CHEMICAL AND BIOLOGICAL WARFARE RESEARCH AND DEVELOPMENT DURING THE CIVIL WAR

by
Jeffery K. Smart

Who that had to die from a blow
would not rather place his head under Nasmyth's hammer,
than submit it to a drummer-boy armed with a ferrule?

B. W. Richardson, 1864

The Civil War proved to be a fertile time for research and development of experimental chemical and biological weapons and protective equipment. Many of these inventions and concepts proposed during the war were the forerunners of similar items used on a much larger scale during World War I, the first major war that included the use of chemical and biological weapons.

CHEMICAL WARFARE

Chemical Warfare Agents

Many of the key chemical warfare agents used during World War I were 18th and 19th century discoveries known to chemists prior to the Civil War. The following chemical warfare agents were discovered or synthesized prior to 1861:

- Chlorine (1774)[1]
- Hydrogen Cyanide (1782)[2]
- Cyanogen Chloride (1802)[3]
- Phosgene (1812)[4]
- Mustard Agent (1822)[5]
- Cacodyl (1837)[6]
- Chloropicrin (1848)[7]

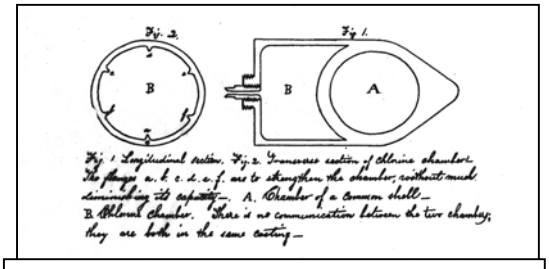
Sulfur and Sulfuric Acid. In addition to the key World War I chemical warfare agents, sulfur, an ingredient of gunpowder, produced noxious fumes and was considered a potential chemical weapon. In 1861, the Confederacy had several hundred tons of sulfur stored in New Orleans for sugar refining. Charlotte, NC, had a factory that produced sulfuric acid for use to make nitric acid, which in turn was used to make mercury fulminate, used in percussion caps. In the North, there were sulfuric acid plants in operation in Pennsylvania, New Jersey, and Massachusetts that produced approximately 40,000 tons per year.[8]

Chemical Warfare Proposals and Use

Although many of the chemical warfare agents were identified prior to the war, only a few of the chemicals were proposed for use on the battlefield during the war. These were generally the chemicals well known to industry and medicine.

Poison Gas From Balloon. In 1861, Confederate Private Isham Walker wrote a letter to Lucius Walker, the Secretary of War, proposing that poison gas be used against Fort Pickens and the Federal ships guarding it near Pensacola, FL. To deliver the poison gas, Walker proposed using a gas balloon. His plan was not accepted.[9]

Chlorine Shell. On April 5, 1862, the same day the Union Army began siege operations against the extensive Confederate fortifications at Yorktown, VA, John W. Doughty, a New York City schoolteacher, wrote to Secretary of War Edwin M. Stanton suggesting that 10-inch artillery shells filled with liquid chlorine gas be used against the Confederates. He envisioned:



Doughty's Chlorine Shell (National Archives)

If the shell should explode over the heads of the enemy, the gas would, by its great specific gravity, rapidly fall to the ground: the men could not dodge it, and their first intimation of its presence would be by its inhalation, which would most effectually disqualify every man for service that was within the circle of its influence; rendering the disarming and capturing of them as certain as though both their legs were broken.

He also pointed out that chlorine shells would be particularly effective against ironclads and steam rams, creating an atmosphere that would make the "inmates to be more anxious about their own safety than about the destruction of their enemy." The lack of persistency of chlorine was also a benefit:

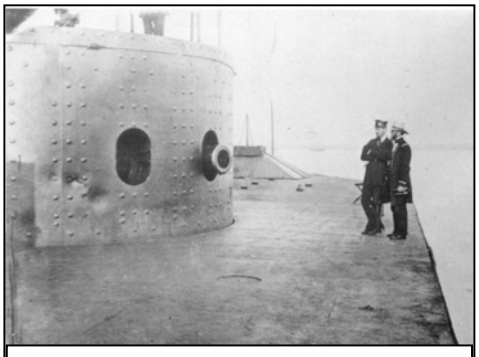
> *It may be asked if the gas which drove the enemy from his guns, would not prevent the attacking party who used the gas, from taking possession of the abandoned position. I answer it would not: for, this shell does not like the Chinese stink-pots, deposit a material emitting a deleterious gas lighter than the atmosphere, but suddenly projects into the air, a free gas much heavier than the atmosphere, which does its work as it descends to the earth, where it is soon absorbed.*

