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A Diabolical Device

The North Vietnamese Birdcage Mine

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In memory of Patrick 'Zeke' Zegenhagen.

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About the authors



David Pearson, FSA – is an archaeologist and senior curator in the Military and Technology Section at the Australian War Memorial in Canberra. He has published extensively on archaeological, digital preservation, and military historical issues and his main research concerns the technical and social contexts of conflict archaeology and associated artifacts. He has published four books, many chapters and articles in scholarly journals and is a fellow of the Society of Antiquaries of London. Pearson has over thirty years of experience working in national cultural institutions since 1994. He is responsible for bringing many interesting items into the Memorial's collection, particularly the birdcage mine, when he first became interested in it as part of an overall effort by Navy to increase its representation at the Memorial, and his particular effort to acquire more CDT-3 artifacts from Vietnam and other conflicts.



Patrick 'Zeke' Zegenhagan – dealt with explosives for his whole adult life. He joined the RAN in 1963, before qualifying as a CD in 1966, and in 1967–1968 went to Vung Tau, Vietnam, with the 2nd Contingent of CDT-3. After discharging from the RAN in 1969, he spent time in the Commonwealth Police before going back to demolition work in 1977; first as a contractor, then setting up his own commercial blasting business, blasting and demolition above and below ground and under water until his retirement in 1998. Although he encountered all sorts of standard, improvised and repurposed ordnance in Vietnam, he never encountered a birdcage mine. However Zegenhagan held a fascination for this type of pressure mine since he first heard about it and saw one in the early 1970s. Subsequently, he became interested in documenting how it worked, was adapted and deployed before this knowledge disappeared. He died 8 October 2024 before this work was published.



Michael 'Mike or Golden' Ey – spent much of his military and subsequent life as a diver. He joined the RAN in 1963 and served on HMAS Ships Anzac, Yarra and Supply. He qualified as a CD in 1968 before going on to serve in Vietnam in 1969 with the 5th Contingent CDT-3. In particular, he was deployed to Cua Viet in April to learn about the birdcage mine and support USN EOD units in the recovery of vessels, weapons and ordnance, the former littering the river from various mining incidences. He was also involved in countering the NVA swimmer-sapper attack on the MV Heredia (carrying almost 8,000 tons of explosives) by two Russian BMP-2 limpet mines and an improvised VC Mine containing 18 kgs of explosive at the De Long Pier, Vung Tau harbour on 22 May 1969.

He discharged from the RAN in 1973 becoming a commercial diver in the Sydney area before going on to work on off-shore oil rigs for 18 years around the world; first as diver and later as a driller. Ey then became a maintenance diver for Novotel Twin Waters Resort before retiring in 1994. He is interested in diving and explosives of all types and in preserving the history of the CD Branch.



Bishop Lester Dighton – has worked in several trades, plus made studies into many and various subjects and disciplines, resulting in a general overall knowledge of devices, methodologies, and philosophies. Ordained as Deacon, then Priest and Consecrated as Bishop in 2003. He has published Bible studies, texts, short stories and papers for different groups on a variety of subjects. Bishop Lester has been the Chaplain for the Linville Anzac Parade since 2007, and Chaplain to various returned and retired military personnel. He has collaborated with Patrick Zegenhagan for 40 years on various building projects, research and publications, organising CDT-3 re-unions, all of which culminated in the birdcage mine investigations.

Foreword

Mines are one of the most effective asymmetrical capabilities. For hundreds of years, nations and their militaries have used mines – both at sea and on land – to deny access to areas of strategic significance. Mines have remained a constant in warfare due to their cost-effectiveness, persistence and psychological impact. They allow smaller and technologically less advantaged forces to challenge even the most powerful adversaries. Mines provide an effective means of denying access to critical waterways and imposing costs on opposing forces.

Notwithstanding great progress in mine countermeasure technology, mines continue to pose a threat to ships and boats on and under the sea, and in coastal and riverine waterways. Some modern mines use advanced sensors and novel concealment methods. Yet, effective mines can be developed from very basic materials. As a consequence, a mine threat can emerge very rapidly, with few indicators to give advanced warning. The birdcage mine developed by North Vietnamese forces in 1968 is an excellent example.

'A Diabolical Device' is an extensively researched account of the development and use of this little-known mine. The authors, David Pearson, Patrick (Zeke) Zegenhagen, Mike Ey and Lester Dighton, have drawn on their own professional expertise in writing this publication. Significantly, they also describe the work of the Royal Australian Navy's Clearance Diving Teams in responding to and disarming the different forms of birdcage mine.

The birdcage mines had a significant impact on any forces that were required to navigate the Cua Viet River. Not only did the presence of mines require United States and Australian forces to expend valuable resources on countermeasures, forces were reluctant to enter areas where they suspected mines had been placed. This demonstrates not just the direct kinetic effects of mine warfare, but also its psychological impact.

The Australian Defence Force is currently making significant investments in mine countermeasure capabilities, focusing on introducing new and innovative technology including remotely operated autonomous and uninhabited systems. However, history has shown that technological superiority does not guarantee success, and that even the most advanced nation can be outmanoeuvred by a less sophisticated adversary that leverages asymmetrical tactics. The birdcage mine is a perfect illustration of a rudimentary device that had a devastating impact. 'A Diabolical Device' demonstrates the need for continued innovation in mine countermeasures and effective operational planning.

Captain Alastair Cooper RAN

A Diabolical Device

The North Vietnamese Birdcage Mine

David Pearson FSA, Patrick 'Zeke' Zegenhagen, Mike Ey and Lester Dighton

During a United States Navy Explosive Ordnance Disposal (EOD) call-out in South Vietnam on 9 November 1968, two Team 40's Patrol Boat Rivers (PBR) were travelling from base upriver between Cua Viet and Dong Ha. In the second boat was Australian Petty Officer Clearance Diver Barry 'Tug' Wilson, who was temporarily attached to the unit. At about 1.30 am, the lead boat came under shore-based fire. In response, the boat increased speed and engaged the enemy with machine guns. Tug could hear the incident unfolding on the radio – the coxswain shouting, the boat's engine roaring and its machine guns firing. Then he heard a dull thud and, after that, complete silence. The second PBR's skipper, aware of the danger posed by birdcage pressure mines, immediately shut down his boat's engine to protect against the mine's pressure-firing mechanism, which was triggered by a boat's movement through the water. Tug's boat then drifted without lights, in complete silence, until dawn, after which it was driven very slowly back to base.

Tug was part of the crew sent to recover the first PBR. The dive team found that the bodies of the boat crew and surrounding area had been booby trapped. Tug had to enter the murky water, deactivate the explosive booby traps, and recover the bodies by hand – a nerve-wracking experience. Once the boat was recovered, the team assessed that the blast had broken its back (keel) and killed all on board. Further investigation confirmed the cause of the explosion was a birdcage mine: the remains of a birdcage cage housing, its defining feature, were found embedded in the wrecked boat's hull.¹

Introduction

Many weapons bear their inventor's name, or the name of the person who inspired the weapon. Well known examples include the Browning pistol, Owen machine carbine, and the Molotov cocktail. Other weapons have generic military nomenclature, such as the Standard Missile 1 (SM1) or the M16A1 assault rifle. This paper analyses one weapon that has no such known nomenclature, and which cannot be traced to any particular person: the North

¹ Barry 'Tug' Wilson, Personal Communications, May 2021. According to McAulay, the first known birdcage mine captured intact was found at Cua Viet in August 1968 by USN EOD personnel during Operation Clearwater. See Lex McAulay, *In the Ocean's Dark Embrace: Royal Australian Navy Clearance Diving Team 3 (USN EODMUPAC Team 21 & 35), Vietnam 1967–71*. Maryborough, Qld: Banner Books, 1997, pp. 99–100. This was 3 months before the first incident involving a CDT-3 member; Tug Wilson encountered one in November 1968.

Vietnamese 'birdcage' pressure mine (actuator or triggering device).² The birdcage mine is a shallow-water influence mine actuated by the positive and negative pressure generated by the hull of a passing vessel. The mine has simple componentry, can be assembled and deployed by people with minimal technical training, and can utilise any readily available explosive. Once in the water, it can resist counter-mining, and be activated using variable time delay to sink riverine vessels. During the Vietnam War, its use had a significant impact on allied morale and led to the loss of allied control of the waterways closest to the demilitarised zone (DMZ) between North and South Vietnam. Chavanne suggests that 'underwater weapons became the greatest threat to the brown water navy in I [1] Corps' region' in Vietnam, where the birdcage was deployed.³ The Cua Viet region is the only area in South Vietnam where the birdcage mine is known by the authors to have been used.

In Australia, the birdcage mine is largely unknown outside the clearance diving community (Figure 1). This paper examines and records the inner workings and effectiveness of the birdcage mine through the experiences of the Royal Australian Navy's (RAN) Clearance Diving Team 3 (CDT-3) operations in Vietnam. On occasion, elements of the team were attached to United States Explosive Ordnance Disposal (US EOD) units, which operated in the shallow waters of the Cua Viet region of I Corps, near the DMZ. The main birdcage mine analysed in this paper is held in the collection of the Australian War Memorial; it was donated to the collection by the Australian Defence Force (ADF) Diving School at HMAS *Penguin*. While it may be simple in construction, it is ingenious in concept.

Historical perspective

The Memorial example of the birdcage mine was brought to Australia by CDT-3 members for EOD training purposes during the Vietnam War (Figure 1).⁴ It remained with the RAN Clearance Diving Museum (attached to the ADF Diving School) at HMAS *Penguin* until December 2020, when it was donated to the Memorial.⁵

2 The birdcage mine actuator is the surviving part of the mine in question. The explosive base charge, in its various forms, is external to the actuator unit and could be deployed with the actuator or separate from it. For the purpose of this article, the authors refer to the surviving unit without its base charge as the birdcage mine.

3 Jonathan Chavanne, 'Upriver to Hue and Dong Ha: The U.S. Navy's War in I Corps, Vietnam, 1967–1970', Master of Arts thesis, Texas A&M University, 1990, p. 79, core.ac.uk/download/pdf/4315159.pdf, accessed 6 June 2024.

4 We understand from Lieutenant Edward 'Jake' Linton BEM RAN (Officer in Charge 8th Contingent, CDT-3 Vietnam) that this came back in a Conex box when the 8th Contingent left Vietnam in May 1971 (Edward Linton, Personal Communications, June 2021).

5 David Pearson and Commander Andrew Schroder RAN, tracked down the Memorial birdcage mine (Figure 1, AWM2020.839.1) and a BMP-2 limpet mine (AWM2021.184.2) from Vietnam, as well as a HY-2 'Silkworm' missile (AWM2021.184.1) from the First Gulf War to the ADF Diving School. These items were subsequently acquired by the Memorial to improve CDT-3 representation in the national collection. Special thanks to Commander Paul Doble RAN, then commanding



Figure 1: Right-hand-side view of the disassembled birdcage pressure mine (Example 1). This is the Mark 2 variant with modifications a. to e. described in text (scale 10cm). This example was donated to the Australian War Memorial from the ADF Diving School at HMAS Penguin in December 2020 (AWM internal photograph, 2023).

There are two other surviving examples at the ADF Diving School (both are earlier versions of the mine, and can be seen at Figures 2 and 3), while a fourth, with a different type of chemical arming device, is pictured in the July 1971 edition of *Navy News* (Figure 4).⁶ The essential details of these examples are identified in Table 1.

RAN CDT-3 deployed to Vietnam between 5 February 1967 and 5 May 1971, with 49 divers (in eight contingents) serving over this period.⁷ CDT-3's role in Vietnam was primarily defensive. Based in Vung Tau and then Da Nang, it operated as part of Operation Stable Door's Harbour Defence Group, EOD component, which was tasked primarily with protecting shipping in Vung Tau harbour from enemy swimmer-sapper attacks. The Harbour Defence Group was a sub-unit of US Task Force 115, which was responsible for coastal surveillance under Operation Market Time, undertaking the stopping, boarding, searching and capture or destruction of enemy vessels. CDT-3 was, on occasion, also involved in Market Time operations. The team fell under the administrative control of the US Navy (USN) and its Inshore Undersea Warfare Group 1 (IUWG-1), a component of the US Pacific Fleet.

officer of the ADF Diving School, for making this possible.

⁶ It appears that at least 4 such mines were brought to Australia (Figures 1–4, examples 1-4). The example pictured in the *Navy News* in 1971 has at least one chemical arming device located on its cage (which is different to the Memorial model) (Figure 4). 'RAN divers honoured for Vietnam service', *Navy News*, 9 July 1971, p. 2, navy.gov.au/media-room/publications/navy-news-july-1971, accessed 6 June 2024.

⁷ Ross Blue, *United and Undaunted: The History of the Clearance Diving Branch of the R.A.N.* Sydney: Naval Historical Society of Australia, 1976, p. 25.

Example	Current location	Type, as identified in this study	Dimensions	
			Actuator housing (length; width at base)	Base of actuator housing to top of birdcage (length; width at cage)
Description in a contemporary Manual (Figure 8) ⁸	N/a	Mark 1	Unspecified length Approximately 120mm wide at base	Approximately 430mm long (cage unspecified length and width)
Figure 1	Australian War Memorial (ex ADF Diving School)	Mark 2a.–e.	224mm long (with disassembled components added) 162mm wide at base	Approximately 460mm long (cage 265mm) ⁹ 220mm wide at max cage Ø
Figure 2	ADF Diving School	Mark 1	222mm long 170mm wide at base	450mm long (cage 260mm) 215mm wide at max cage Ø
Figure 3	ADF Diving School	Mark 1f.	220mm long 160mm wide at base	Unknown – cage not present
Figure 4	Unknown, noted in July 1971 as at HMAS Watson ¹⁰	Possible Mark 2 – has two chemical arming devices	Unknown	Unknown

Table 1: Locations and general dimensions of birdcage mine examples used in this study.

