An Explosive Story: The Rise and Fall of the Common Depth Charge

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Introduction

With the outbreak of World War I, the submarine came into its own. For the Germans and British - and to a lesser extent the French, Austrians and Americans - the submarine became an important weapon for use against surface fleets. By the spring of 1917 German U-boats had brought the Allies to the brink of starvation. In World War II, U-boats again dominated until late 1943. In the Pacific, marauding US submarines gradually throttled Japanese movement, particularly on its inland seas. One of the main problems in coping with this weapon was the lack of a suitable counter.

Normally the introduction of a new weapon quickly leads to the development of countermeasures. Yet while by 1914 John Holland's sea-going submarine had been in use for more than fourteen years, and the Whitehead motor-torpedo had been available since 1866, no preparations to attack this submersible warship had been proposed, let alone implemented. Indeed, that oft-quoted doyen of naval affairs, Fred T. Jane, asserted in 1902 that "the sea-going submarine is a pure myth."[1] On the other hand, by 1908 Germany had realised that however great the battleship construction programme initiated by Admiral von Tirpitz and supported strongly by the Kaiser,[2] it still could be blockaded easily because of its short coastline. The Germans thus seized on the U-boat as a possible answer to the threat posed by the Royal Navy. Its first submarine, ***U-l,*** was launched at Kiel on 30 August 1905. By August 1914 it had twenty-eight U-boats operational and by June 1917 sixty-one were at sea.[3] Most were targeted against inbound British trade west of Ireland, although some emphasis was also placed on attacking the RN's much larger fleet.

In 1914 the admirals of the Royal Navy remained contemptuous of the potential of the submarine. It was thus not surprising that serious preparations had not been made to defend against the U-boat. The loss of the cruisers ***Pathfinder, Aboutir, Cressy, Hogue, Hawke*** and ***Hermes*** to U-boat torpedoes in the first three months of the war was a tremendous shock. Indeed, many refused to believe it, instead attributing the losses to mines. Although still unreliable (a fault not fully appreciated until mid-World War II), torpedoes were respected, carried on most major surface ships, and could run for up to three and one-half miles at thirty-eight knots. The prevalent attitude among officers of the various surface fleets (including even the Germans) was to scoff at this unproven weapon.

One reason for the lack of anti-submarine weaponry was that there was no detecting device of any kind, above or below water, except for the human eye. Hydrophones, radar, radio

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direction finding, and mechanical depth sounders were still in the future. When a submarine submerged it escaped totally from the seaman's ken, and nothing could force it to surface except time and its own crew. If a submarine were sighted while diving, there were no craft specifically designed to hunt it. In fact, most ships promptly left the scene once its abilities were appreciated. This essay will not consider the problems of underwater detection, which were at best only partially solved by 1918, but will focus instead on the issues involved in destroying submerged submarines. This means, of course, the development of the depth charge.

Depth Charge Developments in the Royal Navy

Tentative steps to counter the threat of submarines had been taken even before 1914, although these involved little more than talk. In March 1910, an Admiralty Submarine Attack Committee (SAC) was formed as a result of a series of trials with the Home Fleet in which several methods of dealing with an attacking submarine were tried without much success[4] Most offensive actions were aimed at damaging or ensnaring the periscope. One of the more illustrative tales of these endeavours appeared in a letter from Stanley M. Woodward of Southsea, who as a Midshipman in 1915 was sent to Kephalos Bay, Imbros Island, just outside the Dardanelles during that abortive landing:

> The boom was patrolled at night by two picket boats armed with three-pounder guns and Maxims [machine guns]. The Senior Officer in H.M.S. ***Exmouth*** didn't think that this was enough, and ordered each boat to embark two large blacksmiths, armed with flogging hammers, to stand, one on each side of the coxswain. On a periscope being sighted the boat was to steal quietly up alongside it, and the nearest blacksmith was to give it a dint with his hammer![5]

As early as 1900 John Holland, who had just sold the first submarine to the US Navy, wrote that "as nearly as [the] human mind can discern now, the submarine is indeed a 'sea-devil,' against which no means we possess at present can prevail. To me it is a most profound puzzle."[6] When France commissioned more than a dozen submarines, Viscount Goschen, First Lord of the Admiralty, reported to the House of Commons in 1900 that "the question of meeting the submarine menace is receiving much consideration. It is in that direction that practical suggestions would be welcome...It is clear that one submarine cannot fight another...We need pay no attention to the submarine in naval warfare. The submarine is the arm of the weaker power."[7] Fifteen years later these attitudes still prevailed on both sides of the ocean.