The proposed shell had two compartments: one filled with two or three quarts of chlorine and the other with explosives. This principle of gas compressed in a chemical chamber released by the action of a bursting charge became the standard for chemical weapons of the Twentieth Century. He enclosed a drawing of the proposed shell in his letter.

The moral question of using chemical weapons was also addressed in his letter since he thought the shells would save the lives of the attackers and defenders. He concluded:

> *As to the moral question involved in its introduction, I have, after watching the progress of events during the last eight months with reference to it, arrived at the somewhat paradoxical conclusion, that its introduction would very much lessen the sanguinary character of the battlefield, and at the same time render conflicts more decisive in their results.*

This plan was apparently never acted on, as it was probably presented to Brigadier General James W. Ripley, Chief of Ordnance, who was described by one author as being "congenitally immune to new ideas."[10]



The Turret of the U.S.S. Monitor (US Army Military History Institute)

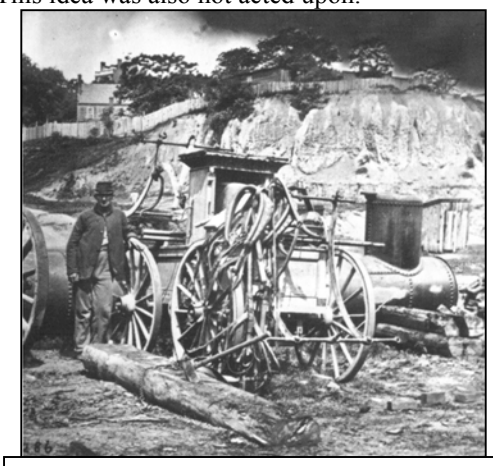
Chloroform as a Knockout Gas. In April 1862, shortly after the engagement between the U.S.S. *Monitor* and the C.S.S. *Virginia* at Hampton Roads, VA, ended in a draw, Union Commodore L. M. Goldsborough, commanding naval forces at Hampton Roads, sent the following letter to Assistant Secretary of the Navy Gustavus V. Fox:

> *The present program for the Merrimac is to take the Monitor at all hazards, for which she is provided with numerous grapnels and steel wedges, the latter to choke the*

tower [turret] *and prevent its revolving; go to Yorktown, thence to Washington City, and finally to New York. Chloroform is to be used in abundance by the Merrimac to produce insensibility on board the Monitor. I was under the impression that chemicals were rather scarce among them.*

This plan was never carried out and its own crew destroyed the *Virginia* later in the year.[11]

Chloroform Spray Fire Engine. A similar idea by Joseph Lott from Hartford, Connecticut in 1862 was to load fire engines with chloroform and spray it on enemy troops behind their earthworks defending Yorktown and Corinth. This idea was also not acted upon.[12]



A Pump Fire Engine (Library of Congress)

Hydrochloric/Sulfuric Acid Cloud. With trench warfare and stalemate facing the opposing sides at Petersburg, VA, in June 1864, Forrest Shepherd of New Haven, CT, a professor of agricultural chemistry at Western Reserve University, wrote to President Abraham Lincoln proposing that the Army use a mist of hydrochloric acid against the Confederates. He envisioned:

that by mingling strong sulfuric acid with strong hydrochloric, or muriatic acid on a broad surface like a shovel or shallow pan, a dense white cloud is at once formed, and being slightly heavier than the atmosphere, rests upon the ground and is high enough to conceal the operator behind it. This may easily be continued by additional sprinkling of the two acids and a light breeze will waft it onward.