⁸ Anon., n.d. 'Viet Cong Mine Actuators, Pressure-Operated', n.p. The digital copy of the manual that authors' accessed does not have a front cover or any other publishing details. It is presumed to be of US origin.

⁹ There is some ambiguity around this measurement, as it is unclear where the cage locks on to the actuator housing; it seems to be variable.

¹⁰ *Navy News*, 9 July 1971, p. 2.



Figure 2: A birdcage mine at the ADF Diving School (Example 2). This is an earlier Mark 1 example, painted in camouflage. Also note the deflated bladder which is in better condition than the bladder in Figure 1. (photography courtesy of Shane Casey, 2024).



Figure 3: Another birdcage mine at the ADF Diving School (Example 3). It is an unstripped variation of a standard actuator housing (without the birdcage or bladder), which appears to include an alternative arming delay device (Mark 1f). The unit is painted grey and the internal arrangements are unknown (photograph courtesy of Shane Casey, 2024).

IUWG-1 was responsible for the defence of the South Vietnamese harbours at Vung Tau, Cua Viet, Da Nang, Qui Nhon, Nha Trang, Cam Ranh Bay and Saigon (Figures 5 and 6).¹¹

CDT-3 also contributed to Operation Game Warden: the surveillance and clearance of the rivers and waterways of the Mekong Delta and Rung Sat. This included offensive actions against enemy bunkers and barricades, as well as pre-assault beach clearance. CDT-3 was, on occasion, also involved in search and destroy operations with USN SEAL teams, other elements of the US Navy and units of the South Vietnamese Navy, regional forces

¹¹ Blue, 1976, p. 25; McAulay, 1997; Jeffrey Grey, *Up Top: The Royal Australian Navy and Southeast Asian Conflicts 1955-1972*. Sydney: Allen and Unwin in association with the Australian War Memorial, 1998, pp. 287, 299–300; Edward Linton and Hector Donohue, *United and Undaunted. The First 100 Years: A History of Diving in the Royal Australian Navy 1911-2011*. Queanbeyan, NSW: Grinkle Press Pty Ltd, 2015, pp. 141–159, 349; Hector Donohue, 'Vietnam and the Evolution of the Clearance Diving Branch', in Tom Frame (ed.), *The Australian Navy in Vietnam: Lessons and Legacies from 1965*. Canberra: Barton Books, 2015, pp. 70–86; Don 'Scotty' Allan and John Kennett, *All in the Line of Duty*. Ridgehaven, SA: RAN Clearance Diver Association/Flipside Print, 2019, pp. 30–67, 71–77; Hector Donohue, 'Postscript: Clearance Diving Team Three Vietnam 1966–1971', in David Bruhn (ed.), *Gators Offshore and Upriver: The U.S. Navy's Amphibious Ships and Underwater Demolition Teams, and Royal Australian Navy Clearance Divers in Vietnam*. Berwyn Heights, Md: Heritage Books, 2019, pp. 275–286.



Lieutenant Donald now is Commanding Officer of Mine Warfare and Clearance Diving Section, HMAS Watson. He is pictured examining various pieces of enemy explosives in use by the Vietcong. Lieutenant Donald's role is to train Navy clearance divers in explosive ordnance disposal.

Figure 4: Example 4, Lieutenant Alex Donald RAN, Officer in Charge, CDT-3, 6th Contingent, with what appears to be a different chemical arming device to the Memorial example (the cylindrical object on the left of the birdcage). The image indicates that at least four birdcage mines were returned to Australia (Navy News, 9 July 1971, vol 14(14), p. 2).

and Junk Force units.¹² However, it was CDT-3's interactions with birdcage mines in the Cua Viet area, along the DMZ, that left a lasting impression on the divers.

General Characteristics

Prior to its acquisition, the Memorial's birdcage mine was disassembled and mounted on a

¹² Grey, 1998, pp. 287, 299–300.

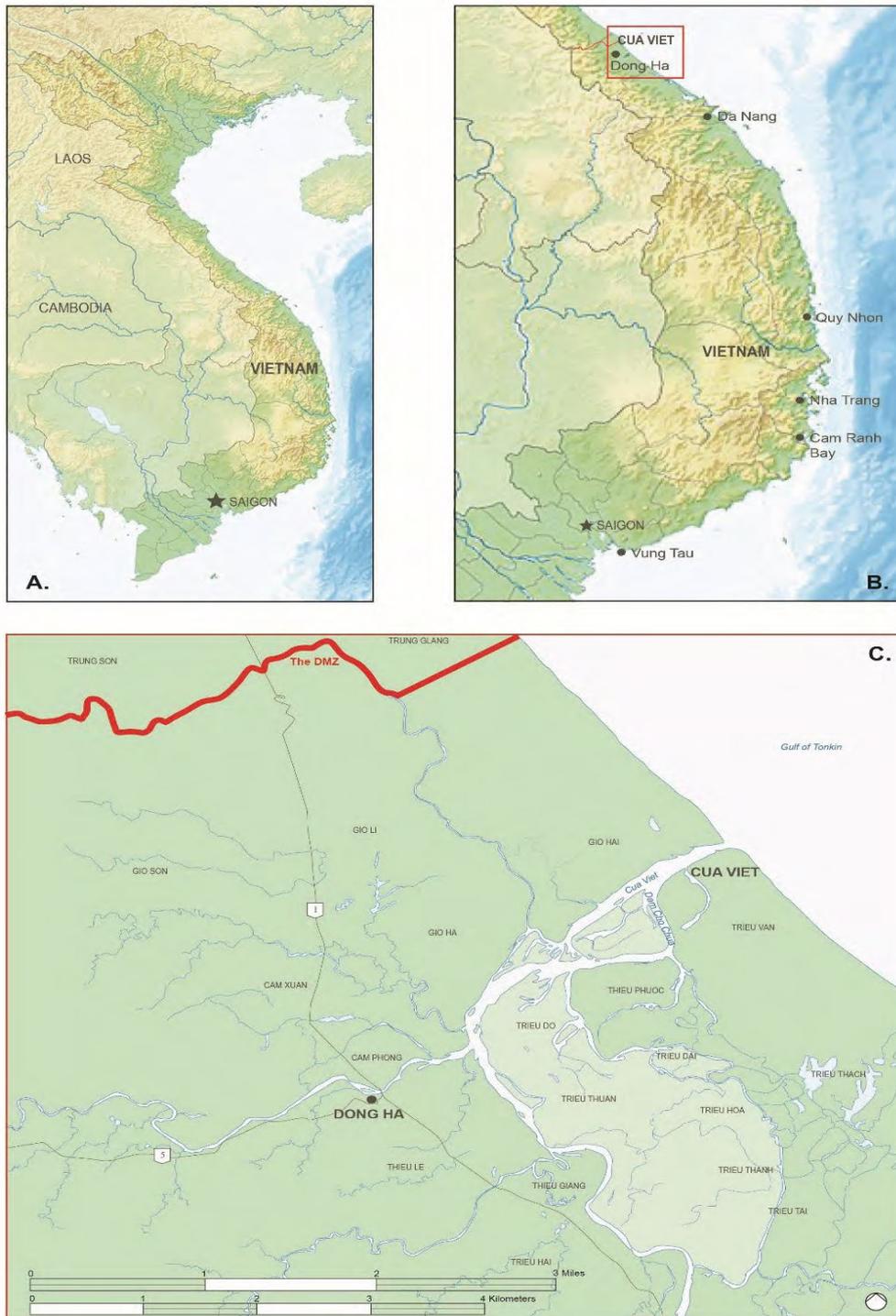


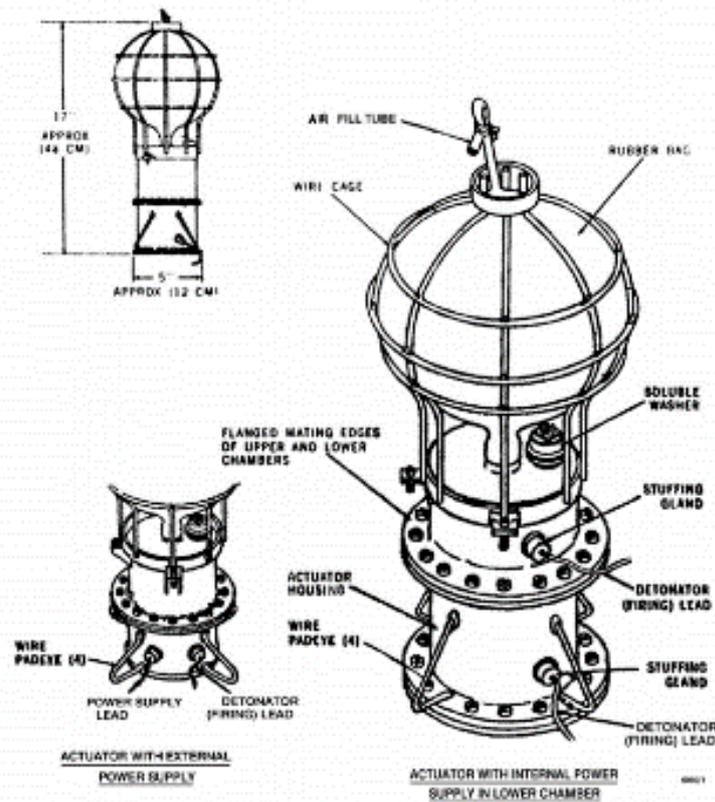
Figure 5: Map of Vietnam showing places described in the text. Inset: A) Location of Vietnam in relation to surrounding countries; B) Locations in South Vietnam that are mentioned in the text, 1968–1971. Note the location of Cua Viet near the demilitarised zone (DMZ); C) The river system between Cua Viet and Dong Ha. The red line shows the location of the DMZ (Drawing by Catherine McCulloch).



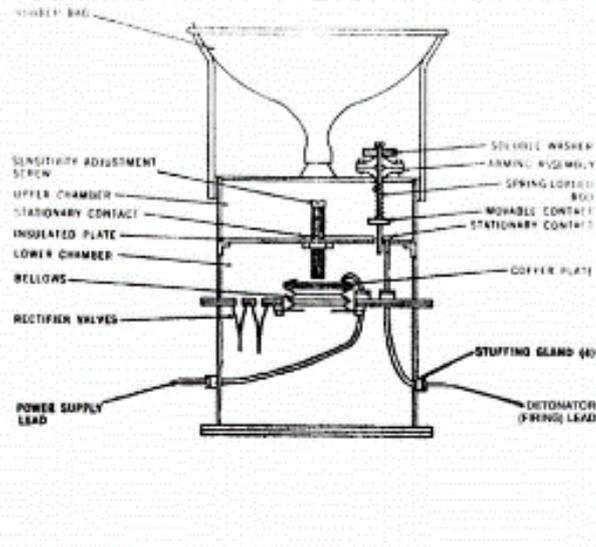
Figure 6: Explosive Ordnance Disposal Team Base, Cua Viet, 1970. Note the skimmer (twin out-board assault) boats in the foreground (Photograph by Russ Steer, AWM P01620.015).



Figure 7: Left-hand-side view of the Memorial's disassembled birdcage mine (Example 1, scale 10cm) (AWM internal photograph, 2023).

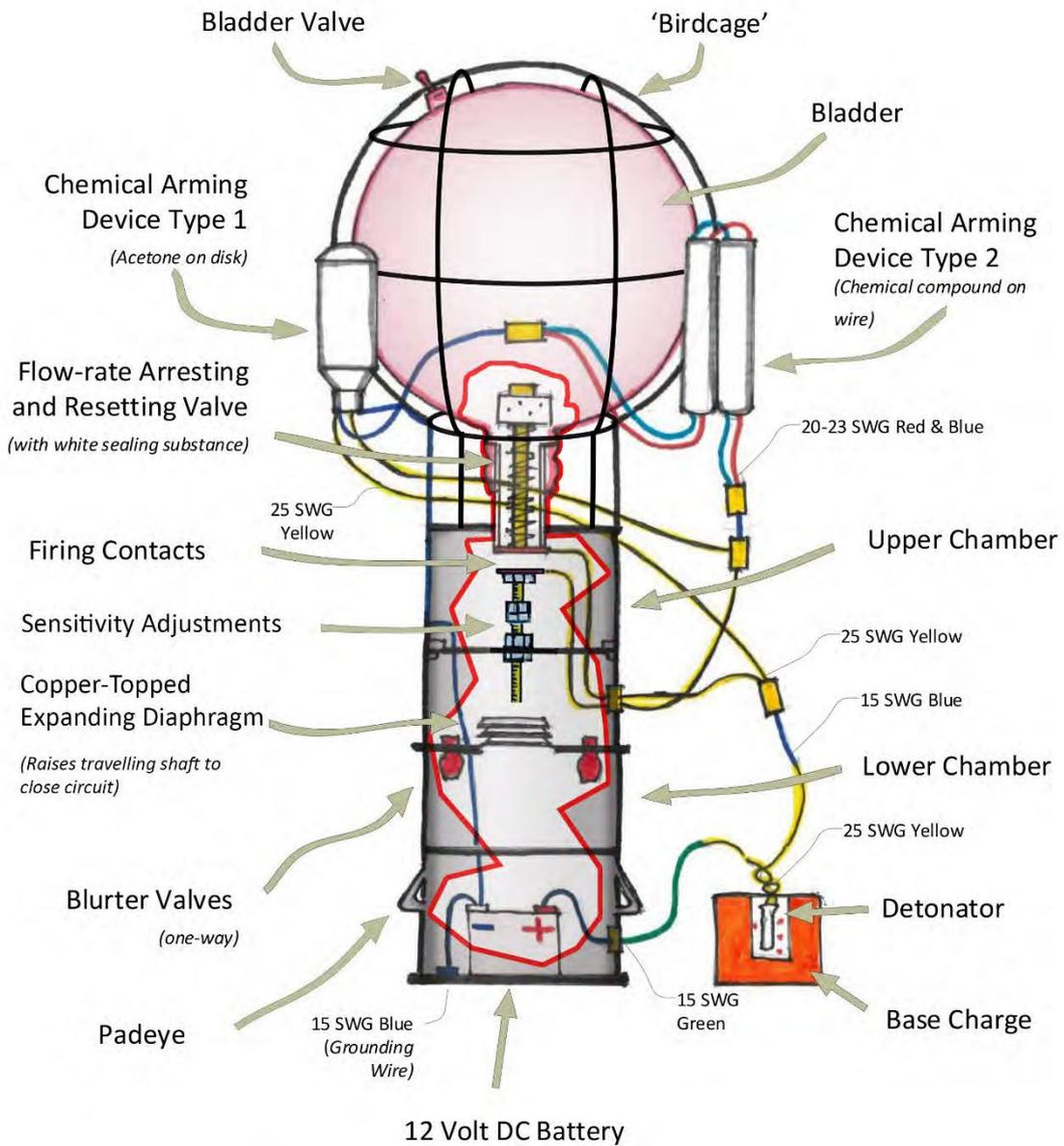


APPEARANCE & DIMENSIONS OF PRESSURE-OPERATED MINE ACTUATORS



GENERAL ARRANGEMENT OF A PRESSURE-OPERATED MINE ACTUATOR WITH EXTERNAL POWER

Figure 8: Diagram of the birdcage mine (designated Mark 1, with external battery 1d.), from a contemporary publication, which depicts the mine without the Mark 2a.-e. modifications found on the Memorial example, c.1968 (Anon., n.d. 'Viet Cong Mine Actuators, Pressure-Operated', n.p.).



