A photograph of a submarine on the surface of the ocean, viewed from a high angle. The conning tower is prominent in the center, with the hull extending outwards. The water is a deep blue-green color.

# DISASTERS OF THE DEEP

A COMPREHENSIVE SURVEY OF  
SUBMARINE ACCIDENTS & DISASTERS

**EDWYN GRAY**



*DISASTERS OF*  

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*THE DEEP*

*Non Fiction*

A Damned Un-English Weapon.

The Killing Time.

The Devil's Device.

Captains of War.

Operation Pacific.

Hitler's Battleships.

*Fiction*

No Survivors.

Action Atlantic.

Tokyo Torpedo.

Last Command.

Fighting Submarine.

Devil Flotilla.

Diving Stations.

Crash Dive 500.

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# DISASTERS OF THE DEEP

A Comprehensive Survey of  
Submarine Accidents and Disasters

by

EDWYN GRAY



LEO COOPER

First published as *Few Survived* in Great Britain 1986 by  
LEO COOPER

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in association with Seeker and Warburg Ltd,  
Reissued in 1996 by  
Pen & Sword Books Ltd  
47 Church Street  
Barnsley, S. Yorks, S70 2AS

This third revised and updated edition is published in 2003 by  
LEO COOPER  
an imprint of Pen & Sword Books Ltd

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A CIP record for this book is available from  
The British Library

ISBN 0 85052 987 5

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Printed in Great Britain by  
CPI UK

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*To Vivienne with love*

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# Author's Note to the Third Edition

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During the seven years that have passed since the second edition of *Few Survived* was published many more Cold War accidents have been de-classified and are now in the public domain. Several make for chilling reading. It has also been a period packed with unusual incidents such as the bizarre fate of the survivors from two North Korean submarine accidents, two fatal encounters between nuclear submarines and fishing trawlers, as well as similar but lesser incidents in home waters and abroad. The *Kursk* disaster, of course, dominated the first year of the new millennium and its aftermath rumbled on for nearly two more years. This Russian tragedy and some other accidents also brought political repercussions in their wake – the first time that politics has entered into the centuries-old saga of underwater disasters. And, worryingly, several other incidents in recent years suggest that the lessons gleaned from past tragedies have not been adequately assimilated.

Ongoing research continues to uncover new and additional facts which have a bearing on certain incidents described in the original text and I would like to take this opportunity to mention briefly some significant matters that require updating.

To begin with it has been established that, although John Day was the first man to lose his life in a 'submarine' disaster [see [pages 19–21](#)] his vessel, *Maria*, was the *second* pioneer submersible to sink. In 1719 a Turkish 'submarine' *Timsah*, designed by Ibrahim Effendi, foundered in Constantinople harbour during a demonstration of its diving abilities. Happily her five-man crew escaped unharmed.

The puzzling double sinking of Russia's *Kambala* [page 62] has also now been resolved. The report in *The Times History of the Great War* of her loss at Kronstadt in 1909 proved to be erroneous and, on further investigation, was found to refer to the foundering of *Delfin* on 20 June 1904, an accident described earlier on page 50. *Kambala*, in fact, sank only once when she was rammed by a Russian battleship on 12 June 1909 and was never salvaged.

Due to a mistaken date details of *C.12*'s accident on the River Humber [page 82] were placed out of chronological order. The submarine actually sank on 6 October 1918 but was not salvaged until February 1920. It should also be noted that an unintentional ambiguity in my account of the collision between *E.4* and *E.41* on 15 August 1916 seemed to imply that the entire crew of *E.41* were saved [page 88]. Sadly this was not the case for sixteen crew members – mainly engine-room personnel – were posted as missing following the accident. I am indebted to Mr M.I. Frewer, a grandson of the Leading Stoker Walter Frewer, one of those who did not survive, for bringing the correct facts to my notice.

The statistics of submarine losses in the First World War quoted at the beginning of Chapter Seven have been extensively revised and the reader is referred to Appendix Four which has been fully updated to reflect the most recent research available.

*HMS Affray*'s tragic loss in 1951 [pages 200–205] continues to throw up surprises and attract media attention despite the passing of half a century. Some of the information that has surfaced in recent years helps to resolve the so-called mystery of her loss and is important enough to merit further detailed examination. This will be found in the new Chapter Fifteen.

Two other incidents need to be touched upon briefly. It has been confirmed that the attempted salvage of the Soviet Golf-class submarine, now identified as *K.129*, succeeded in raising the bow section of the submarine [see [pages 217–219](#)]. The bodies of six Russian sailors were recovered and buried at sea by the Americans. A movie-film of the ceremony has been screened on domestic air



foreign television within the last five years. The wreckage was inspected by CIA experts and the intelligence obtained enabled the Pentagon to penetrate the Soviet Navy's world-wide communication systems. It was a coup equal in importance to the capture of Nazi Germany's Enigma coding machine in the Second World War and it is not therefore surprising that the United States laid down a smokescreen of disinformation to conceal their success from the Russians. It was a similar need for secrecy that allowed the myths and mysteries of how *Scorpion's* wreck was located to develop [see [pages 213–215](#)]. The US Navy was anxious to conceal the extent of its network of oceanic sonar buoys (SOSUS) from its Cold War adversaries and it could not afford to publicize the fact that the lost submarine was found as the result of cross-bearings from these underwater sentinels. It was a secret the Pentagon kept concealed for some thirty years – long after the Russians and the rest of the world knew all about SOSUS.

A second new chapter has been added to cover the recently revealed details of Cold War incidents, the *Kursk* disaster, and other accidents that have occurred since 1995. As a result of this the original [Chapter 14](#) has now been renumbered [Chapter 16](#). In addition all the appendices have been revised and enlarged to reflect the very latest available information. In all, some 9,000 words have been added to the text of the 2nd edition and numerous other corrections have been inserted.

My thanks are due again to all those correspondents who have assisted with information and other research material and I would like to acknowledge my debt to: Commander Jeff Tall, OBE, RN, the director of the Royal Navy Submarine Museum at Gosport, and especially to Margaret Bidmead, its curator, for her unstinting assistance in digging up vital facts and figures; and also to my Australian research colleague Denis Cahill who can always be relied upon to find the impossible at the drop of a hat. Thank you also Mrs Dorice Janzer of Florida (Project Jennifer and *CSS Hunley*); Innes McCartney of Periscope Books (*Affray*); Edward Mariott and Goldhawk Universal Productions (*Affray*); Graham Currie for searching out internet websites; Dan Agardh and Bertil Skogsberg from Sweden (*Dumlupinar*); M.I. Frewer (*E.4* and *E.41*); Peter Haywood's *E.41 Newsletter*; Mrs W. Mogg; Eric Bugden (*Affray* and other British accidents); Jon Guttman of *Military History*, Leesburg, Va, USA; Barbara Davis (advice on radioactivity) and, of course, Charles Hewitt, Brigadier Henry Wilson and my friends at Pen & Sword Books Ltd.

