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CONTENTS

Articles and Statements

Anniversaries

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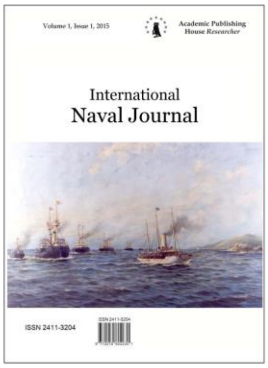


Articles and Statements

Uruguayan Navy during WW2

Pedro R. Barreiro [a, *]

[a] Uruguayan Academy of Maritime and River History, Montevideo, Uruguay

Translation from Spain by N.W. Mitiukov

Abstract

The participation of large ships of the Uruguayan navy on World War II is described quite well in the literature. But the actions of small ships usually remain behind the scenes. Information about them is usually limited to a set of characteristics from naval reference books and an indication that such ships were just in the specified period. The article describes the small ships of the Uruguayan Navy, the period of the Second World War, their brief description and biography. The article is a shortened version of the author's monograph published earlier.

Keywords: Uruguay, naval, World War II, fleet, warship.

1. Введение

В 2009 г. в России вышли справочники «Флоты Второй мировой» (Floty Vtoroi Mirovoi, 2009, 594-595) и «ВМС Латинской Америки и Азии» (VMS…, 2008), информация об уругвайском флоте в которых поместилась в полстраницы. Вероятно, причина этого крылась в недоступности уругвайских источников. Предлагаемая публикация представляет собой справки на корабли и суда уругвайского флота, принявшие участие во Второй мировой войне. В работе опущены справки на крейсер «Uruguay» и патрульные суда типа «Paysandu», информация о которых представлена в справочнике. Справки по приведенным кораблям и судам представляют собой сжатый вариант ранее вышедшей более объемной работы автора (Barreiro, 2009).

Парусный учебный корабль «Capitán Miranda» (ROU 20)

Построен как гидрографическое судно в 1930 году в Матагорде (Пуэрто-Реаль, Кадис, Испания). Корпус стальной, клиперский форштевень. Максимальная длина 54,85 м, ширина 8 м, осадка 3,4 м, высота борта 6 м. Дизельные двигатели и паруса. В 1977 г. перестроен в учебный парусный корабль с удлинением корпуса 64 м и осадкой до 3,8 м с полной реконструкцией кубриков. На форштевне добавлена резная фигура. Рангоут шхуны с тремя алюминиевыми мачтами и вспомогательным двигателем в 750 л.с. Скорость 10 уз. Площадь парусов увеличилась до 853,35 м^2. Вооружен 37-мм пушкой для салютов.

[*] Corresponding author
E-mail addresses: barreiro.pr@gmail.com (P.R. Barreiro)

Во время VIII Учебного плавания (1987 г.) совершил кругосветку за 355 дней, пройдя 34.101 миль. В 1993 г. прошел перестройку на верфи «Empresa Nacional Bazán» в Кадисе. В 2013-2017 гг. прошел ремонт с модернизацией всех систем в Национальном военно-морском доке в Монтевидео, выйдя в море 15.03.2017 г. по случаю двухсотлетней годовщины Уругвайского флота.

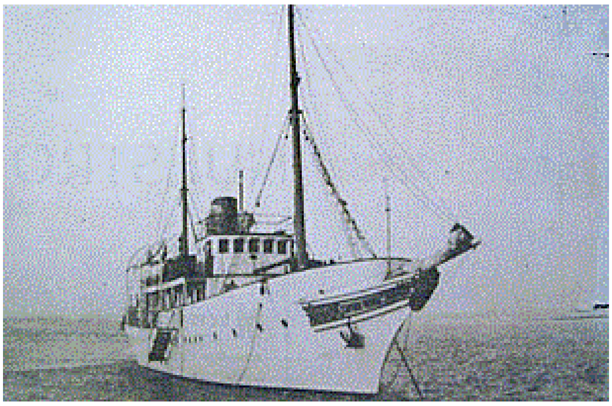



Рис. 1. «Capitán Miranda» во время войны (слева) и в настоящее время (справа)

Авизо «Vanguardia»

Построено в Глазго (Шотландия) в 1908 г. как уругвайское почтовое судно. Предназначалось для передачи мешков с корреспонденцией с иностранных судов, проходивших мимо порта Монтевидео. Длина 29,86 м, ширина 4,47 м, осадка 1,87 м, высота борта 2,43 м. Железный корпус с деревянными надстройками. Водоизмещение 93/95 дл. т. Машина горизонтальная тройного расширения мощностью 280 л.с. Максимальная скорость 12 уз. Вооружение 2 37-мм орудия.

Переведен в таможенную службу, а чуть позже, 13.01.1916 г. передан военно-морскому флоту, где классифицирован как авизо. Вооружение: две 37-мм пушки Гочкисса, одна двухствольная 11-мм митральеза Гочкисса.

Посыльное судно «Huracán»

Построен в 1881 г. в Камдене (штат Нью-Джерси, США) как буксир «*Fortuna*» для Сэмуэля Линидинга. Длина 36,67 м, ширина 6,70 м, осадка 3,20 м. Корпус деревянный. Максимальное водоизмещение 197 дл. н. Паровая машина двойного расширения 565 л.с. Скорость 12 уз.

Взят в аренду в 1886 г. для подавления революционного движения. В 1906 г. приобретен морской спасательной компанией Антонио Луссича (Antonio Lussich) и переименован в «Huracán». В 1916 г. в собственности государственной администрации порта Монтевидео (с 1931 г. Национальная администрация портов). Передан флоту 08.06.1933 г. и вошел в строй как посыльное судно (aviso de escuadra). В 1945 г. передан в распоряжение Военно-морской школы. Исключен из списков флота 21.08.1953 г. Вооружение: 2 75-мм орудия Круппа.

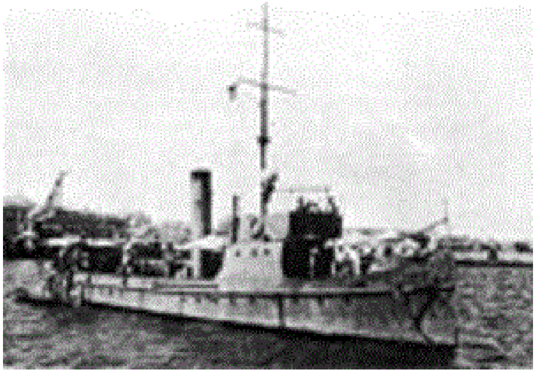
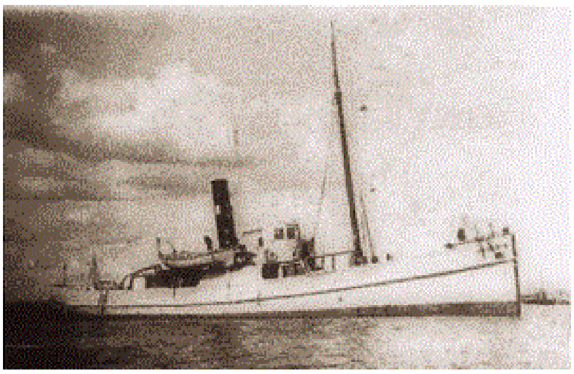



Рис. 2. «Vanguardia» «Huracán»

Авизо «Zapicán»

Построен в Глазго (Шотландия) как буксир «*Atlántico*» для спасательной компании Луссич (Lussich). Длина 27,7 м, ширина 7 м, осадка 2,5 м. Водоизмещение 162 дл. т. Паровая машина компаунд 422 л.с. Скорость 11/12 уз.

Затонул в ходе аварии у входа порт Монтевидео 19.04.1919 г. Поднят на следующий месяц, и после ремонта в июне 1921 г. снова в эксплуатации. После национализации фирмы Луссич передан в распоряжение администрации порта под новым названием «Zapicán». Это же наименование сохранилось при передаче в состав военно-морского флота.

Канонерская лодка «18 de Julio»

Роскошная яхта «*Lady Neell*», построенная для графа Шрусбери и Тэлбота (Shrewsbury y Talbot) фирмой «Ramage & Ferguson», Лейте (Шотландия) в 1884 г. В 1892 г. куплена Уильямом М. Джонстоном (William M. Johnstone) и переименована в «*Normania*». В 1896 г. приобретена Альфредом Кортни Шенли (Alfred Courtney Schenley). В период между 1898 и 1906 гг. принадлежала Генри Осборн-О'Хагану (Henry Osborne-O'Hagan), а в 1906 г. зарегистрирована на имя Мануэля Адано (Manuel Adano) с портом приписки Буэнос-Айрес (Аргентина). 06.08.1907 г. приобретена уругвайским правительством и вошла в состав военно-морского флота как канонерская лодка «*18 de Julio*».

Длина 56,74 м, ширина 7,67 м, осадка 4,65 м, высота борта 5,4 м. Корпус железный, клепаный, клиперский нос, водоизмещение 423,12 дл. т. Рангоут с оснасткой шхуны с тремя мачтами (в Уругвае добавили реи). Паровая машина компаунд, 600 л.с., два цилиндрических котла, скорость 12 уз. Вооружение: 2 47-мм пушки Максим-Виккерс, и 2 11-мм пулемета Гочкисс.

В 1917 г. преобразована в учебный корабль и в 1924 г. передана Морской школе (Escuela de Marineros), при этом удалена грот-мачта. Выведена из активной службы 14.06.1931 г. и переоборудована в Школу юнг (Escuela de Grumetes). В августе 1956 г разоружена и передана спортивному клубу в городе Сальто для использования в качестве штаб-квартиры. Спустя некоторое время во время шторма на стоянке села на дно. Там же разобрана на слом.

Пароход «Corsario»

Водоизмещение 130 дл. т., скорость 10 уз. Вооружение 2-37-мм пушки.

Учебное судно «Aspirante»

Трехмачтовая шхуна«Gelmirez», построенная в Испании. Деревянный корпус, длина 31,97 м, ширина 7,53 м, осадка 3,14 м, Водоизмещение 104,9 дл. т. В 1931 г. переименована в «*Trinidad Parodi*», а в 1933 г. в «*Exir Dallen*». В 1934 г. добавлен вспомогательный двигатель. После круиза по Средиземному морю и Атлантическому океану, в период между 1933–35 гг. владелец привел шхуну в Монтевидео, где продал уругвайскому правительству.

14.08.1936 г. вошла в состав военно-морского флота как «*Aspirante*». Использовалась в основном как учебное судно. С 1938 г. учебное судно при школе механиков (Escuela de Mecánicos).

Авизо «Lavalleja»

Паровой буксир, построенный примерно в 1880 г., для спасательной компании Антонио Лусича (Antonio Lussich). Деревянный корпус, водоизмещение 60 дл. т. Скорость 13 уз. Псоле перехода в собственность государства, находился в подчинении командира порта Монтевидео и военно-морского флота, использовался в основном для в патрульных и спасательных целей. В 70-е гг. продан компании «Artesa» и переоборудован в рыболовное судно «*Ciudad de Piriápolis*». Позже сдан на слом.

Патрульный катер «Colonia» (PR10)

Вошел в состав Уругвайского флота 08.07.1945 г. как спасательное судно военно-морской авиации «*Rescate*». Позднее получил идентификационный номер R-1. Деревянный корпус, длина 19,2 м, ширина 4,6 м, осадка 1,2 м. Максимальное водоизмещение 26 дл. т. Два бензиновых двигателя *Hall Scott V12 Defender* по 630 л.с. Максимальная скорость 33,5 уз. Вооружение: двух двухствольных 12,7-мм пулемета.

21.04.1969 г. переведен в Патрульный дивизион как «*Colonia*» (PR-10). Исключен из списков флота 21.04.1988 г.

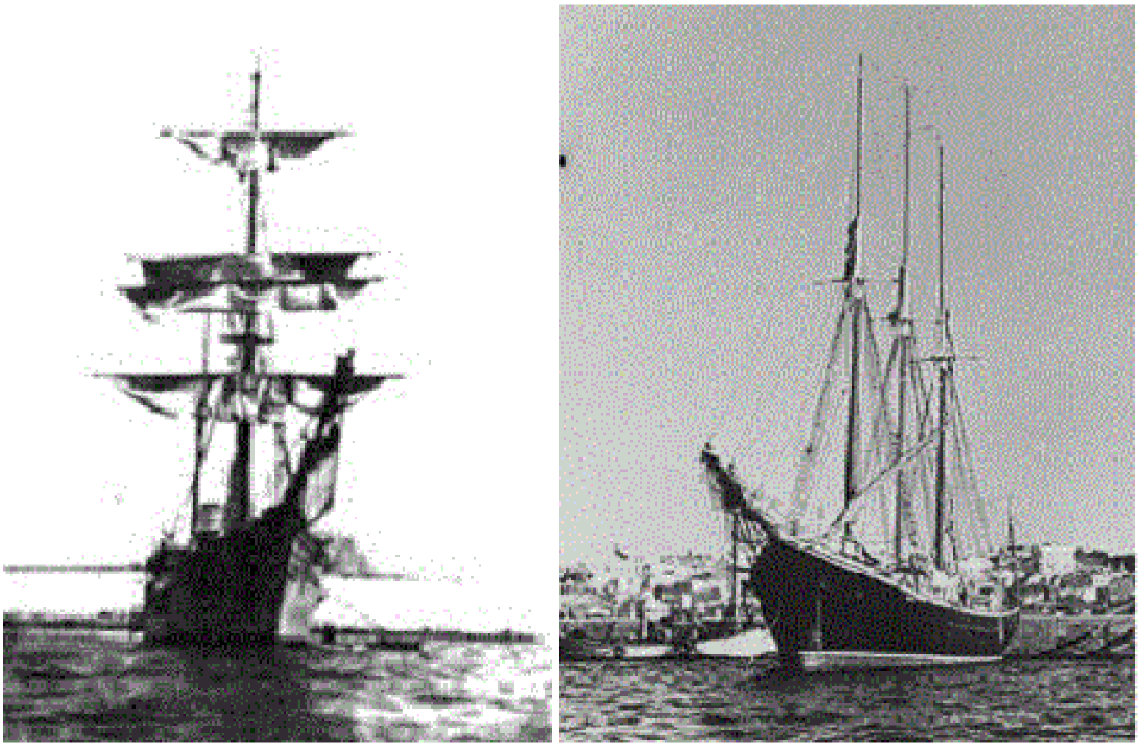


Рис. 3. «18 de Julio» «Exir Dallen»

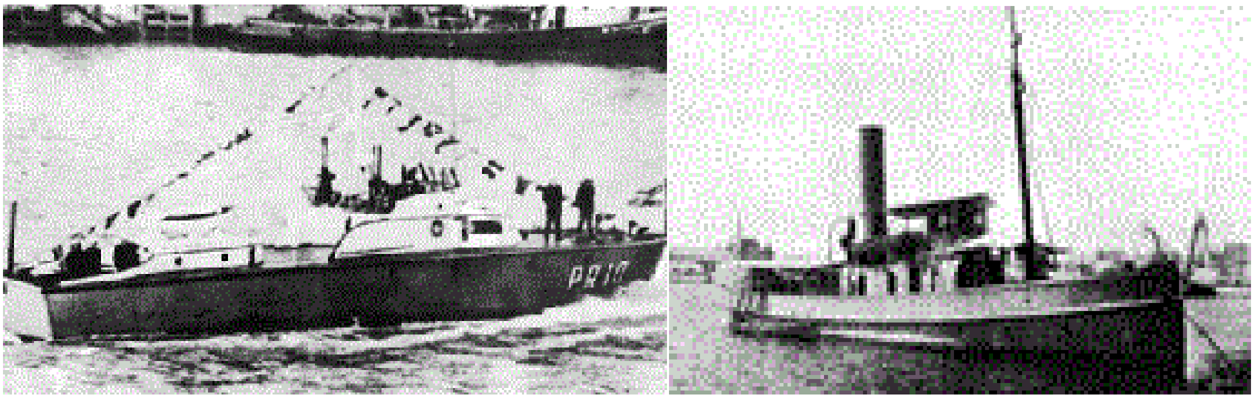


Рис. 4. «Colonia» «Corsario»

Корвет «Maldonado» (B-1 и PC-1)

Противолодочный корабль типа «173-футовый Патрульный корабль со стальным корпусом» («173-foot steel-hull Patrol Craft») был построен в Нью-Йорке (США) в 1943 г. Стальной корпус имел длину 53 м, ширину 7 м, водоизмещение 284 дл. т. Два дизеля GP мощностью по 2000 л.с. вращали каждый свой винт. Максимальная скорость 21 уз., экипаж 65 чел. Вооружение 76-мм универсальное орудие, одно 40-мм, два 20-мм орудий, бомбомет «Маусетрап». Корабль поставили уругвайскому флоту по программе ленд-лиза, где его классифицировали как корвет. Он стал первым специализированным противолодочным кораблем уругвайского флота. Корабль переменил флаг в Майами 1 апреля 1944 г. и прибыл в Монтевидео 31 июля того же года. Он сперва обозначался как B.1, позднее как PC.1. Исключен из списков флота 21 ноября 1970 г.