Not to Scale

Figure 9: Cut-away diagram of the features of the Memorial birdcage mine (Mark 2a.-e.) (Drawing by Patrick Zegehnagen, David Pearson and Shane Casey).

wooden board, with its circuitry exposed (Figures 1, 7 and 26), and had been used for training at HMAS *Penguin*. The general dimensions of the three extant examples analysed (two Mark 1s and one Mark 2), as well as a description from a manual contemporary to the time, give a total assembled height between 430 and 460 millimetres. The actuator housings (upper and lower chambers, without the birdcage) range from 220 to 224 millimetres in length and 120 to 170 millimetres in width.¹³ The variation in size recorded in Table 1 is probably indicative of small-scale production, using available materials, as well as the condition of the examples measured, where the examples in better condition allowed for more accurate measurement than those that are currently in a deformed condition.¹⁴ The device was easily deployable in shallow waters by local watercraft. The birdcage mine actuator, in its various forms, contains no explosive, and is the mechanism used to close an electrical firing circuit, which detonates an attached explosive underwater.

Several variations of this mine have been identified and classified by the authors in this study, and are listed in Table 2. Variations may have evolved as a series of gradual improvements as a consequence of evolving operational circumstances. Examination of the physical object and related historical documents suggest the identification of the first variation is the Mark 1a.–f., which evolved into the Mark 2a.–f. There may be further variants that have not been identified in this study. The Memorial’s birdcage mine is a Mark 2 with a.–e. configuration, as described in Table 2.

Type/ modification	Defining component/s	Sources
Mark 1		
1a.	Soluble washer	Mark 1 at ADF Diving School (Figure 2), Manual and Figure 8 ¹⁵
1b.	Presences of arming pin	Manual and Figure 8 ¹⁶
1c.	Presences of internal battery	Manual and Figure 8 ¹⁷
1d.	External power supply	Manual and Figure 8 ¹⁸
1e.	Sensitivity adjustment screw	Manual and Figure 8 ¹⁹
1f.	Addition of alternative arming delay device	Mark 1f. at the ADF Diving School (Figure 3)

13 Anon., n.d. ‘Viet Cong Mine Actuators, Pressure-Operated’ n.p.

14 It was noted in a publication in 1965 that ‘Viet Cong armaments plants are marvels of ingenuity and “field-expediency,” to use an American military phrase’. Malcolm Browne, *The New Face of War: A Report on a Communist Guerrilla Campaign*. London: Cassell, 1965, p. 17. The author then provides detailed descriptions of some improvised factories and types of ordnance found to have been constructed in them (pp. 17–29).

15 Anon., n.d. ‘Viet Cong Mine Actuators, Pressure-Operated’, n.p.

16 *Ibid.*

17 *Ibid.*

18 *Ibid.*

19 *Ibid.*

Mark 2		
2a.	Addition of flow-rate arresting and resetting valve (anti-counter-mining device)	Mark 2 at the AWM (Figure 1 and 20) and McAulay ²⁰
2b.	Addition of chemical arming device Type 1 (repurposed North Vietnamese Chemical Long Delay Mortar Fuze Model NCC 82)	Mark 2 at the AWM (Figure 1), Figures 22, 23 & 24, US Monthly Summary Sep 1970 ²¹
2c.	Addition of chemical arming device Type 2	Mark 2 at the AWM (Figure 1), Figures 22 & 25, US Monthly Summary Sep 1970 ²²
2d.	Removal of soluble washer arming plug	Mark 2 at the AWM (Figure 1), Figures 21 & 22 (compare with Figures 16 & 17)
2e.	Modification to sensitivity adjustment screw mechanism (adjustment to range of expending diaphragm contact to range of travelling staff contact)	Mark 2 at the AWM (Figure 1), US Monthly Summary Nov 1970 ²³
2f.	Modification to internal wiring (unknown detail)	US Monthly Summary April 1971 ²⁴

Table 2: Birdcage mine variations identified in this study, as classified by the authors.

The following description of a generic birdcage mine is largely based on nomenclature from a manual, most probably of US origin, which refers to a birdcage (which the authors have classified as the Mark 1), and shows in detail the component and mine activation diagrams (Figures 8, 9 and 10).²⁵ More detail, some specific to the Memorial model, is provided in the

20 McAulay, 1999, p. 142.

21 USN Vietnam Command File (AR/522) Archives Branch, Naval History and Heritage Command – Monthly Summary September 1970, pp. 50–52, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam/monthly-summaries-1970/september.html, accessed 6 June 2024.

22 *Ibid.*

23 USN Vietnam Command File (AR/522) Archives Branch, Naval History and Heritage Command – Monthly Summary November 1970, p. 64, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam/monthly-summaries-1970/november.html, accessed 6 June 2024.

24 USN Vietnam Command File (AR/522) Archives Branch, Naval History and Heritage Command – Monthly Summary April 1971, p. 81, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam/monthly-summaries-1971/april.html, accessed 6 June 2024.

25 Anon., n.d. 'Viet Cong Mine Actuators, Pressure-Operated', n.p.

sections titled Mark 2a.–f. below.

In all versions of the mine, the basic pressure actuation sequence works in the same manner. When a watercraft moves, it produces a forward and downward bow-wave pressure. This acts upon the inflated bladder of the mine, forcing gas (air) from the bladder into the lower chamber via one-way blurter valves at the base of the upper chamber (Figures 9 and 10). As the vessel passes over the mine, and the bow-wave pressure diminishes, the pressure in the upper chamber drops. The bladder is unable to return to its original pressure due to the air trapped in the lower chamber by the one-way blurter valves. The air in the lower chamber, unable to vent back via the upper chamber, expands and forces the diaphragm (or bellows) upward, causing an attached copper plate to close an electrical circuit, which fires the mine. Such a switching method is known as a pneumatic electric (PE) switch.

Generally, a bow-wave pressure reduction occurs when a vessel has passed about one third of its length past the mine, resulting in the mine's detonation approximately halfway along the target boat's hull. Most non-planing hull designs achieve an almost negative pressure in the approximate centre of the vessel during passage at cruising speeds. Known as the 'squat effect', this is amplified in shallow waters, such as the riverine conditions in South Vietnam. This may have been a design concept built into the birdcage mine functionality.²⁶ Depending on the size of the vessel, the explosion would typically result in the vessel's keel being broken, effectively breaking the vessel in half (Figures 11, 12 and 13).

Later modifications to the mine's actuation process made it more resistant to counter-mining, sensitive to different types of craft, and able to arm in a variety of ways, all of which will be described in further detail in the discussion that follows, using Figure 9.

a.) The metal cage

The top of the mine features a metal wire enclosure resembling a birdcage. Within the cage is an inflated bladder. Both are attached to an airtight cylinder that is divided into two chambers. The upper chamber of the airtight cylinder houses the internal firing mechanism, while the lower chamber contains a battery and the two blurter valves.

The birdcage provides a rigid framework against which the internal bladder, after being squashed by a vessel's bow wave pressure, expels its air into the unit's lower chamber, thus initiating the mine's actuation sequence. If there were no rigid framework against which the bladder could be squashed, the pressure from a vessel's bow wave would only result in the bladder leaning over in the stream and not deflating sufficiently into the lower chamber to cause the closure of the electrical circuit.

²⁶ L Francis Herreshoff, *The Common Sense of Yacht Design*, part 1. New York: The Rudder Publishing Co, 1946, pp. 7–8; 'Marine Insight: How Squat, Bank and Bank Cushion Effects Influence Ships in Restricted Waters?' marineinsight.com/marine-navigation/how-squat-bank-and-bank-cushion-effects-influence-ships-in-restricted-waters, accessed 6 June 2024.

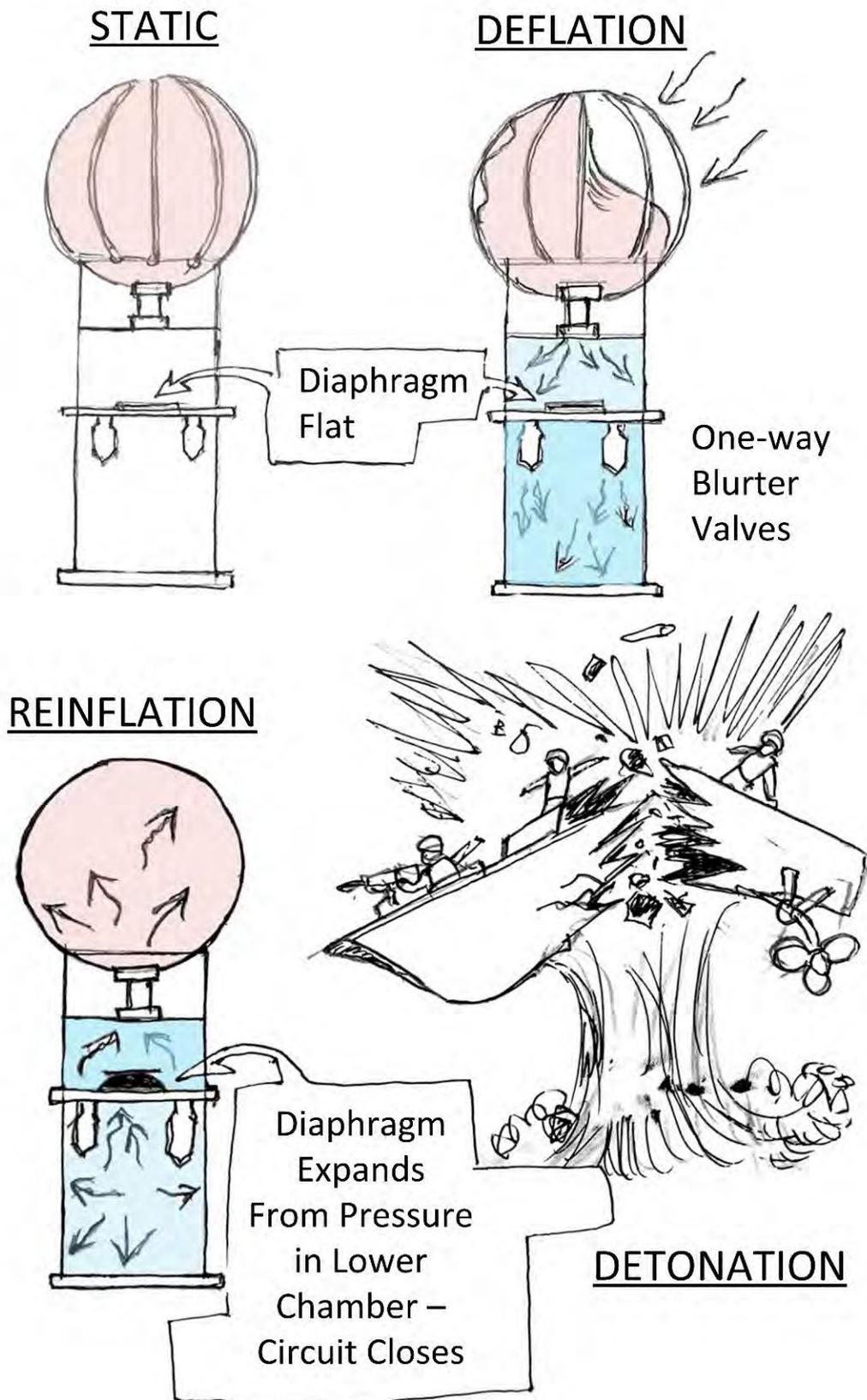


Figure 10: Detonation process diagram, showing the internal activation phases of the birdcage mine. Pressure stages: 1) static; 2) deflation; 3) reinflation; and 4) detonation (Drawing by Patrick Zegenhagen and David Pearson).

