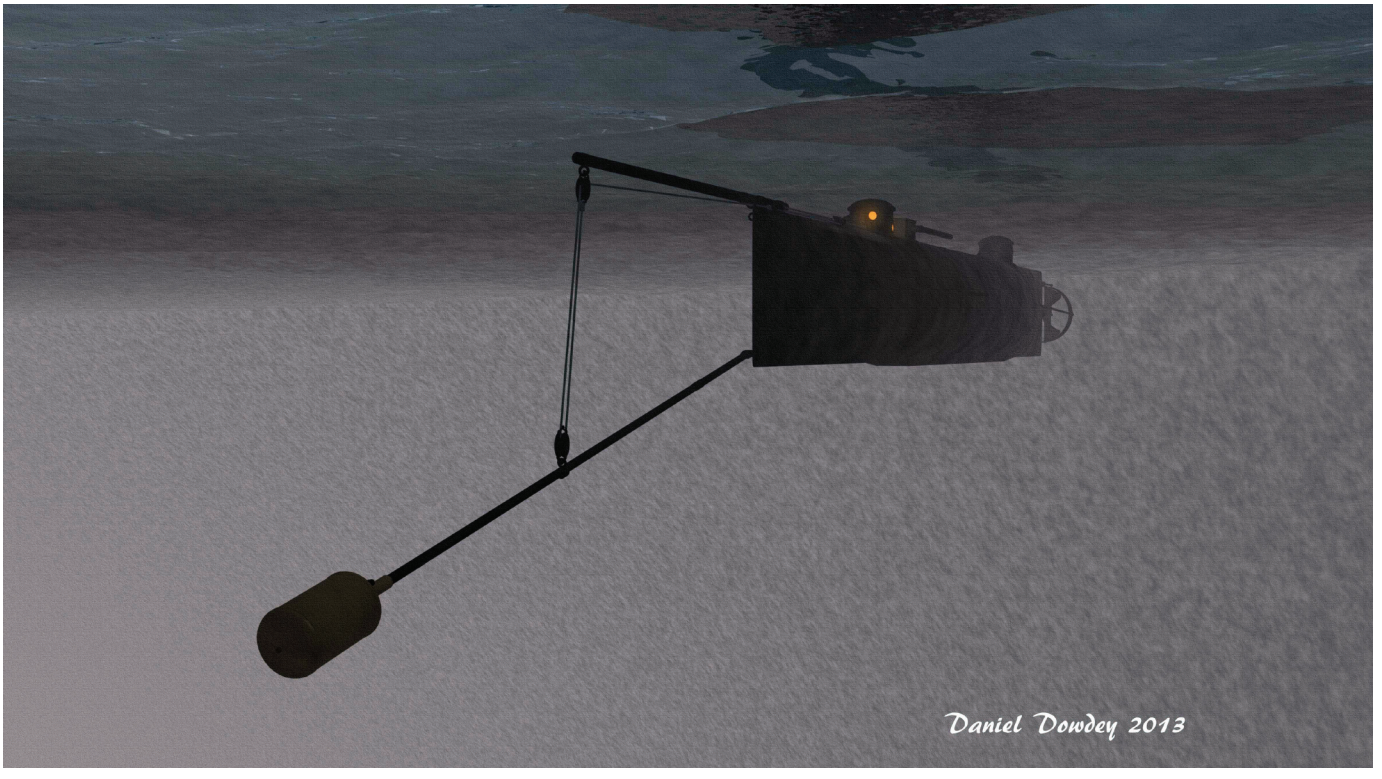
Although Robert Fulton never actually built a spar torpedo, on 4 September 1813 he had described to Captain Stephen Decatur a new method of torpedo attack he had devised. Fulton proceeded to draw a diagram showing a boat supporting two torpedoes on long spars which projected below the level of its keel, and which were to be exploded against the underwater hull of an enemy ship. Since he had acted in an advisory capacity during the war with Britain, it is conceivable that his ideas had been put into practice by others. It is on record, for instance, that HMS *Ramillies* captured and sank a spar torpedo boat off Long Island in 1813, and there is evidence of their use on the Great Lakes.

The first effective spar torpedo attack had to wait another fifty years, when Confederate Lieutenant William T Glassell, commanding a 'David' semi-submersible torpedo boat, exploded his spar torpedo against the Union frigate USS *New Ironsides* on 5 October 1863. His victim did not sink, but was badly damaged.