Attacking ships essentially relied upon the submarine surfacing to allow its commander a last quick look before firing. That this would occur was probable, since early submarines had only rudimentary periscopes. Crash diving times were considerably longer than were later achieved, although it was boasted by manufacturers that a boat could disappear entirely in as little as two minutes. Submarines were also endangered by international law, which required them to surface to warn their prey before attacking. With the submarine on the surface, potential attackers had to be prepared to act rapidly. Submariners later came to appreciate that smaller warships and merchantmen were not worth torpedoing, which led to the fitting of deck guns on submarines for more minor surface targets.[8]

Between 1904 and 1914, various experiments were undertaken to snare visible submarines. One idea, which was never really tried, involved the use of a hand charge comprised of

18.5 pounds of guncotton fired by a Bickford burning fuse and fitted with a short line with a running noose to be slipped over the periscope using a boat-hook. Another involved the use of a 2.5-pound towing charge, again using guncotton, to which was attached a spring-loaded grapnel hook towed by a wire. When the latter was swept across a submarine and caught, the charge was fired electrically. This technique did not prove very effective in trials. A third method involved an indicating net, a complicated and dangerous contraption 720 feet long by thirty-six feet deep laid from a reel. The idea was to float large numbers across the probable track of a submarine when it dived. Weighted at the bottom with lead and supported by cork floats from life jackets, these contraptions were fitted with indicator flags that flipped up when a submarine became enmeshed. Presumably the crews were then to throw hand charges. Finally, there was the oval lasso net fitted with a floating 18.5-pound charge that was supposed to have been drawn close to a submarine and fired electrically.[9] In 1911 SAC even suggested spreading a chemical on the sea to adhere to a submarine's periscope and blind it. The unfortunate loss of the RN submarine ***A-l*** during these trials forced them to be abandoned. The final assessment was that these make-shift apparati could work and that the fleet was well-prepared to operate in an area "suspected to be infested with submarines." But not everyone was so sanguine. As the Commander-in-Chief of the Home Fleet, Sir Arthur Wilson, warned in 1904, "surely no other type of vessel has assumed suddenly so vast an influence over the daytime operations of an enemy."[10]

Throughout 1914 and the first half of 1915, surface ships half-heartedly relied on gunnery, ramming and a few bizarre tactics. One method that was not used had been tested in 1901 at the Torpedo School at HMS ***Vernon.*** In this trial the specially strengthened destroyer ***Starfish*** was equipped with a pivoting forty-two foot spar to which was fastened a thirty-two pound charge of wet guncotton, fired electrically if dropped onto the casing or conning tower of a target. As if this feat were not sufficiently difficult, the task of replacing the then-shattered spar must have been nearly impossible in a seaway on the low and unprotected foc's'les of the day. Fortunately, this approach passed into limbo before the war actually required its use."

Ramming remained popular against submarines throughout both wars for three reasons. First, a large segment of the RN believed it was effective against any ship. The evidence adduced for this was the loss in 1893 of the battleship ***Victoria*** after being rammed accidentally by ***Camperdown*** during manoeuvres. Second, when ***A-l*** was accidentally rammed and sunk by SS ***Berwick Castle*** in 1904,[12] it was taken as proof that this was a reasonable way to despatch submarines. More important was the case of {7-15, the first U-boat sunk after being rammed by the cruiser ***Birmingham*** on 9 August 1914 off Fair Isle, only five days after the declaration of war.

A considerable number of auxiliary patrol craft (A/S vessels) were commissioned once it was appreciated that U-boats were likely to become a menace off Britain's east and south coasts. These craft, fitted with one or two small guns and rifles in case they came upon a floating mine, were trawlers, drifters, smacks, yachts, and (to the intense annoyance of "Jackie" Fisher, the First Sea Lord) naval net layers, harbour craft and tenders. They had absolutely no anti-submarine weaponry in the modern sense of the term. By December 1915, despite the existence of 2556 A/S vessels,[13] Allied losses had exceeded 2.5 million tons of merchantmen and were rising alarmingly. Anti-submarine measures did, however, receive a valuable assist from the more sophisticated mines, frequently planted to deter U-boats.

"Passive defence" was also employed. Such efforts included anti-torpedo nets extended on booms from the sides of most major warships. Yet this procedure was not particularly successful, since the nets were so cumbersome that ships could not manoeuvre properly. When the battleship ***Ocean*** was mined in 1915 trying to force the Dardanelles, many men were

dragged down by the nets as the ship capsized.[14] The nets were finally abandoned when it was found that torpedoes often penetrated them. Another technique was the use of the anti-torpedo bulge, a second layer of hull built along the vital centre portion of battleships, separated by some feet from the true hull.