In the case of the Memorial's Mark 2b. and c. modifications, the cage also provides a rigid framework on which to mount chemical arming devices.

b.) Bladder

The spherical inflatable bladder, much like the bladder within a football, was usually made from rubber, enclosed in the metal birdcage and attached to upper cylinder of the airtight chamber by an air-flow tube. Earlier examples are thought to have been improvised from available material such as animal skins and basketball bladders, but this could not be verified.²⁷ There is a nipples, air-filling tube to inflate the bladder, which appears to be partly present in Figure 2. After initial inflation, the mine was deployed to the bottom of a waterway. The existing water pressure (hydrostatic) compressed the air in the bladder, forcing air into the airtight upper and lower chambers, equalising the internal pressure and making the weapon ready to be armed.²⁸ The perishable rubber parts of the Memorial's mine (Figure 1) have significantly deteriorated in the half-century since it was collected in Vietnam.

c.) Upper chamber

The cylindrical metal of the upper chamber is connected to the metal cage and bladder at the top of the chamber. The upper chamber contains the firing contacts, a sensitivity adjustment screw, a copper-topped expanding diaphragm and two blunter valves. Externally, at the bottom of the upper chamber, is a flanged mating edge which connects to the corresponding edge on the lower chamber. The metal cage is attached to the top sides of the upper chamber and the bladder's air-flow tube perforates the middle top surface of the chamber (inside the cage). Depending on the mine's modification there are multiple ways to arm the mine that affect the internal layout of the upper chamber:

- Mark 1a. uses a soluble washer on the top face on the upper chamber, accessed via a porthole. When the soluble washer is dissolved, a spring-loaded rod with a travelling contact is forced down onto a stationary contact, which arms the mine.²⁹
- Mark 1b. uses an arming pin (or clip) in lieu of the soluble washer on the Mark 1a.³⁰ This is, presumably, activated manually prior to deploying the mine.
- Mark 1f. appears to use a screw-topped external arming adjustment arrangement.
- Mark 2b. and 2c. also feature the porthole of Mark 1a. In these versions, the porthole is sealed with a wooden plug and the mine is armed using one or two chemical arming devices (Type 1 – Mark 2b. and Type 2 – Mark 2c.) located on either side of the metal cage.

27 This was a common assumption amongst the CDT-3 Branch prior to this investigation.

28 Anon., n.d. 'Viet Cong Mine Actuators, Pressure-Operated', n.p.

29 *Ibid.*

30 *Ibid.*

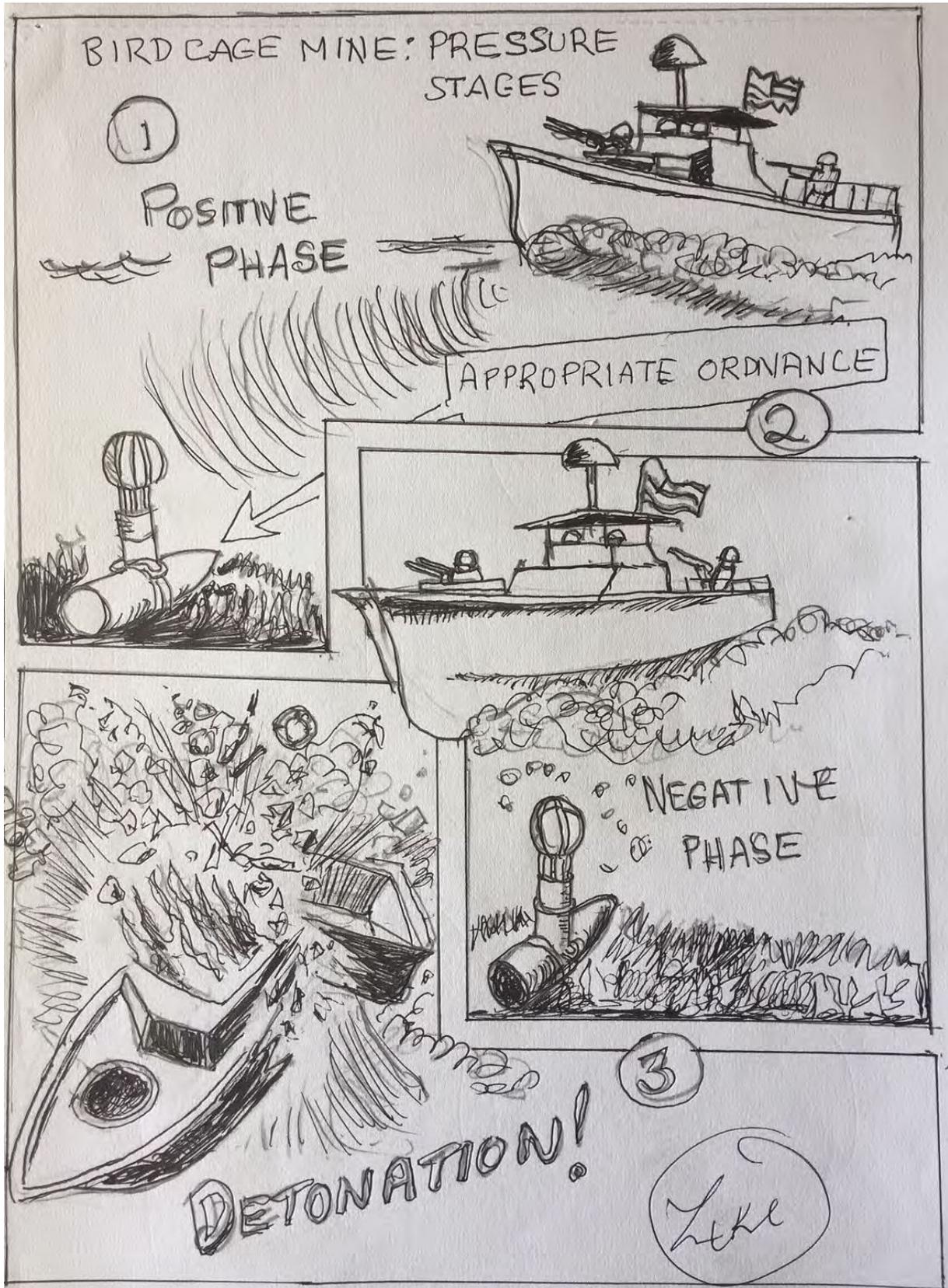


Figure 11: The stages of activation of a birdcage mine (drawing by Patrick Zegenhagen).



Figure 12: Side-view of the hull of a patrol boat river (PBR) destroyed by a birdcage mine on the Cua Viet River on the way to Dong Ha, 9 August 1968, as described by POCD Tug Wilson (see Figure 13). Note that the characteristic damage caused by the birdcage mine – the mine has detonated in the middle of the hull and deformed it inwards (probably lifting the boat out of the water before cracking its keel). The remains of the metal birdcage were found embedded in the hull after recovery (photography courtesy of Tug Wilson, taken by CPO Darlington, US Navy, November 1968, AWM2021.483.1).



Figure 13: Upper-hull-view of a patrol boat river (PBR) destroyed by a birdcage mine on the Cua Viet River on the way to Dong Ha, 9 August 1968, as described by POCD Tug Wilson (see Figure 12) (photography courtesy of Tug Wilson, taken by CPO Darlington, US Navy, November 1968, AWM 2021.483.1).

d.) The firing circuit

During the positive pressure phase provided by a vessel's bow-wave, air is forced from the bladder, via the air-flow tube, into the upper chamber and through two one-way blunter valves into the lower chamber. During the negative phase that follows (when the air is discharged from the upper chamber), the pressure in the lower chamber, unable to flow back into the upper chamber, causes a flexible copper-topped expanding diaphragm, or bellows, situated on the top of the lower chamber and bottom of the upper chamber, to expand (Fig-

ures 8, 9 and 14). In the Mark 1, this action causes the diaphragm to push up to a sensitivity adjustment screw and close the firing circuit, providing the electrical current needed to detonate the mine's explosive charge (Figures 8, 10 and 11).

The mine's actuation can be set to target vessels of specific sizes based on the varying range of pressure waves that different sized vessels produce. Located in the upper chamber, and part of the firing circuit, the sensitivity adjustment screw can be altered to meet the size and pressure specifics of a target vessel. Adjustment is made by moving the screw up or down: up to increase the contact distance, and hence the travelling time of the copper-topped expanding diaphragm to complete the firing circuit, and down to decrease that time (Mark 1e. only) (Figures 9 and 14). The objective of the different settings is to locate the mine's detonation under the targeted vessel at the point where it will effect maximum damage.

Another birdcage actuator at the ADF Diving School, at HMAS *Penguin*, appears to be later variation of the Mark 1, and is annotated here as the Mark 1f. (Figure 3). This variant consists of what appears to be a standard actuator housing (without the birdcage or bladder). However, it has a raised 35-millimetre cylindrical device atop the upper chamber and to the side of the centrally-positioned bladder-tube access port (air intake valve), in the position of the soluble washer port of the Mark 1a. The visible part of this component is held in place by a flange, consisting of a circular metal plate (possibly aluminium) with four screws, mounted on what appears to be two thin layers of fibrous sealing substance. Above the plate, there is a centrally located metal threaded shaft (or plunger) that emerges from the circular plate into which it appears to be screwed, and which is surrounded by another insulating material. A smaller diameter shaft with a flat-headed criss-cross screw adjustment head protrudes from the top of the threaded shaft.

The surround at the base of the raised cylindrical device, where it joins the upper chamber, is made of pliable compounds, which are good for sealing out water while allowing for movement. Therefore, the device is probably not another type of sensitivity adjustment screw. It is surmised here that, as the threaded shaft is raised away from the cylindrical housing, the device could be in a discharged state. As such, this is probably another type of alternative arming delay device that predates the external chemical arming devices (Types 1 and 2) on the Mark 2, described in further detail in section 'Adaptation: The Mark 2 Variant'. This Mark 1f. modification also appears to be of different construction from the rest of the actuator housing, appearing to be over-engineered for the role assigned to it. Therefore, it may be an adapted component that was reused from yet another application or ordnance (possibly allied), and shows the genius and versatility of the enemy. However, without further physical investigation, which would involve stripping down the unit, or additional historical context including its capture details, its current status cannot be ascertained further (Figure 3).



Figure 14: Two one-way blunter valves (the significance of the different coloured valves is unknown), copper-plated expanding diaphragm (blue), travelling shaft and the component located between the upper and lower chambers are shown disassembled from the mine (scale 5cm) (AWM internal photograph, 2023).

e.) Lower chamber

The cylindrical metal housing of the lower chamber is longer than that of the upper chamber and houses the internal power supply (Figure 15). There is a flanged mating edge on the top and bottom edges; the former to connect the upper cylinder to the lower. There are four metal padeyes (metal plates with a projecting loop) protruding from the outside of the chamber that can be used to attach the explosive charges, and may also be used to anchor the mine against the current or stream in a river. Inside the chamber, two one-way blunter valves allow air from the bladder, via the upper chamber, to enter the lower chamber, in preparation for closing the firing circuit. The battery, if present, which powers the actuation circuit is housed in the bottom of this component. There is a protrusion port on the outside of the lower chamber to provide access for the detonator circuit wires, which enable explosives to be connected outside the actuator housing while maintaining the lower chamber's watertight integrity.

The rough finish of the upper and lower chamber housing of the Memorial mine suggests that it was manufactured from mild steel to which a thick coating of black paint was applied. Earlier Mark 1 examples were noted as being made from steel, unpainted and unmarked, although one of the Mark 1s held at the ADF Diving School is camouflage painted

and the other is painted grey (Figures 2 and 3).³¹ The robust construction was necessary to maintain the mine's stability under changing river conditions and variable hydrostatic pressures, while the paint presumably helped to camouflage the mine and protect the metalwork from corrosion.

f.) Battery

The mine could operate using either an internal (Mark 1c.) or external power (Mark 1d.) supply.³² The authors are unsure why the requirement for an external power supply was introduced. The Mark 2 example at the Memorial uses an internal battery of between 9 and 12 volt capacity (Figure 15), probably closer to 12 volts, which would have had a life of around



Figure 15: The battery, and writing thereon, of the Memorial mine, showing that the battery was manufactured in Hanoi (scale 10cm) (AWM internal photograph, 2023).

³¹ *Ibid.* The Mark 1 birdcage mine in the Clearance Diving Museum is painted black with brown and green splotches (Figure 2).

³² Anon., n.d. 'Viet Cong Mine Actuators, Pressure-Operated', n.p.

three months in the water under the prevailing conditions in the Cua Viet area.

g.) Circuitry

The circuitry of the Mark 1 mine seen in Figure 8 is not clear. However, as described in Figure 9, for the Memorial mine, the manufacturers employed an economy of wire. Most of the main circuitry in the Memorial mine is yellow plastic-insulated wire. At critical or potential points of failure in the circuitry, a heavier gauge wire is used, presumably to guarantee current flow.

The Mark 2 Memorial mine has two arming units: a primary circuit servicing the main, long-term arming unit, and a branching circuit servicing the backup unit, both of which are shown in Figure 9. The primary circuit originates from the positive terminal of the 12-volt DC battery and travels to a detonator, then to the pressure-contact plate firing switch (pneumatic electric (PE) switch). The wiring of the second chemical arming device (Mark 2c.) branches from the main circuit, above the firing switch, dividing into two units in parallel. It then converges into the low-resistance blue wire before re-joining the main circuit at the base of the first chemical arming device (Mark 2b., Figure 9).

In the event that the primary arming device fails, the secondary device will come into play. Only one device needs to function to arm the mine. The chemical arming devices in the Mark 2 unit function as long-term arming delays, while the soluble plug in the Mark 1 is essentially a safety device.

h.) Markings

The limited evidence available suggests that these mines were not marked. This is the case with the Memorial birdcage mine, which has no apparent markings (impressed or hand painted) on metal components. However, the internal battery is marked on one side with 'QUOC DOANH PIN VẮN ĐIEN HANOI VIETNAM' (now National Battery Company, Hanoi Vietnam) (Figure 15).³³ It is not known whether there are any markings on the other side of the battery, as it has not been removed from the device.

i.) Base charge

The birdcage mine actuator does not contain any explosives; it is purely an actuator (or switching mechanism) used to initiate an explosive device attached. The base charge of the mine could be anchored to the lower chamber using the padeyes. The actuator's bladder provided considerable buoyancy, which was countered by the high-density explosive (HE), which was also used as ballast. The bladder was also subject to current and tidal flow (stream), and so the padeyes (evenly spaced around the actuator's base), could be used, if required, as lashing points for driven stakes to secure the mine against lateral stream flow and also against counter-mining pressure waves.

³³ *Ibid.* As noted above, other earlier examples of the mine were noted as unpainted and unmarked.