The first successful submarine attack was the *H L Hunley*'s sinking of the USS *Housatonic* on the night of 17 February 1864, again using a spar torpedo. The little submersible was a desperate measure by the Confederates to break the stranglehold of the Union navy's blockade of the port of Charleston. Prior to her successful action, she had already drowned most of the men of two of her crews, and following the attack she disappeared. Her wreck was discovered buried in silt and sand not far off Charleston Harbour in 2000. The Friends of the *Hunley*, the association which raised and is working to preserve her, has full details of this pioneer vessel on their website www.hunley.org.

Historians had always assumed that the *Hunley*'s commander would attempt to ram the spar torpedo into the hull of his target like one of Fulton's harpoons, then withdraw, leaving the weapon impaled in the victim. The charge would be detonated at a safe distance by pulling on a cord attached to the torpedo. Study of the tip of *Hunley*'s spar, however, has revealed the remains of the copper casing of the torpedo, meaning that it was detonated when still attached to the spar. A Singer drawing of the torpedo in The National Archives has been used to calculate that it

An illustration of the *H L Hunley* by Daniel Dowdey, showing her spar torpedo. (Friends of the *Hunley*)



contained a charge of up to 135lbs (61kg) of black powder. As the spar is only 16ft (4.9m) long, detonating this large charge at such a short distance could well have knocked several crew members unconscious. We know the *Hunley* survived the explosion, since the commander of Fort Moultrie saw the prearranged blue magnesium light signal to indicate the mission had succeeded, a blue light also seen by survivors of the *Housatonic*. She may have been damaged by the blast in such close proximity, but the fact that her wreck was eventually discovered not far off Charleston Harbour and safety, has forced historians to revise their notions that the spar torpedo was basically a suicide weapon, as dangerous to the assailant as the victim.

Spar torpedoes were fitted to other Confederate vessels, in particular the ironclad CSS *Richmond*, which carried a spar torpedo projecting from her bow underwater. When taken up by the Union side, a significant change was made. Whereas the *Hunley*, in order to approach her target unseen until the very last moment, had been designed as a submersible, and was therefore vulnerable to even a small amount of damage caused by the underwater shockwave, the Union spar torpedo crews used surface boats to bring their torpedo into contact with the underwater part of the enemy's hull, just as Fulton had intended. If their boats were sturdy enough, they would have their bows lifted by the underwater explosion but with luck they would survive. The enemy vessel, holed below the waterline by even the modest charges of the day, and with no internal subdivision, would head for the bottom.

The Union's spar torpedo boats claimed their first victim under the command of the young daredevil Lieutenant William Barker Cushing. At the age of three he had run away to sea, falling off the end of a jetty while pursuing a departing ship. Saved from drowning by a nearby sailor, he had decided a year later to depart to see the world on one of his father's horses. Attempting to shoe it himself, the four-year-old had been kicked senseless by the indignant horse. Dropped from the naval academy because of endless pranks, he answered his nation's call when civil war broke out, and managed to have himself reinstated into the navy. The attack on the troublesome rebel ironclad *Albemarle* was Cushing's idea. With the help of John Lay, he rigged up two steam launches as spar torpedo boats and set off for the *Albemarle*'s lair on the Roanoke River. One launch sank en route, but on the night of 27 October 1864 the attack went in. Finding his prey protected by a boom of floating logs, Cushing circled some way off, then called for full steam to enable his launch to leap the slime-covered log boom. Having crossed this barrier, he manipulated Lay's four lanyards, one attached to each of his hands and feet, to deploy the torpedo head underneath the hull of *Albemarle* and then detonate it. The explosion swamped his launch, forcing Cushing and his crew to abandon it and try to escape as best they could. The *Albemarle*, despite the efforts of her commander, Lieutenant Warley and his crew, sank to the river bottom with a hole blown in her bows. Cushing was eight days short of his twenty-second birthday.

The relative effectiveness of the spar torpedo led all other naval powers to adopt it in one form or another. Following the end of the American Civil War, the next use of the spar torpedo in anger was by the Russians on the Danube and in the Black Sea during the Russo-Turkish war of 1877–78, and then by the French against the Chinese seven years later (for details see Part IV).