The use of booms to defend harbours was non-existent at the outset of the war. This forced the abandonment for several months after 1 September 1914 of the Scapa Flow anchorage when a submarine was sighted outside. The Navy learned slowly. In October 1939, ***U-47*** penetrated the same anchorage and sank the ***Royal Oak*** before harbour defenses were strengthened. Eventually, dummy ships were constructed as decoys; dazzle and disruptive paint was introduced; and convoying was adopted, albeit with great reluctance by all parties and not in any significant volume until utter disaster threatened in the spring of 1917.

While active anti-submarine measures were being examined, the pace was leisurely. In 1914 Admiral Jellicoe complained to the Admiralty that even when a submarine was sighted his ships had no method of attacking once it submerged.[15] While this was not quite true, available equipment was not much use. Apart from the four methods already mentioned, new ones were tested by SAC and the Torpedo School at HMS ***Vernon.*** One involved a high-speed explosive grapnel sweep, towed at a depth of sixty feet by a sweeping "kite." This was the most popular system, experimented with extensively between 1911 and 1914 and responsible for four or five U-boat kills during the war. A modification was the Jeffrey's Travelling Torpedo, in which an explosive charge was held in a chute on the stern of the towing vessel until the sweep grapnel hooked onto a submarine, whereupon the torpedo-shaped charge travelled down the wire until it struck the grapnel and detonated. It was tested successfully, but was superseded by the true depth charge.

Another technique was the modified sweep. This entailed a vertical loop of electric cable supported on the surface by twelve glass floats, the bottom held down by a kite and carrying a series of seventy-pound armed charges. This was then attached to a pivoting beam on a destroyer; when the loop became entangled in a submarine, the beam swung and fired the charges. It was not popular with the crews that had to launch and recover it. Lord Mountevans, a famous destroyer commander, called it "the first anti-submarine device with which we were fitted officially...and probably the worst..Any German submarine who got caught in a fool device like that deserves to be sunk."[16]

Yet other procedures were also tried. One involved firing Lyddite shells at submarines at periscope depth. Unfortunately, the lighter four and six-inch shells caused little damage even when detonated twelve feet from the hull, and the former tended to ricochet and remain above the surface. While a twelve-inch shell detonated at 100 feet was found to inflict some harm, the results were insubstantial, despite being fitted with various nose shapes to assist diving. The modification of army trench mortars was also tried. These weapons fired shells and mortars of many sizes and weights, from 2.8 inches up. As well, stick-fitted bombs, designed to be fired from existing ships' guns, were used. Intensive tests of these mortars and explosives of eighty to 200 pounds occupied trial teams throughout 1915 and 1916.[17]

Three other experiments also merit brief mention. Minesweepers and smaller torpedo boat destroyers (TBDs) were equipped with modified sweeps to be towed between two ships at fourteen knots with several electrically-fired charges of up to 103 pounds.[18] These were used quite extensively in restricted waters. Rifle grenades, with up to a pound of explosive were tried, although it was found that they had to hit the submarine to do any damage at all. Finally there was the Lance Bomb, a conical thirty-five to forty-pound steel container fitted to a five-foot wooden shaft. Activated by pulling a Mills grenade pin, which provided ten seconds in which to toss the contraption at the submarine, four of these were fitted in racks on trawlers and

drifters. The same device was adopted initially by the United States Navy in 1917 and by the Turks at the Dardanelles to destroy trapped E-Class RN submarines, using an impact fuse.[19]

All these were attempts using existing technology to come to grips with the submerged submarine. The first hint of the possibility of designing a depth charge occurred in a brief reference to the need for a "dropping mine," possibly adapted from the Scotti Countermine described in a 1913 Torpedo School report.[20] At Jellicoe's request, SAC asked the Torpedo School for an anti-submarine, "dropable mine." The immediate answer was to adopt a large Service Mark-II mine, which due to its size and 1150-pound weight was called the Cruiser Mine. This was preset to detonate at a depth of forty-five feet by a hydrostatic valve developed by Thomas Firth and Sons of Sheffield in September 1914.[21] To the concern of the crew, one would be balanced precariously on a wood framework at the ship's stern, secured by a wire bridle and slip.[22] Although it was not appreciated at the time, ***Vernon*** had in effect invented the depth charge, complete with the most satisfactory type of firing mechanism.