The effect on the enemy was:

When the cloud strikes a man it sets him to coughing, sneezing, etc., but does not kill him, while it would effectually prevent him from firing a gun, or if he should fire, to aim at his object. It has occurred to me that Gen. [Ambrose E.] *Burnside, with his colored troops might, on a dark night, with a gentle breeze favorable, surprise and capture the strongholds of Petersburg, or Fort Darling, perhaps without loss or shedding of blood."*

Although the heat generated from the mixing of hydrochloric acid and sulfuric acid would vaporize some of the hydrochloric acid, the volume required to create a potent cloud that would drift intact across to the Confederate lines would require large amounts of both acids. Perhaps for this reason, Shepherd's letter was apparently filed away and quickly forgotten.[13]

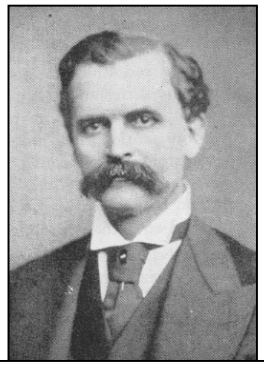
Cacodyl Glass Grenade. In January 1964, Captain E. C. Boynton proposed a "Kacodyl" glass grenade that combined an incendiary with a toxic gas. He envisioned this grenade for use against ships:

When a mixture of acetate of potash and arsenious acid is distilled at a low red heat, a disagreeable odor, and actively poisonous, results, called Alkarsine... If this liquid be exposed to the air, it oxidizes, ignites, and throws off deadly fumes of arsenious acid.

When Alkarsine is distilled with strong chlorohydric acid, and the product digested in a vessel containing zinc, water, and carbonic acid, a heavy oily liquid insoluble in water is produced, which takes fire the instant it is brought in contact with the air. If this substance, termed Kacodyl... was confined in glass globes or bottles, and dropped in the deck of a vessel, or thrust below, all the horrors of combustion and deadly arsenical inhalations would be realized, beside which the terrors of the Greek fire would be contemptible.

There is no evidence that such grenades were ever tested against a wooden ship, although as early as 1862, there was at least one anonymous report in Scientific American that stated: "Several incendiary and asphyxiating shells have been invented for the purpose of scattering liquid fire and noxious fumes around the space where they explode."[14]

Suffocating Smoke Cartridge. Following the tunneling incident that led to the Union debacle at the Crater during the Petersburg siege, Confederate troops prepared a combustible cartridge to produce a suffocating smoke as a countermeasure to prevent another surprise tunneling operation. Under the direction of Colonel William W. Blackford, an engineer officer, the Confederates dug tunnels of their own extending out in front of several of their key positions. In these tunnels, the soldiers dug holes four inches in diameter extending out approximately 10-15 feet toward Union lines and placed sentinels to watch the holes. Colonel Blackford provided the instructions for these sentinels:



William W. Blackford (Armed Forces Chemical Journal)

In case the enemy struck one of these holes, the guards on duty were provided with cartridges of combustibles, the smoke from which would suffocate a man. These they were to run into the holes and fire by a fuse, closing their end of the hole tightly, and then, summoning the guard, they were to dig into and take possession of the opposing mine as rapidly as possible, giving another dose of suffocating smoke from time to time to keep the enemy out of his workings until they could dig into them.

Unfortunately, the composition of the combustible was unknown. One historian guessed that it might have been similar to gunpowder but containing a much higher proportion of sulfur. This would create a sulfur dioxide cloud when burned. Another guess was that the material was similar to the mixture used in stink balls. This was a mixture of sulfur, rosin, pitch, asafetida, raspings from horses' hoofs, and other materials designed to produced a nauseating smoke. The actual use of these cartridges was not reported, but were known to have at least been deployed to the front lines.[15]

Stink Shell. In 1864, Brigadier General William N. Pendleton, Lee's Chief of Artillery, considered the "Chinese stink-balls" as a potential chemical weapon to break the siege of Petersburg. He wrote Lieutenant Colonel Briscoe G. Baldwin, Lee's Chief of Ordnance:

I saw noticed in a recent paper a stink-shell, and it seems to me such missiles might be made useful to some extent at least. . . The question is whether the explosion can be combined with suffocating effect of certain offensive gases, or whether apart from explosion such gases may not be emitted from a continuously burning composition as to render the vicinity of each falling shell intolerable. It seems at least worth a trial.