Inspired, no doubt, by their countrymen's pioneering use of the spar torpedo, and bolstered by Russian and French successes in the years since the end of the civil war, the Torpedo Station was still issuing detailed *Spar-Torpedo Instructions for the United States Navy* as late as 1890. According to these instructions the standard outfit of Service spar torpedoes comprised a set of twenty-four, with twelve for use on board ship and twelve for the ship's boats.

Each Service spar torpedo measured 12in (30.5cm) long by 9in (22.9cm) square, all inside measurements. They were fabricated from sheet iron tinned inside and out, the inside surfaces being shellacked and the exterior asphalted. The empty case weighed about 15lbs (6.8kg), and the charge was equivalent to 34lbs (15.4kg) of dry gun-cotton, including the primer. The latter was fired by electricity, rubber grommets being arranged in the top of the case. Exercise torpedoes were also available, slightly longer than the Service type but only a third of the width and depth, and shellacked inside and outside. The Exercise torpedo weighed 3lbs (1.4kg) and its charge of dry gun-cotton added another 4lbs (1.8kg). The firing circuit was to be made up by cutting and connecting suitable lengths of insulated double cable from the 300ft-long (91.4m) reel supplied.

The Service spar torpedo for boat use would be attached to a spar made up of two steel tubes 18ft and 15ft long which telescoped one inside the other with an overlap of 2ft (9.45m total length), held in place in the bow of the boat by a complex system of yokes and gearing, to permit accurate placing of the torpedo. The boat torpedo was to be immersed to a depth of at least 10ft, and could safely be exploded 22ft away horizontally (3m deep by 6.7m distant).

Interestingly, the Service spar torpedoes for ship's use were to be attached to the ends of 45ft-long (13.7m) wooden spars braced out from the sides of the ship, one on

either side of the foremast and one on either side of the mizzen. Ship's torpedoes were also to be immersed to a depth of at least 10ft, but to ensure the safety of the attacking ship had to be exploded at a distance of at least 35ft (10.7m) from her hull. For the Exercise torpedo, an immersion of 5ft at a range of 20ft was suitable for firing from both a boat and the ship (1.5m depth at 6.1m distance). Instructions were also provided for converting the Service torpedo to a contact exploder, and for constructing improvised spar torpedoes from wooden kegs or casks, caulked on the outside to make them watertight, and charged with black powder.

For its part, the Royal Navy also continued with the spar torpedo up to and beyond the end of the nineteenth century. One design comprised a metal cage enclosing a ring of six TNT cylinders placed around a seventh cylinder, to which was attached an electrical primer and lead to a battery on the launch. Firing was initiated by a pair of contact horns protruding from the head of the torpedo.

The surviving early film sequence shot by Alfred West in around 1898 shows Royal Navy spar torpedo exercises, probably in Fraser Lake, which was part of Portsmouth Harbour. In the full sequence, when the huge water plume has subsided, the steam pinnace setting off the spar torpedo explosion appears unharmed.

THE 'CROUCHING DRAGONS'