The ideal form of mine's base charge would be a cast HE, which neither absorbs nor dissolves in water, and has a high figure of insensitivity (FOI), being resistant to impact shock, making it less susceptible to counter-mining and mine sweeping. These explosives include TNT, and blends of TNT, such as RDX/TNT, CE/TNT.³⁴

The birdcage mine was readily adapted to utilise captured US military ordnance, such as demolition blocks or general purpose aircraft bombs, as seen in Figures 16 and 17.³⁵ Used with an appropriate underwater explosive charge, the mine could be configured to actuate single or multiple charges.³⁶

Discussion

There is nothing crude about the design of a mine actuation device that uses the dynamic pressures generated by the moving bow of a vessel that passes over the ordnance to close an electrical firing circuit at a critical position on the target's hull (Figure 11). The mine was designed to function most effectively at a depth where water covered the actuator unit, from approximately 60 centimetres (about two feet) to about 4.6 metres (15 feet) of water. Extreme tidal variations in the Cua Viet River, where the mine was encountered, made this a range, not an absolute. The authors' investigations enable a number of general comments to be surmised about the mine.

a.) Birdcage mine buoyancy

The mine must be heavy enough to keep it on the bottom of the waterway. To counter any upward buoyancy created by the bladder when deploying the mine, the operator had to ensure that its high-density explosive base charge provided sufficient ballast. If there was in-

34 FOI between 85 to 100. The variability of the charge is shown in a number of examples: on 27 September 1970, 2 mines in excellent condition (possibly the ones shown in Figures 16 and 17) were found in the Cua Viet River. Both had been in the water for about 6 hours. Each were described as having two chemical delays and the attached charges consisting of, in one case, 4 20-pound blocks of plastic explosive and, in the other, 5 such blocks (USN AR/522 – Monthly Summary September 1970, pp. 50–52). Similarly, a birdcage mine recovered on 26 November 1970 in the Cua Viet River had a chemical arming device and charge of about 80 pounds of Chicom plastic explosive – the device set for a large craft (LCM-6 or bigger) (USN AR/522 – Monthly Summary November 1970, p. 64). Another, in January 1971, was also found on the Cua Viet River, with 'about 30 pounds of C-4 in a basket' (USN Vietnam Command File AR/522 Archives Branch, Naval History and Heritage Command – Monthly Summary January 1971, p. 64, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam/monthly-summaries-1971/january.html, accessed 6 June 2024). On 2 February 1971, on the Ben Hai River (north of Cau Viet), 6 men in a Sampan were seen 'with 20 watermine pressure actuating devices and a large amount of TNT and plastic explosives' (USN Vietnam Command File AR/522 Archives Branch, Naval History and Heritage Command – Monthly Summary February 1971, p. 64, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam/monthly-summaries-1971/february.html, accessed 6 June 2024).

35 Anon, n.d. 'Viet Cong Mine Actuators, Pressure-Operated', n.p.

36 *Ibid.*



Figure 16: Two birdcage mines, each equipped with two chemical arming devices (Type 1 – Mark 2b. and Type 2 – Mark 2c.) found at Cua Viet in 1970. The photograph was taken by LSCD Russ Steer, who served with VNN EOD (explosive ordnance disposal) in Cua Viet for two weeks in September 1970. Note the complete, inflated bladder (with purpose-built air filling tube at the top of the bladder to inflate or deflate it); the presence of the soluble washer arming assembly housing still in place on the top of the upper chamber; and satchel bags of explosives attached to the bottom of the mine via the padeyes. Condoms appear to have been used to protect the electric wire penetrating the base of the lower chamber of one example (Photograph by LSCD Russ Steer, September 1970, AWM Negative P01620.018).

sufficient weight, an alternative method of anchoring the device would have been to use the mine's padeyes as lashing points for stakes driven into the river bottom.

b.) Cost efficiency

The birdcage mine was constructed from simple, presumably cheap componentry, and could be assembled in small-scale workshops. The mine destroyed highly sophisticated and expensive US river craft, such as the PBR, which cost US\$75,000 (US\$593,000 in 2018).³⁷ It was a most cost effective weapon. It worked equally effectively on a 32-foot PBR travelling at over 30 knots (34.5 miles per hour, or 55.5 kilometres per hour), a 56-foot Mobile Riverine Force LCM-6 travelling at 9 knots, and a motorised Junk Force vessel at less than 5 knots (Figures 18 and 19).³⁸

³⁷ The cost of a PBR in 2018 is discussed in John Sherwood, 'Defending the Mekong Delta: Tet and the Legacy of the Brown-Water Navy', *War on the Rocks*, 31 January 2018, warontherocks.com/2018/01/tet-navy, accessed 6 June 2024.

³⁸ 'Vietnam Era Patrol Boats', warboats.org, warboats.org/vietnamboats.htm, accessed 6 June 2024.



Figure 17: Another image of the same event in the previous Figure taken by LSCD Russ Steer in September 1970. Note the size of the mine and the method of attaching the explosive charge satchels to the lower chamber padeyes of the mines. One of the crowd is seen pushing a knife into one of the mine's explosive satchels (with a cigarette in his mouth), and another scraping out the contents of another satchel by hand. They are obviously familiar with their tasks, and are most probably members of the VNN EOD. The other men watching are probably either members of the same unit or auxiliaries to it (Photograph by LSCD Russ Steer, September 1970, P01620.019).

c.) Simplicity versus efficacy

The mine's relative simplicity meant that it could be manufactured from Vietnamese or allied components, or a combination of both. It could also be adapted to use most US explosive ordnance – TNT being the main filler of US bombs and munitions at the time. The enemy was proficient in exploiting ordnance laid in minefields, as well as in converting dud-fired US munitions to their own use. Access to supplies of such ordnance provided the enemy with a ready-use storehouse of mines, parts and explosives for redeployment. The simplicity of the component parts and their lack of markings on the Memorial example (notwithstanding the markings on the battery), make it virtually impossible to confirm the origin of any of the component parts.

One of the major advantages of the birdcage mine is its size and portability, which enables ease of transport, handling and laying. It could be easily deployed by people with minimal technical training. However, by being easily deployed by non-technical people, there was an increased potential for errors in deployment. This is consistent with Lieutenant Edward 'Jake' Linton's, commanding officer of the 8th Contingent, CDT-3 Vietnam, observations below (see 'CDT-3 encounters with the birdcage').



Figure 18: A patrol boat river (PBR) 'damaged' by a birdcage mine in the Cua Viet River, early 1971 (Photograph by ABCD Tony Ey, 1971, AWM Negative P11391.051).

Adaptation: The Mark 2 Variant

All versions of the mine known to the authors were initiated using dynamic pressure, as previously described. However, a physical examination of the Australian War Memorial's example revealed additional modifications to the Mark 1 (see Table 2), and it is this example that forms the basis of this paper's adaptation observations. The Memorial birdcage mine is a Mark 2 variation, with the following modifications:

- Mark 2a. – addition of flow-rate arresting and resetting valve
- Mark 2b. and c. – addition of chemical arming devices Types 1 and 2
- Mark 2d. – removal of the soluble washer arming plug
- Mark 2e. – modification to sensitivity adjustment screw mechanism.

These are discussed in more detail below.

a) Mark 2a.: Flow-rate arresting and resetting valve (modification on or before April 1970)

US countermeasures resulted in further modifications to the birdcage mine. In response to the birdcage mining threat, from August 1969, the Americans sent skimmers with two men ahead of any minesweeping or logistics craft that would be using the Cua Viet River (Figure 6).³⁹ 'The skimmer crews threw explosive charges at six-second intervals, so that the pressure differential would activate any [birdcage] mine firing mechanism.'⁴⁰



Figure 19: YFU-62 (harbour utility craft, built in 1943) on the Cua Viet River, east of Dong Ha, with the loss of seven US Navy personnel, apparently sunk by a command-detonated mine, January 1969 (nav-source.org/archives/10/18/180973.htm). There is a birdcage mine (Mark 1) in the foreground of this craft, which may or may not be relevant to its sinking (photograph courtesy of John Perryman, Sea Power Centre – Australia).

The defining feature of the Mark 2 is the introduction of the flow-rate arresting and resetting valve. This is an anti-counter-mining device that involves a substantial re-engineering of

³⁹ *Ibid.* Skimmers were 13.3-foot work boats with outboard engines, travelling at over 28 knots, with a crew of between 2 and 6. Also see Australian War Memorial Image P03654.007.

⁴⁰ McAulay, 1997, p. 124. See also Chavanne, 2011, p. 103.

the air-flow tube and incorporates a shock-activated, resetting spring valve. This modification appears to have been first noted in April 1970 on Cua Viet River.⁴¹ As Lex McAulay notes, 'An anti-countermining device was discovered on some mines, rendering them immune to the water pressure effect of the small explosive charges which had previously caused the mine to detonate harmlessly'.⁴² Allied forces deduced that explosive counter-mining measures such as scare charges – small hand-held explosives similar to a hand grenade in size, arming and delivery – could be thrown ahead of watercraft to detonate birdcage mines. Close inspection of the Memorial example (as much as is possible, given that the bladder has solidified over this component) shows that it appears to include this valve, which is referred to as the Mark 2a. The inclusion of this valve would have involved considerable re-engineering of the Mark 1, thereby constituting the authors' distinction of this as a different version (i.e. Mark 2, Figures 20 and 21).

The flow-rate arresting and resetting valve allows sustained (relatively slow) pressure from the bow-wave of an approaching boat to discharge more slowly. When the flowrate is sustained, the mine will function in its designed positive–negative pressure phase manner. When the pressure change is sudden and brief, as in the case of the first phase of a scare-charge detonation, the flow-rate arrestor acts as an anti-counter-mining switch. It consists of a long, spring-loaded rod (Figure 20) that extends outside the upper chamber, above the bladder discharge tube (inside the bladder itself). Affixed to the top of this rod is a white substance of unknown composition. When exposed to sudden pressure event, such as that from a scare charge, the white material is rapidly forced down onto the upper lip connected to the bladder, sealing the tube. This stops airflow and prevents the mine from pressure actuation. During the negative phase of a scare charge explosion, the bladder returns to its original status, and the spring-loaded shaft pushes the white sealing material back into its original position, effectively rearming the mine after each scare charge.⁴³

The tolerance for success of the flow-rate arresting and resetting valve would be small, and the white sealing material must have been suitably pliable to be continually reset. In this configuration, the mine could potentially survive multiple scare-charge attacks.

41 This was noted during the rotation of the CDT-3 7th Contingent.

42 McAulay, 1999, p. 142; The *US Department of Defense Dictionary of Military Terms* defines an anti-counter-mining device as 'A device fitted in an influence mine designed to prevent its actuation by shock'. The Joint Chiefs of Staff, *U.S. Department of Defense: Dictionary of Military Terms*, New York: Arco Publishing, 1988, p. 30.

43 The US Monthly Summary Reports have a number of examples where skimmers detonated the mines with scare charges on a scare charge run. For example, four were counter-mined using scare charges in January 1971 (USN AR/522 – Monthly Summary January 1971, pp. 64–65). Similarly, in April 1971 3 mines were counter-mined using scare charges, but on 25 April 1971 'a MID 92 skimmer suffered 40% damage when two pressure mines were detonated close aboard by scare charges' (USN AR/522 – Monthly Summary April 1971, pp. 80–81).

b) Mark 2b.: Chemical arming device type 1 (modification on or before September 1970)

The introduction of a chemical arming (delay) device meant that the mine, once laid, was not armed for some time, and could not be induced to actuate until a chemical arming device had armed the mine. The Memorial birdcage mine has two additional long-term (delay) chemical arming devices, which the authors have categorised as Type 1 (Mark 2b.) and Type 2 (Mark 2c.). Both types of device are visible in Figure 22.

The US Navy noted that a number of mines exploded on 27 September 1970, and two pressure influence mines were recovered from the Cua Viet river, one 'partially exposed in two feet of water' and the second 'of the same type' in a fisherman's net:

Both mines were in excellent condition and appeared to have been in the water no more than six hours. Each mine had two chemical-delay arming pencils [chemical arming devices] ... The two mines including pressure influence detonator [actuator] and attached charge were identical except that the first mine had four 20 pound blocks of plastic explosive hanging from the detonator [actuator] and the second mine had five blocks.⁴⁴

These two mines are possibly the ones depicted in the photographs at Figures 16 and 17, which were taken by Leading Seaman Clearance Diver Russ Steer in September 1970 while he was detached with the Republic of Vietnam Navy (VNN) EOD at Cua Viet. The images show two arming devices similar to the ones found on the Memorial birdcage located on either side of the metal cage.⁴⁵

The Type 1 chemical arming device (Mark 2b.) (Figures 23 and 24) is located on the upper component of the birdcage mine, attached to the birdcage and wired into the primary electrical circuit (Figure 9). It has been subsequently identified as a repurposed North Vietnamese, Chemical Long Delay Fuze Model NCC 82 for an 82mm Mortar round. According to a 1968 US Manual on Projected Munitions Fuzes in Vietnam, this type of aluminium 82mm mortar fuze was the only long delay fuze type then employed with projected munitions in country at that time.⁴⁶ It consists of a chamber containing a chemical (acetone) sealed by a plastic disc (delay) that constrains a cocked striker contact. The duration of the delay is determined by the strength of the acetone, the thickness of the plastic disk, and the temperature at the location of the mine's deployment. The coloured acetone filled glass ampule in the fuze could provide a delay of: 2.5 hours (yellow); 3.5 hours (red); 5 hours (blue); or 8 hours (violet).⁴⁷ The cocked striker contact is released when the acetone burns through the

44 USN AR/522 – Monthly Summary September 1970, pp. 50–52.

45 Australian War Memorial Images P01620.018 and P01620.019 (Figures 16 and 17). See also Donohue, 2019, p. 284.

46 Office of the Assistant Chief of Staff, Intelligence. *CMEC Technical Intelligence Brief No.3-68, Communist Bloc Projected Munition Fuzes in Vietnam*. San Francisco, Cal., Headquarters, United States Military Assistance Command, Vietnam, 18 December 1968, pp. 9–3, pp. 9–4.