Кроме того, следует дополнить соответствующие разделы справочника информацией о службе в уругвайском флоте единиц военной постройки, переданных Уругваю после войны.

Фрегат «Montevideo» (PF-1)

Корвет типа «*Castle*», построен «*Harland & Wolff*», Белфаст (Северная Ирландия) для британского королевского флота под названием «HMS Rising Castle» (K-398). Передан в партии из 12 корветов Канаде в обмен на такое же количество тральщиков типа «*Algerine*», переименован в «HMCS Arnprior» (K-494).

Длина 76,33 м, ширина 10,9 м, осадка 3,05 м, водоизмещение 1.060 дл. т. Силовая установка: 2 цилиндрических котла «Harland & Wolff», паровая машина тройного расширения с приводом на один вал, 1 винт. Максимальная скорость 16 уз., крейсерская скорость 10 уз. Вооружение: 1 двухствольное 102-мм орудие Mk XIX, 6 20-мм зенитных пулеметов, 1 противолодочный бомбомет «*Squid*», 1 кормовой рельс для размещения на нем 15 мин. Радиолокационное вооружение: радар типа 272, сонар ASDIC 144Q, сонар ASDIC 147B.

В июне 1944 г. вошел в состав канадского флота, сопровождал конвои между портами Восточной побережья Северной Америки и Британскими островами. В июне - августе 1945 г. капитально отремонтирован в порту Сент-Джон. В сентябре того же года выведен в резерв в порту Галифакс (Новая Шотландия).

Приобретен уругвайским правительством в 1948 г. Отправлен в Дармут и 14.06.1953 г. вошел в состав флота как фрегат «ROU Montevideo» (PF.1). В основном использовался как учебное судно. 28.06.1972 г. перечислен в резерв. Разоружен в 1973 г. и исключен в 1975 г.

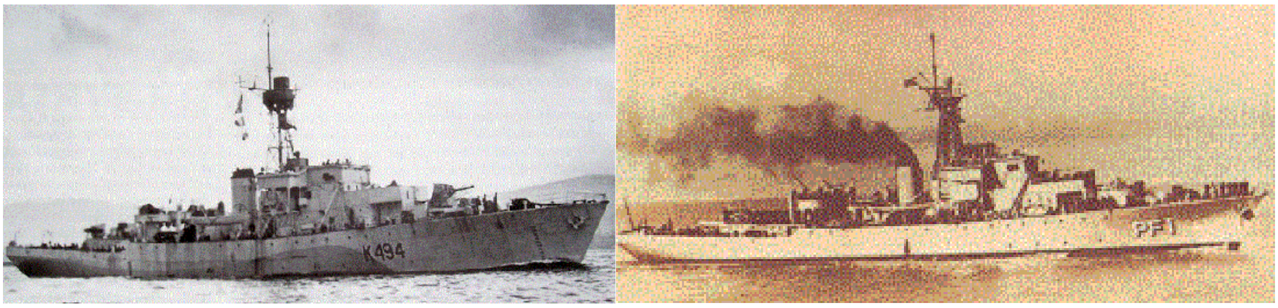


Рис. 5. HMCS «Arnprior» «Montevideo»

Referenses

Floty Vtoroi Mirovoi, 2009 – Floty Vtoroi Mirovoi (Navies of WW2, on Russian). Moscow: Yauza, 2009. 608 p.

VMS..., 2008 – VMS stran Latinskoi Ameriki i Azii (Navies of Latin America and Asia) // *Morskaya kampania*. 2008. № 4.

Barreiro, 2009 – *Barreiro, P.* (2009). Cañoneras y Cruceros. Montevideo: Del Sur Ediciones.

Furest, 1995 – *Furest, R.W.* (1995). Los cruceros “Montevideo” y “Uruguay”. Montevideo.

ВМС Уругвая в период Второй мировой войны

Педро Р. Баррейро [a, *]

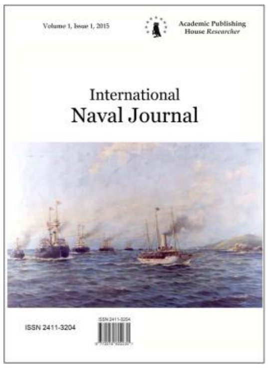
Уругвайская академия морской и речной истории, Монтевидео, Уругвай

Перевод с испанского Н.В. Митюков

[*] Корреспондирующий автор
Адреса электронной почты: barreiro.pr@gmail.com (П.Р. Баррейро)

Аннотация. Участие крупных кораблей военно-морских сил Уругвая во Второй мировой войне достаточно хорошо описано в литературе. Но действия мелких кораблей обычно остается за кадром. Информация о них обычно ограничивается набором характеристик из военно-морских справочников и указанием, что такие корабли просто были в указанный период. В работе дается описание небольших кораблей ВМС Уругвая, периода Второй мировой войны, их краткая характеристика и биография. Статья представляет собой сокращенный вариант авторской монографии, изданной ранее.

Ключевые слова: Уругвай, военно-морской, Вторая мировая война, флот, боевой корабль.



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Swansong: Blakely, Brooke and Vavasseur. Part 1

Kent R. Crawford [a,*], Donald E. Carlucci [b]

[a] Gunnery Fire Control Group, Indianapolis (IN), USA
[b] Stevens Institute of Technology, Hoboken (NJ), USA

Abstract

The decades of the 1860s and 1870s were characterized by one of the most thorough-going Technological Revolutions the world had ever seen, it has been characterized as the 'second industrial revolution.' And this Revolution affected the world's Navies no less than every other human endeavor. In the field of ordnance, iron smooth bore cannon firing solid round shot were replaced by rifled cannon. History recalls the many of the designers and/or manufacturers of the Great Guns. There was, however, one particular designer whose brief career has been overlooked until recently.

The performance and detailed information of the better known major gun founders is well documented and easily obtainable, but those of the lesser known producers are lost to history. Except for some third party accounts, official documents and some sub-contractor sales records, little remains of Captain Blakely's work. Almost all of his business records appear to have been passed to Vavasseur in 1867, whose own files and records were incorporated into the Armstrong archives when The London Ordnance Company merged with Armstrong in 1883, and subsequently destroyed in WW II. This paper seeks to remedy that lack, to the greatest extent possible. With few exceptions, the Muzzle Velocity figures in the tabular data are calculated values, and should be considered nominal.

Keywords: Naval, artillery, Blakeley, gun.

1. Introduction

The decades of the 1860s and 1870s were characterized by one of the most thorough-going Technological Revolutions the world had ever seen. Indeed, it has been characterized as the 'second industrial revolution.' And this Revolution affected the world's Navies no less than every other human endeavor. The wooden sail-powered warships that had held sway from the 16^{th} century gave way to iron hulls and armor, and sails gave way to steam. In the field of ordnance, iron smooth bore cannon firing solid round shot were replaced by rifled cannon – Great Guns – firing elongated shot and shell.

History recalls the many of the designers and/or manufacturers of the Great Guns. In the United States, Dahlgren, Parrott and Rodman are recorded. And in Europe, Armstrong, Whitworth and Krupp are well remembered.

There was, however, one particular designer whose brief career has been overlooked until recently, even though his name and works were well known to readers of The Engineer,

* Corresponding author
E-mail addresses: krand7@yahoo.com (K.R. Crawford), Donald.e.carlucci.civ@mail.mil (D.E. Carlucci)

The Mechanics Magazine and Holley's contemporary A Treatise on Ordnance and Armor, T.A. Blakely ((Holley, 1865), and Dr. Steven Roberts (Roberts, 2012) available on Scribd.com. This is his final revision, which came about as a result of some collaboration when my research had over-lapped his.). Blakely's work is also fundamental to the cannon produced by two others, John Mercer Brooke of the Confederate States of America Navy, and Josiah Vavasseur, best known for his gun mountings. All three of these brilliant men and their works will be covered in this paper.

The performance and detailed information of the better known major gun founders is well documented and easily obtainable, but those of the lesser known producers are lost to history. Except for some third party accounts, official documents and some sub-contractor sales records, little remains of Captain Blakely's work. Almost all of his business records appear to have been passed to Vavasseur in 1867, whose own files and records were incorporated into the Armstrong archives when The London Ordnance Company merged with Armstrong in 1883, and subsequently destroyed in WW II. Brooke's records were lost in the confusion as the Confederacy collapsed in 1865, leaving his personal journal to document his work. This paper seeks to remedy that lack, to the greatest extent possible. With few exceptions, the Muzzle Velocity figures in the tabular data are calculated values, and should be considered nominal.

Alexander Blakely, 1827–1868

Dr. Steven Roberts

Alexander Blakely was born in Sligo, Ireland on January 7, 1827; the son of the Very Reverend Theophilus Alexander and his second wife, Mary William Blakely. His father, of English descent, was a minister in the Anglican Church, eventually becoming Dean of Down. He was nominally Theophilus Alexander Blakely but preferred his second name, rarely using his first and signing with just his initials. Blakely had two sisters, Mary Stewart Blakely and Isabella Chalmers Blakely; the odd female given-names were a family trait.

After education at the Royal Military College, Woolwich, on June 14, 1844, at the unusually young age of 17 Alexander Blakely was commissioned from Gentleman Cadet to Second Lieutenant in the Royal Regiment of Artillery; on April 2, 1846 he became First Lieutenant, and on April 1, 1852 he achieved the rank of Second Captain of Artillery, he was known universally as Cap-tain Blakely for the rest of his life. He retired on half-pay on August 18, 1852. During the Crimean War in July 1855 he took the temporary rank of Major and Assistant Quartermaster General in the Irregular Cavalry of General Robert Vivian's 22,000 strong "Turkish Contingent", a mercenary corps organized by the British Army. He served as such until December 23, 1855. Blakely finally left the service on May 10, 1861, by selling-out his commission.

On March 12, 1855 Captain Blakely had appeared as an independent witness before the Parliamentary Committee of Inquiry into the Condition of the Army at Sebastopol. He was one of the few junior officers to be invited to appear: he reported bluntly that during his visit in the last fortnight of December the British soldiers "were very wretchedly clothed, very ragged and looked half starved. They complained that they did not get their rations and had no rum at all". His observations were reported nationally in the newspapers.

On December 31, 1856, when aged 30, Alexander Theophilus Blakely, Esq., Captain, half-pay, Royal Artillery, married Harriette Catherine Tonge, widow of Captain John Henry Tonge, 16th Lancers, of Alveston, Gloucestershire, the only child of the late John Maugham Connell, of Cheltenham, Gloucestershire. Blakely and his new wife moved from his single gentleman's lodgings in Little Ryder Street, St James's, London to a small rented house at 34 Montpelier Square, Brompton, West London, which was his family home for the best part of his short life. They had no children.

He was an inveterate traveler; he served the Royal Artillery at Plymouth between 1844 and 1846, on the Ionian Islands, in the Mediterranean, from 1846 until 1849, and then on the fortress peninsular of Gibraltar between 1846 and 1852, where he retired on half-pay after his health failed. After wintering in Italy to recuperate in 1852 he visited Constantinople, Turkey; in 1854 he was in the Crimea. In the spring of 1859 he was in Spain and Italy; in March 1862 he was in Hamburg, before going on to Vienna and Constantinople again; in the summer of 1863 he was in Paris, in the winter of 1864 in Russia. In the war between France and Austria in northern Italy in May 1859

Blakely was with the Austrians providing reports for *The Times* newspaper. He also spent much time in Ireland during the 1860s, where he held a property called 'Clermont' at Ballykeel, Hollywood, County Down.

Even at the age of eighteen when replacing the old 18 and 24 pounders that defended Plymouth harbour with 32 pounder cannon he was proposing to the Master General of Ordnance in London, a much larger gun than that which had ever been considered before. He, as a mere Second Lieutenant, was ignored. Later, when visiting Constantinople in 1853, Blakely proposed to the Ottoman authorities an original scheme for the defence of the Dardanelles against Russian incursion – it involved floating batteries and twenty cannon each firing a projectile of an unprecedented 300 pounds weight. The heaviest shot in the Royal Navy then was 68 pounds.

Blakely was one of the first to apply theoretical science to the manufacture of ordnance, and went on to obtain several patents for inventions relating to cannon. In this occupation he came up against the interests of the industrialists William Armstrong and Joseph Whitworth, who both sought to acquire manufacturing contracts for cannon from the government. Always something of a controversialist, he engaged in vigorous debates with these giants of industry and with scientific competitors such as his fellow countryman, Robert Mallet, creator of the great 36 inch calibre mortar of 1856.

Blakely, after his initial military service, undertook a long period of scientific research and calculation on which he founded original principles of ordnance. He became skilled in manipulating the London press into giving his ideas coverage. He used the learned societies to give prominence and veracity to his principles of ordnance, and cultivated many scientific allies, as well as being fearless, but reasoned, when challenged by his peers. His first break came from the support of William Needham of the Butterley Company, a huge concern that owned coal pits and ironworks, who was clearly looking for government gun contracts. The Butterley works made his first test pieces.

From his unique *scientific* base Blakely was able to acquire and then capitalize early orders from Giuseppe Garibaldi in Sardinia, Francisco Bolognesi in Peru and Edward Anderson of the Confederate States during 1860 and 1861 into credit at a London bank or at Fawcett Preston, the Liverpool ironworks, to get the first production orders completed. Although, in 1898 Blakely's widow stated that she had contributed £9,000 towards her husband's early experiments.

By the 1860s he was a respected expert on ordnance and was called to speak to the relevant committees of the British Parliament. Blakely was a valued contributor and speaker to the learned societies of the period in his role as engineer and artillerist. He also took on the industrial interest by forming his own joint stock company to make cannon. His profession from then, he stated, was "Manufacturer of Ordnance".

Although most noted for his loyalty to the cause of the Confederate States of America, for whom he provided nearly a hundred guns, Blakely's ordnance, advice and licenses for manufacture were sought by Chili, China, Denmark, Italy, Morocco, Peru, Portugal, Russia, Spain, Sweden, and, interestingly, the United States.

Blakely was a Member of the Royal Society of London, the British Association for the Advancement of Science, the Royal Irish Academy, an Honorary Member of the Society of Engineers, the "Smeatonians", and was a Founding Fellow of the Anthropological Society of London. He was also a vigorous contributor to the debates of the Royal United Service Institution, the military "think-tank" of the day. Socially, he was also a member of the Army & Navy Club, and of the Royal Victoria Yacht Club. He owned at least two yachts.