The Petersburg Trenches (Library of Congress)

The response back from Ordnance Department was: "Stink-balls, none on hand; don't keep them; will make if ordered." Apparently, they were never ordered.[16]

BIOLOGICAL WARFARE

Biological Warfare Agents

The human race has been attacked by diseases from the earliest of times. Biological warfare, however, differed from the random introduction of diseases by being human initiated, deliberate, and directed at a specific target. Several of the key biological warfare agents identified as weapons during the 20th century were identified or at least described prior to the Civil War:

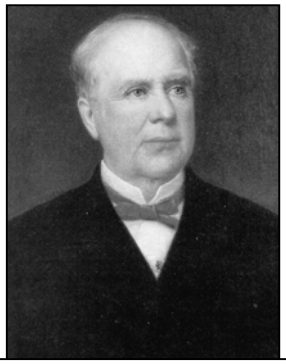
- Anthrax (5000 BC)[17]
- Plague (1320 BC)[18]
- Smallpox (1122 BC)[19]
- Typhus (430 BC)[20]
- Yellow Fever (1600's)[21]

Biological Warfare Proposals and Use

During the Civil War, there were several reported attempts to use biological warfare by the Confederates against Union forces and civilian populations.

Yellow Fever Infected Bodies and Contaminated Clothing. In 1862, R. R. Barrow, a Southern planter, proposed taking bodies infected with Yellow Fever and contaminated clothing to Union held New Orleans in an attempt to spread the disease. Of course, the plan would have failed due to the post war discovery that mosquitoes rather than clothing and material transmitted yellow fever**.** There was no indication that the Barrow's proposal was ever carried out.[22]

Smallpox Contaminated Clothing. Dr. Luke Blackburn of Kentucky, a Southern sympathizer, apparently plotted to infect clothing with the smallpox virus and then sell them to Union troops during 1863. Reference to this incident appeared in a 1893 book concerning the youngest U.S. officer in the war:



Dr. Luke Blackburn (Kentucky State Archives)

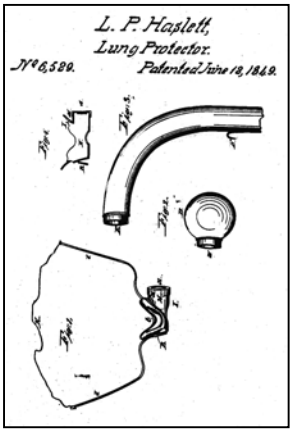
> *Subsequently, when young* [Charles W.] *Randall was a Lieutenant in the Seventeenth Vermont, his health became permanently impaired by smallpox, which it was believed he took from infected clothing, having purchased in Washington some undergarments at a store which afterward came under suspicion as a place of consignment under the infection scheme suggested by Dr. Blackburn of Kentucky. But, whatever the origin, the disease destroyed his blood, and shortly after the war he died of quick consumption.*[23]

This plan was similar to the attempt to infect Indians with smallpox during colonial wars.

Yellow Fever Infected Clothing. In 1864, Dr. Blackburn, while in St. Georges, Bermuda, also attempted to cause a yellow fever epidemic in the North by shipping infected clothing there. When his plot was discovered, he left Bermuda and took refuge in Canada.[24]

Dead Animals and Poisons in Drinking Water. There were several reported incidents of Confederate forces contaminating wells and ponds with either poisons or the carcasses of dead animals. Major General William T. Sherman reported that the Confederates retreating from Vicksburg drove animals into the ponds and then shot them. The U.S. Army apparently considered this form of warfare as barbarous and uncivilized. War Department General Orders No. 100, dated April 24, 1863, stated: "The use of poison in any manner, be it to poison wells, or food, or arms, is wholly excluded from modern warfare."[25]

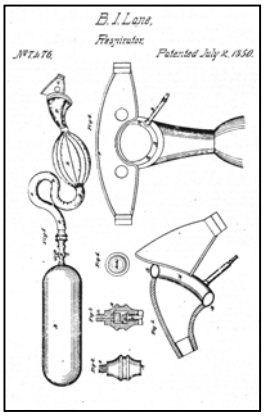
CHEMICAL/BIOLOGICAL WARFARE DEFENSIVE TECHNOLOGY



With the growing use of toxic chemicals in industry, the need for protection of firemen in toxic smokes, and the war proposals for using chemical weapons, it was not surprising that the development of protective equipment against toxic chemicals occurred simultaneously with the proposals to use chemical weapons.