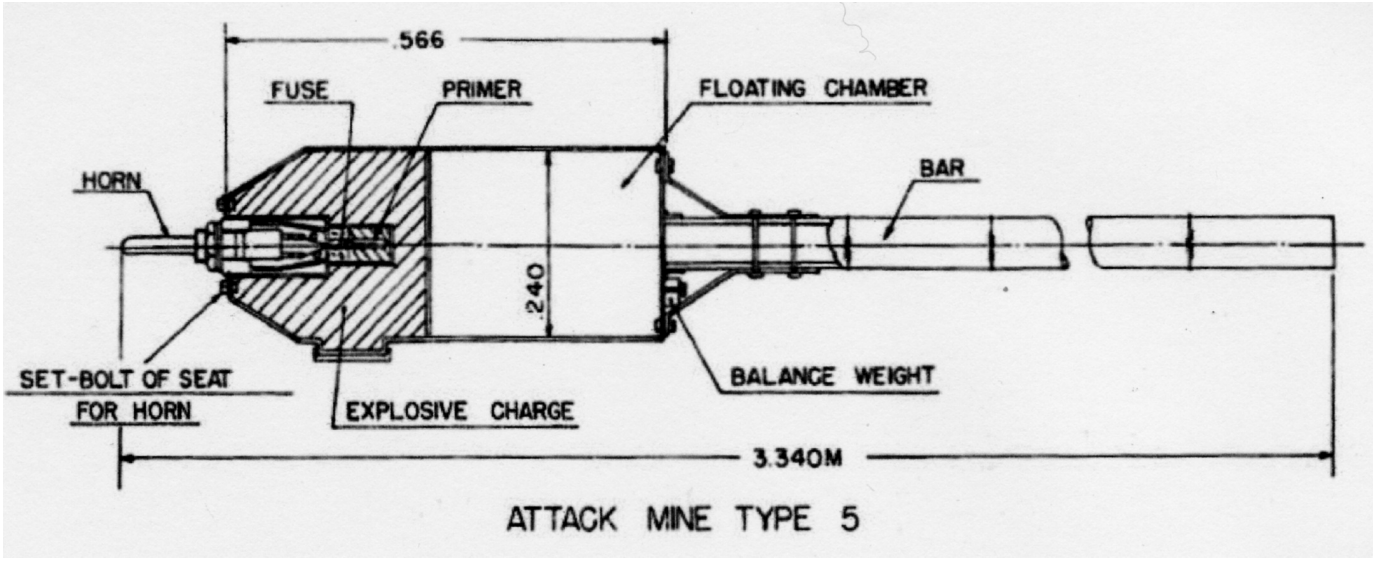
The final manifestation of the spar torpedo concept were the 'Crouching Dragons', or 'Fukuryu', the weapon of a brave and dedicated group of young men of the Imperial Japanese navy's Special Service Corps in 1945. As seen in the illustration on the next page, here we have an explosive device on the end of a long pole, intended to sink a vessel by exploding against its underwater hull. To all appearances, this is a classic spar torpedo – and conceived as a desperate last resort against a vastly superior naval power, as was the very first spar torpedo.

Unbelievable as it may sound, these sailors were trained as suicide frogmen, prepared to wade out from the invasion beaches, or hole up in diving chambers hidden off the coast in wrecked ships or underwater caves, in order to thrust their spar torpedo into the hull of an Allied landing craft heading for the shores of Japan.

A surviving Fukuryu trainee, Mr Shimizu Kazuro, was interviewed by a journalist at his home in Nagano prefecture in the course of 2013. He described how conditions for the Japanese in 1945 were becoming desperate. As a young naval trainee of just sixteen he was drafted to the 'Tokkotai', the Special Service Corps who made up the kamikaze units. From an initial total of 300 trainees, all firstborn sons, only children, and boys with no father were drafted out, then the trainees thought to be of

Discovered in the Solent, a dinner plate, possibly from RN mess No 20 attached to the torpedo school at HMS *Vernon*, was decorated with a spar torpedo and its successor, a very early Whitehead, but both evidently in use at one and the same time. The Latin inscriptions translate as 'Great perils lurk' and '*Vernon* is always strong'.

An indistinct still from a very early film, shot by Alfred West in around 1898, showing spar torpedo and mine explosions. The original, one of a six-frame fragment, was attached by West to documents to prove his copyright, and is now held at The National Archives, Kew.



Above: Drawing from the January 1946 report by the Naval Technical Mission to Japan, index no S-91(N): The Fukuryu Special Harbor Defense and Underwater Attack Unit – Tokyo Bay.

above-average intelligence were separated and sent away, and the 100 left were the kamikaze recruits.

The Crouching Dragons wore rubber diving suits, and breathed recycled air through a simple arrangement using caustic lye. However, if they forgot to breathe in using their nostrils and exhale though the mouth, they could accidentally inhale caustic lye and quickly lose consciousness. Training consisted of jumping from boats and practising descending to their operating depth, and then they would practise walking on the seabed, guided from a boat by an officer pulling on guide ropes. All too often the trainees would be dragged down by their equipment, which out of the water weighed more than they did, or they would mix up their breathing procedure and suffocate, or the defective brazing on the breathing gear would fail and let in water with disastrous results, or they would simply become entangled in weeds and drown.

Mr Kazuro recalled how at least fifty of his comrades died in this appalling manner. There were too many to cremate in a religious ceremony at the local shrine, so their bodies were simply piled on fires lit along the shore.

Reference works often state that the Fukuryu units were disbanded before hostilities ended because of these appalling casualties. But that was not so. After the news of the Hiroshima and Nagasaki atomic bombs, and the emperor's radio broadcast, the officers ordered all the equipment and documents to be gathered up and burnt. The Fukuryu were to have remained a closely-guarded secret. It was only after many years that the survivors revived the memory of their lost comrades, and arranged for the small commemorative statue to be made and placed in the Yushukan Museum.