Sir Richard Burton, the famous explorer and writer, became a friend of Blakely's in the early 1860s. They plotted together to provide ordnance for Francesco II, King of the Two Sicilies, in May 1860 when southern Italy was invaded by Garibaldi, the revolutionary, another customer of Blakely's!

For a few years he was a wealthy man. In 1866 he moved from Montpelier Square to the much grander No 1 Park Lane, overlooking Marble Arch, Hyde Park, in London. His immediate neighbour was the Dowager Duchess of Somerset. The new house had formerly been the town residence of Sir Edward Bulwer Lytton, Bt, MP. In the summer of 1865 he bought the 300 ton steam yacht *Ceres* of Charles Kuhn Prioleau, the English partner in Fraser, Trenholm & Company, treasury agents to the Confederate States. Mrs. Harriette Blakely became a patroness of charities, including one to assist members of the ballet in time of sickness and distress.

Blakely was by no means a snob; he supported with funds, along with his peers Edward Reed, the naval architect, and Henry Maudslay, the engine builder, the London Association of Foreman Engineers, in its scientific and benevolent work.

In addition to his ordnance interests, when the Atlantic Telegraph cable, between Ireland and Newfoundland, was being manufactured Blakely made a mathematical investigation into its characteristics. He proposed, in August 1857, that to reduce the waste of cable payed out in slack, that the speed of laying be increased and the specific gravity of the cable be reduced. He patented in that year a process to control the velocity of cable sinking in the ocean.

In the General Election of 1865 Captain Blakely stood as a candidate in the Liberal interest for the Tavistock constituency in Devon, where he was developing an iron works. The two winners, also Liberals, took 330 and 179 votes, Blakely, the fifth and last, had just eight votes. He does not appear to have canvassed personally.

During 1865 and 1866 Blakely maintained an adulterous relationship with Mrs. Harriet Dering, which was exposed in her divorce proceedings in June 1867. This, and the failure of his ordnance company in 1866, completely ruined his reputation in England. He fled the country and was declared an “Outlaw” to be arrested on sight for failing to appear before the courts of justice on July 27, 1867.

He was to flee to the only place that would welcome him, the source of his first success in gun-making, where his cannon had just seen off an invading fleet, where he was regarded almost as a hero. In his moment of distress, Blakely left his creditors and the moralists behind him in Europe and, by way of Panama, made for Peru.

Captain Alexander Blakely RA died at Chorrillos in distant Peru of yellow fever on May 4, 1868, age 41. He is buried alongside Mrs Dering in the *Cementaría Británico de Bellavista*, at Callao.

He left no will; the only persons entitled to his personal property and effects being Harriette Catherine Blakely, his widow, Mary William Blakely, his mother, Isabella Chalmers Blakely, his sister, and Mary Stewart Spankie, his other sister. Isabella was never to wed; Mary had married Robert Spankie, a government lawyer in India.

Despite his adultery, thirty years after his death, in 1898 his widow began a campaign to recognize Blakely’s contribution to artillery.

John Mercer Brooke, 1826–1906

Wikipedia

John Mercer Brooke (December 18, 1826 – December 14, 1906) was an American sailor, engineer, scientist, and educator. He was instrumental in the creation of the Transatlantic Cable, and was a noted marine and military innovator.

Early life and career

John M. Brooke was born in Fort Brooke (modern-day Tampa), Florida. He was related to Congressman John Francis Mercer. His father was an army officer, General George Mercer Brooke, who died in San Antonio, Texas. He was a kinsman of General Dabney Herndon Maury as well as Virginia governor Robert Brooke.

1. Brooke graduated from one of the earliest classes of the United States Naval Academy (Conrad: 9) and became a lieutenant in the United States Navy in 1855. He worked for many years with Commander Matthew Fontaine Maury at the United States Naval Observatory (USNO), charting the stars as well as assisting in taking soundings of the ocean's bottom to determine the shape of the sea floor. Many believed the sea floor was flat, but all previous soundings as deep as eleven miles (18 km) could not find the ocean bottom. Part of this was due to powerful undercurrents far below, rivers in the ocean traveling in various directions. In the struggles with soundings, which nobody had done anything of value at great depths, it was Maury's failure with a unique device he invented that gave Brooke an idea of taking deep sea soundings. Brooke perfected a "deep-sea sounding device" which was used afterwards by navies of the world until modern times and modern equipment replaced it. At Maury's direction, Brooke also added a "core-sampling device" for taking samples of the material of the sea floor.

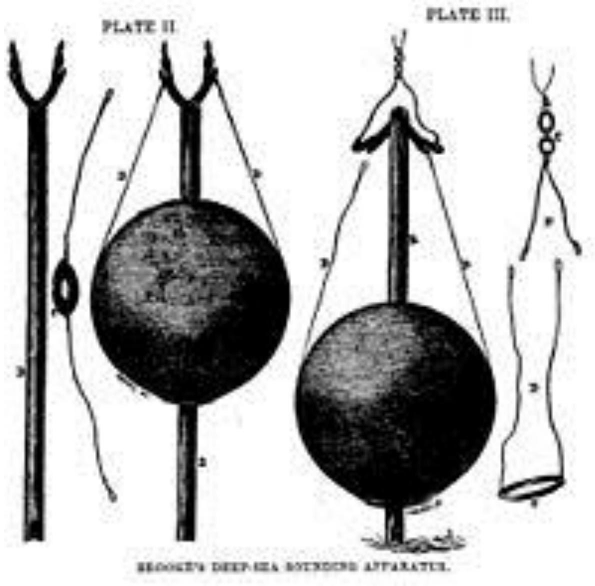


Fig. 1. Brooke's deep-sea sounding and core-sampling device

The outcome was a cannonball with a hollow tube through the center of it — a tube coated on the inside so as not to contaminate the samples. Studying this seafloor material with his microscope, Maury saw something that fascinated him. A sample was sent to Jacob Whitman Bailey at the United States Military Academy, who in November 1853 responded:

Telegraph

The inference in all of this is that the area where the samples came from was the "telegraphic plateau" as called by Maury who had sent out ships to sound those depths at two hundred mile intervals from Newfoundland to Ireland. Maury had charted the underwater mountain ridge. The microscopic organisms left the sea floor on this "telegraphic plateau" were deep and soft so that the area was that of a long mountain chain with the top of those underwater mountains having a firm and soft coating of these dead organisms. This meant that the area was deep enough that no ship's anchor, nor any fisherman's net, would drag the area. The fact that there was no abrasion on these minute organisms meant that there were no strong currents in that area at that depth. Soon after publishing this, Cyrus West Field wrote to Maury of the USNO on the feasibility of laying a transatlantic cable and was given a positive reply and later details explanation face to face. Cyrus Field also contacted Samuel Morse regarding the feasibility of transmitting an electric current a distance of 1,600 miles (2,600 km) underwater. Again, Field was given an affirmative and soon visited Morse. Cyrus Field continued contacting these two men, Maury and Morse, gathering all possible information and offered them shares in his great adventure that would become a reality in 1858 when the Queen of the United Kingdom communicated with President Buchanan in Morse code through the transatlantic cable (PBS – American Experience – The Great Trans-atlantic Cable; History of the Atlantic Cable and Undersea Communications Archived 2007-08-20 at the Wayback Machine).

Later career

As an expert in maritime surveys, he participated in exploratory missions in the Pacific. He had a role in the counseling and instruction of officers of the nascent Japanese Navy. In Japan, he was a technical adviser aboard the Japanese steamer *Kanrin Maru*, and he helped sail the ship to the United States in February 1860. He was accompanied by Japanese representatives aboard the *Powhatan*.

In 1861, Brooke resigned from the U.S. Navy to join the Confederate_Navy. He was involved in the conversion of the frigate USS *Merrimack* into the ironclad CSS *Virginia*. He was also instrumental in the development of a new rifled gun for the Navy that became known as the Brooke rifle (Brooke gun). In 1862, he was promoted to commander, and in 1863, to Chief of the Confederate Navy's Bureau of Ordnance and Hydrography, until the end of the war. He was instrumental in the organization and establishment of the Confederate States Naval Academy (Conrad: 9).

After the war, he became a professor at the Virginia Military Institute, at Lexington, Virginia. He retired in Lexington in 1899. He died there in 1906 and is buried in its 'Stonewall' Jackson Memorial Cemetery.

Family life

John Mercer Brooke's parents were George Mercer Brooke, b. 1785 (Va.) and Lucy Thomas.

John Mercer Brooke married:

1. Mary Elizabeth Selden Garnett, b. 1 Mar 1826 who had died. They had one daughter named Anna Maria Brooke, b. 12 Dec 1856 who never married.
2. Catherine Carter "Kate" Corbin, the widow of Alexander Swift 'Sandie' Pendleton (killed in action September 22, 1864).

John Mercer Brooke and Catherine Carter "Kate" Corbin of Moss Neck Manor (and widow of 'Sandie' Pendleton) married on 14 Mar 1871 at St. George's Episcopal Church (Fredericksburg, Virginia). John and "Kate" had three children:

1. George Mercer Brooke II b. 17 May 1875 (Father of George Mercer Brooke, Jr.)
2. Rosa Johnston Brooke, b. 1876
3. Richard Corbin Brooke, b. 1878

John Mercer Brooke and Catherine Carter "Kate" Corbin-Pendelton-Brooke are buried beside each other in the Stonewall Jackson Cemetery, Lexington, VA

Namesake

The US Navy honored his career by naming the first ship of a new class of Destroyer Escort / Fast Frigate ships in his name. USS *BROOKE* – DEG-1 (Later renamed FFG-1)

Further reading

- *Brooke, John Mercer (2002). Ironclads and Big Guns of the Confederacy: The Journal and Letters of John M. Brooke. Univ of South Carolina Press. p. 257. ISBN 9781570034183.*

Josiah Vavasseur, 1834–1908

Wikipedia

Josiah Vavasseur, CB (26 November 1834 – 13 November 1908) was an English industrialist who founded Vavasseur and Co. (also known as London Ordnance Works). In 1883 the company merged with W.G. Armstrong and Company, and Vavasseur became a director of the firm. Late in life he adopted Cecil Fisher, only son of Admiral John Fisher, and the Fisher family inherited.

Early career

Vavasseur was born in Braintree, Essex in 1834, and following school he spent six years as an apprentice to the engineering firm of James Horn and Company in White Chapel. In 1857 he partnered with David Guthrie in establishing the *Patent Dyewood and Drug Mills*, at 17 New Park Street, Southwark. By 1860, he was in business as *Josiah Vavasseur and Company*, engineers of 8 Sumner Street, Southwark. He obtained a patent for improvements in cannon rifling and the firm bought a small iron works at 28 Gravel Lane, Southwark. In the same year Vavasseur became a member of the Honourable Artillery Company. In 1861 he developed a portable machine for the rifling of smooth-bore guns, which he later sold to Russia.

In 1862 Vavasseur's firm became subcontractor to Captain Alexander Blakely, RA, who held a number of patents in gun construction and sold guns to countries in Europe, South America and particularly North America, where demand was high due to the Civil War. Vavasseur initially produced a series of 2.9 inch guns for the Confederate States, but the ship carrying them foundered, and they never reached their destination. Vavasseur's rifling machine was employed by Blakely for the rifling of some of his largest guns. In 1863 Vavasseur and Blakely collaborated on the production of spherical steel shot, intended to penetrate the armour of ironclads coming into service at the time. Later in 1863 *Josiah Vavasseur and Company* merged with *The Blakely Cannon Company*, resulting in the *Blakely Ordnance Company*, with Josiah Vavasseur as engineer and manager. In 1865 the new company became *The Blakely Ordnance Company, Limited* with

Vavasseur as Resident Engineer. One year later, the *panic of 1866* caused a squeeze on liquidity that forced *The Blakely Ordnance Company, Limited* into liquidation, and Vavasseur out of his job.

Fig. 2. The Vavasseur gun mounting was so important to Josiah Vavasseur that he included it in his coat of arms

London Ordnance Works

The collapse of Blakely's enterprise made it possible for Vavasseur to buy back the iron works in Southwark, and in 1867 the firm *Josiah Vavasseur and Company* was back in business, commonly referred to as the *London Ordnance Works*. The company took over at least one of the orders in the books of the Blakely Company, for 11-inch steel guns, delivered to Chile in 1867. The continuation of Blakely's projects was made easier (and cheaper) by the fact that the strain on Blakely's personal finances had prevented the renewal of his gun patents. Vavasseur also made smaller guns, including 27 12-pounders for France during the Franco-Prussian War 1870-1871. The production at the Ordnance Works included towed torpedoes of the Harvey design and spar torpedoes and mines designed by Captain Charles Ambrose McEvoy, formerly of the Confederate Navy.

In 1866 he invented the copper rotating ring, or band, for the projectiles of breech-loading guns, and this system was widely adopted. The patent laws of Prussia prevented Vavasseur from protecting his invention in that country, and made it possible for the Krupp Company to produce projectiles that Vavasseur saw as an infringement to his patent. The inventor tried to protect his claims in 1877, when British shipyards were building the *Fusō* and the two *Kongo* class ironclads for Japan. They were all armed with Krupp guns, and when the offending shells arrived in Britain, Vavasseur had an injunction placed on them. In the ensuing court case (and appeal) in 1878, it was decided that the Japanese *Mikado* (emperor) could not be sued and that his property (the shells) could not be held. The nature of the lawsuit was rather controversial and the verdict was frequently cited in works on international law.

In 1877 Vavasseur patented and developed a mounting for breech-loaded guns, which came to be used by most of the world's navies. The demand for the Vavasseur mounting was so high that *London Ordnance Works* was unable to cope, so in 1883 *Josiah Vavasseur and Company* merged with *Sir W.G. Armstrong & Company*. The Vavasseur company name disappeared, Josiah Vavasseur became a director, and all production was transferred to the Elswick Ordnance Works. Here *"he continued his work of improving ordnance in every detail"*, until the last three or four years of his life, when ill-health prevented his attendance.

Final years

Josiah Vavasseur became a very wealthy man, and he was able to buy the manor of Kilverstone Hall and to donate substantial funds to religious and philanthropic undertakings. The major part of his fortune went to Cecil Fisher, the only son of Admiral John Fisher. The story of the inheritance was retold by *The* New York Times on November 21, 1910, when Cecil Fisher came to the United States to marry Miss Jane Morgan. The paper wrote that Cecil Fisher as a young lieutenant had helped Vavasseur with his work on quick-firing guns at Whale Island. A friendship evolved, and Vavasseur had adopted Cecil on the condition that he would take the name and arms of Vavasseur. When Josiah Vavasseur died on November 13, 1908, Cecil Vavasseur Fisher inherited the equivalent of 2 million USD (corresponding to $53.3 million in 2016), and when Admiral Fisher was made a baron on December 7, 1909, he took the name Baron Fisher of Kilverstone

Blakely Construction

"Captain T.A. Blakely is recognized in England as one of the first to invent and the very first to demonstrate mathematically and reduce to a working system, the reinforcing of guns with hoops placed under initial tension, so that each hoop compresses what is within it…also to have first proposed guns of the concentric tubes having different degrees of elasticity, the inner tube being the most elastic…" (Holley, 1865: 36).