As well as this rather cumbersome mine, a number of thirty-five and sixty-five pound aircraft bombs were adapted by fitting them with a mechanically operated pull-off pistol operated by a fixed-length lanyard attached to a float that "pulled the pin" when the bomb sank to the required depth. Unfortunately, the lanyard frequently became tangled and set off the charge prematurely. This system was also provisionally adapted to a number of sixteen-pound charges of guncotton in cans, pending a permanent design. Two of these could be clamped together, and this 32.5-pound charge was the first so-called depth charge Type A. Type B was similar, although it was fired by a dissolving chemical pellet when the supply of floats ran out. Type C was the aircraft bomb adaption, also in two weights. These had a damaging range of about twenty feet, compared to the Cruiser Mine which was effective to about 100 feet (see table 1).[23]

Since this system showed promise, on 13 June 1915 SAC reported that the design for a practical depth charge and hydrostatic pistol had been perfected and that six were ready for official testing. These were the initial Type Ds, designed to operate at two selected depths, forty and eighty feet, and containing 300 pounds of TNT or amatol (a TNT mixture with ammonium nitrate, used when TNT became scarce). There was also a Type D*, containing 120 pounds for use in smaller vessels. They could be fitted with underwater "parachutes" to delay the rate of sinking for shallow targets and even had primer safety gear to make them safe until deliberately released. The Type D danger circle to submarines was considered to be about 140 feet.

By July 1917 a firing pistol, set into a six-inch central tube, was developed to allow depth settings of fifty to 200 feet by turning a brass key on the outer face, exposing various sized flooding holes to the hydrostatic chamber, which was fitted with a rubber bellows that cocked the firing pin. There is some disagreement over who invented this concept, but credit should probably be shared by Mr. Taylor of Sunbeam Motors, working at ***Vernon,*** and Mr. Newitt, the Superintending Electrical Engineer of Chatham Dockyard.[24] Safety was assured by providing a 3.5-pound primer in the other end of the central tube, fired by the pistol and detonator. Except for minor variations in the pistol to allow a greater selection of firing depths, and provisions for adding weights to hasten descent to greater (650 feet) depths required for newer U-boats in the Second World War, this was the general—and very satisfactory—design of the depth charge for thirty years. The noteworthy aspect is the longevity of the entire design.

A Type E and an "Egerton" Type (named for the Commanding Officer of the destroyer ***Lance*** who was incensed at not having any method to attack a submerged submarine)[25] were developed for interim use out of locally-available materials, with 118 to 154 pounds of explosives, detonated by a lanyard-and-float system or electrically. They never went into production. However a Type G depth charge, containing only forty-five pounds of explosive, was

Table 1
Depth Charge Types, 1914-1918
(Royal and Commonwealth Navies)

Type	Weight Of Charge (lbs.)	Charge	Depth Of Firing (ft.)	Operation	Source
A	32.5	GC	40	Mechanical	Temp, adapt.
B	32.5	GC	40/80	Mechanical	Temp, adapt.
C	35	TNT or Amatol	40/80	Mechanical	A/C bomb
C*	35	TNT or Amatol	50	Hydrostatic	A/C bomb
D	300	TNT or Amatol	40 to 150	Hydrostatic	VERNON
D*	120	TNT or Amatol	40/80	Hydrostatic	VERNON
E	116	TNT or Amatol	50	Mechanical	Adaption for small vessels
F	70	TNT	45	Hydrostatic	For Bomb Throwers
Iruiser Mine	250	GC	45	Hydrostatic	Mine

Note: "GC" indicates a wet guncotton charge.

Source: See text.

developed after an April 1916 conference. This weapon was also fired by the new hydrostatic valve, intended for the smallest A/S vessels incapable of carrying the heavier Types D and D*. In August 1915 an order for 1000 Type D charges was placed with four firms. On 10 October it was determined by SAC that only two types, D and D*, would be produced, and by January 1916 they were distributed to the fleet. A handbook, ***CB 1231*** was issued in September 1916. The very first depth charge success was the sinking of ***U-68*** by the Q-ship ***Farnborough*** off Kerry, Ireland, on 22 March 1916. The U-boat was blown to the surface when it submerged after a gun action.[26]

The numbers of depth charges available initially allowed for only two per ship, carried in a sloping chute in the stern, one being released by an hydraulic release gear operated from the bridge and the other by an ordinary hand-operated slip. As supplies gradually increased, in July 1917 four were issued to each ship,[27] and by 1918 thirty to fifty were provided to larger vessels, such as destroyers and a few larger trawlers, although some "gun and torpedo armament had to be surrendered...on account of stability."[28] One officer of the day in HMS

Cockatrice recalled that because of this new and unplanned weight "the whole ship's company was in a state of jitters...we were in a shocking state of instability, and our metacentric height must have been half way up the funnels! We hung 'on the roll' to a degree that was terrifying!"[29] Tests soon showed that even small vessels were safe from the explosion of the heavy Type D charge unless it was fired at less than 100 feet and at least ten knots, so the lighter Type D* was discontinued.