Protective Masks

Haslett Mask. One of the earliest known patents for a protective mask in the United States was Lewis P. Haslett's in 1847. Haslett was from Louisville, KY, and improved on his first patent for an Inhaler or Lung-Protector in 1849. This patent stated: "I... have invented a new and useful Machine for Protecting the Lungs Against the Inhalation of Injurious Substances..." This early protective device covered the nostrils and used water moistened woolen fabric as a filtering material. It also had an exhaling valve to prevent carbon dioxide poisoning. For more "more volatile substances, such as gas, smoke, etc.," the device used a hose that moved the intake valve near to the floor.[26]



Lane Mask. Benjamin I. Lane of Cambridge, MA, patented his Respiring Apparatus, also called "Lane's Pneumatic Life-Preserver," in 1850. His patent stated that the apparatus allowed the breathing of pure air from an air chamber "...thereby enabling a person to enter buildings and vessels filled with smoke or impure air and into sewers, mines, wells, and other places filled with noxious gases or impure air..." The nosepiece was made of vulcanized rubber with a head strap and goggles and was attached to the brass copper air chamber or tank by a vulcanized rubber tube. A vulcanized rubber bag between the tank and the facepiece held enough of the pressurized air for four or five breaths. Then the user exhaled through his mouth, which was unprotected, which automatically triggered the refilling of the bag from the tank. The tank was worn on the users back and was pressurized to five or seven atmospheres by an air pump or bellows.[27]

Stenhouse Mask. British inventors also designed protective masks. In 1854, John Stenhouse, a prominent Scottish chemist, aware of the dangers of toxic chemicals, designed a protective mask using a charcoal filter that protected against chlorine, hydrogen sulfide, ammonia and other gases. The mask consisted of powdered wood charcoal held in place between two layers of wire gauze. The charcoal was replaceable through a small door in gauze. The frame of the mask was copper, with soft lead edges lined with velvet to fit the face. The upper support strap was elastic, while the lower strap tied behind the head. He declined to patent the mask and instead made the design available to the general public. Apparently a number of his masks were produced and used by several large chemical manufacturers in London.

Stenhouse Mask (Armed Forces Chemical Journal)

George Wilson, a professor of technology at the University of Edinburgh, envisioned a military use for Stenhouse's mask. He wrote in 1854, during the Crimean War when there were several proposals to use chemical weapons, that:

The longing for a short and decisive war has led to the invention of a suffocating bombshell; which on bursting, spreads far and wide an irrespirable or poisonous vapor; one of the liquids proposed for this shell is the strongest ammonia, and against this it is believed that the charcoal respirator may defend our soldiers. As likely to serve this end, it is at present before the Board of Ordnance.[28]

Since the proposed chemical shells were rejected, the need for a protective mask was also apparently rejected.

Hoffmann Mask. Theodore A. Hoffmann patented an "Improvement in Respirators" in 1866 that consisted of an apparatus worn on the nose and mouth to protest against "malarious and contagious elements" in the atmosphere. The mask was made of two layers of cotton or other textile fabric, shaped to fit the mouth and nose. The edges of the mask were bound with an elastic border to prevent leakage.[29]

Collective Protection Systems

Stenhouse Collective Protection System. Stenhouse also worked on an early version of collective protection for a room. He designed a filter similar to his mask filter that purified air entering rooms. It was successfully tested on several government buildings and absorbed obnoxious smells from the city streets.[30]

Although the proposals and attempts at chemical and biological warfare during the Civil War were mostly unsuccessful, the concepts were not forgotten. Fifty years later, some were used with deadly results during World War I.