Finally, all opinions expressed in this book are those of the author and do not necessarily reflect official views. Similarly the blame for any errors or mistakes must rest with me.

Edwyn Gray  
Attleborough, Norfolk  
December 2002

## ‘Give us air’

On 29 January, 1917, the Royal Navy’s new-fangled K-class steam submarines suddenly ceased to be a joke. From that day onwards *K* stood for *Killer*. And men of proven courage pleaded sickness, failed to report for duty on the flimsiest of excuses, and even mutinied to avoid serving in these gargantuan death traps. Of the twenty-one K-boats built\* no fewer than sixteen were involved in major accidents and eight ended their careers on the bottom of the sea as rusting iron coffins.

The antics of these steam monsters and their reputation for elephantine cussedness had made them the butt of wardroom wit and a target for the mess comedian’s latest obscenity for many a war-wearied month. But the laughter came to an abrupt end on that fateful January morning in 1917 when the latest addition to the class, *K.13*, set off from Fairfield’s yards on the Clyde for her final acceptance trials at Gareloch.

\* \* \*

*K.3*, the first of the giants to go into service, had suffered more than her fair share of tribulation during her official trials. The temperature in the boiler room reached alarming heights even when the submarine was surfaced with her hatches open. And a tendency to push her bows down when meeting a head sea was not an encouraging trait to the discerning seaman.

She was equally unhappy under water. On one notable occasion the future King George VI, then serving as a very junior officer in the Grand Fleet, was invited aboard to watch her being put through her paces. But when her skipper, Commander Ernest Leir, proudly demonstrated the submarine’s diving abilities, *K.3* simply dug her bows down hard like a recalcitrant horse refusing a fence and headed for the bottom at a steep angle. She hit the seabed with a resounding thump and stayed there with her bows buried in the mud. The water in Stokes Bay was only 150 feet deep and the submarine’s stern remained poking up above the surface – her two huge bronze propellers spinning impotently in the sunshine.

Fortunately for the future of the British monarchy the crew managed to extricate the submarine from the mud without too much difficulty and, twenty minutes later, *K.3* was floating obediently on the surface once again. Prince George kept well away from submarines after that. In fact he went to the opposite extreme and took up flying.

The following January, on patrol in the North Sea and steaming at 10 knots, *K.3* again demonstrated her alarming tendency to bury her nose in the water. And when an unexpected sea suddenly crashed against her port side the water swept down the funnel intakes and swamped the boiler fires. Without power the submarine broached out of control and the sea, now on the beam and whipped into a steep chop by the strong breeze, cascaded down the funnels. By the time the hatches and funnels were

finally closed the boiler room was knee-deep in water. Fortunately *K.3*, like the rest of her class, was equipped with a small auxiliary diesel engine, and Leir used this barely adequate power unit to bring the submarine's bows into the wind so that he could regain control and coax his charge safely back to Scapa Flow.

*K.2* did even better than her flotilla mate: she caught fire in a spectacular manner during her initial diving trials in Portsmouth dockyard. The submarine had just submerged in one of the harbour basins when a sudden explosion sent a sheet of flame searing through the engine-room. Her skipper, Norman Laurence, surfaced hurriedly and ordered the crew to their fire stations. To the astonishment of the onlookers watching from the dockside the men tumbled out of the hatches, scooped water out of the basin with large iron buckets, and then dashed below again to help quench the flames. With an incredible lack of foresight someone had forgotten to fit the submarine with fire extinguishers and it was fortunate that this otherwise farcical incident did not develop into a major tragedy.

Not to be outdone in the comedy stakes, *K.6*, carrying out a similar submergence test at Devonport, stubbornly refused to return to the surface when the order was given to blow the ballast tanks and the fifty men inside the submarine were trapped for more than two hours before a dockyard inspector traced the trouble to a fault in the compressed air system. Not surprisingly the local dockyard workers had experienced quite enough of the K-boat's odd quirks and many of them refused to go down for a second time and further tests had to be postponed for nearly a week.

And so the saga continued. *K.4* ran aground on Walney Island during trials, while *K.11* ruined her generator when, like *K.3*, she shipped water down her funnel intakes during surface trials in heavy weather. It was hardly an encouraging beginning for a new and completely revolutionary type of submarine.

There is little doubt that many of these incidents were still fresh in the mind of Commandant Godfrey Herbert DSO as he edged *K.13* out into the Clyde with the aid of two tugs. Not that he had any fears concerning his own boat. *K.13* had already carried out two test dives without trouble and, on 1 January, had reached a surface speed of 23½ knots over the measured mile to gain the honour of being the world's fastest submarine. But the K-boat jinx was never very far away. A rope entangled itself around the propellers, causing a short delay to their departure. And a potentially more dangerous incident was to occur within minutes of leaving the builder's berth when someone accidentally switched off the starter of the steering gear and put the helm out of action.

Veering out of control, *K.13* swung to the left and immediately grounded herself on a mudbank. This indiscretion was bad enough in itself, but worse was to follow. The strong ebb tide began dragging the stern downstream and, pivoting from the bows, the submarine was soon broadside on an almost completely blocking the river. The steamer *Sonna* tried to squeeze through the narrowing gap between *K.13*'s stern and the dredger *Shieldhall* which was moored to a quay on the other side of the river. There was a shriek of rending metal as the steamer got herself sandwiched between the two boats and, after several minutes of swearing and confusion, *Sonna*'s skipper pulled the steamer clear by going full astern.

Herbert tried a similar solution. *K.13* came off the mud with a shuddering lurch and then proceeded to move down the river *stern first!* It was an undignified mode of progress for one of His Majesty's ships but Herbert had no alternative and *K.13* was forced to steam backwards until she reached the junction with the River Cart where there was sufficient room to turn the submarine around and point her bows downstream in a more conventional manner.

*K.13* was well loaded. In addition to her regular crew of fifty-three officers and men, she was also carrying fourteen directors and employees of her builders, Fairfields; eleven other civilian and Admiralty officials; plus the captain and engineer officer of her sister-ship *K.14*. She picked up

another of Fairfield's directors and Professor Percy Hillhouse, the Company's senior naval architect at Craigendoran Pier and by noon was heading for the placid waters of Gareloch. A short test dive en route revealed a leak in the boiler room but it was not regarded as significant and the VIPs adjourned to lunch aboard the tender *Comet* undismayed by the morning's alarming sequence of events. The leisurely meal finished at 3.15 pm and, having left two of the civilians behind on the tender, the submarine moved slowly towards the head of the loch for her final acceptance dive with exactly eight men aboard.