The case for Blakely's conclusions begins with the well known limitations of cast iron; it tends to fail catastrophically with little or no warning. In response to this, guns were cast 'heavier' with thicker metal around the breech end. The ultimate expression of this trend was the Rodman and Dahlgren guns of the U.S. Civil War period, 1861–1865, whose designs matched the pressure curve of the propellant burn. However, experiments and other analysis demonstrated the futility of that approach. "To obtain much greater strength by casting guns heavier is impossible, because in cast guns (whether of iron, brass or other metal) the outside [of the tube] helps but very little in restraining the explosive force of the powder tending to burst the gun, the strain not being communicated to it by the intervening metal. The consequence is, that, in large guns, the inside is split, while the outside is scarcely strained. This split rapidly increases, and the gun ultimately bursts…no possible thickness can enable a cylinder to bear a pressure from within greater on each square inch than the tensile strength of a square inch bar of the material; if the tensile strength of cast iron be 6 tons per [square] inch, a cylinder of that metal, however thick, cannot bear a pressure from within of 6 tons per [square] inch." Captain Blakely, upon examining sectioned diagrams of tests firings, noted that the cracks or splits were "… much more open at the inside, and some not extending to the outside" of the tube (Holley, 1865: 234-235) (for a full discussion of interior ballistics, see: Carlucci, 2014). So thickening the tube would, at best, delay failure rather than prevent it. The success of the Rodman and 15-in Dahlgren guns may well be due to the hollow casting process which allowed cooling by pressurized water from the bore out, which tended to harden the cast iron and make it less susceptible to cracking.

Blakely's early guns were constructed using the principles of 'initial tension' and 'varying elasticity,' were initially of a cast iron barrel with wrought iron hoops shrunk over the 'powder chamber' to withstand the pressure from the propellant burn. They were known as Blakely Conversions, but were entirely different from the well known Palliser Conversions of the last half of the 1860s. The intent of the Palliser Conversions was to make use of the large inventory of cast iron smooth bore guns. These guns would be bored-out for an increase of about one third of the original caliber, which would eliminate much of the damaged metal of the original bore, and a wrought iron or steel liner inserted to take the rifling. The tube at the breech end was closed by a plug of greater thickness than the tube, which was screwed into the cast iron breech, to prevent the cast iron from being blown out by the gas pressure. The main strength of the gun was the inserted tube and not the cast iron body, as any pressure that would rupture the tube would certainly burst the gun. Palliser's system proved to be the most successful method of converting cast iron smooth bore guns into rifled 'shell' guns, and was widely used, though experience demonstrated that propellant charges were necessarily reduced; as in the case of the British 64 pdr Mk I from 10 lbs to 8, which was extended to the purpose-built Mk. IV.

A Blakely Conversion started with a new casting of a standard pattern, or a stock casting that had not been bored. This blank would be bored and rifled, and then turned to provide a smooth uniform surface over the powder chamber. To this, heated wrought iron hoops would be mechanically fitted and allowed to cool, thus creating the 'initial tension' between the reinforce and the cast iron barrel. The more malleable wrought iron could be extended without fracture, allowing the tensile strength to resist the strain of the propellant burn (Holley, 1865: 241-242), (Report, 1867: 545). And as the art of manufacturing steel improved, the use of wrought iron was replaced by [low] steel.

For the most part, Blakely Conversions are easy to identify as the trunnions, muzzle swell and scroll work of the forward part of the barrel, and even in some cases the body shape, were left unaltered. However, that is not a hard rule. The Confederate States of America did produce Blakely Conversions of the standard U.S. Navy 32 prd 57 cwt and 7 in 42 pdr M1845 guns at the Tredegar Iron Works. But they also rifled and reinforced [banded] a number of existing smooth guns including 32 pdrs of all weights, 10-in and 8-in Rodman coast defense guns, and even some Dahlgren 9-in guns. But since these were not newly cast, they cannot be considered true Blakely Conversions, and the gun was likely not as 'strong' as a newly cast piece.

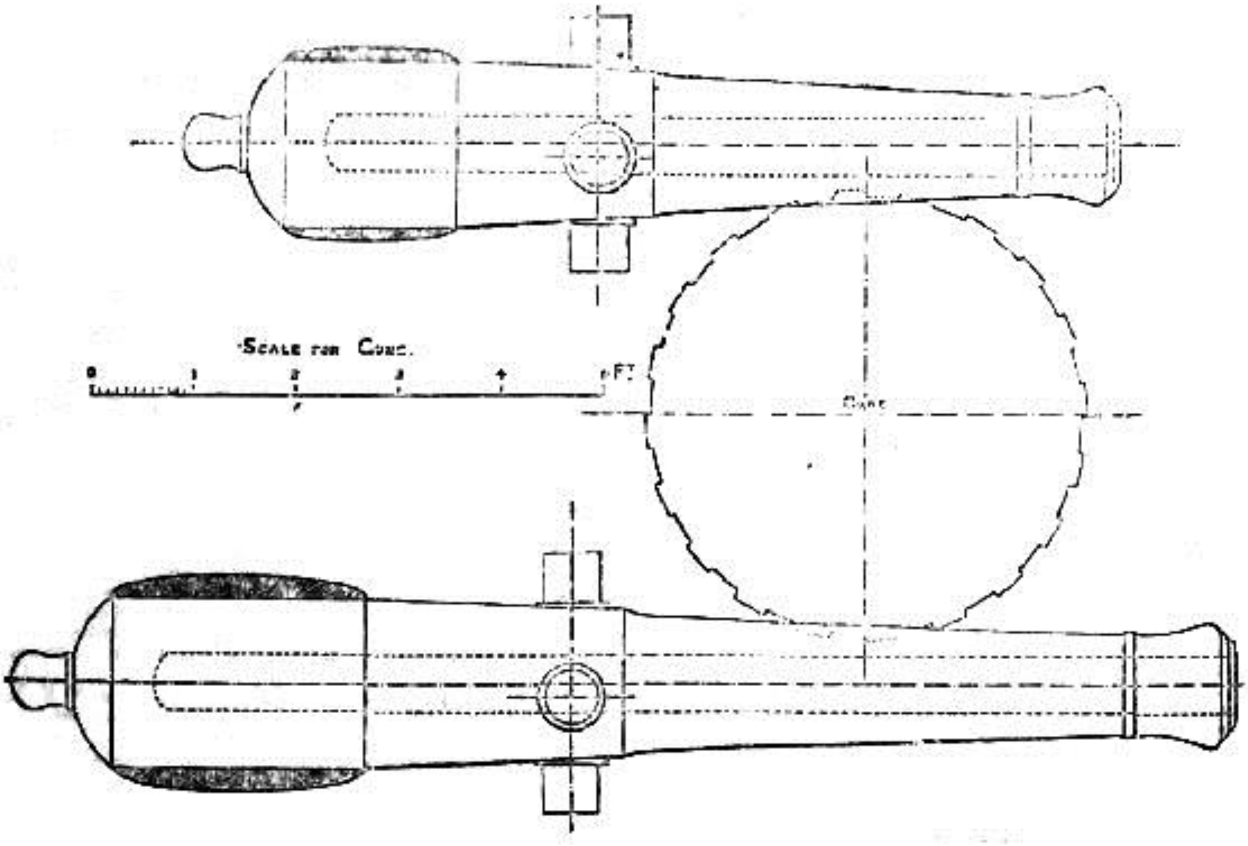


Fig. 3. 2 early Blakely Conversions from The Engineer

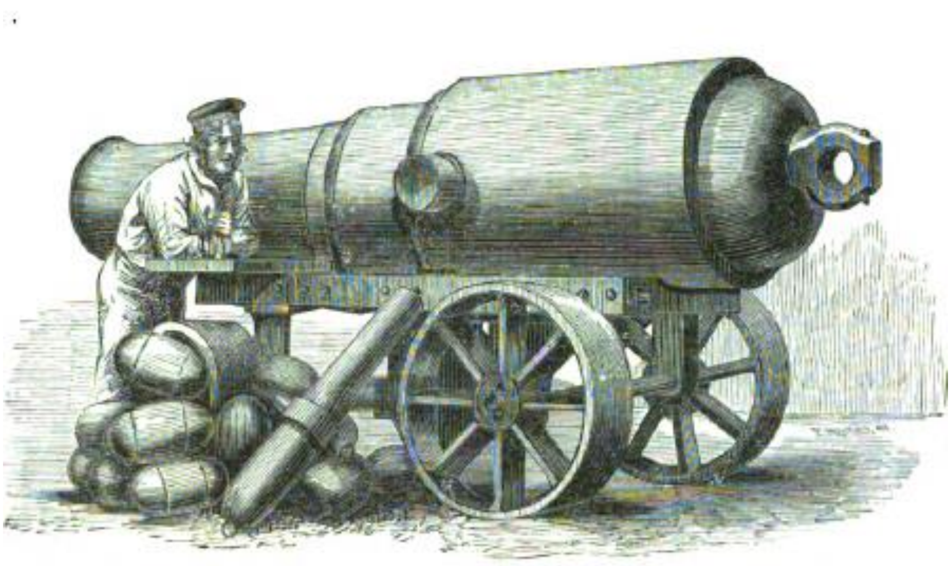


Fig. 4. 8.5in Blakely Conversion for the Great Exhibition in 1862, from Holley

The Spanish government successfully tried a 32 pdr (6.4-in) Blakely gun beginning in March of 1859 firing 1200 rounds without any injury or strain to the gun. Beginning on 4 September 1860, a Spanish 16cm gun built on the Blakely principles was tried, and fired 1366 rounds. Following this, the Commission responsible for Artillery determined that reinforced cast iron was the best course. The Commission had adopted the French La Hitte rifling on 29 November 1858. The resulting guns were, in fact, constructed according to the Blakely Patents and design, though he took no official credit. He wrote on 13 September 1861 that "the Spanish Government last year adopted the plan of building guns which I have advocated for some year without any communication with me... The Spanish officers discovered the proper tension for the outer layers of a gun by observation first and calculation afterwards." *

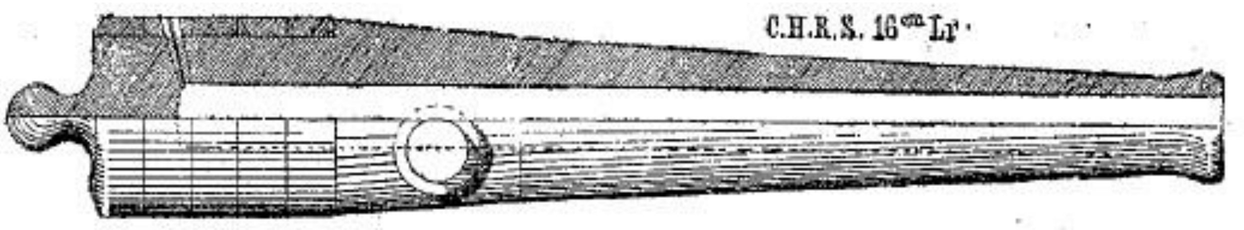


Fig. 5. Spanish 16cm Blakely

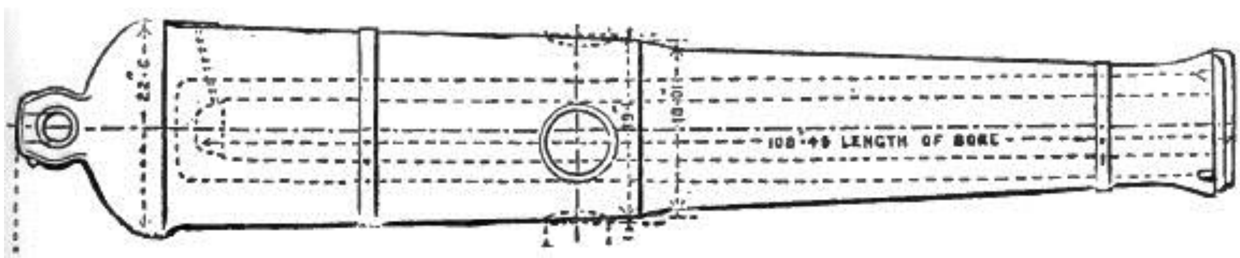


Fig. 6. Palliser Conversion 68pdr to 64pdr

* (Roberts, 2012). These 16cm guns seem to be true and completely Spanish production, though duplicating Blakely's work. Note that the chamber is not the Blakely pattern. Produced at Trubia as the C.H.R.S. 16 cm Modelo 1862, in two models; Largo (Long) and Corto (Short), they were widely used for coast defense and fortresses, and the Navy. Refer to the various articles by Juan L. Calvo.

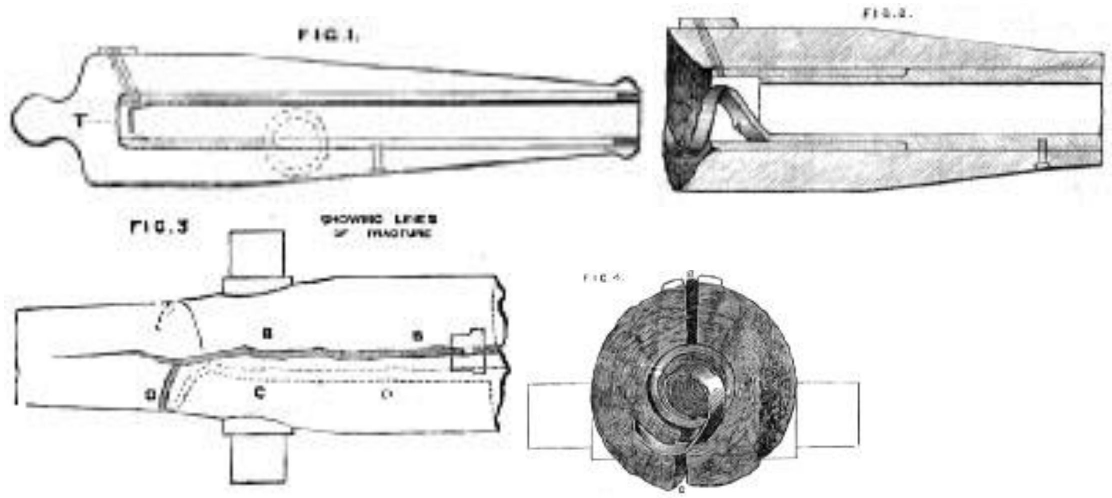


Fig. 7. Spanish Navy 16cm BL Hontoria Md 1879 No 2 that burst in 1881. This was the Palliser Conversion of the 20cm Rivera. The new liner, and cup reinforce at the bottom of the bore, were of wrought iron coils, not steel. So the intended strength was not there, and the breech blew out

Lt. Edward Simpson presented a quite different view of the trial results. “A Commission appointed by the Spanish Government made an extensive series of experiments on the [Blakely] gun…and the results of their experiments, has recommended its adoption into Spanish Service, and the government has ordered 600 sixty-pounders [sic] to be contracted.”

It would appear that the good Captain was being a bit disingenuous; else he possibly would have had grounds for a Patent Infringement suit. But Blakely rarely was transparent in matters of his business dealings. As Tennent revealed in 1864, “Upwards of 400 guns on his [Blakely’s] plan have since been made in England, and ‘thousands,’ as that the patentee states, in other countries, chiefly in France and the United States…” In fact, he granted use of his 1855 Patents, also taken in France, to the French government in 1860, as evidenced by the basic similarity among his 1859 – 60 designs, the Spanish gun as illustrated above, and the French M.1860 illustrated in the image below, taken by Holley from official drawings dated 1863. The late Dr. Steven Roberts had also confirmed Licenses granted to Spain (Trubia?) and Russia (Bard?)