NOTES

[1] Mario Sartori, *The War Gases* (New York: D. Van Nostrand Company, Inc., 1943), 33.
[2] Ibid., 181.
[3] Ibid., 188.
[4] Ibid., 59.
[5] Ibid., 217.
[6] "Bunsen, Robert Wilhelm," *The New Encyclopedia Britannica* (London: Encyclopedia Britannica, Inc., 1987), 2:634.
[7] Sartori, *The War Gases*, 165.
[8] Wyndham D. Miles, "Civil War: A Discourse on How the Conflict was Influenced by Chemistry and Chemists," *Chemical &Engineering News (C&EN)* 39, no. 14 (April 1961): 109-113; Wyndham D. D., "Chemical Warfare in the Civil War," *Armed Forces Chemical Journal (AFCJ)* 12, no. 2 (March-April 1958): 27; Harry A. Kuhn, "Chemical Industry and National Defense," *AFCJ* 14, no. 2 (March-April 1960): 6.
[9] Bell I. Wiley, "Drop Poison Gas from a Balloon," *Civil War Times*, printed from The History Net, November 14, 1997.
[10] Miles, "The Civil War: A Discourse on How the Conflict was Influenced by Chemistry and Chemists," 112; Miles, "Chemical Warfare in the Civil War," 27 and 33; F. Stansbury Haydon, "A Proposed Gas Shell, 1862," *Chemical Warfare Bulletin (CWB)* 24, no. 3 (July 1938): 115-119; D. B. Sabine, "Blue and Gray Chemistry," *Civil War Times Illustrated (CWTI)* (October 1969): 27.
[11] "Early Projected Gas Attack," *CWB* 23, no. 3 (July 1937): 119-120.
[12] Miles, "Chemical Warfare in the Civil War," 33; Haydon, "A Proposed Gas Shell, 1862," 116-118.
[13] Miles, "Chemical Warfare in the Civil War," 27.
[14] Ibid., 33.
[15] Wyndham Miles, "Suffocating Smoke at Petersburg" *AFCJ* 13, no. 4 (July-August 1959): 35.
[16] "How Many Have Heard of This," *Chemical Warfare* 10, no. 11 (November 1924): 11-12.
[17] W. Edmund Farrar and Annette C. Reboli, "The Genus Bacillus-Medical," *The Prokaryotes* (New York: Springer-Verlag, 1992), 2:1746.
[18] "Plague," *Microsoft® Encarta® Reference Library 2002*.
[19] "Smallpox," *The New Encyclopedia Britannica*, 10:887.
[20] Emilio Weiss, "Rickettsias," *Encyclopedia of Microbiology* (San Diego: Academic Press, Inc., 1992), 3:586.
[21] Douglass S. Thompson and Thomas H. Weller, "Yellow Fever," *Microsoft® Encarta® Reference Library 2002*.
[22] Wiley, "Drop Poison Gas from a Balloon."
[23] Albert Clarke, "The Youngest Officer in the War," *Stories of Our Soldiers* (Boston: The Journal Newspaper Company, 1893), 229.
[24] James Ziral, "Island Haven For a Struggling Confederacy," *CWTI* 28, no. 6 (November-December 1989): 12; J. D. Haines, "Did a Confederate Doctor engage in a Primitive Form of Biological Warfare? The Northern Press Thought So," *America's Civil War* 12, no. 4 (September 1999): 12, 16, and 20; Andrew G. Robertson and Laura J. Robertson, "From Asps to Allegations: Biological Warfare in History," *Military Medicine* 160, no. 8 (August 1995): 370.
[25] Ibid., 369-370; William T. Sherman, *Memoirs of General W. T. Sherman* (New York: Literary Classics of the United States, Inc., 1990), 356; Ann Van Wynen Thomas, and A. J. Thomas, Jr., *Development of International Legal Limitations on the Use of Chemical and Biological Weapons: Volume II Basic Report*, (U.S. Arms Control and Disarmament Agency, 1968), 48-49.
[26] U.S. Patent No. 6,529, June 12, 1849.
[27] U.S. Patent No. 7,476, July 2, 1850.
[28] Wyndham D. Miles, "The Velvet-Lines Gas Mask of John Stenhouse," *AFCJ* 12, no. 3 (May-June 1958): 24-25.
[29] U.S. Patent No. 58,255, September 25, 1966.
[30] Miles, "The Velvet-Lines Gas Mask of John Stenhouse," 24-25.