The K-class design had been evolved out of fear – fear that the German Navy was building submarines capable of 20 knots on the surface – and the Admiralty demanded a submarine of even greater performance for operations with the Grand Fleet. But the primitive diesel engines then available were incapable of producing the tremendous power required to achieve the speeds desired by Whitehall. And, almost as an act of desperation, Sir Eustace Tennyson d'Eyncourt, the Director of Naval Construction, decided to use steam engines – the only form of propulsion capable of producing the horsepower necessary to thrust nearly 2,000 tons of inert steel through the sea at a surface velocity of 23 knots or more.

It was a revolutionary design, a morganatic marriage between the steam engine and the submarine a union that had been tried several times before and had always failed. But there was no viable alternative to the shotgun wedding forced upon the unfortunate designer, and d'Eyncourt was no fool. Despite the carping of ignorant critics, many experts now consider that his steam-powered creation gave satisfactory service when due allowance has been made for their inherent limitations.

Displacing 1,883 tons the K-class were almost three times as big as any previous submarine and with an overall length of 338 feet, they were not easy to handle. The main engines, two steam turbines fed by two oil-fired boilers, produced 10,500 horsepower and these were backed by four electric motors for underwater propulsion plus an 1,800 hp diesel unit for use on the surface while the boilers were building up pressure.

Each boat cost over £300,000 to produce and needed a crew of fifty-three men to run it efficiently. And in those halcyon days you could build a destroyer for £133,500. But in wartime money was no object and men were expendable.

Steam was, of course, only used on the surface. When diving the boilers were shut down and an ingenious system of double-acting levers first tilted the funnels over and then retracted them into special wells to clear the boiler uptakes. The resulting and rather ominous holes were then covered by circular watertight shutters. Four ventilators, shaped like giant mushrooms, helped to disperse the heat from the boiler room and these, too, could be lowered and sealed when the submarine submerged. The entire operation took four minutes to complete as against the thirty seconds diving time required by a conventional diesel-engined submarine.

Of equal importance to the crew, however, these complex design problems meant that the K-boat had six extra apertures to contend with – six more places where something could go wrong. As one matelot observed: 'A K-boat has got more holes to fill than a French whore!'

Commander Herbert, however, was easy in his mind as he took *K.13* into Gareloch for the final test dive. A careful check of the dials and instruments showed everything functioning correctly. One indicator, it is true, was seen to be flickering but Engineer Lieutenant Arthur Lane said this was due to faulty wiring and a bad contact. And Herbert had accepted the explanation. It was, however, a vital and important indicator. *It showed whether the boiler room ventilators were fully shut before diving.*

As the executive order was given *K.13* dipped under the waters of the loch and Herbert instructed the coxswain, Chief Petty Officer Oscar Moth, to trim her for twenty feet. Suddenly the quiet routine was broken.

‘The boiler room is flooding freely, sir!’

Almost simultaneously Lane shouted up through the voicepipe: ‘Surface at once. The boiler room flooding.’

Herbert was an experienced submariner and he had already survived an earlier disaster.\* He wasted no time asking questions. He rapped out an order to blow Nos. 2 and 3 tanks and surface.

The crew responded to the emergency with an efficiency born from long months of arduous training. Wheels spun, valves closed and levers were pulled. Compressed air hissed into the forward ballast tanks but *K.13* failed to respond. In fact she was sinking steadily by the stern and Coxswain Moth, seated in front of the depth gauges, confirmed Herbert’s worst fears.

‘She’s out of control, sir.’

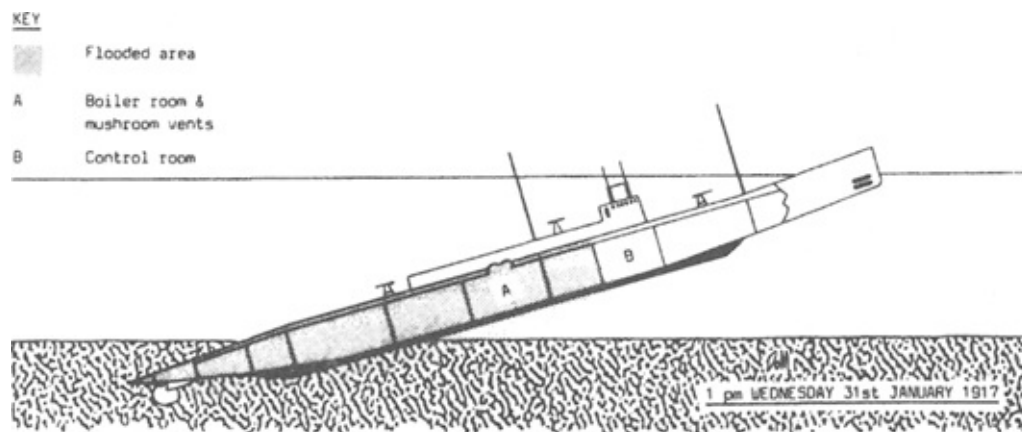
The ears of the men in the control room began to pop as the air pressure inside the submarine increased. And they knew what the sudden change in pressure signified. *K.13* was flooding at a dangerously rapid rate.

‘Close watertight doors.’

‘Drop forward keel.’

‘Blow all tanks, ’planes hard a’rise.’

But the emergency measures were of no avail against the terrifying power of the sea. Nothing could arrest the downward plunge and *K.13* finally came to rest with her stern on the bottom of the lagoon fifty feet down, at an angle of four degrees. As Herbert gave the order to stop motors a jet of water shot out of the voicepipe and it had to be quickly plugged to prevent the control room from suffering the same fate as the stern compartments. As if this was not enough, a fire broke out in the main switchboard which the men had to beat out with their bare hands. Other electrical circuits smouldered and flamed. Vivid blue flashes added an eerie dimension to the terrifying inferno. Choked and blinded by the fumes and smoke, and jolted by fierce electric shocks, the crew struggled to extinguish the flames and regain control. It was a race against time for the fires were consuming precious oxygen. But against all the odds, with torn and bleeding hands, aching heads and smoke blackened faces, they finally succeeded.



There was an urgent knocking on the rear bulkhead of the control room and two shocked civilians tumbled through the hatchway as someone cautiously opened the watertight door. They told Herbert that all compartments aft of the midships torpedo room were flooded. Seeking confirmation, *K.13* captain tried to raise Lane on the telephone. But the line was silent. It was obvious that the men in the flooded stern section were already dead and Herbert wondered how much longer the rest of the crew would survive. The bulkheads were only designed to withstand a pressure of fifteen pounds per square inch – and the pressure of the sea at a depth of fifty-five feet was nearly twenty-five pounds per square inch. How long would the bulkheads hold?