Below: Next door to the Yasukuni shrine in Japan is the Yushukan Museum of the Heroes. Thanks to the efforts of survivors such as Shimizu Kazuro, a statue was placed in the museum to honour the lost Fukuryu trainees, the 'human spar torpedoes', so many of whom lost their lives not in action, but in training.

THE TOWED TORPEDO

Robert Fulton had conceived the idea of a towed torpedo back in 1804 for the attack on Boulogne, when pairs of large coffers and pairs of hogsheads were towed to where they were left to drift down onto the French ships under the action of wind and tide. When he sank the *Dorothea* off the Downs in October 1805 he had used the same type of arrangement. He modified this idea in 1807 for the demonstration when he sank the old brig at New York, keeping his charges underwater, suspended from floats. And there the idea rested.

Several years before the appearance of Mr Harvey's kite or towed torpedo, the CSS *Hunley* was originally intended to tow behind her a 90lb (41kg) explosive charge. Diving under the hull of the target, she was to tow the charge into contact with the ship on the side from which she had commenced her run, when it would be detonated. The target's hull was intended to cushion the little submersible from the blast.

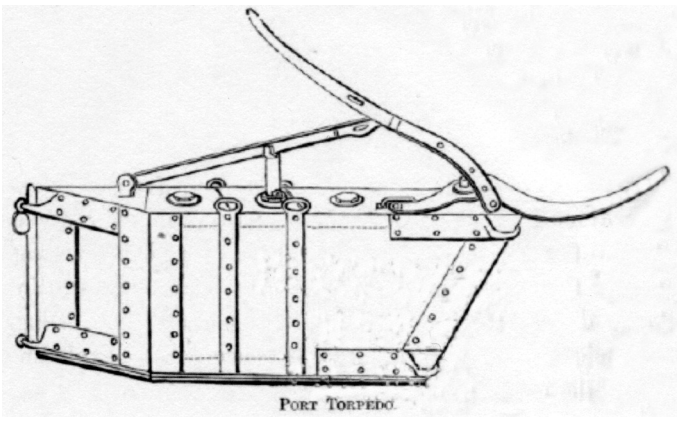
Because of difficulties with towing a large charge by a slow-moving submersible, with the ever-constant danger of their own charge coming into contact with *Hunley* and sinking her, the plan was changed to the definitive spar torpedo design which she used with success against the *Housatonic*.

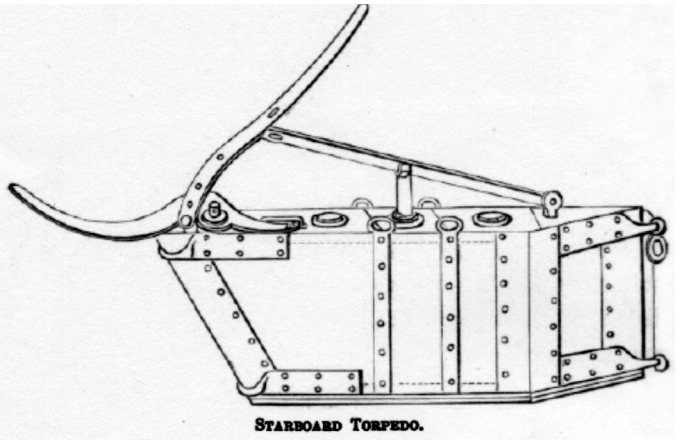
The Harvey kite torpedo

In 1871 Captain John Harvey, Royal Navy (retired), wrote in a letter that he had been working on the idea of a towed torpedo for some 'quarter of a century', which would mean that he had begun in or around 1846, but that his nephew Commander Frederick Harvey had brought it to the stage where it could be deployed operationally. The idea took up from where Fulton left off. The explosive charge was contained in an otter board, of the type used by fishermen to keep open the mouth of their trawl net. It was towed beneath the surface suspended from a cork float. The towing cable was kept at an angle of 45 degrees to the course of the attacking vessel by a second line controlled by brakemen.