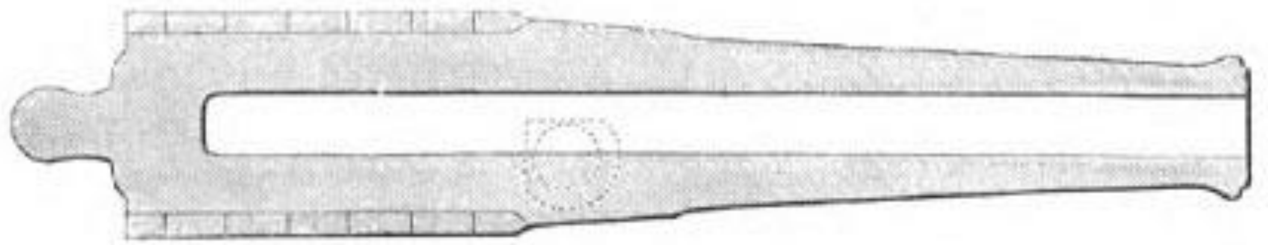


Fig. 8. French M.1860

Captain Blakely also presented in Evidence before the Select Committee on Ordnance in 1862 rather detailed knowledge of the French ‘canon de 30’ which was not readily available to the general public. He noted that the usual charge for those guns was between 7 to 8 lbs, but that higher charges were known to be used, more specifically charges of 27 to 28 lbs of powder for firing 92 to 100 lb. shot at armor plate, and that in trials on August 9th, 1861 a 99 lb. (45 kg.) flat-fronted steel shot with a 27½ lb. (12 kg.) charge had penetrated a target composed of 4 ½ in plate with 18ins wood backing and a 1in skin at 1089 yards range. He added that some of those guns had endured 2000 rounds.

The Captain was again being a bit disingenuous. The gun that dealt with the large charges and heavy projectiles was not a standard M.1860. Rather, it was an all-steel, very sophisticated –

a level of sophistication the French service artillery would not achieve until their M.1875 – design from Colonel Treville de Beaulien. Such a combination of charge weight of the *Ripault* powder and projectile weight could not be endured by cast-iron guns, even reinforced, and were not to be used save in dire emergency.

When asked if the 'cutting away' (turning/lathing) of some of the cast-iron barrel to allow the reinforce to be more flush with the contour of the gun would not weaken the gun longitudinally, as had befallen British guns in the 1859 – 62 trials, he responded that the use of steel for the reinforcing hoops, and very careful adjustment of the hoops [for proper 'initial tension'] would not weaken the guns (see below). As noted above, the 'conversion' process required turning the newly cast gun to provide a smooth surface parallel to the bore on which to apply the hoops; essentially 'cutting away' some of the cast-iron barrel.

In 1862, the Imperial Russian Navy mounted 6-in rifled guns on the four wooden ships of the *Almaz* class. A. Shirokorad's wonderful Encyclopedia of Motherland Artillery contains an orphan image of a 6-in MLR, which appears to be a Blakely Conversion. The gun itself matches a standard Russian pattern. The rifling appears to be the Wahrendorff poly-groove, which the Russians were well aware of having purchased hundreds of field guns from the Akers foundry. The reinforcing hoops are more extensive than Blakely's standard, which may reflect some French influence, given such influence in 1860 and 1861 when they developed the 4pdr and 8pdr guns rifled for studded projectiles. It is quite possible, even likely, that the 6-in guns were constructed by Francis Biard (Bard in Russian) at his foundry near St. Petersburg, given that in early 1863 he and Blakely entered into a partnership to market Blakely great guns in Russia. Indeed, Biard could well have been Blakely's agent and taken delivery of the two great guns shipped to Russia for trials in 1862, making the manufacture of the twelve 6in Conversions something of a trial run for Blakely's products and expertise (Shirokorad, 2000; Tredrea, Sozaev, 2010; Roberts, 2012).

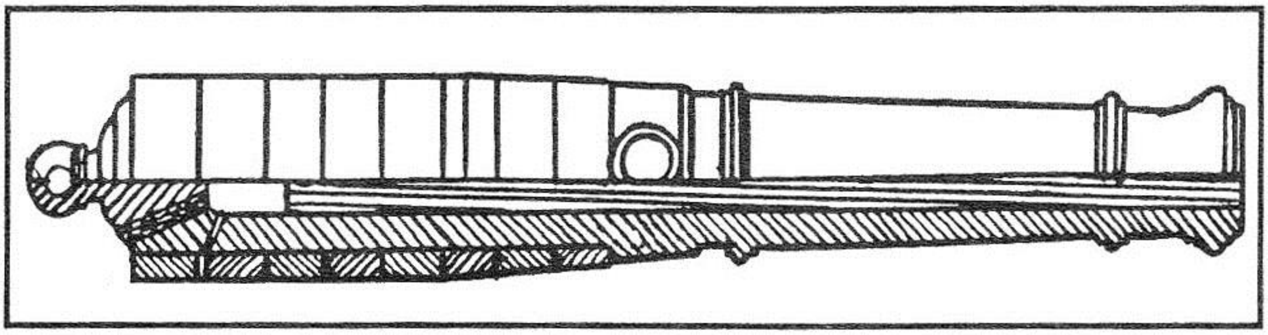


Fig. 9. Blakely Conversion 6in gun, from Shirokorad

As wrought iron gave way to steel for the reinforcing hoops, by late1862 cast iron was replaced by low steel, and high steel became the favored material for the reinforcing hoops. In 1863, Blakely advertised all-steel guns and steel projectiles for them.

As already mentioned, the various Militaries had a vested interest in reinforcing their large stocks of cast iron smooth bore artillery to allow for their continued use. Using the British Royal Navy as an example of the test programs initiated by France, Spain and Russia, the Government established an Ordnance Select Committee in 1858, to, among other things; test the various theories and designs for continuing to use cast iron guns.

One of the methods chosen was to test for Endurance to destruction. This was done by using a standard charge and projectile weight (the projectiles being iron cylinders). Ten rounds would be fired with the normal charge and projectile weight. The next ten rounds would be with the projectile weight increased to twice the normal weight, but using the same charge. The third set would use a projectile three times the normal weight, and so on until the gun burst. Between 28 November 1859 and 13 August 1862, twenty Great Guns were tried.

The first gun was a standard 130 pdr 10-in smooth bore, reinforced with wrought iron rings by the Royal Gun Factory, Woolwich. With a 20 pound charge of LG (Large Grain) powder and a 131 ½ pound projectile, the gun burst with the 39th round.

On 9 January 1860, a similarly reinforced standard 68 pdr (8.12-in smooth bore) was tried. Beginning with the normal 16 lb charge and 68 lb projectile, the gun burst with the 51st round. As one can see from the image below, no effort was made to turn the barrel to provide a uniformly level surface. The cast iron under the wrought iron rings shattered without damaging the reinforce.

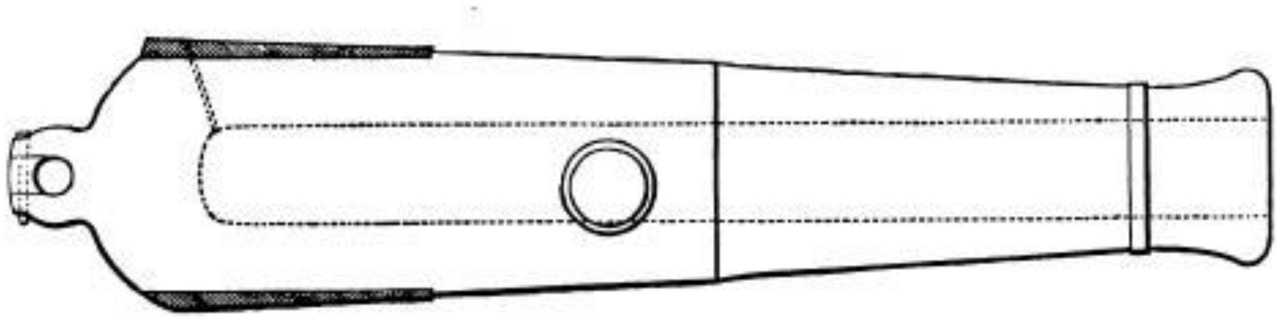


Fig. 10. Woolwich Banded 68pdr

The last of the standard, unaltered, 68 prd guns was tried on 28 February 1861. Some 23 cwt of reinforcing material had been added according to Mr. Lancaster's theories. It burst with the 61st round.

On 6 November 1860, a standard 68 pdr gun was tried. It had been strengthened with a wrought iron liner, which reduced the bore to 6.5-in. but retained the standard 16 lb charge and 68 lb projectile. The gun burst with the 71st round, and seemed to present a reasonable alternative for strengthening guns.

In the final test, on 13 August 1862, a 32pdr smooth bore with a wrought iron liner, reducing the bore to 5.26-in, was tried. Using a 10 lb charge and a 32 lb projectile, it lasted to the 74th round. The gun did not burst, but the liner became detached and blocked the vent. However, upon examination, it was found that the liner was cracked and the cast iron barrel had deep cracks and fissures.

From these two trials, it would seem that Captain Palliser's successful conversions had more to do with developing a method of attaching and securing the liner than the use of steel for the liner, which was much more prevalent in 1866 than in 1860 – 62. But even so, the powder charge was limited to 6 lbs of RLG (Rifle Large Grain) to avoid the damage evidenced in the final trial.

On 8 and 30 November 1860, two virtually identical 68prds were tried. But they were not pre-existing guns, but new castings. They were originally bored to 32 pdr caliber (6.5-in), proved, and then turned to provide a smooth surface slightly tapered from the trunnions to the breech. Then bored out to 68pdr caliber and hooped to a plan proposed by Col. St. George. The first gun burst with the 67th round, and the second at the 68th round.

On 2 and 4 May 1860, two blocks cast especially for hooping according to proposals from Sir William Armstrong were tried, which reflected his current understanding of reinforcing wrought iron hoops. The first was bored to 7-in caliber, and the second to 7.5-in. It is likely both guns were externally identical, though the second was 6 cwt lighter. Both used the standard 16 lb charge of a 68 pdr, but the projectile weight for the 7-in was only 45 lbs, and the second 55.75 lbs. Neither performed well, the 7-in bursting at round 36, and the 7.5-in at round 22. Captain Blakely, in testimony before the Select Committee in 1863, criticized the design, stating that too much of the iron had been removed and the hoops were not the correct tension in relation to the thickness of the barrel.

On 17 April 1860, a Woolwich gun was tried. Cast as a block especially for hooping, probably very similar to the Armstrong guns noted above, it was hooped with wrought iron and bored to a caliber of 6.5-in. Using the standard 16 lb charge for a 68pdr, the projectile weighed only 35 lbs. The gun burst with the 36th round.

Two other Woolwich guns from 68 pdr blanks were tried on 16 February and 18 April 1860. Both were bored to 6.5-in caliber. The first was reinforced with wrought iron hoops, the second with wrought iron rings. Both were rifled on the shunt principle. Both used a non-standard 18 lb charge, and the projectile weight for the first was 90 lbs and 89 lbs for the second. Neither gun performed well. The first burst with round 4, and the second with round 12.

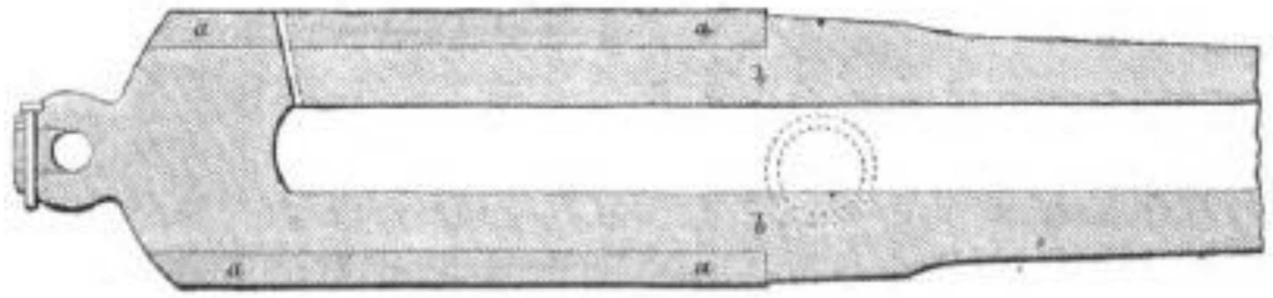


Fig. 11. Armstrong Banded 68pdr

On 20 November and 28 December 1860, two blocks especially cast for hooping, probably similar to the Armstrong guns noted above, were strengthened with an envelope of gunmetal (an alloy of copper and 10 % tin, similar to bronze) to a plan proposed by Capt. Coffin, R.N. The guns were bored to 6.5-in caliber, with the standard 16 lb charge of a 68 pdr and a light 35 lb projectile. The weight of metal used for the reinforce the cast iron barrel made the gun some 23 cwt heavier than the Woolwich gun noted above, and 25 cwt heavier than the Armstrong 7-in gun. The guns burst with the 22nd and 31st rounds respectively.

On 1 November and 8 December 1860, two guns proposed by Col St, George were tried. The method of construction mirrored his 68pdr guns described above, but used blocks for 32pdrs instead. First bored to 18pdr caliber, then turned to provide a smooth taper from trunnions to breech, then bored up to 32pdr (6.375-in) and hooped. With the standard 10 lb charge and 32 lb projectile, the first burst with the 67th round, and the second with the 59th, very similar to the 68prds.

On 9 October 1861, a 32 pdr smooth bore gun, strengthened with wrought iron jacket and hoops by Mr. Lancaster was tried. With the standard 10 lb charge and 32 lb projectile, this heavy gun survived to the 81st round.

Six days later, a much heavier gun, a 70pdr block especially cast for hooping, bored to 32 pdr caliber (6.375-in) and strengthened with wrought iron hoops by Mr. Lancaster was tried. Using the standard 16 lb charge and 68 lb projectile, the gun burst with the 35th round.

And finally, there were special trials for two Blakely conversions. These were handled somewhat differently than the normal procedure, which makes direct comparison somewhat difficult. The major differences are that the gun was first fired 50 times with 'standard' charge, and then the charge was reduced, the projectile weight changed, and the weight of the projectile in each step of 10 shots was an increase of one half the projectile weight, so the weight built up more slowly.

The first gun was from a 70 pdr block, bored to 6.5-in and rifled to take Bashley Britten's projectiles. The trial took place on 24 March 1862. The first 50 rounds were fired using an 8 lb charge and a 67 ½ lb projectile. Then the charge was reduced to 7.5 lb and the projectile weight increased to 90 lbs, so the second 10 would be at 135 lbs and the third 180 lbs. This gun burst with the 84th round.

The second gun was based on a 32pdr block, rifled and banded in the same manner. On 16 July 1862, the first 50 rounds were fired with an 8 lb charge and a 67 ½ lb projectile. Then the charge was reduced to 5 lbs and the projectile weight to 48 lbs. The gun burst with the 188th round (Holley, 1865: 60-64).

Probably the importance of these trials rests in the fact that only four rifled guns had been tried, and the two from Woolwich had not performed well. But there was also the inference that Blakely conversions, when used with moderate charges and suitable projectiles, could be relied upon to perform well.

But another consideration comes into play during the same time span. Navies were wrestling with the problems presented by armored warships, and guns powerful enough, firing projectiles strong enough, to penetrate armor.

Much unwarranted criticism has been leveled at ordnance designers and engineers by contemporary politicians and subsequent historians for not having prepared for armored warships. What the critics failed to grasp is that the engineers and gun manufacturers – from Cavali, Wahrendoff, de Beaulien, Armstrong, Blakely, Whitworth, Dahlgren, Rodman, Parrott and countless others were concerned with improving or evolving ordnance beyond the Paixhans 'Shell' Guns, which were the weapon *sine qua non* of naval warfare in the mid-19th century. And while the armored floating batteries used at Kinburn in 1855 had handily stood up to shot and shell from Russian 24 pdr (c. 15 cm, 6 in), authorities insisted the batteries could not have withstood fire from the 8 in, 68 pdr, 60 pdr and 10 in guns common in both navies and for coast defense. Subsequent trials lent credence to that argument, though it was later proven that the failure of the armor was due to the low quality of the iron rather than the overwhelming power of the guns. Plus such batteries could not be used to project national power in that they were not 'blue water' vessels and could hardly move under their own power. And there were literally thousands of wooden warships of all sizes, many of which were steamers. So the major rationale behind rifled artillery remained lobbing conical explosive shell to a greater range and with much better accuracy smooth bore guns. Even the much vaunted Armstrong 7 in 110 pdr breech loading rifle was designed as a 'shell' gun, and proved quite inadequate against armor.