Herbert remembered that *E.50* was also undergoing diving trials in the loch that day and, almost a forlorn hope, he tried to communicate with the other submarine by using *K.13*'s Fessenden apparatus. But the underwater signalling device had been damaged by the fire and it failed to work. Nor was that their only problem. The rear drop-keel and the remaining half of the compressed air reserves were controlled from a panel in the engine-room and this meant it was impossible to make use of either. They were trapped. Their only hope of survival depended on the prompt action of the men on the surface. How long would it be before they realised that the submarine was in trouble?

Before ordering further emergency measures Herbert held a roll-call. Only forty-nine of the eighty men who were aboard *K.13* when she headed out into Gareloch answered to their names. Thirty-one of their shipmates were already dead, and the merciful swiftness of their end stood in sharp contrast to the probable fate of the stricken submarine.

Professor Hillhouse added to the gloom when he produced a slide-rule and began working out how much air was left and how long it would take to consume it. His answer was scarcely encouraging – eight hours at most. And further calculations showed that even if Herbert could blow every single drop of water from the forward tanks there would still be insufficient buoyancy to refloat the stricken submarine.

The dismal news filtered through the forward compartments where the men sat quietly in the corners trying to avoid excessive movement in order to save oxygen. They were shaken by the accident but were outwardly calm and seemed to accept the verdict with resignation. Coxswain Mottram, addressing no one in particular, summed up their unspoken thoughts.

‘What a bloody rotten way to die.’

\* \* \*

By four o'clock the men waiting on the surface were getting worried by *K.13*'s failure to reappear. Michell, the captain of the *E.50*, sent an urgent wireless message to the Senior Naval Officer, Clyde, reporting a probable accident and requesting immediate assistance and salvage apparatus. Six hours later the gunboat *Gossamer* set out for Gareloch, followed, shortly afterwards, by the salvage vessel *Tay* and *Thrush*. No one, it seemed, was in much of a hurry, despite the urgent nature of the emergency.

Michell had already noted an unusual rush of air when *K.13* first dived and he had taken the precaution of testing the water for the presence of acid. If the sea had entered the battery compartments the crew would have perished from chlorine gas poisoning within a few minutes. But his test proved negative, although he observed a thin stream of air bubbles rising from the depths of the loch together with small patches of floating oil. Michell was sure he had found *K.13*'s resting place and he sent two men to circle the spot in a dinghy as night closed over the grey waters. At least the salvage vessel, when they arrived, would not have to waste precious time searching for the missing submarine; and every minute saved could equal a human life.

Inside their steel tomb the survivors waited quietly – not for rescue but for death. Some settled down to write farewell letters and make-shift wills. Others tried to sleep. Sandwiches were passed around but, not surprisingly, no one felt hungry. The foul air, however, had given everyone a raging thirst but the sea had contaminated the fresh-water tank and there was nothing to drink. Herbert, wanting to conserve power, had turned off the radiators and the men were shivering with cold. Some wrapped themselves in blankets. Others huddled together seeking mutual warmth. Those who could pray did so. Those who could not tried to shut the thought of death from their minds.

The rescuers, meanwhile, were in a state of utter confusion. The Royal Navy had no emergency

organization to deal with a submarine disaster and success depended on the initiative and the improvising abilities of the men on the spot – two attributes for which, fortunately, the British sailor was universally renowned. The official reaction to the situation, however, proved to be dismally inept.

*Gossamer* did not arrive on the scene until after midnight. She carried a diving suit but no diver. And when a qualified diver was finally located the suit was found to have perished with age and nearly drowned its wearer. *Thrush*, too, had now reached the loch. But, although designated as a salvage vessel, she possessed neither a diver nor a suit.

After an eternity of waiting a civilian diver from Fairfields made the first descent into the freezing water and began inching his way along the slippery surface of *K.13*'s hull. A morse message tapped out from inside the submarine was picked up and relayed to the surface.

*All well before engine room bulkhead.*

The truth, unfortunately, was less reassuring. Conditions inside the submarine were worsening. The air was slowly poisoning the trapped men and the rising level of carbon dioxide was slowing the reactions. Soon they would be unable to assist their rescuers, and most were already quietly waiting for the inevitable end. According to the Professor's calculations their time had already run out.

Herbert, however, remained confident that, given the right equipment, it was still possible to salvage the submarine. His main fear was that the men on the surface would concentrate their efforts and resources on lifting the submarine instead of, first, supplying air and food to the trapped survivors. He discussed the problem in the privacy of his cabin with Commander Francis Goodhart, an experienced submariner and the captain-designate of *K.13*'s sister *K.14*, who was only on board to learn something about K-boat routine before assuming command of his own boat. They agreed that someone should attempt to get to the surface so that they could advise the salvage team on the correct order of priorities.

They devised a plan to get into the conning-tower, build up the air pressure, and then open the hatch so that one of them could escape and float up to the surface. It was a technique that had been adopted in several previous underwater escapes, and, although dangerous, it held a good promise of success given a modicum of luck. The two men agreed that Goodhart should make the attempt as it was Herbert's duty, as the captain of *K.13*, to remain with his crew.

A detailed report was prepared, setting out the exact conditions inside the submarine, to which Herbert, conscious of the worried relatives ashore, thoughtfully added a list of the survivors. The completed document was then sealed inside a metal watertight cylinder and fastened to Goodhart's arm. But, before the escape attempt could be made, certain preparatory work had to be carried out. A small hole would have to be cut in the side of the conning-tower and an improvised sea-cock fitted so that the flooding-up procedure could be controlled. Despite the appalling conditions inside the submarine, the work was carried out with skilful efficiency by some of the artisan workmen from Fairfields and at midday, some twenty hours after *K.13* had made her fatal dive, Herbert and Goodhart climbed into the tower and closed the lower hatch.

The success or failure of the mission was now totally dependent on the determination and nerve of the two young officers. There is nothing the Royal Navy cannot do. Or so they had been taught in the days as Dartmouth cadets. Now it was time to live up to that proud boast.

Goodhart opened the makeshift valve to let in the water and, gradually, the pressure built up as the incoming sea compressed the air inside the dark, cramped tower. When the water had risen to the waists Herbert reached forward and released the compressed air. Then, holding on to the steel support of the ladder, he waited while Goodhart pulled the clips and opened the upper hatch.

The sudden surge of air swept *K.14*'s captain out of the compartment and Herbert caught a quick glimpse of his body streaking up through the water surrounded by a cloud of bubbles. Then, caught u

by the power of the compressed air, Herbert found himself being forced upwards through the open hatch in the wake of his companion. There was nothing he could do to resist the pressure and releasing his grip on the supports and covering his face with his hands for protection, he allowed his body to be blown out of the conning-tower.