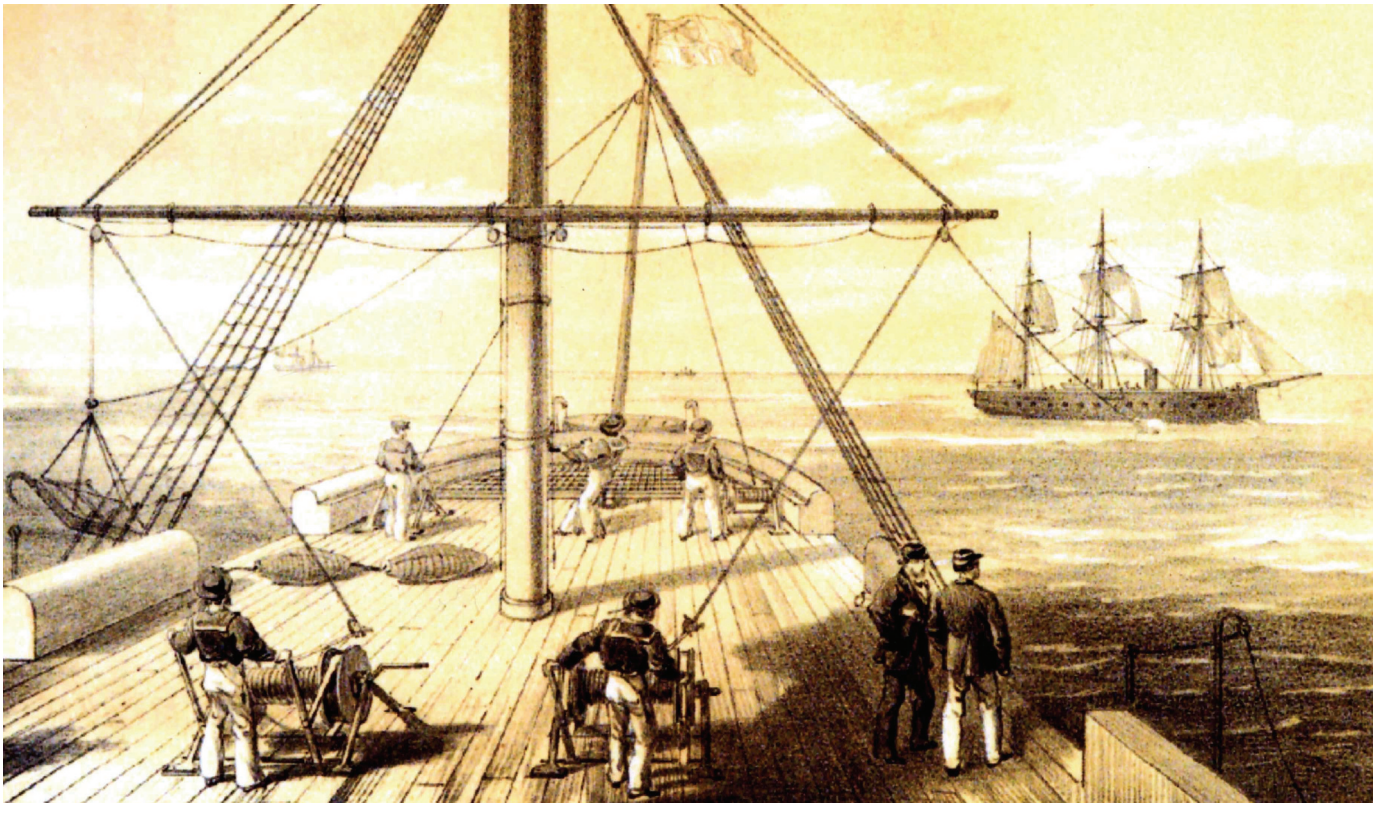
The principle was simple but daring. The attacking vessel streamed its Harvey torpedo, and at a safe distance the firing key was activated, to avoid the risk of the tow cable becoming entangled in the ship's propeller, pulling the device into one's own ship. The attacker passed to one side of the target vessel, so as to bring the Harvey into contact with the victim's hull. A pair of firing levers was then depressed, exploding the charge. It was simple, it worked, and it was much less expensive than a Whitehead torpedo, of which the Harvey was a contemporary, all factors designed to ensure its popularity with the Admiralty and the Treasury. And it must be said that although there were certain risks, faced with the slow-firing big guns of the day, it was much safer than the even cheaper alternative, the spar torpedo.