47 *Ibid.*



Figure 20: The spring-loaded shaft that pushes white sealing material to close the flow-rate arresting and resetting valve (Mark 2a.) (scale 5cm) (AWM internal photograph, 2023).

plastic disc and completes the mine's electrical arming circuitry.

c) Mark 2c.: Chemical arming device type 2 (modification on or before September 1970)

The second Type 2 chemical arming device (Mark 2c.) (Figure 25) is a twin-tube component attached to the opposite side of the metal cage to the first chemical mechanism, as seen in Figure 22, and seems to be contemporaneous with the first arming device. It is a secondary method of arming the mine (presumably as a backup if the first arming device fails) and appears to be wired into the backup circuit. On the Memorial birdcage mine, one of the cylinders has not been opened and exposed, so the precise function of its contents is unclear. It is reasonable to conclude, however, that the cocked-striker electrical switch in the opened tube, consisting of a spring-loaded wire-retaining switch, is activated, when released, by the corrosive action of a chemical material in the unopened tube.⁴⁸ In comparison with the first device, the Type 2 appears to be of a more basic-improvised construction.

The introduction of a chemical delayed-arming device means that the mine, after being laid, is dormant while the area is, potentially, swept with scare charges. The inclusion of an

⁴⁸ Alternatively, the cocked striker may be released by fatigue, or more likely, an electrolytic action resulting from the application of an electrical current to a solution of copper sulphate which, if the wire is copper, will dissolve and initiate the releaser.



Figure 21: In this example, the mine bladder has deteriorated and solidified over the flow-rate arrestor and resetting valve (Mark 2a.) (AWM internal photograph, 2023).

anti-counter-mining device (such as the flow-rate arresting and resetting valve – Mark 2a.) renders the mine, once armed, immune to the effect of counter-mining charges, which are designed to activate the mine’s firing mechanism by the pressure differentiation generated by the charge. These modifications made the mine increasingly resistant to countermeasures.

If the mine, while unarmed on long-term delay, is subject to pressure from a passing boat, the mine mechanism will activate (the bellows will expand and the travelling shaft will close the firing contacts), but the mine will not fire due to the open circuit at the delay point. If the pressure is not bled off from the lower chamber, the mine will fire as soon as the delay closes. A bleed-off mechanism would have been essential to the efficient working of the Mark 2, but such an arrangement is not evident on the Memorial’s Mark 2 example (unless the two different coloured blunter-valves have some significance – see Figure 14).

d) Mark 2d.: Removal of the soluble arming mechanism (modification after September 1970)

The soluble washer arming assembly appears to have been removed some time after September 1970. In the Memorial’s example, the receptor port for the safety soluble plug has been sealed with a wooden bung (plug), probably indicating that it was no longer required or another method had been developed. The example in Figures 16 and 17 appears to show an interim process was used: the soluble washer arming assembly seems to be in place –

that is, at least the part protruding from the upper chamber – and is contemporaneous with the two chemical arming devices. With the introduction of two long-term chemical arming devices mentioned above, this short-term arming device may have become redundant, so



Figure 22: The two chemical arming devices (Type 1 – Mark 2b. (left) and Type 2 – Mark 2c. (right)) (scale 10cm) (AWM internal photograph, 2023).

that the soluble plug was removed from later versions of the mine. This may also indicate that the chemical arming devices were performing well and that three ways to arm the mine were not required. It also suggests that mines were made in some quantity – as there would have been no need to plug an obsolete port. However, without further evidence, this is conjecture.

e) Mark 2e.: Modification to sensitivity adjustment screw mechanism (modification on or be-fore November 1970)

The sensitivity adjustment screw located on the Mark 1 actuators' vertical centre line/ axis could be adjusted to alter the required time-pressure (travelling time) to initiate the explosives.⁴⁹ The responsiveness of the sensitivity adjustment seems to have been further refined by November 1970, noting that it was recorded in the monthly summary of the US Commander Naval Forces Vietnam:

At 1130H on 26 November, an NVA pressure mine was turned over to a unit of MID 92 by

a fisherman about 3.5 kilometers southwest of Cua Viet ... The mine contained about 80 lb. of Chicom plastic explosive and had a chemical delay arming device. The firing device was set for a large craft (LCM-6 or bigger).⁵⁰

An investigation of the Memorial example shows that it can be adjusted for initiation sensitivity to target specific sized vessels by raising or lowering the travelling shaft. But its sensitivity, relative to the sensitive adjustment screw of the Mark 1e., cannot be ascertained.

The Mark 2e. (the Memorial example, Figure 1) configuration is different from the Mark 1e. (the first ADF Diving School example, Figure 2) in that in the later Mark 2e. iteration:

⁴⁹ Anon., n.d. 'Viet Cong Mine Actuators, Pressure-Operated', n.p.

⁵⁰ USN AR/522 – Monthly Summary November 1970, p. 64.

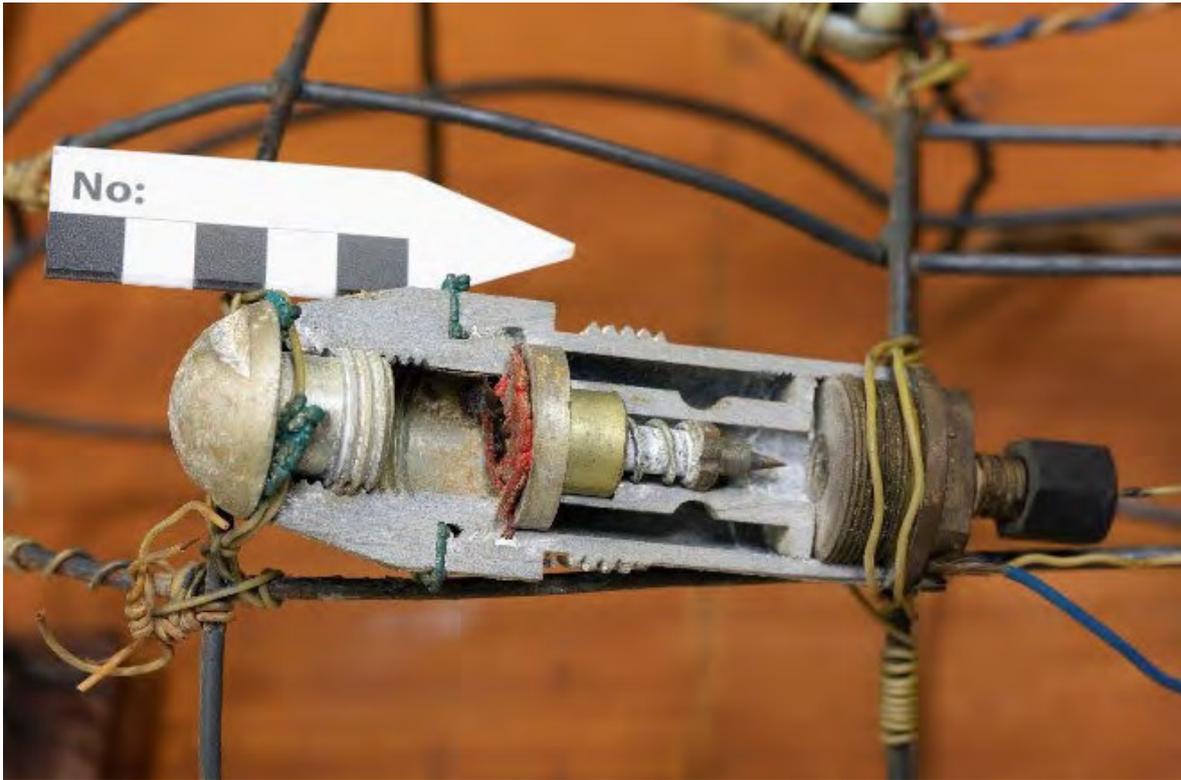


Figure 23: Chemical arming device Type 1 (Mark 2b.), which has been identified as a North Vietnamese, Chemical Long Delay Fuze Model NNC 82 for a 82mm Mortar round (scale 5cm) (AWM internal photograph, 2023).

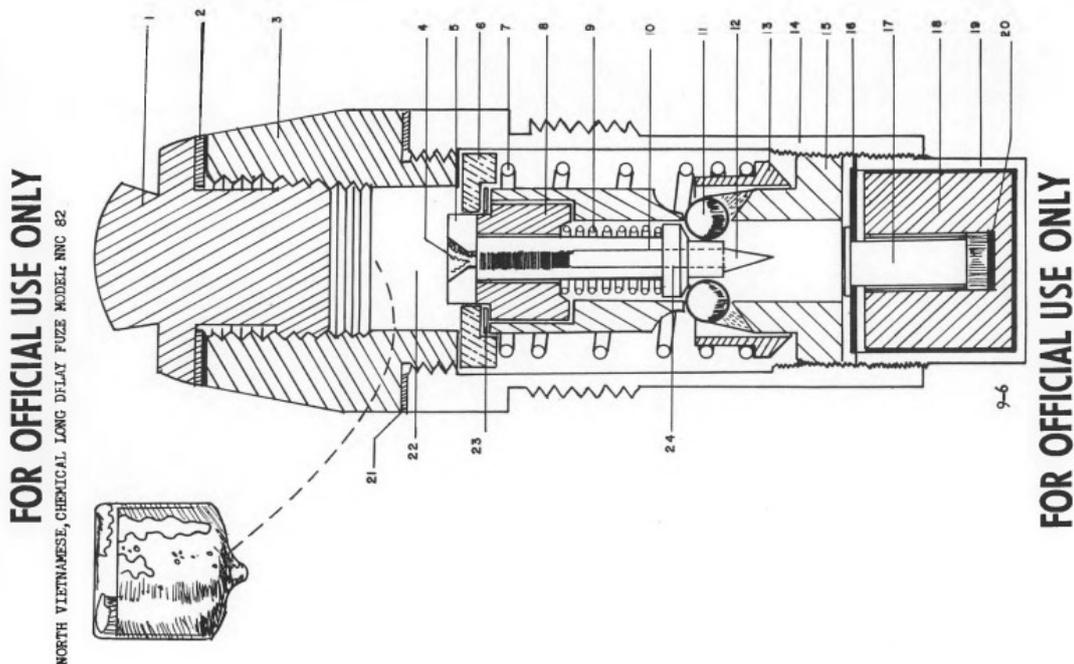


Figure 24: Cross-section drawing of Chemical arming device Type 1 (Mark 2b.) – North Vietnamese, Chemical Long Delay Fuze Model NNC 82 in a side configuration for comparison with Figure 23 (Office of the Assistant Chief of Staff, Intelligence. CMEC Technical Intelligence Brief No.3-68, Communist Bloc Projected Munition Fuzes in Vietnam. San Francisco, Cal., Headquarters, United States Military Assistance Command, Vietnam 18 December 1968, p. 9-6).

- the soluble arming arrangement is redundant and disabled (Figure 9)
- has additional mechanics introduced within the actuator on the central axis, under the bladder, to provide space and capacity for a flow-rate arresting and resetting valve (Figures 9 and 20).

The firing mechanism of Mark 2e. is also different from that of the Mark 1e. In the former, the copper-topped expanding diaphragm is raised under pneumatic pressure, coming into contact with the travelling shaft (which has already been pre-set for sensitivity) to close the firing circuit; in the latter the copper-topped expanding diaphragm comes into contact with the sensitivity adjustment screw to close the firing circuit. In the Mark 1e., the sensitivity adjustment screw is conductive and, when closed with the copper-topped diaphragm, forms part of the firing circuit (Figure 8). In comparison, the circuit contacts on the Mark 2e. are at the top of the travelling shaft and independent of the adjustment screw, as shown in Figures 9 and 14. Why the firing mechanism was modified along these lines is unclear. However, like the sensitivity adjustment screw, the travelling shaft can also be adjusted for vessel size: a



Figure 25: Chemical arming device Type 2 (Mark 2c.), which appears to be more basic and improvised than the Type 1 (scale 5cm) (AWM internal photograph, 2023).

larger gap between the base of the travelling shaft and the diaphragm plate targets a vessel with a larger bow/pressure-wave. There also appear to be two additional adjustments on the travelling shaft for sensitivity and for fine-tuning the shaft's assembly (Figure 9).

Once target vessels were identified and the basic settings determined, final adjustments could presumably be made to target those vessels specifically. Mines of this configuration were an effective weapon and, although analogue in construction, were comparable to the smart, digital mines of today.