Another perhaps unique feature of Blakely designs was the consideration given to air space for the expanding gasses produced by the burning of the propellant charge. This calls for an examination of the shape of the bore at the breech end of the gun as well as the diameter of the charge and volume of the chamber, bearing in mind that the diameter of the chamber must be the same as that of the bore. Thus the shape of the breech end of the bore and the location of the vent/touch hole play a critical role.

Projectiles

Smooth bore muzzle loading guns suffered from a major but necessary impediment, windage. The spherical projectile was a slightly smaller diameter than the bore of the gun, simply so that it could be loaded easily. This produced two disadvantages from a gunnery perspective. First, the lack of a seal or 'gas check' wasted a portion of the energy released by the burning propellant charge, as some of the expanding gas escaped around the ball rather than 'pushing' it. And second, the space around the ball allowed it to knock about in the bore, and hence leave the muzzle a fraction of a degree off, exacerbated by any spin picked up in the process. So as range increased, accuracy plummeted.

Swedish Baron Martin von Wahrendorff made a breakthrough in 1840 with a breech loading smooth bore cannon firing round shot and shell coated with lead. Breech loading eliminated the necessity for windage, and the coating provided a seal/gas check, which allowed the full pressure of the expanding propellant gasses to push on the ball, and prevented the ball from knocking about in the bore, which enhanced accuracy and more reliable ranging. However, the lead made for a heavy projectile, which combined with the small propellant charge necessitated by the breech mechanism, meant lower muzzle velocity.

In 1846, as a result of a friendly gun trial with Col. Giovanni Cavalli, Wahrendorff developed a successful combination of multi-groove rifling and lead coated conical shell. This combination was used by Armstrong for his BLRs. Other manufacturers adopted lead as the gas check in their designs.

Sir Bashley Britten was one of the first and most successful designers. He used a lead sabot as the base of the shell body, which would expand under the gas pressure to grip the rifling, which was of his own design. Most of Blakely's early guns, conversions and designs, specified rifling for Britten projectiles, and he continued to use Britten projectiles even after he patented his own 'hook-slant' rifling until he designed his own 'family' of projectiles.

The American Civil War (1861–1865) provided real world combat experience, testing theories and designs and exposing flaws. Parrott developed a short brass cup attached to the base of his projectiles. Dahlgren preferred a mechanical fit of raised ridges in the body of the projectile fitting into matching grooves in the bore, but, like Armstrong's shunt system and the French La Hitte system, windage was necessary.

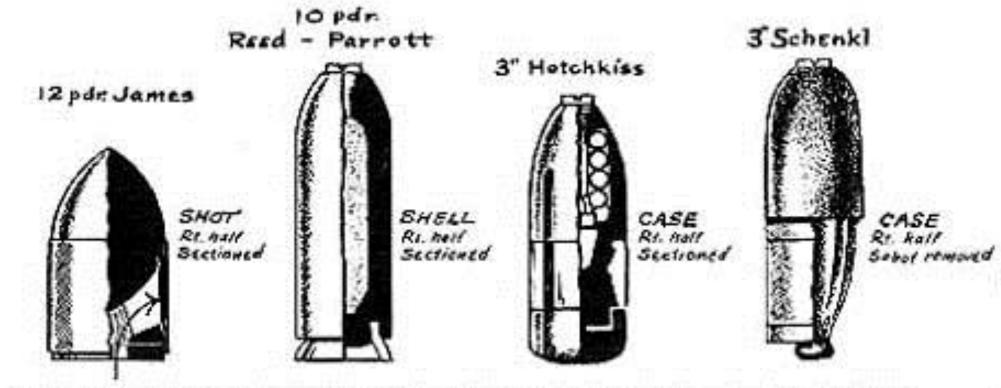



Fig. 12. Britten 7in Shell Civil War Projectiles

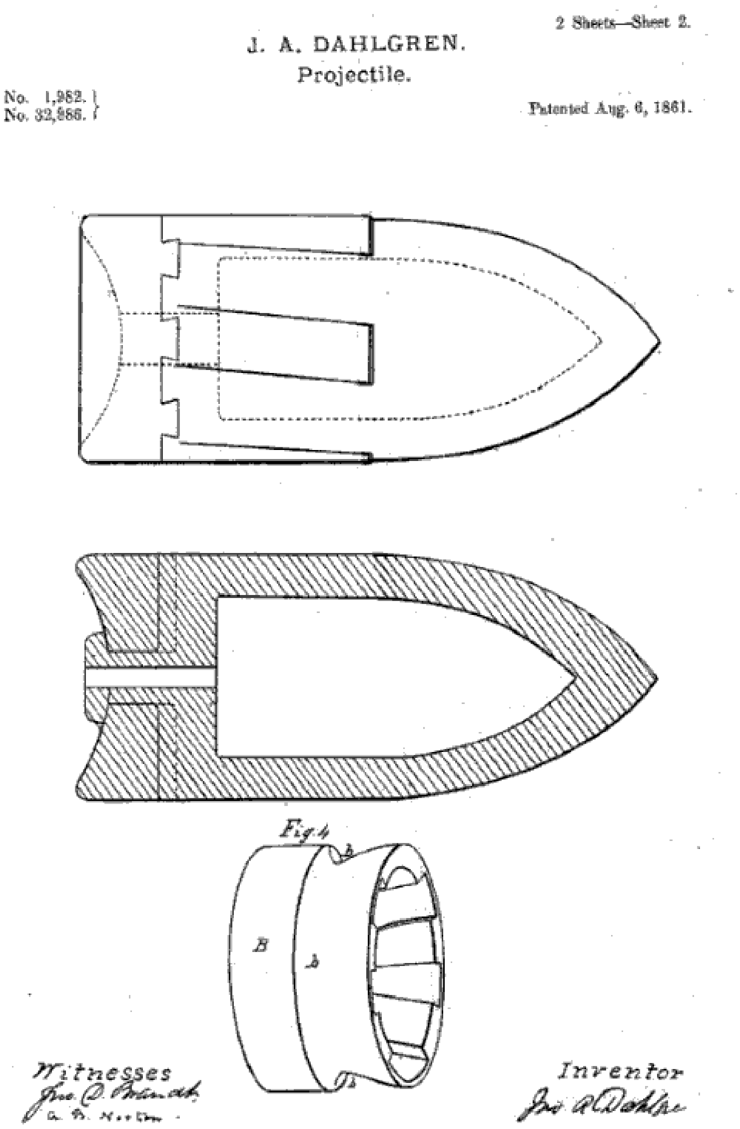


Fig. 13. Dahlgren Rifling

Lead proved to be a less than ideal metal for the gas check; it was too soft. This led to two problems; when it worked as intended it left residue in the grooves of the rifling, which built up over time and use, causing numerous problems including parting the gas check causing accuracy and ranging errors. The other flaw was that lead was very malleable and not strong under pressure. So while it allowed the 'cup' of the sabot to grip the rifling, but it also did not allow a strong attachment to the projectile. Detachment meant the projectile would not take the spin, and would fly rather randomly.

The Confederacy produced or acquired an extensive *pot pouri* of projectiles. Inherited guns, imported guns and newly manufactured guns all had to be provided with projectiles. As original stocks were expended, Confederate industry had to fill the demand. This encouraged experimentation and new designs, some quite ingenious. One of the more successful was the foundry known as Tennessee, and the projectiles produced there tended to be quite effective. They also produced an effective gas check design, involving a brass ring attached to the base of the projectile.

Brooke designed or approved the projectiles used by the Confederate States Navy. He designed a gas check for naval projectiles, and numerous projectiles specifically for his gun designs.

Fig. 14. Tennessee Shell

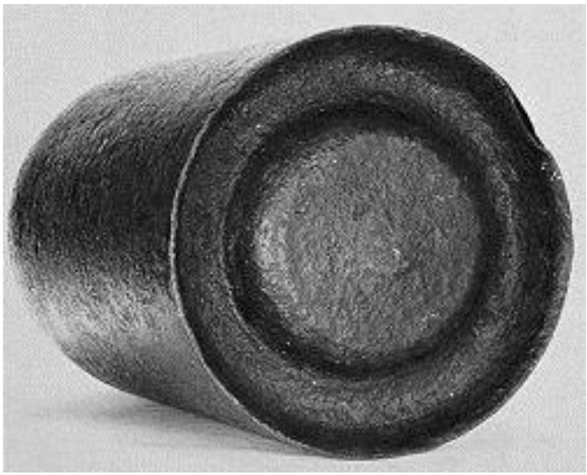


Fig. 15. Brooke Gas Check Brooke 8in Shell

Late in the war, he designed, and the Tredegar Foundry produced, one of the most advanced projectiles of the period, a Capped Armor Piercing Shell! In essence, he combined the wrought iron 'nose' of a bolt and the body of a shell with the fuze located on the side, and an effective gas check. Due to its weight, it was likely intended for the 7 in Triple Banded gun. Unfortunately for the Confederacy, this innovative design appeared very late in the war, at a time when its impact would be minimal.

Another advanced design came from the Mullane foundry, in a cross between a shot and a bolt. A truncated cone from the body of the solid cast iron projectile was capped with a wrought iron or low steel disc, serving, in a sense, as a 'cap' to enable penetration of the armor plate. Like the Brooke projectile mentioned above, it mid- to late War production. Note the copper cup gas check was also an effective design, strongly attached to the projectile body.

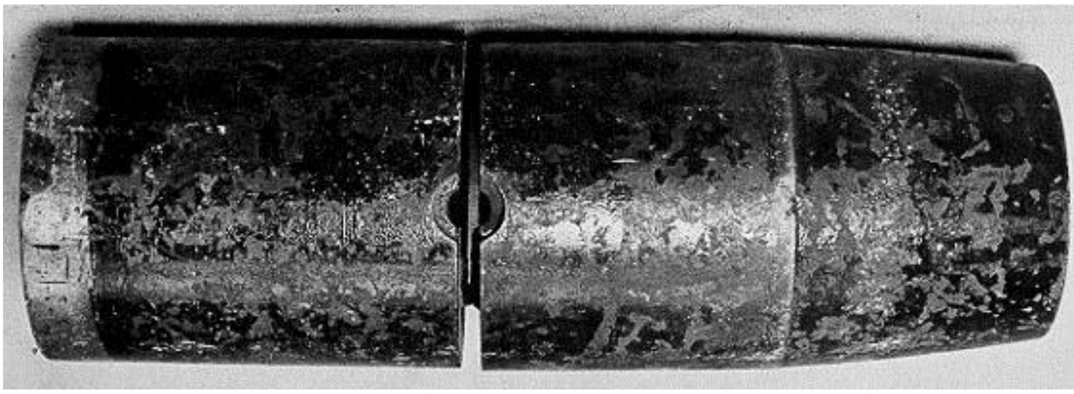


Fig. 16. Brooke 7in AP

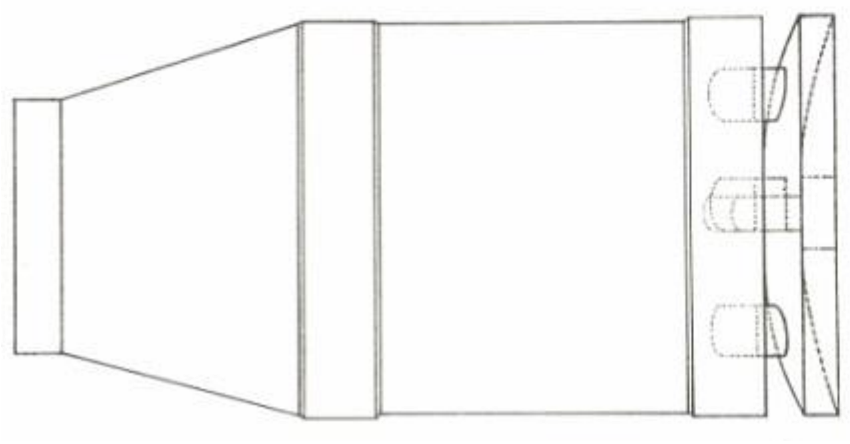
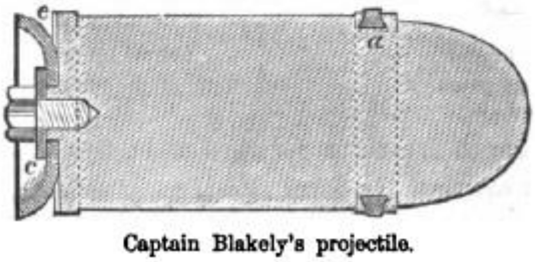


Fig. 17. Mullane 8in AP Bolt

In 1863, Blakely and his partners had their own works for assembling Great Guns of his design. He had also designed his own 'family' of standardized projectiles, consisting of a round nosed steel shot, a nose fuzed shell also round nosed, and cylindrical flat-nosed bolts. The gas check was in the form of a copper cup attached to the base of the projectiles, using tallow to fill the space around the cup, which also served as a lubricant.



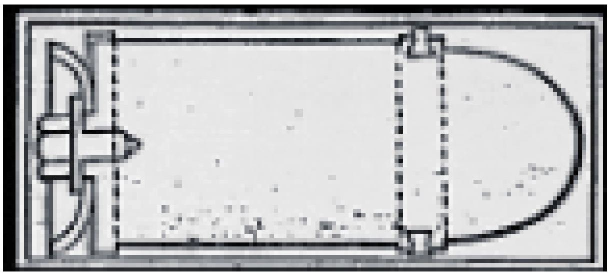


Fig. 18. Blakely Projectile from Holley Blakely Projectile from Appendix

Steel founder Henry Bessemer introduced steel round shot for smooth bore guns in 1862, as a means of improving performance against armor. Later that year, Blakely provided 70 steel round shot along with 70 bolts and 70 Bashley Britten shell as the load-out for the 7in MLR mounted on the CSS *Alabama*. In 1863, Blakely and Vavasseur offered such projectiles as a 'product' for their all-steel Great Guns. By February 1864, 104 lb (47.2 kg) steel round shot for 9in guns and 198 lb (89.8 kg) steel round shot for 11in guns were in regular production, thousands of which were shipped to Russia for the guns Blakely was producing for their Navy and coastal fortifications.

That there was correspondence between Blakely and Brooke is not in doubt. Unfortunately, the extent of that correspondence is unknown. The only hard evidence is an exchange of letters pertaining to the bursting of the breech of one of the 12.75 in coast defense guns at Charleston, South Carolina on September 11, 1863. Blakely's response was dated January 28, 1864. He had also written to Brooke earlier in 1863, probably prior to the invoice date in May, describing the two guns. But both in letters published in The Engineer and in testimony to Parliament, Blakely alluded to contacts with Brooke, including a statement that Brooke's guns were licensed use of Blakely's Patents, and that he had communicated in his principles of ordnance construction early in 1862. And the official Confederate records refer to the Brooke guns as "Blakely guns manufactured in the Confederacy," nor did Brooke claim credit for any of Blakely's patented principles.

One of the minor mysteries about this correspondence involves the gas check that Blakely Patented in 1863. There are some historians who believe the design came from Brooke. There are two pieces of evidence that support that position. One is a very rough drawing in Brooke's journal. The other is an artifact shell for a 5.3in gun shortly after the war identified as 'Blakely.' But there are problems with this theory. First, Blakely did not produce a 5.3in gun, nor do Confederate records indicate ever receiving such a gun from Blakely. And third, 5.3in is the caliber of the Parrott 60 pdr gun. No doubt the Confederacy inherited or captured several of these guns, and numerous other calibers of Parrott guns, early in the war, and would need to produce projectiles for them, patterned after those they had.

Blakely's 1863 Patent 3,087/1863 covered both the copper cup form and a copper ring form in conjunction with his designs for steel shot and shell, and was licensed to the Confederate States Navy and used for large projectiles made at the Selma, Alabama arsenal. The copper cup design was labeled as 'Blakely.' So the artifact is very likely a Selma produced shell for a Parrott 60pdr gun in Confederate service.