Table 2
Depth Charge Usage and Success, 1914-1918

			U-Boat Kills (Including Austrian)		
	Depth Charges		All	By	Damaging
Year	Issued	Expend	Known	D/Cs	Attacks
1914	NIL	NIL	5	NIL	2
1915	NK	NK	19	NIL	63
1916	3,171	NK	22	3	123
1917	20,145	1,727	63	11	437
					+ 192A/C
1918	51,125	14,724	69	24	205
					+ 130A/C
Total	74,441	16,451	178	38 = 21%	

Notes: NK = Not Known or no records. 1918 figures are to November. The 1917 data on depth charges expended are for two-thirds of the year only. The credit for U-boat kills by depth charges includes a number of cases in which depth charges were only one of a number of contributing factors.
A / C = Aircraft attacks.

Sources: Great Britain, Admiralty, Technical History Section, ***Technical History No. 7, The A/S Division*** (London, 1919); R. M. Grant, ***U-Boats Destroyed*** (London, 1964); R. H. Gibson and M. Prendergast, ***The German Submarine War*** (London, 1931); Henry Keatts, ***Field Reference To Sunken U-Boats*** (King's Point, NY, 1987).

With the development of these depth charges, a means was required to propel them to a safe distance from A / S vessels—in other words, a depth charge thrower was needed. The army's howitzer bomb thrower, an extension of the trench mortar concept, had been developed early in the conflict, and 174 were mounted in auxiliary patrol craft in 1917 and 1918. The howitzers were five and 7.5 inches, at first designed to fire a 100-pound projectile with forty-five pounds of explosive just over a mile, with a delayed-action fuse of two seconds, giving a depth of about forty feet at detonation. Later a 350-pound "stick" bomb with a 200-pound charge was developed, with a range of 650 yards. The stick bombs were supplied for firing from the twelve-

pounders carried by A/S ships. Fuses were preset for forty, ninety, 100 and 140-foot depths.[30] While better than nothing, they enjoyed little success due to inaccuracies, delays in firing, the lightness of many of the charges, and inexperienced crews, for most were fitted on auxiliary vessels and merchantmen. Still, it was a major project, with 1277 issued. Only one U-boat seems to have been destroyed by these variations on bomb-throwers.[31] By August 1917 the development of a thrower which could propel a depth charge forty yards from the ship doing the firing was completed, using the howitzer heavy bomb-thrower principle, powered by a two-pound pom-pom cartridge. A contract was let to Wm. Thornycroft and Co. of Southampton, which made 3010 themselves or on license. The first was shipped by July 1917.[32] Two were fitted in torpedo craft and other vessels with sufficiently strong decks to withstand the thrust.

By the end of the war, 437 TBDs and destroyer leaders had been provided with depth charges; so too had sixty-three 'P' boat patrol craft, 101 sloops, 285 trawlers, and innumerable smaller motor launches and boom patrol craft. Of these, 351 TBDs and 100 other craft were also equipped with Thornycroft depth charge throwers.[33] By July 1918 sixty-seven trawlers and auxiliaries of the Royal Canadian Navy on the east coast had been provided with depth charges.[34] Air attacks did not play a large role in destroying submarines in World War I. Only one submarine, ***UB-32,*** was sunk by an aircraft alone, but four more were despatched with the assistance of surface ships (see table 2).[35]

Depth Charge Development in the US Navy

Meanwhile, after its entry into the war in February 1917 the United States first copied the RN's depth charge types. The American Depth Charge Mark 1 was the fifty-pound float-and-line pull-off pistol variation, adjustable for twenty-five to 100 feet. While 10,000 were contracted, this type never went into serious production once American officers became aware of later RN developments. The MK 2 was the D Type, of which 50,000 were ordered between July 1917 and war's end, plus an order for the British government for 15,000. MK 3 was a slightly modified version, good to 300-foot depths; MK 4 was similar to the RN's Type D Heavy, seven inches greater in diameter than the MK 3 and weighing 745 pounds. These were at first supplied in pairs and stored in small racks, but later a one-ton rack was provided to hold up to thirteen charges. For throwers, the USN's Bureau of Ordinance designed its own Y Gun, modified from the Thornycroft thrower but designed for centreline fitting, to throw two charges at a time about forty-five yards on either side. The first construction started on 24 November 1917 at the New London Ship Engine Co.[36]