Just as with fishermen's otter boards, those of the Harvey were shaped so as to be handed port and starboard. This meant that their firing levers also had to be handed, those for the port torpedo being fitted on the right and vice versa for the starboard torpedo, as can be seen in the drawings. These and all others in this description are taken from Frederick Harvey's *Instructions for the Management of Harvey's Sea Torpedo*, which he wrote in 1871. The torpedoes themselves were constructed of seasoned elm $1^1/_2$in (38mm) thick, reinforced by external iron strapping. An internal case containing the explosive bolt was made of thick copper sheet. The torpedoes in the illustration are the 'large' model.





On the left: **the port torpedo.** ***On the right:*** **the starboard torpedo.**



Coming into action by passing astern of the target vessel. The starboard torpedo is hoisted on the lower yard, its safety bolt still in place. The port torpedo has struck the target ship's hull to starboard. Although not clear, it is likely that the charge will have detonated on the other (i.e. port) side, or indeed under her keel.

Even the large model was of modest size, being 5ft long x 6 1/8in wide x 1ft 8 3/4in deep (1.524m x 155.6mm x 527mm). The exploding bolt could contain, among other explosives, either 60lbs (27.2kg) of compressed gun-cotton, 76lbs (34.5kg) of black powder, or 100lbs (45.4kg) of dynamite. For the more impecunious, Harvey also offered a 'small' model, the dimensions being 3ft 8in x 5in x 1ft 6in (1012m x 127mm x 457mm). It could carry up to 22lbs (10kg) of compressed gun-cotton, 27lbs (12.25kg) of black powder, or 35lbs (15.9kg) of dynamite.

The Harvey was tested against the turret ironclad HMS *Royal Sovereign*, and the results were excellent. For the first trials the target was anchored, and blank-fired her turret guns to verify how many shots she could loose off before the torpedo hit. With a towline of 300ft (91.4m), the steam paddle-wheel tug *Camel* scored ten hits out of ten, all below the waterline. With *Royal Sovereign* manoeuvring at between 8 and 9 knots, and *Camel* towing at 10–11 knots, again all six torpedoes streamed scored hits.

Despite these excellent results, the British Admiralty were reluctant to purchase large numbers of Harvey torpedoes, despite the vigorous support of Fisher. The reason was clear: the Whitehead was proving its effectiveness, and the fish torpedo was in a different class altogether. Nonetheless, the Royal Navy did purchase Harvey torpedoes and kept them on the establishment for over forty years. They could be fitted with electrical firing primers invented by Captain McEvoy in 1871.

The Russians tried a copy of the Harvey in action against the Turks, also with an electric primer, invented by Captain Menzing, a German. It appears that their towed torpedoes made contact with their targets, but that the electrical firing key failed every time.

The French adopted the Harvey, but considerably modified it at Boyardville after 1872, presumably in order to avoid paying royalties to Harvey. According to instructions first issued in 1875, practice in the French navy was to stream the torpedo closely behind the towing ship, then extend the control spar and draw the torpedo out on the beam when the enemy was in range, a curious arrangement which risked fouling the ship's propeller. It was the favourite weapon for squadron action, and every large ironclad was equipped with a towed torpedo on each beam. It was felt that if an enemy vessel avoided an attempt to ram her, then one or other of the towed torpedoes would strike. The French discovered that the towed torpedo worked even better if the target vessel was under way, rather than moored, as her own motion drew the torpedo into contact with her hull.

By 1877 the French torpedo tactics had been brought

The torpedo salesman's dream scenario: an ironclad fleet surprised at night by a formation of torpedo boats towing Harvey torpedoes.

to such a high level of efficiency that the commander-in-chief of the French navy commented that the ram and the towed torpedo 'tended to neutralize each other; [the towed torpedo] is destined effectively to hold at bay any enemy who desires to use his ram.' They kept them in front-line service longer than most navies. The Americans experimented with the Harvey, but did not retain them for long.

The Harvey was useful if employed as a complement to the ram when fighting heavily armoured ships. If you missed with the ram, which was more than likely, then one or other Harvey had a good chance of striking a mortal blow to the target. A stealthy attack at night, on an anchored or slow-moving blockading ship, also had a good chance of success.

Of course, in daylight, unless your own vessel was heavily armoured, to close to ramming distance or towed torpedo range was suicidal. And in a daylight fleet action, with numerous vessels manoeuvring to bring guns to bear or effect a ramming, to stream two volatile explosive devices, ready armed and primed, on each beam of your own vessel was highly hazardous. If your vessel was disabled, or lost steering, then it was just possible that a Harvey might be drawn against your own hull, with the exploder levers towards your ship.