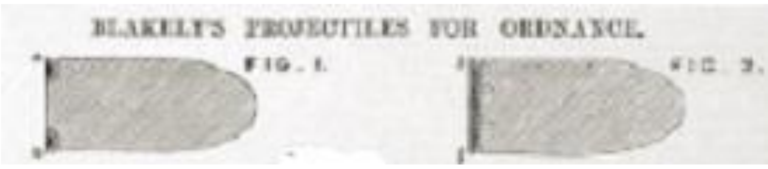


Fig. 19. Blakely Projectiles from Engineer

On July 29, 1864, The Engineer published the drawings of two versions of Blakely shot. Figure 2 is obviously the same as the images from Holley and the Appendix to the Report of the Commissioners on the Paris Exhibition of 1867 of the copper cup design. Figure 1, however, shows something completely different, and may very well be the Brooke copper ring design! Unless there is some confirmation in the Brooke journals, or computer enhancement of the few photos of Blakely's 'showroom display' of his projectiles – there are some anomalies regarding the gas checks that imply different types – there is no hard evidence, though Brooke may very well have communicated the specifics in correspondence.

Following the 1866 collapse and subsequent bankruptcy of the Blakely Ordnance Company, Josiah Vavasseur assumed the responsibility of fulfilling the last items of business, which included the final assembly and delivery of guns to Russia and Peru. While best known for his work designing gun mounts, he also operated a small ordnance company. His guns, based on Blakely's Patents – available upon the Captain's death in 1868 -- and work, represent continuation and further development, or evolution as technologies improved over time.

For his Muzzle Loading Rifles (MLR) he used a modified form of 'rib' rifling that he and Blakely had developed in 1863.

This is to say that the raised 'ribs' were part of the cast steel barrel, while the grooves were cast in the body of the projectile, creating a mechanical fit. A thin layer of lead or other soft metal around the grooved portion of the body would serve as a gas check. Also note the improved ballistic shape of the nose. Did this projectile design signal a major change for Blakely MLRs guns in the coming years? Perhaps they were. When Vavasseur's London Ordnance Company began production in late 1867, he went directly to the 'rib' form of rifling, as if the decision had already been made. There is some circumstantial evidence that lends support to that premise. Confederate experience implied that the 'hook-slant' form of rifling tended to tear the copper ring and shallow cup forms of gas check, especially the former, and that poly-groove rifling was superior. And the more successful cup design added to the weight of the projectile and was rather vulnerable to deformation during shipping and loading.

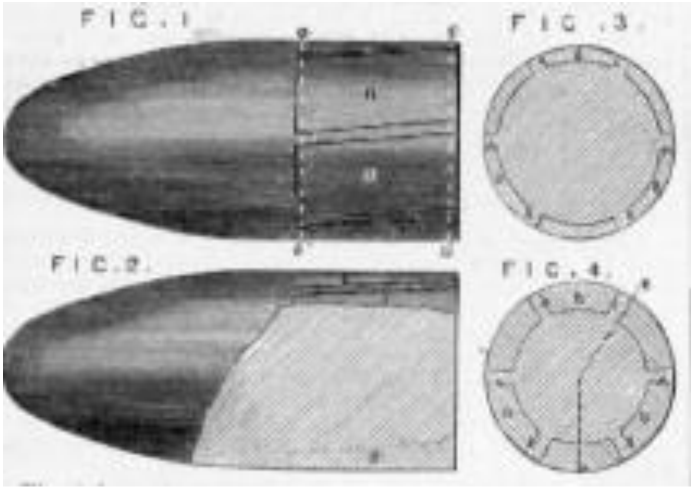


Fig. 20. Blakely Vavasseur MLR Shot

Vavasseur opened the London Ordnance Works on November 27, 1867 as a side-line to his J. Vavasseur Co. from which he designed and produced the gun mountings for which he is justifiably famous, offering MLRs and BLRs of his own design, based on the principles of his friend Blakely. In the years since they had patented the grooved projectile and 'ribbed' rifling, he had made some modifications. The rifling was at a 1:30 rotation, regardless of caliber. He discarded the soft metal layer for the body of the projectile, some windage was allowed, but rather less than the British 'shunt' or French La Hitte systems. The projectile was properly 'centered' and securely stabilized, and so did not rely on fragile 'centering pins' and strength of zinc studs to prevent movement in the bore.

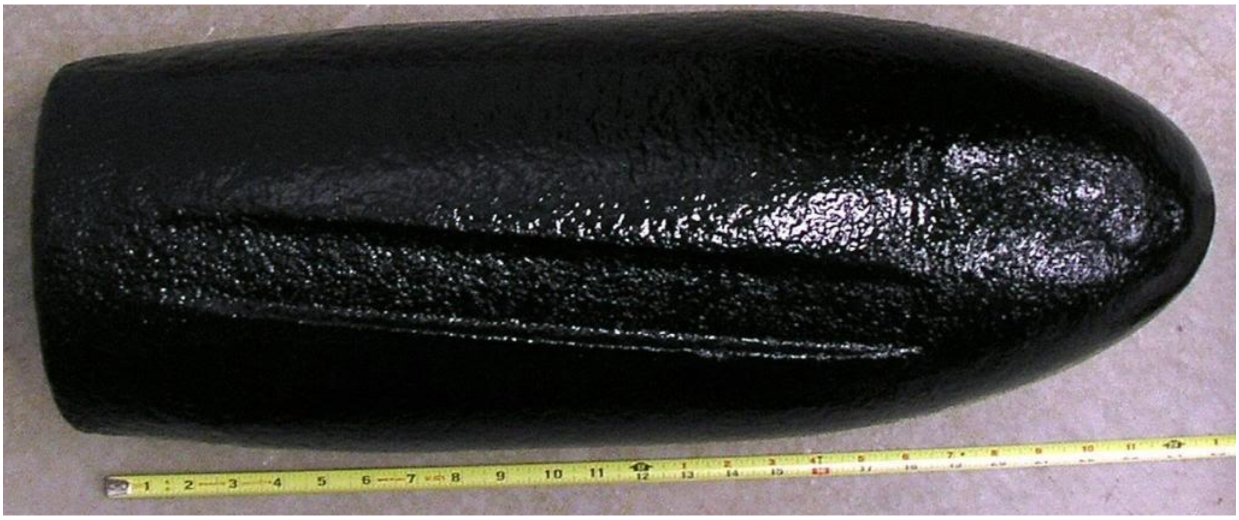


Fig. 21. Vavasseur 9in Shot

Fig. 22. Vavasseur MLR rifling from Mechanics

Another point of interest is the aerodynamic shape of the projectiles. The normal nose shape in the late 1860s and 1870s was 1.0 to 1.5 crh (caliber radius head), but Vavasseur's were about 4.0 crh. This translates into less loss of velocity at range compared with blunter projectiles.

Another line of development came from the fertile minds of Blakely and Vavasseur working together. This encompassed Breech Loading Rifled guns, and the projectiles to be used with them. Blakely had designed a BLR, which was manufactured by Fawcett Preston, who claimed it was "for a foreign government." It, along with a new 6.4in MLR, were tested on July 21 in the presence of representatives from the RN, France, Austria, Russia and Sardinia, using a 56 lb. Bashley Britten Shell, a charge of 7.5 lbs and with Britten rifling. A hypothetical reconstruction of this BLR is included below.

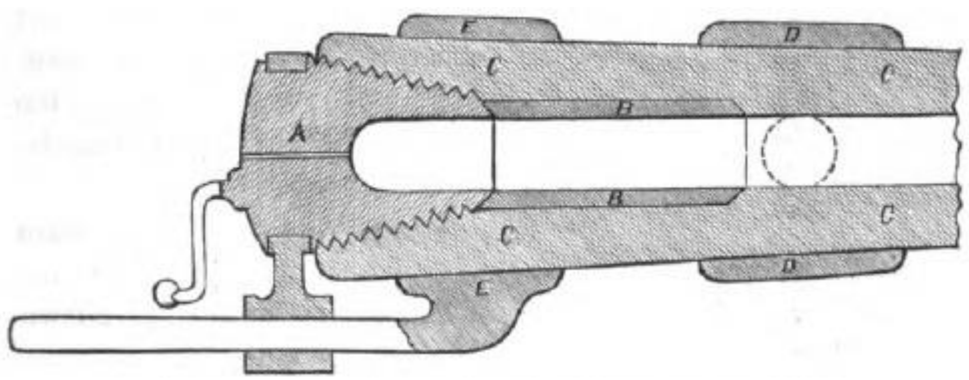


Fig. 23. Blakely 1860 BLR design

On August 1, a second BLR was tested, observed by the same representatives, but the Blakely breech mechanism had been replaced by one of the 'French' type, which may indicate who the "foreign government" was. Rifling was no doubt on the *La Hitte* system. A hypothetical reconstruction of this gun is also included below.

There are several interesting features that should be noted. First, the shape of the breech mechanism was much advanced compared to that adopted by France in the same year, and would operate more rapidly. Three turns of the arm would be sufficient to open the breech, which would then slide back to allow loading. Second, the air space in the screw – not to be filled with powder – would reduce gas pressure in the chamber. And third, the use of an internal reinforcing tube for the chamber, and the overlap of the external reinforcing hoops, extended from the breech to beyond the trunnions. The body of the gun would have been cast iron, with the breech and reinforces wrought iron or low steel.

In 1863, Blakely and Vavasseur turned their attention to BLRs, but using all steel with an advanced mounting. The concept was to use the gas expansion from firing to open the weighted breech for the next round, in essence a crude 'semi-automatic' mechanism.

As part of this development project, they designed and jointly patented (filed January 11, 1866) a new form of projectile specifically for Breech Loading guns. The issues of centering, gripping the rifling and gas check would be solved by the use of copper rings around the body of the projectile. The use of the 'boat-tailed' design was unfortunate, having the effect of concentrating much of the gas pressure on a single copper ring, causing deformation and failure. The other design, however, was perfectly feasible. There is little doubt that a breech-loading gun had been manufactured for this project, though no details have survived. The asset inventory made in 1866 as a result of the bankruptcy lists "One steel breech loader," caliber not noted. Also listed is an ambiguous "One rifled steel gun," with no other details. Yet the development of projectiles for rifled guns would beg the necessity of the existence of such a gun, and hence a breech mechanism, if a BLR 'system' was to be offered commercially. Likely such a gun would have been a companion piece to the 5.8 in (147 mm) 70pdr MLR produced in early 1865 (see below) for Venezuela.

In 1868, Japan bought some BLRs and projectiles from the London Ordnance Company. The absence of Patent Laws extending protection of the British patent allowed the shells to be examined by all interested parties, which resulted in other European countries adopting the copper driving rings for their own use. France discarded the La Hitte system and adopted the new forms with their M1870 guns, and Krupp did likewise. Vavasseur sued, but to no avail in a lengthy case that finally saw the Emperor (Mikado) of Japan as the defendant. It was finally ruled that the Emperor could not be sued, leaving no recourse but to drop the matter.

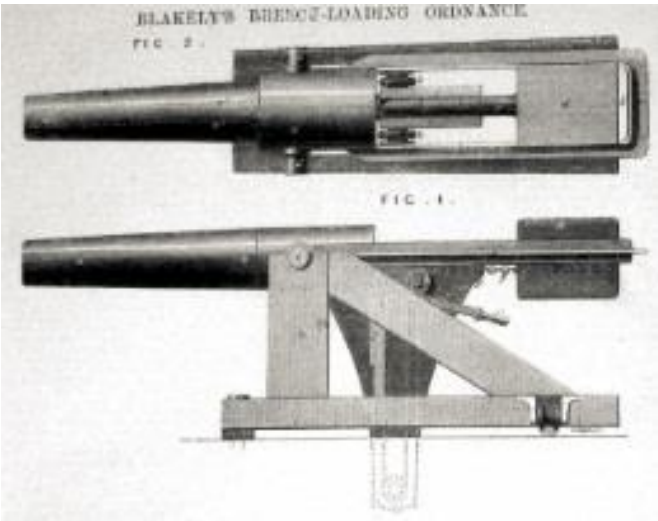


Fig. 24. Blakely BLR from Engineer

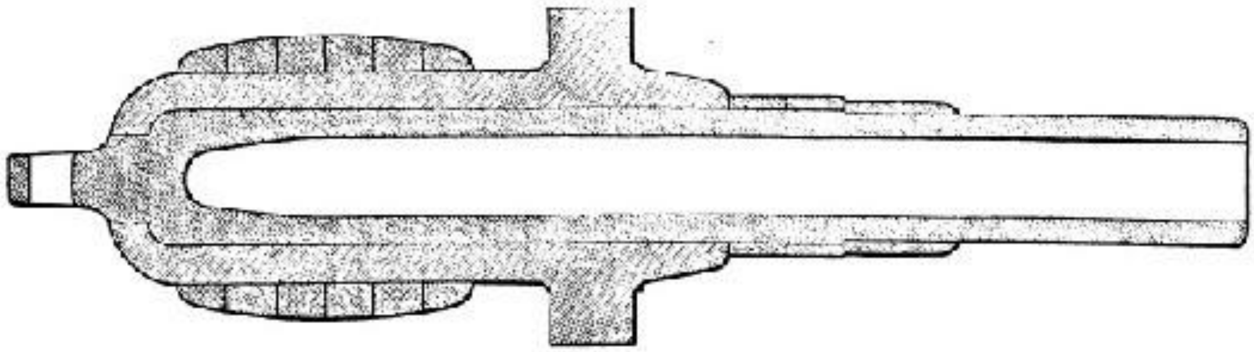


Fig. 25. Blakely 8in steel gun 1863 from Holley

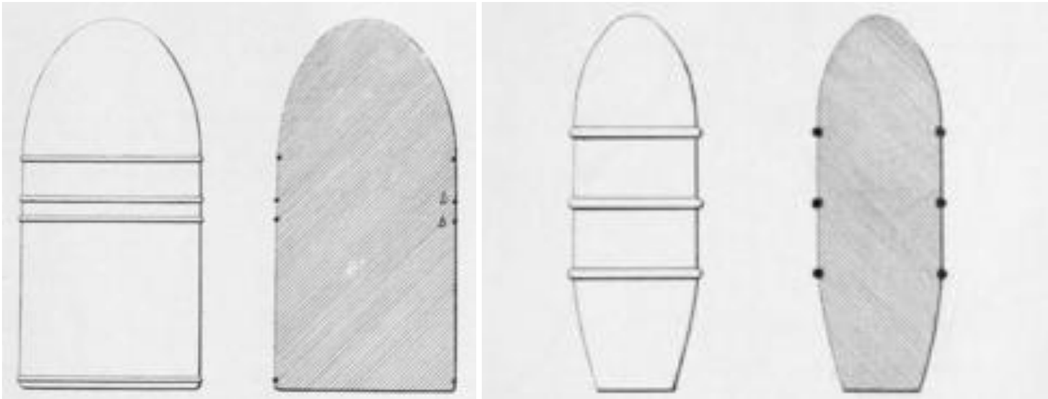


Fig. 26. Early Vavasseur BL shells

Vavasseur continued to develop the driving band concept. In 1872 he developed an improved model, which was patented under his name in 1875. Instead of four narrow copper rings, two much wider bands, one near the base and the other on the shoulder, were intended for smaller calibers, and for larger calibers, three somewhat narrower bands near the base.

The final form, patented in 1883, featured a broad band near the base, with the centering of the projectile handled by broadening the width of the shoulder of the projectile.