On board *Thrush* the first knowledge of the escape attempt was a tremendous upheaval in the water as the air rushed to the surface from the opened hatch. Suddenly, in the centre of the frothing maelstrom, a human head bobbed into view. Someone made a grab and a bedraggled and breathless Herbert was dragged to safety more dead than alive. There was, however, no sign of Goodhart.

Once he had been revived Herbert wasted no time in telling the salvage officers what conditions were like in the crippled submarine. Compressed air, he explained, was their only hope of survival. Compressed air to help support the leaking engine-room bulkhead, to replenish the poisoned atmosphere inside *K.13* and, most important of all, to enable the trapped men to blow the forward ballast tanks and bring the bows nearer to the surface. The salvage men got busy.

High-pressure hoses were taken down to the stricken submarine but the divers were unable to find any means of connecting them into the hull and, while they searched for the external valves, the men on the surface weighed up the merits of several alternative plans. Captain Frederick Young, the Naval Salvage Adviser who had just arrived from Liverpool, suggested making an escape tube although he was more than a little vague how long this would take. Other salvage experts added their own proposals and theories. While they pitted their brains to find a solution the men inside *K.13* were slowly dying.

Hopes rose at six o'clock that evening when the divers finally managed to connect the air hose. But they were quickly dashed when it was found that, for some reason, the air was not getting through the valve. It was a heartbreaking disappointment after so much effort, and the despair of the rescuers was made all the more poignant by the series of regular morse messages being tapped against the hull, signalling by the entombed men:

'GIVE US AIR. GIVE US AIR.'

Conditions inside the submarine were now impossible. The poisoned air dulled the men's reactions and slowed their brain responses. Breathing was difficult and painful, and there was so little oxygen in the atmosphere that striking a match produced only a puff of smoke and no flame. Even Lieutenant Singer, upon whom command had devolved after Herbert's involuntary escape, was prostrate in his bunk suffering from delirium. But progress was being made. A hydrophone had been placed against the hull by the divers so that the men on the surface could hear what was happening inside the submarine, and a signal lamp had been rigged to pass messages through the periscope.

Soon after midnight the trouble in the air-hose was located. The experts discovered that it was blocked by several inches of ice. With the temperature at freezing point the possibility should have been obvious, but working under stress at high pressure no one had stopped long enough to give the problem rational thought. As a result they had wasted seven more vital hours.

Once again the divers descended and fastened the air-hose in place. A signal was passed through the periscope and, moving with difficulty, two of the men inside the submarine cautiously opened the inboard air valve. There was a sharp hiss and moments later the life-giving compressed air was sweeping through the boat. Like men awakened from the dead the comatose survivors rose from their resting places, took deep breaths of the clean fresh air and felt their strength and determination returning. They even found the energy to cheer. And they had good reason. It was thirty-five hours since *K.13* had made her fatal plunge and they were all miraculously still alive.

Now that the atmosphere inside the hull had been revitalized the men turned their attention to the problem of getting the submarine to the surface. The compressed air was diverted to recharge the exhausted air bottles to the maximum pressure of 2,500 pounds per square inch and, as soon as the



were full, orders were given to blow all available ballast tanks. At first nothing happened and the survivors were on the point of giving up hope when, suddenly, the bubbles in the depth indicator began to move. A few moments later they felt the deck tilt gently as the bows slowly rose upwards.

There was mounting excitement on the salvage vessels as the rescuers saw a surging froth of bubbling foam erupting on the surface. And at 3 am the forward periscope poked up through the tumult of white water. *Thrush*, working in unison with one of the trawlers, immediately steered through the maelstrom and passed a 6½-inch wire under the bows of the submarine to prevent it from sinking back again. But, to Michell's disappointment, *K.13*'s bow section remained some eight feet so below the surface and any immediate hope of bringing the survivors to safety via the torpedo tubes were dashed.

The rescuers now planned to rig a second pipeline through which food, drink, air and messages could be passed. And Herbert, in anticipation, had already instructed the divers to remove the brass plate covering the ventilator to the submarine's wardroom and bring it up to the surface. Expert fitters soon secured the second hose to the salvaged plate and the divers went back down into the freezing waters of the loch to replace it in position. But despite signalled instructions the men inside *K.13* seemed incapable of helping themselves. Still suffering from the effects of their terrifying entombment they could not understand what the men on the surface wanted them to do, and those who were still fit enough to think coherently were busy working in the midships torpedo room where water leaking through the engine-room bulkhead was threatening to flood the compartment.

The solitary bilge pump which they had been using to clear the water was no longer operating because of the high angle of the bows and, although they found a solution to the problem by lifting the manhole cover to an empty fuel tank which could be utilized to drain away the water, the work took two hours to complete. In normal circumstances three men could have unbolted and lifted the cover in five minutes flat.

It was dawn before the trapped men realized that they were being told to open the wardroom ventilator hatch. Gasping for breath, they reached up and pulled the clips. The poisoned air rushed up through the outlet pipe and there were sharp screams of agony from the survivors as the sudden decrease in pressure sent shafts of pain through their eardrums. Herbert, sitting in a bosun's chair slung beneath the bows of the trawler, waited for the foul air to disperse and then put his mouth to the surface end of the hose.

'Can you hear me down there?' he shouted.

'Yes – loud and clear.' It was William McClean, Fairfield's submarine manager, who answered.

'Is everyone all right?'

'We're holding out but we badly need air. And water. Has anyone seen Commander Herbert?'

'This is Herbert speaking.'

A cheer filtered up through the pipe. Herbert managed to find some words of encouragement and then passed an airline down the wide-bore hose. This was followed by brandy, milk, coffee, chocolate and beef essence. The men swallowed the drinks with the eagerness of parched camels. They had had nothing to drink for nearly forty hours.

Now that the second pipe had been safely secured the salvage officers considered that time was on the side of the rescuers. The men inside the submarine had food, drink and air in unlimited quantities. And preparations to lift *K.13* could therefore proceed slowly and methodically so that every conceivable precaution could be taken to avoid further mishaps. But Herbert and Michell both disagreed with the experts' plans. The vital engine-room bulkhead was still leaking, and, in Michell's opinion, it was likely to collapse before much longer – especially as the pressure inside the submarine had now been reduced. If it did, no power on earth could save the trapped men from the flood of water.

that would follow in the wake of its collapse.

While the salvage team was arguing another setback occurred when a soda bottle jammed and blocked the second pipe. All efforts to clear the obstruction failed and at 11 am the men inside *K.13* were instructed to close the inner ventilation hatch so that the pipe could be dismantled and returned to the surface for inspection. Meanwhile, and oblivious to this latest crisis, Michell was still trying to persuade his fellow-rescuers to raise the submarine's bows above the surface so that the survivors could crawl to safety through the torpedo tubes. It was only when Herbert added his support that the others reluctantly agreed.