For more than twenty years after the conclusion of the war, the matter of despatching detected submarines rested, at least as far as depth charge development was concerned. Slow and steady progress was made in detection with the development of piezo-electric echo equipment and its interpretation, the now familiar "ping" of ASDIC. Kept very secret, even among erstwhile Allies until after American entry into the Second World War in late 1941, it was optimistically presumed to be the satisfactory answer to the renewed U-boat construction programme of the 1930s. And it was felt that once the submarines were detected, the 300-pound depth charge would deal with them. In the House of Commons, Sir Samuel Hoare proclaimed in November 1937 that "today we are justified in saying that although we regard the submarine as an extravagant nuisance that ought to be abolished, the submarine is no longer a danger to the security of the British Empire."[37]

The RN in the Second World War

With the onset of the Second World War, the depth charge was initially the only A/S weapon available. The preferred kind, the Type D, had not changed since 1918. There were insufficient supplies for non-A/S vessels. At Sydney, N.S., Commander J.D. "Chummy" Prentice, responsible in 1939 for anti-submarine defenses, had to make his own using milk cans, 300-pounds of coal mine forcite, and waterproof hand-lit fuses.[38] Instructions initially told attacking ships to drop five-charge patterns and never more than ten at one time.[39] This was efficient enough for peacetime trials, and against early and slower U-boats but was to prove too parsimonious for later, hardier boats and their commanders. In the first year of the war after September 1939, twenty-nine U-boats were sunk, fourteen by depth charge attack, a forty-eight percent rate attributable to this elderly weapon.[40] Yet compared to the 4000 attacks in the same period, the success rate was disappointingly low. To the end of the war, the success rate for depth charge attacks rarely rose above seven percent, an immense effort for little return, except perhaps for the terrorising of the crews below.

While a method had been established shortly after 1934 to time the dropping of depth charges using the paper trace from the ASDIC range recorder as the ship ran over its target, most commanders preferred to use a stop watch and the naked eye, thus requiring a skill not at first appreciated.[41] As more U-Boats arrived in the fray and additional escorts were commissioned (the latter led inexorably to a decrease in the skills of the average A/S crew), more efficient attack methods were obviously required. The ten-charge pattern soon became standard and was later raised to fourteen in hopes of bracketing the U-boat both directionally and in terms of depth. Initial spacing of charges was at forty yards, but by early 1943 studies of survivor interrogations showed that sixty yards was sufficient to get the same effect while covering a wider area. As well, the more powerful explosive "minol" replaced TNT and amatol. When it was discovered that newer U-Boats could dive to 500 feet and more, the heavier MK VII Heavy depth charge was introduced, equipped with a cast iron or concrete weight which improved the sinking rate from ten to 16.5 feet per second, with a new pistol modification allowing for depths up to 550 feet (see table 3).[42] Even so, such charges still took more than half a minute to sink to the target's depth, allowing the U-boat too often to evade the attack. The range of the throwers was increased somewhat by lashing the carrier arbour to the thrower with codline and providing a more powerful firing cartridge and a newly-designed firing cylinder. Safety was enhanced by the primer being separated from the pistol's detonator by a "fork," which was pulled loose only when the depth charge was fired.

A new torpedo-shaped depth charge was introduced for use in destroyers for very deep or bottomed U-boats in mid-war. But the MK X (Mark 10), with over a ton of amatol or minol explosive was used very rarely (only thirty-two were ever fired). Due to being housed in exposed torpedo tubes, these monsters seldom worked, and many hilarious and sometimes bitter tales about them involve failures and frustrations.

In the same vein, the anti-submarine aircraft bomb and the earlier air dropped depth charges (the MK 8) were notable for a lack of success in damaging their targets, due mostly to low-level aiming inaccuracies and the inadequate 175-pound explosive failing to incapacitate the U-boats.[43] When an R A F "Anson" accidentally bombed HM S/M ***Snapper*** in December 1939, hitting it at the base of the conning tower with a 100-pound bomb, the only damage was four broken light bulbs. Only 35% of attacks were assessed even as probable kills. It was not until frustrated pilots complained about a lack of success even when they caught submarines on or near the surface that in late 1942 an air-dropped 300-pound Torpex depth charge, the Mark VIII, was introduced. Fitted with a protective collapsible nose faring and a pistol designed

to fire automatically at twenty-five feet (but which in fact fired at about thirty-four feet, too deep to be ideal), this depth charge ushered in an era in which aircraft attacks became one of the principal methods for destroying U-boats.[44]

Table 3
Depth Charge Types, 1939-1945
(RN and Commonwealth)