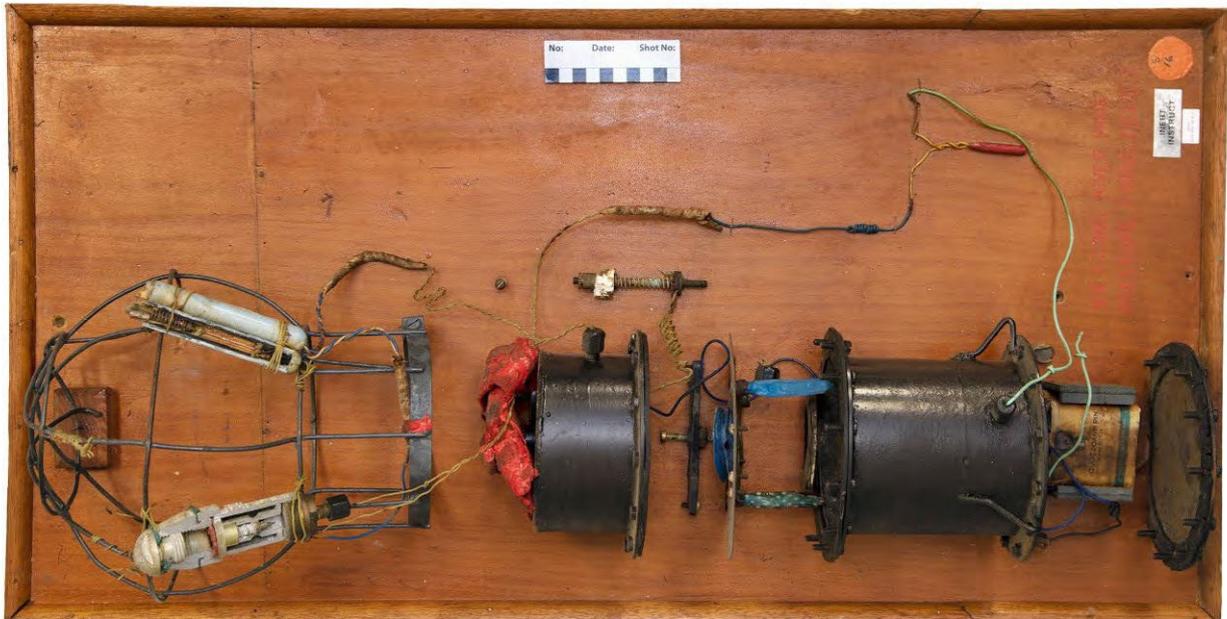


Figure 26: Top view of the Memorial's mine (also see Figures 1 and 7), showing that its fabricated components were probably of small-scale production using available materials, rather than being a product improvisation (scale 10cm) (AWM internal photograph, 2023).

Other factors

Mark 2f.: Internal wiring (modification on or before April 1971)

On 26 April 1971 'a new type containing internal wiring and 80 lbs. of explosive' was hauled up in the nets of fishermen.⁵¹ There is no evidence of such a modification on the Memorial mine, and given the date of the new type recovered, the internal wiring most probably supersedes CDT-3 operations in Vietnam. The last contingent in Vietnam departed on 5 May 1971. For completeness, it is included in this study, though as a notation only.

The authors surmise that perhaps the enemy was concerned about the potential for counter-mining scare charges to disrupt the external circuitry of earlier models. Given that modifications occurred as adaptations to changing circumstances, this modification may have also resulted from allied EOD divers locating mines and manually rendering them safe by cutting

⁵¹ USN AR/522 – Monthly Summary April 1971, p. 81.

their external firing circuits.

Dating of the Australian War Memorial's Birdcage Mine

The construction date of the Memorial's birdcage mine can be approximated (relatively dated)⁵² by its modifications (Mark 2a.–e.), the last of which was introduced on or before November 1970. The Memorial's birdcage mine does not appear to include the later Mark 2f. modification to internal wiring, dated to April 1971. Given that the last CDT-3 team (the 8th Contingent) left Vietnam in May 1971, the Memorial mine was most likely recovered between November 1970 and March 1971. It is not one of the mines recovered when Leading Seaman Clearance Diver Russ Steer was in Cua Viet in September 1970 (Figures 16 and 17), which have the soluble washer arming assembly that is not present on the more advanced Memorial example. CDT-3's Report of Proceedings (ROP) mention a number of possible incidents where pressure or birdcage mines were recovered from Cua Viet River: November 1970 – 4 recovered; December 1970 – 5 recovered (a prisoner reported that another 20 were said to have been laid in the river); February 1971 – 6 recovered; and March 1971 – 5 recovered.⁵³ The March 1971 ROP relates that, 'Members of this team participated in the recovery of 3 of the pressure mines mentioned above and in the recovery of the 2 swimmer/sappers bodies'.⁵⁴ It is possible that the Memorial mine is one of these examples.

CDT-3 encounters with the birdcage

The effectiveness of the birdcage mine is documented in several oral histories provided by CDT-3 members who served in Vietnam between November 1968 and May 1971.

November 1968 (First Australian Contact)

One enemy tactic was to fire on boats approaching a deployed mine, causing them to speed up and take evasive action, thereby increasing their vessel's bow-wave pressure. Petty Officer Clearance Diver Barry 'Tug' Wilson (4th Contingent, CDT-3 Vietnam) was detached to USN Team 40's base on the Cua Viet River between 6 and 15 November 1968, when the

52 Relative dating can be defined as 'Placing of events in the order in which they occurred without any relationship to the actual time during which any one event occurred is known as relative dating. It is a qualitative way of describing the sequence of events' (Cindy Kearns and Elizabeth Johnson, *Physical Geology Laboratory: Interactive Diagrams and Questions*, Chapter 33: Principles of Relative Dating, <https://viva.pressbooks.pub/physicalgeologylab/chapter/relative-dating/>, accessed 6 June 2024).

53 AWM78 392/3 – Reports of Proceedings, HMA Ships and Establishments RAN Clearance Diving Team No 3 – January 1970 – April 1971: ROP November 1970, Paragraph 6; December 1970, Paragraph 10; February 1971, Paragraph 5; and March 1971 Paragraph 10a, awm.gov.au/collection/C1420931, accessed 6 June 2024.

54 AWM78 392/3 – ROP March 1971, Paragraph 10a. See also Linton and Donohue, 2015, p. 155.

base, airstrip and PBRs were frequently under attack.⁵⁵ Wilson recounted the results of a birdcage mine incident:

In the early morning of 9 November 1968 between Team 40's Base on the Cua Viet River and Dong Ha at approximately 0100 three of us EOD types, a Lieutenant Junior Grade (JG) USN the OIC, Chief Petty Officer (CPO) Darlington USN and myself a POCD at the time, were woken and called to go to Dong Ha where it had been reported that a PBR had an unexploded rocket grenade embedded in its bow.

On boarding our assigned PBR to take us to Dong Ha another PBR was attached to us and proceeded ahead of us upriver. Radio communication was continuous between the boat coxswains until about 0130 when the other PBR's coxswain excitedly shouted that they were under fire from the river bank and they were closing and engaging, at the same time his voice could be heard over their machine guns firing and also their engine revs had substantially increased. Shortly afterwards a dull thud was heard... then complete silence. Our boat stopped immediately and commenced drifting without lights and in complete silence and did so until dawn, we then commenced to proceed very slowly back to our base as we had been told that Army EOD had looked after the PBR with the rocket propelled grenade in its bow.

At dawn, on the way back, we observed two military aged men hurriedly crossing the river ahead of us in a canoe from left to right. As we were in a free fire zone I brought my USN issued M79 40mm grenade launcher to bear immediately only to be ordered not to fire by the Lieutenant JG (no explanation was given to me for this order and our boat did not engage).⁵⁶

Four or five days later, the sunken PBR (Figures 12 and 13) and the bodies of its five crew were recovered, having floated to the surface. Petty Officer Wilson described what happened:

On recovering the bodies it was discovered that the enemy had been there before us and had booby trapped the bodies and surrounding area. I had to go into the murky water and recover the bodies and remove the explosives. The remains of the sunken PBR was also recovered at the same time by the salvage crew as was some of the wire topping of the birdcage mine then called a bladder pressure mine (the bladder coming from a basketball or soccer ball).⁵⁷

55 AWM78 392/1 – Reports of Proceedings, HMA Ships and Establishments RAN Clearance Diving Team No 3 – February 1967– December 1968: ROP November 1968, Paragraph 50, awm.gov.au/collection/C1420929, accessed 6 June 2024.

56 Wilson, Personal Communications, May 2021. The USN Monthly Summary for November 1968 says that only one surface craft (YLLC-4) was destroyed during this month. USN AR/522 – Monthly Summary November 1968, n.p.

57 Wilson, Personal Communications, May 2021. As shown above, despite the common percep-

November 1968 was the first time that Wilson had heard of this mine. In his opinion, it worked very well, and it shut down river traffic on numerous occasions.

April 1969

It seems that by 1969 the birdcage mine had become a weapon of choice in the shallow, riverine waters near the DMZ. Able Seaman Clearance Diver Mike Ey (5th Contingent, CDT-3 Vietnam) recalled:

POCD John Brumley and I were on exchange for 14 days with two US personnel at the Cua Viet base from 16 April 1969.⁵⁸ We were there specifically to gain knowledge of the birdcage mine, which they had a number of rendered-safe examples for instructional purposes. During this period we were called out to take part in the recovery of a PBR which had been mined, apparently by a birdcage. The PBR had been literally broken in half. We were tasked to recover any weapons and ordnance from the sunken vessel. On this occasion the US divers did the actual recovery.

The next day, accompanied by a Lieutenant JG, we went to the wreck site of a skimmer (twin outboard assault boat). Our primary objective was to recover and prevent the Viet Cong getting hold of a Starlite night vision scope which had been on board. I conducted a large circular search of the river bottom in zero visibility and recovered weapons, webbing and personnel effects, but was unable to recover the scope. We were about 150 metres from the north bank of the Cua Viet River and we were concerned about an attack from inshore. It was a very unhealthy environment and upon completion of our task we quickly departed the area back to Cua Viet. On this occasion we observed several wrecks of US river craft in the area broken in half (a characteristic of the successful denotation of birdcage mines). Owing to the distance from the shore of these wrecks we ruled out as command-detonated [i.e. detonated by an operator] mines as the cause of the sinkings.⁵⁹

September 1970

Leading Seaman Clearance Diver Russ Steer was a member of CDT-3 involved in the recovery of birdcage mines from Cua Viet (7th Contingent, CDT-3 Vietnam). He took photographs that appear to have been taken soon after recovery of two birdcage mines (Figures 16 and 17). It is believed that Leading Seaman Clearance Diver Steer took the photographs while on a deployment to Cua Viet for two weeks in September 1970, while working with the Vietnamese

tion, at least in the case of the Mark 2 example, the bladder is a specialised item and does not come from a soccer ball.

58 AWM78 392/2 – Reports of Proceedings, HMA Ships and Establishments RAN Clearance Diving Team No 3 – January-December 1969: ROP April 1969, Paragraph 9, awm.gov.au/collection/C1420930, 6 June 2024.

59 Mike Ey, Personal Communications, May 2021.

Navy EOD.⁶⁰

14 October 1970–5 May 1971

The modifications to the birdcage mines made in response to American mine countermeasures were highly effective. Lieutenant Edward 'Jake' Linton, commanding officer of the 8th Contingent, CDT-3 Vietnam, recalls:

When the birdcage was introduced to the Vietnam War in the late 1960s, it changed the game in many ways. Although there were plenty of booby traps that were findable, and in most cases able to be dealt with, the birdcage presented much more of a challenge and that challenge was as much psychological as anything else. For a start, the allied forces had no real sweeping capabilities to cover it, it was pressure, contact or remotely actuated and the waters of the deltas and rivers had zero visibility for visual search even if the personnel were available.

The role of the CDT-3 EOD personnel was to deal with ordnance that had been found or suspected of being in a particular place such as a ship's hull or facility. It did not encompass finding pressure mines in Vietnam's waterways; only dealing with them when found or clearing specific areas. The only plus that we had going for us was that the birdcage, though well designed and made, did not always have knowledgeable personnel to prepare or place it so that many of them, through poor preparation, did not detonate when intended. Waterborne allied personnel, especially PBR crews, were understandably concerned for their safety when speed was a countermeasure against ambush but proved to be the opposite if pressure mines were suspected.

The Cua Viet River was not one of our favourite places mainly because it meant transport in a PBR and the threat of the Birdcage. On 26 March 1971 members of my Team were involved in surveying the wreckage of a mine countermeasures vessel (MCM) sunk by a birdcage near the mouth of the Cua Viet River. The vessel was so badly damaged that it was assessed as being only fit for demolition.⁶¹ On 1 April, team members returned to Cua Viet to demolish the wreck of the sunken minesweeper from the month before. They were unable to do so because the Vietnamese Navy could not, or would not provide security for the operation, nor were they willing or able to sweep the river in the vicinity.⁶²

The psychological impact of the diabolical birdcage cannot be over-estimated. The sophisticated mine counter-measures vessel being sunk with a simple, crude but effective,

60 AWM78 392/3 – ROP September 1970, paragraph 13.

61 AWM78 392/3 – ROP March 1971, Paragraphs 9 and 10.

62 AWM78 392/3 – ROP April 1971, Paragraph 4; Linton, Personal Communications, September 2021. See also McAulay 1997, p. 179. Some additional detail of the event is provided in Larry Digney, Personal Communications, September 2021. See also Larry Digney, *Bubbles, Booze, Bombs & Bastards: A Clearance Divers Story*. Hobart, Tas, 2023, pp. 52–53.

home-grown terror weapon had an impact on everyone.

As the last team to deploy we were very motivated to bring home examples of the bird-cage, to show current and future members of our specialisation and the command what was in store for them in future conflicts like Vietnam.⁶³

14 October 1970–5 May 1971

Able Seaman Clearance Diver Larry Digney (8th Contingent, CDT-3 Vietnam) was the first member of his contingent to be deployed to Cua Viet (with USN Petty Officer 2nd Class Rick Watkins), between 28 December 1970 and 9 January 1971.⁶⁴ He comments:

During a number of trips on the Cua Viet River between Cua Viet and Dong Ha and back, we respected the birdcage mines enough to lay down on the bar armour modified LCM-8 landing craft roof during transit. So, if a water mine detonated beneath us we might survive the blast and prevent a shattered spine. We also faced outwards with our automatic weapons ready in case of ambush from the river banks. The Cua Viet River was a known training area for NVA (North Vietnamese Army) sappers and was extensively used to test their equipment and skills, to considerable effect.⁶⁵

Digney recalls that evidence of the enemy's successes 'were strewn all along the river, in the shape of sunken US river craft. The trip to Dong Ha on river craft was exciting and filled with tension, as the reality of sunken vessels along the route brought the war very close to home'.⁶⁶ For example, as mentioned above, in December 1970, forces in the area killed 22 swimmer-sapper personnel in one operation alone. Information gained from the survivor of this incident indicated that, besides the 5 mines recovered, there may have been another 20

63 Linton, Personal Communications, September 2021.

64 AWM78 392/3 – ROP December 1970, Paragraph 17; ROP January 1971, Paragraph 11.

65 Larry Digney, Personal Communications, September 2021. See also Digney, *Bubbles, Booze, Bombs & Bastards*, 2023, p. 51.