At noon *Thrush* and the trawler, now assisted by two barges, began to haul in the wire. It was a tense moment for there was the ever-present danger of the hawser snapping under the strain. But the efforts were rewarded. The submarine's bows gradually inched upwards until, finally, they broke the surface and came to rest ten feet clear of the water. Michell jumped into the skiff and rowed out to supervise the last stage of the rescue operation. And then disaster struck again!

*K.13* suddenly lurched and began to slide back as her flooded stern settled deeper into the mud on the bottom of the loch. Frantic teamwork and superb seamanship by the salvage men succeeded in arresting the sinking movement. But the jinx of the K-boats had won, despite their efforts, for when the submarine came to rest the lower lips of the torpedo tubes were two inches beneath the surface. The only certain means of escape had now been rendered useless and it is not difficult to imagine the despair of the trapped survivors when they were given the news through the voicepipe. To compound their despondency a fuse blew on the main switchboard extinguishing all but one of the interior lights. Apart from the glimmer of illumination offered by three emergency hand torches the submarine was now in complete darkness.

After a great deal of heated discussion the experts finally agreed to accept Herbert's suggestion that a hole should be cut into the bow section with an oxy-acetylene torch.

'Damned bad salvage,' was the view of the senior salvage adviser Captain Young. 'You can close the torpedo tubes if the need arises but you can't close a hole cut by a blow-torch.' He himself favoured trying to lift *K.13* again so that the torpedo tubes were clear of the water. But that would have entailed more delay while heavy lifting gear and floating cranes were obtained.

Another expert warned that the accumulation of gases in the ballast tanks could explode when they came into contact with the flame of the torch. But desperate situations demanded drastic remedies. Time was now firmly against them. And, reluctantly, everyone agreed that risks would have to be taken.

Once again there were further delays and setbacks and it was three o'clock in the afternoon of the second day before the preliminary hole, just two feet square, was cut through the plating of the forward deck. There was a further hold-up when the space between the outer and inner hulls was found to be flooded and it was some time before the men inside the submarine were able to open the valves to drain off the water. A suction pipe was sent down to speed up the process and finally, at eight o'clock that evening, the task of cutting through the pressure hull commenced.

The dazzling flame of the blowtorch threw an eerie blue light over the scene and the roar of the pressurised oxy-acetylene gas was magnified by the echoing walls of the cramped working space. The steel plates glowed redly as the flame bit into the metal and the eyes behind the dark goggles narrowed with concentration as the rectangular hole was slowly completed. The anxious men watching from the salvage ships saw the crouched figure suddenly straighten up and push back the protective goggles. Then an arm waved vigorously.

'The hole's cut,' he shouted.

Inside *K.13* discipline still prevailed. Lieutenant Singer moved across to examine the narrow

aperture and ran his fingers along the heat-blackened edge. Looking upwards he could see the stars twinkling. Turning away, he faced the assembled survivors,

‘Civilians first!’

It was just after nine o’clock when the first of the entombed men climbed out through the hole and a tremendous cheer greeted his appearance. Large arc-lamps had been rigged on the rescue ships and the area around the protruding bows of the submarine was as brightly lit as a scene from a searchlight tattoo on Navy Day. One by one the survivors came through the jagged opening where they were met by the rescuers who were waiting to shepherd them to the warmth and safety of the *Thrush*. Herbert himself squatted on the casing to give a welcoming hand to each man as he appeared in the opening.

It took nearly an hour to bring out the forty-seven survivors and, in accordance with tradition, the senior officer, Paris Singer, was the last to leave the boat. He looked pale and drawn in the stark glare of the searchlights but, despite his terrible ordeal, he managed to conjure up a smile. His relief was understandable. The submarine had been on the bottom for an incredible fifty-seven hours. According to every scientific textbook on the subject he should have been dead. Yet, in spite of the impossible odds, the Lieutenant and his companions were still alive. Even today the experts do not know how they survived.

Not surprisingly, for all its muddle, confusion and inefficiency, the saga of the *K.13* ranks as one of the most successful rescue operations in submarine history. In the pages that follow we will encounter many disasters. Some end in triumph, some in tragedy. But none, for sheer endurance, can equal the story of *K.13*.

A full-scale salvage operation began the next day but the water which had been leaking through the damaged engine-room bulkhead partially flooded the torpedo compartment within a few hours and the additional weight over-strained the lifting wires, causing them to break and *K.13* sank slowly to the bottom. And Michell’s earlier fears about the bulkhead were proved to be justified. When the divers went down the following morning they located Goodhart’s body trapped under the roof of the wheelhouse. They also found that all four of the great mushroom ventilators were open to the sea and that, for some reason, they had not been sealed off when the submarine began its dive. Even more alarming, their investigations revealed that the indicators in the engine-room clearly showed that the ventilators were open. The Engineer Officer *must* have been aware of the danger even though he apparently chose to ignore the warnings given by his own instruments. And in the course of the examination the divers made another and even more puzzling discovery. The engine-room hatch was unfastened.

Faced by such overwhelming evidence, the Admiralty Court of Inquiry, which was convened on 1 February, had no hesitation in placing the blame for the disaster squarely on the shoulders of Engineer Lieutenant Arthur Lane. As he had died in the aft section of the submarine he was unable to defend his reputation. Despite the young officer’s excellent record and previously exemplary reports the Court President, Captain Godfrey Corbett, pronounced the Inquiry’s unanimous verdict: ‘Engineer Lieutenant Lane was solely responsible for the accident.’

While the Court was considering the evidence, the salvage operation continued and, in the course of their work, the divers found a probable explanation for the mystery of the partially opened engine-room hatch. A careful search of the flooded stern section revealed only twenty-nine bodies; and one of the missing victims was Engineer Lieutenant Lane.

After a reconstruction of the events immediately following the disaster, the Navy’s experts concluded that Lane and the other missing man, John Steel, had managed to open the engine-room hatch and make their escape before the compartment was completely flooded. It was assumed that both men had drowned before reaching the surface. This theory was confirmed two months later when

Lane's body was found on the banks of the Clyde. And after an inquest he was laid to rest alongside his fellow victims in the cemetery at Faslane. The body of John Steel was never recovered.

*K.13* was raised to the surface six weeks after her fatal plunge on 29 January. In mid-March she was towed into Fairfield's yards for refitting. Some months later, with minimal ceremony, she was recommissioned into the Royal Navy as the *K.22*. Less than a year later the *K.22* was to feature another and even more terrible disaster, but that story will be told in a subsequent chapter.