Type Or Mark	Weight Of Charge (lbs.)	Charge	Depth Of Firing (ft.)	Sink Rate (ft/")	Source
D	300	TNT or Amatol	50 to 280	16.0	1st War
7 & 7*	290 to 300	Amatol, Minol or Torpex	50 to 500	10.0	Type D
7 Heavy	290 to 310	Amatol, Minol or Torpex	140 to 700	16.5	For Deep S/M
8	160	Amatol	14/24	8.9	A/C D/C, with a breakaway tail
10	2,000 - 2,150	Amatol or Monol	150 to 640	21.0	Torpedo tube launched
11 & 11*	175	Torpex	14/39	9.0	A/C D/C, from MK 8
12	50	Minol	25 to 100	7.5	Used by small craft
13	122	Minol	18 to 240	3.2	Slow sinking. Used against surface ships

Notes: A11 depth charges were hydrostatically fired. The MK 7 Heavy was an MK 7* with a steel or concrete weight and a special pistol.

Sources: Willem Hackmann, ***Seek And Strike, Sonar, Anti-Submarine Warfare and the Royal Navy 1914-54*** (London, 1954); S.W. Roskill, ***The War At Sea*** (3 vols., London, 1954); H. St.G. Saunders, ***The Royal Air Force in 1939-45*** (London, n.d.).

The problem of the ships' long run-in to the attack and the tendency to lose touch with the target when it was about 200 yards ahead (for a submarine at about 200 feet) created a long "blind run" during which a wily submariner could often evade being hit. The top submarine killers, such as Captain F J. Walker and Commander Donald MacIntyre, learned to anticipate this diversion. But as early as the summer of 1939 efforts were under way to develop an ahead-

thrown-weapon to be fired when still in contact with the U-boat. In July 1941, the first test took place of a single barrel "ATW" (ahead-thrown-weapon) in the destroyer HMS ***Whitehall.*** While this was less than successful, a lighter, multiple sixty-two pound projectile weapon that detonated only on contact named "Hedgehog" was more successful later in the year. Unfortunately, Hedgehog was somewhat difficult to operate and dangerous to handle on board.[45] Development progressed for a heavier mortar projector, at first called Mortar Type A (a Hedgehog modification) and Type B, and later the better known "Squid" that fired three (later six) 300-pound depth charge-like projectiles well ahead of the ships. This was the final version, settled on in May 1943. These, in turn, required accurate ASDICs, and awaited the development of the Type 147 depth predictor ASDIC, not available until late 1943 for trials in HMS ***Ambuscade.*** In the latter days of the war, the good 144 and 147 ASDICs, the increased fitting of ATW Squid and Hedgehog, the availability of more escort destroyers, sloops and frigates, and a continuous increase in skills finally overwhelmed the remaining U-boats. As a cautionary note, the large fast Type XXI U-boats just arriving in the war's last months might have reversed the trend of the naval war.

Table **4**
Depth Charge and ATW Use, 1939-1945
(RN Bases issued, to all Forces)

	Attack Method, At Sea			Submarines Destroyed at Sea, Ships & A / C (including Italian)	
Year	D/Cs Expended	Hedgehog	Squid	All Known	By D / C
1939	1,897	nil	nil	6	6
1940	12,513	nil	nil	29	29
1941	16,618	NK	nil	42	40
1942	26,006	8,000	nil	91	88
1943	39,434	9,800	nil	226	217
1944	65,241	30,126	1,072	163	133
1945	51,268	55^88	4,449	83	57
Totals	212,977	103,314	5,521	640	530
RCN Total	40,000				

Notes: NK = Not known (or no useful records kept). Hedgehog attacks for 1942 and 1943 are estimates based upon one month's expenditure figures. Data for 1939 is for five months only, 1945 figures are for 4.5 months. The Hedgehog was in partial use for two months in 1941. The figures on submarines destroyed by depth charges include a number which were partially caused by other factors. RCN total is approximate.

Sources: Commander F. Barley, Admiralty, Historical Section to author, March 1961; E.P. Hoyt, ***The Death of the U-Boats*** (New York, 1988); Roskill, ***The War At Sea.***

Table 5
Depth Charge and ATW Successes, 1943-1945
(RN and Commonwealth Reports)

	A/S Attack Successes By Ships			Total U-Boats Sunk At Sea By RN Ships (Including Italian)		
Year	By D/C	By ATW	Total	No.	% To D/C	% To ATW
1943	42.5	***85***	51	226	18.8	3.8
1944	35.5	29.5	65	163	21.8	18.1
1945	***15***	26	335	83	9.0	31.3

Notes: Total U-boats sunk excludes marine accidents, mines, S/M torpedoes, bombed in harbour, etc.