66 McAulay, 1997, p. 171. See also Digney, 2023, p. 51. For example, on the Cua Viet River, mining incidents increased in September 1970, where on the 27 September 'seven mines were discovered within a 15 hour period' of a total of 19 (USN AR/522 – Monthly Summary September 1970, pp. ii, 47–52); in October 1970 there were no incidents (USN Vietnam Command File (AR/522) Archives Branch, Naval History and Heritage Command – Monthly Summary October 1970, pp. 47–53, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam/monthly-summaries-1970/october.html, accessed 6 June 2024); in November 1970 there were 2 incidents (USN AR/522 – Monthly Summary November 1970, p. 64); in December 1970 there were 3 incidents (USN Vietnam Command File (AR/522) Archives Branch, Naval History and Heritage Command – Monthly Summary December 1970, pp. 61–62, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam/monthly-summaries-1970/december.html, accessed 6 June 2024); in January 1971 there were 9 incidents (USN AR/522 – Monthly Summary January 1971, p. 65); in February 1971 there were 5 mining incidents (USN Vietnam Command File USN AR/522 – Monthly Summary February 1971, p. 65. This increased again to 20 in March 1971 and 12 in April 1971 (USN AR/522 – Monthly Summary April 1971, pp. 79–81).

or so mines laid in the river.⁶⁷

14 October 1970–5 May 1971

Petty Officer Clearance Diver Phil Narramore (8th Contingent, CDT-3 Vietnam) was part of a team that went to Cua Viet. He mentions that the Junk Force in the northern area of Vietnam (I Coast Zone) was virtually wiped out by birdcage mines, which destroyed 52 of the 54 Junk Force junks assigned to the region.⁶⁸ Narramore also noted the extent of the destruction of US and South Vietnamese rivercraft in the area, mainly PBRs, but also occasional mine counter-measure vessels.

The exact number of vessels sunk by the normal operating function of the birdcage mine cannot be determined with certainty. Wrecks that had been broken in half, in the characteristic birdcage fashion, and those which were located too far off shore to have been command-detonated were reasonably concluded to have been victims of the birdcage.

Narramore stated that the Cua Viet river area was littered with sunken US and South Vietnamese rivercraft (Figure 18), and that the morale of allied forces assigned to the area to combat the mines and sappers of the Vietnamese People's Navy (VPN) 126 Naval Sapper Regiment was, by 1971, understandably low.

There was a real risk of becoming a victim of the birdcage mine directly or by way of associated ambush. Narramore's opinion was that to be permanently assigned to that area of operations in 1971 (the era of the Mark 2 birdcage) was a death warrant. Able Seaman Clearance Diver Tony Ey (8th Contingent, CDT-3 Vietnam) of the same team, who also spent time at Cua Viet, agreed with Narramore's assessment.⁶⁹

April 1971 (last Australian contact)

Able Seaman Clearance Diver Brian Furner (8th Contingent, CDT-3 Vietnam) discusses CDT-3's last known interaction with a birdcage mine:

In April 1971 John 'Speed' Gilchrist and I attended the EOD detachment in Cua Viet which consisted of a small Vietnamese detachment and one US EOD tech, Tom Williams.

CDT-3 team members had travelled to Cua Viet to destroy a South Vietnamese Navy minesweeper aground near the mouth of the Cua Viet River which had been holed by a mine.

During our few days at Cua Viet, local Vietnamese reported a birdcage mine in the middle of the Cua Viet River resting on a sandbank. After a short conversation with Tom Williams,

67 AWM78 392/3 – ROP December 1970, Paragraph 10.

68 Phil Narramore, Personal Communications, August 2021. Also see also McAulay, 1997, p. 178.

69 Tony Ey, Personal Communications, September 2021.

it was decided John Gilchrist and I would investigate to earn our keep as most of the local units were out on an op and were not expected back until the next day.

Travelling by skimmer to the uncovered sandbank my major concern, as it rushed through my head, was that it was probably a booby trap/ordnance? We pulled the skimmer onto the dry sand bank and could see the object some 50 to 80 metres away, half sitting on its side, but looked to be intact. As I drew the short straw, the plan was to do a quick recce without the need for explosives (using binoculars) to ensure there were no foreign objects attached to the explosive charge, which was usually up to 10–15kgs of HE in a basket with a balloon [actuator] attached upright in the charge. The mine was about 2 feet square and at this stage of our deployment, I had not encountered a birdcage mine in action. So I was a little concerned as to the mine lying on the sandbank intact and ready to go, so to speak.

After carrying out the recce I was able to visually clear the area around the mine and considered that the mine was real and intact. It was decided to countermine it, or BIP (blow in place). I went back to the skimmer where John handed me the satchel charge ready to go. It was probably a little bit of overkill, but what the heck, we were not paying for the explosives. Approaching the birdcage for a second time was a bit daunting, what if I had missed a buried cable attached to mine going back across the river to a location where Charlie was waiting ready to detonate it. 'Don't overthink it, cover your bases' was going through my head on the second approach; probably should have done all this on the first approach. I was very cautious on approach to the mine, as I was unable to see underneath the basket base. I placed the charge as close to the mine as possible without touching or moving it.

I pulled the fuze on the satchel and headed back to the boat where Speed was waiting, engine running, and ready to proceed back down river. After climbing aboard the skimmer, we were both relieved to be well away from the mine. It detonated right on time with a large explosion. We gave it a 10 minute window for safety reasons and went back up river to the detonation area where a large hole was left in the sandbank. Job done!⁷⁰

The efficacy of swimmer–sappers of 126 Naval Sapper Regiment

The sapper of the Vietnam People's Navy (VPN) was the elite of the People's Army of Vietnam (PAVN; US designation NVA), its members being 'selected from the highest graduates of normal military training'.⁷¹ 126 Naval Sapper Regiment was established in January 1966. Its swimmer–sappers received nine months of intensive training, including in: reconnaissance operations; target penetration and withdrawal; assault and demolition training; and political

⁷⁰ Brian Furner, Personal Communications, May 2022.

⁷¹ McAulay, 1997, p. 12.

indoctrination.⁷² The unit principally operated in the I Corps and I Coast Zone, specifically in Cua Viet and the surrounding area near the DMZ but members were also seconded to other areas.⁷³ They were proficient in the assembly of, and were responsible for laying and placing, many types of standard military and improvised mines in the region. These mines could be deployed as moored, bottom or floating mines, and could be initiated by command-detonation, time-delay, contact, magnetic, acoustic, pressure, or a combination of any of the above.⁷⁴

The first captured example of a birdcage mine appeared in August 1968 in the Cua Viet region.⁷⁵ The authors believe that 126 Naval Sapper Regiment was responsible for introducing the birdcage mine into operation, as this was their training and area of operation. According to a 1970 *US NAVFORV Staff Study*, swimmer-sapper attacks had a 'very high payoff ratio', being effective materially and for the casualties inflicted on the defender compared to those casualties exacted on the attacking sappers.⁷⁶

The enemy is cited as having sunk or damaged around 200 vessels in the Cua Viet region before September 1970.⁷⁷ The USN monthly summaries, from the first encounter with the birdcage mine in August 1968 to April 1970 (details were not recorded after this), give statistics for the numbers of vessels destroyed or damaged totalling more than seven vessels destroyed and 494 damaged (the extent of the damage was not provided) across all areas where the US Navy operated. The reports sometimes mention mining incidents but do not indicate whether birdcage mines were involved.⁷⁸ Even in Cua Viet it was, on occasion, difficult to identify whether a mine attack involved command-detonation, pressure activation (presumably a birdcage) or another mine type altogether. The mystery and unknown context of its use made the mine all the more sinister.

Retrospective

The birdcage mine was a brilliantly devised and constructed piece of ordnance, being a small unit, easy to transport, handle and lay, indicative of small-scale production using available

72 *Ibid.*

73 USN AR/522 – Monthly Summary September 1970, p. 50; USN AR/522 – Monthly Summary November 1970, p. 64; USN AR/522 – Monthly Summary December 1970, pp. 59, 62–63; USN AR/522 – Monthly Summary January 1971, p. 64; McAulay, 1997, pp. 12, 76.

74 McAulay, 1997, p. 12; Grey, 1998, p. 285.

75 McAulay, 1997, pp. 99–100.

76 USN Vietnam Command File (AR/522) Archives Branch, Naval History and Heritage Command, 'Countering the Swimmer/Sapper', Operational Analysis Branch, US Naval Forces Vietnam, January 1970, Folder 7, Box 136. See also Grey, 1998, p. 286.

77 Editorial in 'Glorious Exploits by Heroic Cua Viet', *Quan Doi Nhan Dan* (People's Army Newspaper), 16 September 1970, p. 4, cited in Chavanne, 2011, p. 60.

78 USN AR/522 – Monthly Summaries from August 1968 to April 1971, history.navy.mil/research/archives/digital-exhibits-highlights/commander-naval-forces-vietnam.html, accessed 6 June 2024. The authors of this paper are not sure whether a recovered vessel that is reconditioned is recorded in this source as damaged.

materials. The mine is a bottom-laid influence mine, not activated by contact, but by the pressure influence of the positive and negative phases of the target vessel's pressure wave. As such, it is ideal for shallow-water channels and waterways deployed at a depth of about 2 to 15 feet which made it almost impossible to detect visually in the riverine conditions of the Cua Viet region. Additionally, with a performance life of probably around three months (based on the approximate life of 12-volt battery) and could be set to target specific sized vessels and later versions had a resistance to counter-mining. From the evidence presented above, the authors believe that the birdcage mine performed with a record unequalled by any other influence mine deployed in Vietnam.

Examination revealed that an important attribute of the birdcage mine is its capacity for adaptation and development. It was first encountered in Vietnam in August 1968, however there has been speculation that an earlier improvised form of the mine utilised a pig bladder or other inflatable vesicle, such as the inner tube of a soccer ball, secured atop a makeshift cylinder within a bamboo cage.⁷⁹ Yet the birdcage mine which appeared in 1968 (Mark 1) and was modified around 1970 (Mark 2) was not a product of improvisation but of a deliberate modification based on operation circumstances. For example, the original version of the birdcage (Mark 1) was a straightforward two-phase pressure activated mine, incorporating a soluble washer safety arming device. This version was susceptible to counter-mining measures which led to the redesign of the firing mechanism and the incorporation of anti-scare charge components, in particular, the flow-rate arresting and resetting valve and two long-term delay chemical arming devices. The latter two devices, each backing up the other were wired in parallel into the main circuit (one being a repurposed North Vietnamese 82mm Chemical Long Delay Mortar Fuze). The flow rate arrestor modification made the mine highly resistant to attempts at counter-mining by means of independent explosive charges. Counter-mining would only cause immobilisation or detonation of the Mark 2 mine if the counter-mining charge either disrupted the mine's circuitry, or exploded close enough to sympathetically detonate the base charge. The elimination of all external wiring (as recorded in one captured example, not sighted) was most probably a defence against the disruption of the electrical circuit by the shock-pressure of a nearby explosion, and the use of HE with a high FOI, served to increase the resistance of the mine's base charge to counter-mining. Additionally, the flow-rate arresting and resetting valve would reset itself after each attempt at counter-mining, making counter-mining something of a hit-and-miss affair. The only reliable countermeasure to the Mark 2 was to cable-drag the river bottom, a difficult and time-consuming exercise which exposed the sweepers to ambush.

The effect of this mine on the vessels it targeted, and on the morale of those crews was devastating.⁸⁰ Almost impossible to detect, the mine could, without warning, destroy a PBR and its crew in an instant. Tug Wilson's account of a birdcage attack and aftermath is a chilling

79 McAulay, 1997, pp. 99–100.

80 Enemy land-based booby traps produced a similar response.

example of the psychological impact of a birdcage mining incident. The birdcage also had a devastating effect on the morale of the South Vietnamese Navy and its auxiliary forces, such as the Junk Force.⁸¹ For example, the Vietnamese Navy was known to refuse tasks in regions identified as employing the birdcage mine. Petty Officer Clearance Diver John Kershler (7th Contingent) stated 'Cua Viet was a hole of a place on the bank of the river, with an air of indifference about it. It was not a place I enjoyed going to.'⁸²

Despite the effectiveness of this mine in shattering allied rivercraft and morale, the birdcage is virtually unknown outside the allied riverine and the Vietnam People's Navy swimmer-sapper community. However, the example at the Memorial (Figure 26) has a direct connection to Australian CDT-3 members that served in Vietnam. It is a significant part of the Vietnam War's brown-water naval history, and, at least in the case of the Mark 2 version examined, it does not deserve to be classified merely as 'locally produced crude pressure mines [which] were used in the Cua Viet River near the Demilitarised Zone.'⁸³

The story of the birdcage mine is a reminder that cheap, low-tech but ingenious mines remain potent weapons. James Goldrick suggests that British First World War mining operations might contain lessons that still apply.⁸⁴ As often stated in the RAN Clearance Diving community, 'nothing is obsolete.'

81 Phil Narramore, Personal Communications, August 2021. See also McAulay, 1997, p.178.

82 McAulay, 1997, p. 149.

83 Grey, 1998, pp. 285–286. Also see Blue, 1976, p. 25, where he says 'Pressure mines of a crude but effective design were recovered at this time.'

84 James Goldrick, 'Antiaccess for Sea Control: The British Mining Campaign in World War I', *Navy History Magazine*, 2018, vol. 32(5), usni.org/magazines/naval-history-magazine/2018/october/antiaccess-sea-control-british-mining-campaign-world, accessed 6 June 2024; James Goldrick, 'Anti-access for Sea Control: The British Mining Campaign against Germany in the First World War', *Naval History and Heritage Command*, 2019, history.navy.mil/get-involved/essay-contest/2018-winners/anti-access-for-sea-control.html, accessed 6 June 2024.