In the sixteen years between 1917 and 1932 over 300 men lost their lives in K-class and converted K-class submarines; and all died as the result of accidents. Not one single man was killed by enemy action. In fact only one K-boat ever attacked a German ship. On 16 June 1917 *K.7*, under the command of Lieutenant-Commander Gilbert Kellet, fired a spread of four torpedoes at the *U-95* when she ambushed the U-boat on the surface. Three of the torpedoes missed the target and the only one to strike home failed to explode. It was a typical example of the jinx that haunted the K-boats.

Admiral Sir John Fisher once commented, 'I have not yet mastered on what basis our submarines harm the enemy more than themselves.' The K-boats did not exist when Fisher made that remark in 1914, but so far as these steam dinosaurs of the sea were concerned it proved to be remarkably prophetic.

\* Including the M-class conversions.

\* See [Chapter 3](#).

## ‘Into perpetual night’

Doctor Cornelius Van Drebbel, a Dutch physician working in England under the patronage of King James I, built and demonstrated the world’s first practical submarine in 1620 when, so it is recorded, ‘he calmly dived under the water’ while the King and several thousand Londoners lining the banks of the Thames at Whitehall waited to see if he would come up again. Fortunately he did, and became the hero of the hour.

Modern historians now doubt both the validity of Van Drebbel’s claims and the veracity of contemporary chronicles. The boat, they say, was no more than a semi-submersible. And, allowing that there is an element of truth in the account of his trip from Westminster to Greenwich, they conclude that the vessel merely ran awash and was carried downstream by the current rather than by the exertions of the four rowers inside. Bearing in mind that Van Drebbel’s ‘submarine’ was constructed of wood covered by greased leather and propelled by two pairs of oars that verdict is probably near to the truth.

William Bourne, in 1578, had designed a similar craft. This, too, was powered by oars but had a screw-operated bilge tank ballast system for obtaining positive or negative buoyancy was considerably more sophisticated than Van Drebbel’s water-filled pigskin bags. But as Bourne’s design never got beyond the drawing-board the honour for producing the first ‘submarine’ must remain with the Dutchman.

Other inventors followed. The Frenchman De Son – basing his design on a book written by the English divine, Bishop Wilkins, in 1648 – went to Rotterdam to build a submarine in 1653. It was never properly tested at sea as De Son could not obtain a sufficiently powerful clockwork motor to operate the boat’s internal paddle-wheel. Having spent all his money, he was reduced to exhibiting his creation at local fairs and markets in an effort to recoup his investment.

While there was no dearth of would-be submarine designers few had the temerity to convert their paper dreams to reality. Those that did took great care not to tempt fate by taking their inventions beneath the water despite their often wildly exaggerated claims.

In 1747 Nathaniel Symons, described by a contemporary writer as ‘a common country carpenter’, built a submarine which he successfully demonstrated on the River Dart in front of several hundred people. Like the two earlier practical submarine builders, Van Drebbel and De Son, Symons based his vessel on the theoretical drawings of another person – in this case the Abbe Giovanni-Alfonso Borelli whose plans were published posthumously in his *De Motu Animalium* in 1680. It is, however, somewhat difficult to understand how an illiterate country craftsman could chance upon and, even more puzzling, understand a learned work that had been published abroad and was written in Latin.

It is even stranger that, while Borelli had thought in terms of goatskin bottles for altering the

buoyancy of his boat along similar lines to those adopted by Van Drebbel, Symons dipped further back into the past and used a variation of Bourne's bilge tank ballast system.

The fact that the only reference to Symons appears in a contemporary periodical, *The Gentleman's Magazine*, may help to explain these apparent oddities. For journalists then, as today, often possessed vivid imaginations and were not beyond dressing up a story to suit the requirements of their readers. Suffice it to say that, according to the magazine's account, Symons successfully submerged his vessel for forty-five minutes and returned to the surface none the worse for the experience. The age of the submarine disaster was yet to come. And, in the time-scale of history, it came rather sooner than expected.

In 1774, nearly thirty years after Symons' experiments, a Suffolk wagon-maker, John Day, built a watertight compartment inside an old fishing boat, ballasted the vessel with large stones, and submerged in thirty feet of water in a convenient village pond near Yarmouth. After what he considered to be an appropriate period of time – he later claimed it to be twenty-four hours – he released the stones and returned to the surface unscathed. 'Elated with success', he decided to stage a public demonstration.

Day was an odd character. Apart from being both 'illiterate and indigent', it was said that 'his temper was gloomy, reserved and peevish, and his disposition penurious.' He was also said to be 'remarkably obstinate in his opinions and jealous of his fame.'

Certainly it was fame that he sought, and he went about it in an unusual manner. Unable or unwilling to use his own money to construct a larger boat Day wrote to a notorious gambler and man-about-town, Christopher Blake. The deal he offered was simple and straight-forward. If Blake would put up the cash he, Day, would build a new submarine and make them both rich men.

It was exactly the right sort of bait to attract a professional gambler and Blake closed the deal promptly. He advanced Day £350 and offered to give him 10% of all his winnings from the wagers he intended to take on the success of the inventor's enterprise. He tactfully omitted to explain that he was, in effect, betting on his protégé's life.

Day bought an old 50-ton sloop, *Maria*, and started work. He constructed a watertight compartment amidships similar to that in his original submarine and placed seventy-five empty hogsheads inside for additional buoyancy. Ten tons of ballast was packed into the hold and a further twenty tons was slung beneath the keel by means of ropes which could be released from inside the watertight compartment. He then painted the boat bright red and announced that he intended to take *Maria* down to 300 feet and remain submerged for twenty-four hours. Blake hurriedly amended Day's brazen announcement to 130 feet and twelve hours.

On 20 June, 1774, *Maria* was towed out of Plymouth harbour to the strains of a local brass band and the cheers of the assembled crowd. While Day prepared for his demonstration dive Blake moved among the onlookers taking last-minute wagers on the success of the venture. In the early afternoon the little procession of boats located an area of water where soundings showed the required depth of 130 feet. Day, taking with him a wax candle, a box of biscuits and a bottle of water, climbed aboard the *Maria* 'with great composure' where eager helpers were waiting to batten him down inside the watertight compartment. The disposable ballast was added and the assistants had barely time to jump clear as the submarine sank out of sight, or, as one chronicler put it: 'Mr Day descended with her into perpetual night'.

Sadly, but not surprisingly, John Day never returned to the surface. Attempts were made to grapple the boat and raise it but the would-be salvagers met with no success. Blake, sensing disaster, had vanished with the stake money. And a local doctor told the assembled crowd that 'considering the depth I can assure you that Mr Day froze to death'.