Sources: Hackmann, ***Seek And Strike;*** Hoyt, ***The Death of the U-Boats.***

The USN in The Second World War

After the United States joined the conflict in late 1941, its Navy initially used its MK 3 and MK 4 depth charge designs from the First War, along with a similar MK 6. Eventually, the US produced 219,222 of these depth charges, more than any other type. But almost at once the Bureau of Ordinance concentrated on improving the sinking speed, the critical delay while the ship ran in and the charges sank to the U-boat's level, and the pistol firing arrangements. It developed the MK 9 teardrop-shaped charge, with 200 pounds of TNT, sinking at 15 feet per second. The Bureau disliked the RN's hydrostatic pistol because of the danger of firing when a ship was sunk. By late 1942 it developed a proximity fused detonator, fitted in its MK 8 (ash-can shaped) and MK 9 charges. But problems with its delicate circuitry were not really solved, and complications in fabricating the MK 9's odd shape delayed large-scale production until mid-1944. American engineers even researched an MK 14 depth charge, an MK 9 with an acoustic echo-operated pistol and a range of up to seventy feet. Both pistols had problems to the end of the war, particularly in the humid Pacific, and thus were little used in operations.

Two smaller depth charges, the MK 10 and MK 12, and a Scatter Depth Charge composed of six small bombs, were developed but only went into limited production. The USN also copied the Hedgehog (ASP MK 10 and MK 11) and developed a one-third size Hedgehog for smaller ships, the "Mousetrap" (ASP MK 20 and MK 22).** These later developments were consistent with American devotion to advanced technology, but had only modest effect on the A/S war and were still under development at its end.

The depth charge remained the favoured weapon primarily due to its simplicity in inexpert hands and the weight of explosive that could be delivered. Captain "Johnny" Walker's famous "creeping attacks," delivering twenty-four depth charges or more at a bracketing depth by one slow moving escort, controlled by another sitting off to one side and still in contact with the often deep target, became legendary. Moreover, the increasing availability of escorts for pure hunting Groups rather than convoy shepherds allowed contact prosecutions and continuous attacks for as long as thirty-six hours. Commander Prentice recalled dropping twenty-two tons of depth charges, plus Hedgehogs, on ***U-678*** in only 120 feet of water off Brighton in June 1944—and even then not "opening her up."[47] The variety of weapons in the ships, depth charges

(heavy and light), and Hedgehogs and Squids allowed various attack methods to be used, and successes rose accordingly. While in 1945 the depth charge attack success rate remained at a steady seven percent for 107 attacks, the rate for Hedgehog was twenty-six percent in fifty-nine attacks, and for Squid thirty-six percent in forty-seven attacks (see tables 4 and ***5).*****

Conclusion

For the 1915 depth charge, the writing was clear by the beginning of 1945. Stern-dropped attacks using slow-sinking explosives were past. While the Squid, and the later US-developed ASROC rocket-propelled ballistic depth charge are really just younger offspring, in their turn they are being superseded by acoustic hunting torpedoes and even nuclear depth bombs. But the last attacks of World War II in the Pacific by USS ***Gilligan*** and USS ***Cronin*** on 22 August 1945 were depth charge attacks. They mark the end of a fascinating record-and an era.

The effective depth charge had been developed in response to a belatedly appreciated need, largely prodded into development in 1915 by agonized complaints from those at sea battling U-boats. Its success rate, while less than ideal, enabled it to be used almost unmodified until 1943. By then, commanders at sea had come to appreciate that while its explosive force was adequate, there were flaws. Hedgehog was an interim solution, with several drawbacks—it was dangerous on board and did little to affect the morale of U-boat crews. The Squid bomb was, as the last table shows, the ultimate solution, still applying depth charge principles such as 300 pounds of explosives and a hydrostatic firing mechanism, but solving the problem of timing.

While these latter developments, including the USN's fancy fuses, could, like the Types XXI and XXIII U-boats, have changed the progress of the 1939-1945 anti-submarine war, they came too late to do so. The depth charge whether dropped from a WWI trawler, an amateurish corvette, an obsolete Fairey Swordfish aircraft, or a modern sloop or frigate, carried the brunt of the war at sea for the Allies. It is debatable if it "won" the war, for later weapons were more effective. But without it, the war would have been lost in the early days. The navies and their research and development staffs could have done better. But this simple can of explosives in both conflicts parried the U-boat threat. Nonetheless, it was a near run thing.

NOTES

• Fraser McKee is a past National President of the Navy League of Canada and is currently chair of the Liaison Committee of CNRS. His third book, a history of the RCN frigate HMCS ***Swansea,*** is to be published by Vanwell Publishing in 1993.

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