In retrospect, the Harvey was a workable weapon system, but it had the misfortune to arrive on the scene at the same time as the much superior Whitehead.

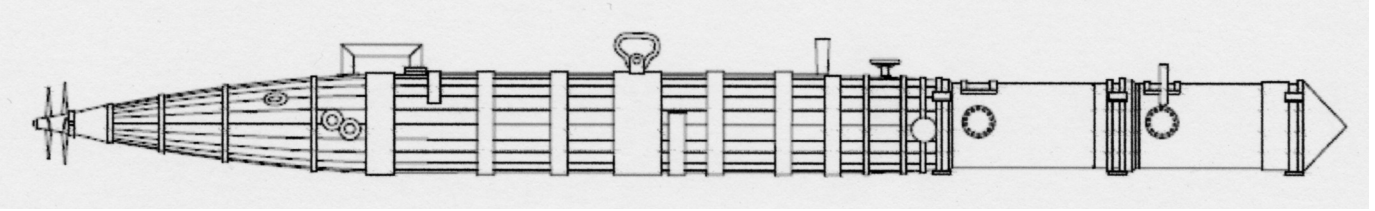
STEALTH WEAPONS: MIGNATTA, BARCHINO SALTATORE, SLC MAIALE, CHARIOT, NEGER AND KAITEN

Fulton had finally been forced to abandon the concept of a stealth attack weapon, lacking the necessary power source to guarantee mobility and accurate delivery of the warhead. Instead he turned to relatively complicated fixed mines for coastal defence. But a century later, inventive minds revived his stealth weapon concept, and brought new power sources to bear to make them a practical proposition.

In 1909, Lieutenant Godfrey Herbert of the Royal Navy, former second-in-command of Nasmith's submarine *A 4*, and serving in surface ships before returning to submarines, patented the idea of a manned torpedo. The Admiralty of the day dismissed it as impractical and unsafe. His idea was to see form in the hands of the Italian navy.

Mignatta

In 1918 the first 'human torpedo' arrived on the scene in a dramatic manner, operated by two Italian naval officers. Major of Naval Engineers Raffaele Rossetti had designed a 'Mignatta' (Italian for 'leech'), using components from a standard Italian Navy B57 Model 14in torpedo.



The drawing above and the following photos of the Mignatta are courtesy of Francesco Franchi.

At the same time Physician Sub Lieutenant Raffaele Paolucci had conceived the idea of walking on the seabed into an enemy anchorage, dragging behind him an explosive charge. He trained for such an action, walking long distances on the seabed wearing a diving suit and dragging behind him a length of iron to represent the charge.

Bringing these two ideas together, Rossetti conceived and built the definitive Mignatta, which ended up 8m (26ft) long with a diameter of 600mm (24in). Powered by compressed air, it was driven by two four-bladed contra-rotating propellers at a slow speed of 2 knots, for a maximum distance of 16km (10 miles). There was no mechanical means of steering: the crew had to direct it by extending their arms and legs. Without breathing apparatus they were obliged to keep their heads above water. The warhead was composed of two detachable charges, each one containing 175kg of explosive and provided with clockwork fuses giving a delay of up to six hours.

The tail of the Mignatta, showing the wooden construction held together with brass hoops.

The scale drawing of the Mignatta shows the two detachable explosive charges. When the second charge has been detached, in front of the central air flask was a second streamlined nose cone, to allow the operators to use the Mignatta to make good their escape. Inside the tail unit are the mechanical parts of the 14in torpedo, with the three-cylinder engine and propeller shaft to the contra-rotating gears in the tail. Note the complete lack of rudders and horizontal tail planes. What appears to be a handhold at the top rear is in fact the compressed air pipe to the engine, carried outside the hull to impart some heating from the surrounding seawater.

Despite the apparent crude nature of the Mignatta, against all expectations Rossetti and Paolucci succeeded in entering Pola harbour on the night of 1 November 1918, even dragging their Mignatta over the harbour defence boom and then over a protective gate. Having attached one of the charges to the Austro-Hungarian flagship *Viribus Unitis*, they were spotted and were forced to scuttle their Mignatta. Taken on board the target vessel as prisoners, they were surprised to learn that the very day they had set

A fine model of Rossetti's Mignatta, built in 2011 by Francesco Franchi.