The learned physician was wrong. Water pressure increases by 15 pounds per square inch for every 30 feet of depth. At 130 feet Day's boat would have been subjected to a pressure of more than 60 pounds per square inch and it is highly probable that *Maria* broke up long before she ever reached the bottom of the sea. Certainly Day never released any of the coloured floats which he had said he would send up at intervals during his descent.

But, despite his ignorance and obstinacy, John Day was a brave man and he has earned a honourable place in history as the first person to lose his life in a submarine disaster. The first, sadly, of many thousands of other equally courageous men.

Fifty years were to pass before the next submarine fatalities, although experiments continued and pioneers like the Pennsylvania-born David Bushnell, who built the *Turtle* in 1775, and another American, Robert Fulton, made considerable progress in the science of submarine design and underwater warfare. Records, however, are irritatingly scant until the middle of the nineteenth century.

The Spanish inventor, Cervo, built a spherical submarine which he demonstrated to the public in 1831. The vessel performed well on the surface but disappeared without trace on its first dive. Equally unfortunate was a French physician, Doctor Petit, from Amiens. He tested his submarine at St Valery sur-Somme in 1834 and, satisfied with its capabilities on the surface, decided, literally, to take the plunge and test it underwater. Some hours later, when the tide went out, the anxious spectators found Petit's self-made coffin resting forlornly in the mud of the estuary, tilted to one side and full of water. The submarine had claimed its third victim.

A more successful venture also ended in tragedy some seventeen years later in 1851. An American shoemaker, Lodner D. Philips, built and tested two 40-foot submarines of cylindrical design with cone-shaped ends. Both were powered by hand-operated propellers and the trim was regulated through a series of manually controlled ballast tanks. One boat, equipped with a saw, was intended for underwater survey and exploration while the second, armed with a primitive gunpowder limpet mine, was constructed for military purposes. Unlike their two immediate predecessors, both submarines worked.

Large crowds assembled to watch Philips diving in Lake Michigan and ample evidence exists to confirm that his boats were capable of prolonged submergence. On one occasion he sawed through a 14-inch block of wood underwater and, on another, he produced a detailed survey report on the formation of the lake bed. His wife and two children often accompanied him on exploratory dives and there is little doubt that Philips produced a perfectly serviceable submarine, allowing, of course, for the limits imposed by the technology of the period.

Moving to Lake Erie, Philips carried out further experiments and set out to make another underwater survey. Unfortunately this time the submarine did not return to the surface and it is assumed that his fragile craft was crushed by the pressure of the water when he dived too deep.

The same year, 1851, also saw the first successful escape from a sunken submarine when Wilhelm Bauer and his two-man crew escaped from *Der Brandtaucher* as it lay crippled and flooded on the bottom of Kiel harbour.

Although a Bavarian by birth and a carpenter by trade, Bauer was a corporal in the Prussian Light Horse Artillery. In 1850 he found himself stationed in Kiel during one of the frequent Schleswig-Holstein border disputes. When Danish warships began blockading the harbour, Bauer, who had been studying the problems of underwater navigation for some years, approached the authorities and offered to build a submarine which, he claimed, would destroy the enemy fleet.

His project was approved and, with the aid of a local ironsmith, Bauer set to work to build his machine. *Der Brandtaucher*, or *Sea Diver*, was constructed from sheet-iron boiler plates. When

completed it proved to be a slab-sided monstrosity weighing some 38 tons. It measured 26½ feet length with a beam of 6 feet and a depth of 9 feet. It had four large glass observation windows set its sides. There was no engine and motive power was provided by a handwheel geared to a propellor the stern. A large weight fitted to a threaded bar which ran almost the full length of the boat was used to control the horizontal trim and, although only a rudimentary device, it worked adequately. Ballast tanks operated by a manual pump adjusted the submarine's buoyancy and its offensive capabilities consisted of two leather 'gloves', which, operated from inside the boat, could be used to attach explosive mines to the keels of enemy ships. That, at least, was the theory.

Bauer's extraordinary vessel was never seriously tested in action for as soon as the Danes saw the submarine creeping towards them on the surface they hurriedly abandoned their blockade and fled. It was a moral rather than a military victory but it showed that the mere threat of a submarine attack could be as potent and effective as the attack itself – a fact of life that remains evident even today and which played an important part in determining the dispositions of both British and Argentine surface ships during the Falklands War.

The Danes, however, quickly renewed the blockade from a safer distance. The Prussian authorities asked Bauer to frighten them away again and, accompanied by two crewmen, Freidrich Witt and Wilhelm Thomsen, he set out across Kiel harbour on 1 February, 1851, for a second and more decisive confrontation with the enemy.

All went well at first. The hatches were secured, the valves were opened to admit water into the ballast tanks and, as the balance weight was moved towards the bows, *Der Brandtaucher* dipped slowly and obediently beneath the surface. The water in the harbour was shallow and safe for diving but, unfortunately, there was an uncharted hole in the seabed some 60 feet deep at the precise spot Bauer had chosen to submerge. So, instead of gently settling on the bottom, *Der Brandtaucher* continued sinking with accelerated momentum. Witt lost control of the balance weight and the submarine plunged deeper and deeper. Water began to pour into the hull through a dozen leaking seams, rivets popped on all sides, and the sheet-iron plating buckled ominously under the intense pressure. The manual pump could not cope with the inrush of water and, to make the situation even more dangerous, the pig-iron ballast in the bilges broke free and slid down the canted deck to add even more weight to the already over-heavy bow section.

Completely out of control *Der Brandtaucher* dropped like a stone until she came to rest in an almost vertical position with her nose buried in the muddy bottom of the harbour. No one could possibly survive such a disaster. The forward section of the boat was flooded, the hull was in imminent danger of collapse, and the air that remained was trapped in the stern.

Bauer realised that the pressure of the sea on the hatch would prevent him from opening it. But his rudimentary knowledge of theoretical physics suggested a solution. If the air inside the submarine could be compressed until it equalled the pressure of the water outside the hull, the hatch could be pushed open with ease and, given a modicum of luck, they could swim to the surface.

Rather foolishly Bauer omitted to explain his scheme to Witt and Thomsen, and when he began unscrewing one of the valves to admit more water into the submarine to compress the air his two assistants thought he had gone mad. There was a wild fight in the darkened boat which ended with Bauer being pinned down on the deck by the two brawny seamen. He tried to explain the theory that lay behind his apparently crazy scheme, but the two sailors took a great deal of persuasion and it speaks volumes for Bauer's forceful personality that they finally allowed him to get up. Then the three men huddled together in the darkness to discuss the pros and cons of Bauer's plan.

Four hours later no agreement had been reached and the air had become dangerously contaminated by the rising level of carbon dioxide. Breathing was difficult and their heads ached. But Bauer still



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