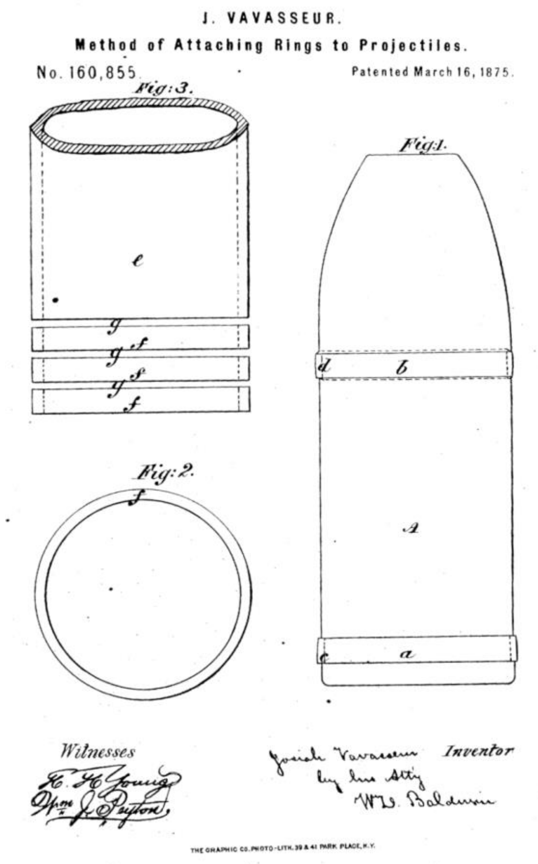


Fig. 27. Vavasseur 1872 shell

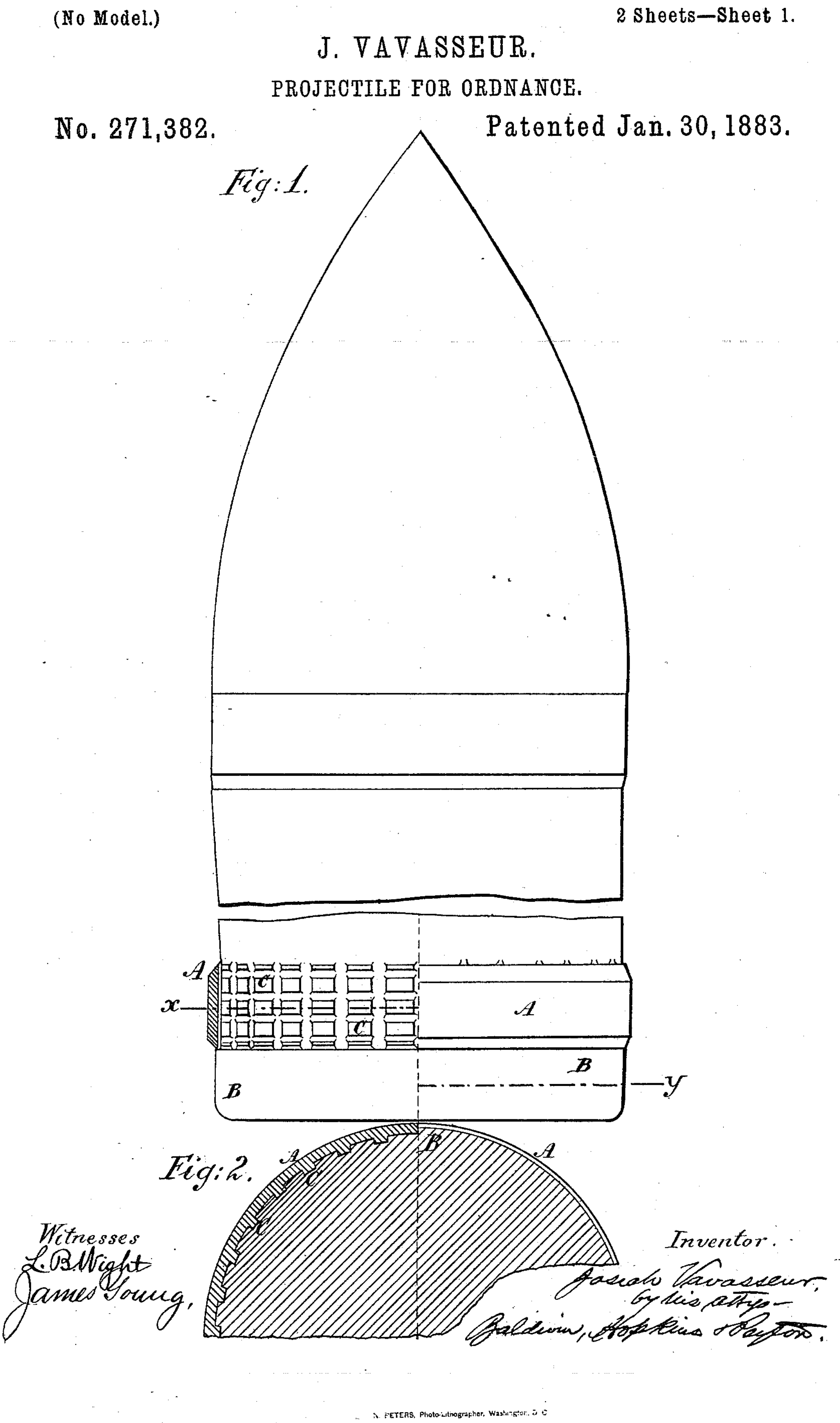
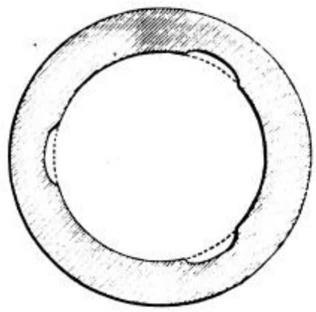


Fig. 28. Vavasseur Shell 1883

Rifling

The purpose of rifling is to impart spin, generally to the right, to give the elongated projectile stability in flight. This spin caused the projectile to 'drift' to the right over the course of its trajectory, becoming more pronounced as range increased. After much experimentation and experience, a rate of 1 revolution in 30 calibers was considered to be the ideal. Captain Blakely preferred a 1:48 ratio, which gave good accuracy at short and medium ranges and put less strain on the gun, and possibly because the lead sabot used in Britten shells performed better with a more gentle twist. However, at long ranges the drift became irregular and excessive, making compensation a chancy proposition.

However, there was no consensus with regard to twist of rifling. The early Armstrong BLRs were 1:36.5 for the 40 pdr, and 1:37 for the 7 in 110 pdr. The Woolwich MLRs were 7 in 1:35, 8 in 1:40, 9 in 1:45, 10 in 1:40, 11 in 1:35, and 12 in 25 ton 1:50. Parrott and Dahlgren rifling was in line, with the 3.67 in 20 pdr 1:32.7, the 4.2 in 30 pdr 1:34.3, the 5.3 in 60 pdr 1:34, the 6.4 in 100 pdr 1:35.625 and the Dahlgren 1:37. Only the French hit the 'magic' 1:30 with their M1864-66 guns, but in the M1870 they used 1:45. For models and production in and after 1863, Blakely used 1:36, excepting for the guns which used the Scott system of a mechanical fit.



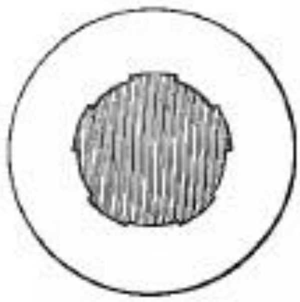


Fig. 29. *la Hitte* system of rifling Bashley Britten Rifling system from Tennant

With the M1855 gun, the French adopted a two groove system evolved from Cavalli's pioneering work as modified by Captain Gillion of the Belgian artillery, and further developed by Col. Treuville de Beaulien. While the gun was partially successful, with only the single 'button' in each groove, the projectile was not 'centered, and allowed considerable 'play' in its journey to the muzzle. Careful measurement demonstrated a variance of as much as 1 degree 7 minutes between the angle of elevation and the angle of the projectile leaving the muzzle. This problem was solved in what is known as the La Hitte system of three grooves and three pairs of buttons. The only shortfall was the acceptance of windage around the projectile which, as discussed above, reduced the potential initial velocity and hence range and striking power.

With the failure of his Breech Loading Rifles against armor, Armstrong adopted a nearly identical system for his, and the Royal Gun Factory at Woolwich, MLRs. Known as the 'shunt system, he replaced the copper 'buttons' with zinc 'studs,' and used a slightly different groove form. Of the three guns Blakely sent to Russia for trials in 1863, two were shunt rifled, and as noted above, the second BLR produced in 1860 was modified to French standards.

As mentioned above, Bashley Britten had developed explosive shells utilizing a lead coated sabot to grip the rifling and serve as a gas check. He also developed a rifling system of shallow grooves favorable to the soft lead, and hence categorized in the 'compression system.' Many of Blakely's early guns were rifled using Britten's system, especially those manufactured by Fossett Preston and Co.

However, the use of lead and the compression system had its drawbacks. That metal was too soft, and thus prone to many types of failure, such as being stripped smooth by the rifling, tearing and the build-up of residue in the grooves.

Commander Scott developed many innovations in guns and projectiles, including both the two and three groove rifling that may have influenced Armstrong and de Beaulien. This slant rifling was a different approach insofar as it was a mechanical system. The projectile was cast with slanted projections that matched the grooves.

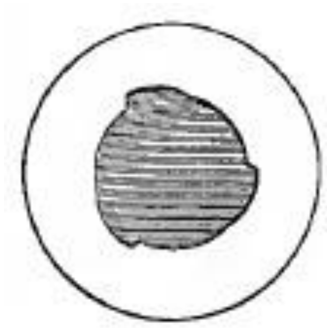
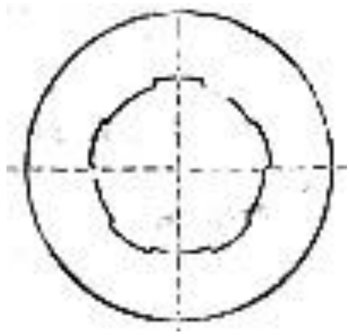



Fig. 30. Scott slant rifling from Holley   Parrott rifling

Blakely used this system on at least two occasions, potentially due to the great weight of the intended shot, bolt and shell to be used. The first was the two 12.75 inch coast defense guns, designed in 1862 and delivered to Charleston, South Carolina in 1863. The second, and more surprising, was the 11 inch, and possibly the 9 inch, all steel guns produced for Peru and Chile in 1864-65, which gave such good service at Callao on May 2, 1866.

Parrott used the same system of rifling for all the guns he designed, ranging in caliber from 2.9 inch field pieces to 10 inch coast defense guns. It was reliable and worked well with his design for copper 'cup' and ring systems of gas check, though the sudden increase in the twist in the chase near the muzzle had been known to occasionally rip and bend 'ring' and 'cup' type gas checks, or loosen their attachment to the body of the projectile, causing erratic flight and poor ranging.

One of the guns Blakely sent to Russia in 1863 was listed as rifled using Parrott's system. Oddly, in its report to the Tsar in May of 1864, this gun is not criticized or even mentioned. Unreliable French commentary notes irregularity of its shooting, but the Report of the Commissioners conducting the trials specifically noted the large contract already given to Blakely, so it does not seem unreasonable to conclude the contract was let on the success of the firing trials. And given that Blakely had applied for patents for brass cup and brass ring forms of gas check, it is conceivable, though not likely that they would be rifled on the Parrott system (see Appendix B).

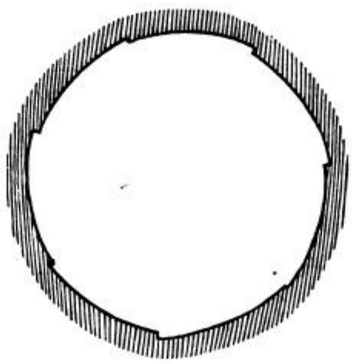



Fig. 31. Prussian poly-groove rifling from Holley   Blakely Brooke slant hook rifling from Holley

The concept of poly-groove rifling was developed in the 1840s by Swedish Baron Martin von Wahrendorff, owner of the Akers foundry and a talented gun designer. The system was acquired by Prussia/Krupp in 1859, and became an integral part of Krupp ordnance, and eventually became universal. Indeed, in the early 1860s, the Russian military took delivery of hundreds of Wahrendorff field guns and in 1862 some twenty 30 pdr blanks [unrifled]. Three were used for trials of rifling systems; one the many small grooves and lead coated projectiles used by Armstrong for his BLRs, one using the *la Hitte* system, and the third Krupp's poly-groove. Results favored the poly-groove system, which became one of the developing specifications for their own M1867 guns.

Two of the guns in the 1863-64 trials were Krupp production. One was a smooth bore, which was used to test the endurance of Krupp steel using large charges. The other, a BLR, seems to have been a test of performance with different projectile weights using a 31.5 lb (35 Russian pounds) charge of Pellet powder. The Report of the Commissioners notes that Krupp was given a specification for a 9in gun firing a 230 lb shot with such a charge, and notes that if the test gun were successful, 14 more would be ordered. Also mentioned was that Krupp was to provide a gun for trials of 10.75 in bore using a 50 Russian pound (45 lbs) of Pellet powder.

This form was the most often used by Blakely, and exclusively by Brooke. The Captain developed it from some of Scott's work, but not intended for mechanical action. Indeed, it performed well using Britten projectiles as well as brass 'cup' and ring gas check designs, perhaps thanks to the 'easy' twist of the rifling.

One of history's ironies is that CSS *Virginia* had only Britten explosive shells at Hampton Roads. The solid shot ordered did not arrive until after she had sailed! Against the wooden Union warships, she was immune to their fire thanks to her armor, and the Brooke guns performed as intended. But against the armor of the USS *Monitor,* the Confederate ship was essentially unarmed.

Breeches/Air Space

By the time Blakely had begun to sell guns of his own design, even though the guns were actually cast and constructed by sub-contractors such as Fawcett Preston Co. and Low Moor Ironworks, he had developed an affinity for a specific form of breech and tube. Essentially, the bore ended with a truncated cone leading to a cup. This was not a new design by any means! Indeed, he made only one slight but important change.

Fig. 32. Breech and chamber of Dahlgren 9in SB Sp Naval M1847 12 'pulgades'

With smooth bore guns, the truncated cone and cup were filled with powder, as evidenced by the location of the vent/touch hole. Blakely simply moved the vent a location about mid way of the truncated cone, and had the bagged charge with a truncated protrusion to align with it. This freed space for gas expansion, as boring an enlarged chamber for the propellant was inconvenient, to say the least.

As with the rifling, Brooke faithfully followed Blakely's lead.

Blakely's attention to gas expansion space was mentioned in connection with his 1860 BLR design, but appears in another novel form in his 1862 design for the 12.75 in guns constructed for the Confederacy. These novel guns featured a bronze cylinder in the breech, 30in long with a 6.5 in internal diameter and a 7.5 in external diameter, solely to provide air space for the expanding gasses of the charge. The intent was to reduce the gas pressure on the body of the gun by allowing it to build up more gradually and lowering peak pressure. And to aid in maintaining a lower gas pressure, the guns were provided with a pellet powder, on which more below.

If Vavasseur were not involved with the design of those Great Guns, he certainly took the importance of air space to heart. With his London Ordnance Company in operation in 1868, he designed a series of MLRs based on Blakely's patents and work, concentrating on all steel built-up guns with 'initial tension' of the reinforcing bands supporting the 'A' tube. He also adopted an existing breech design to provide some air space behind the propellant charge in a manner similar to Blakely.

Critics noted the superficial resemblance between the Paixhans gun and the Vavasseur gun, and concluded that Vavasser used the cylinder to hold the complete charge, which meant smaller charges and poorer performance. Those critics missed two salient features; the 'step' from full bore to smaller cylinder in the Paixhans' gun is vertical, while Vavasseur's has a slope to guide a protrusion of the bagged charge, and the location of the vents.

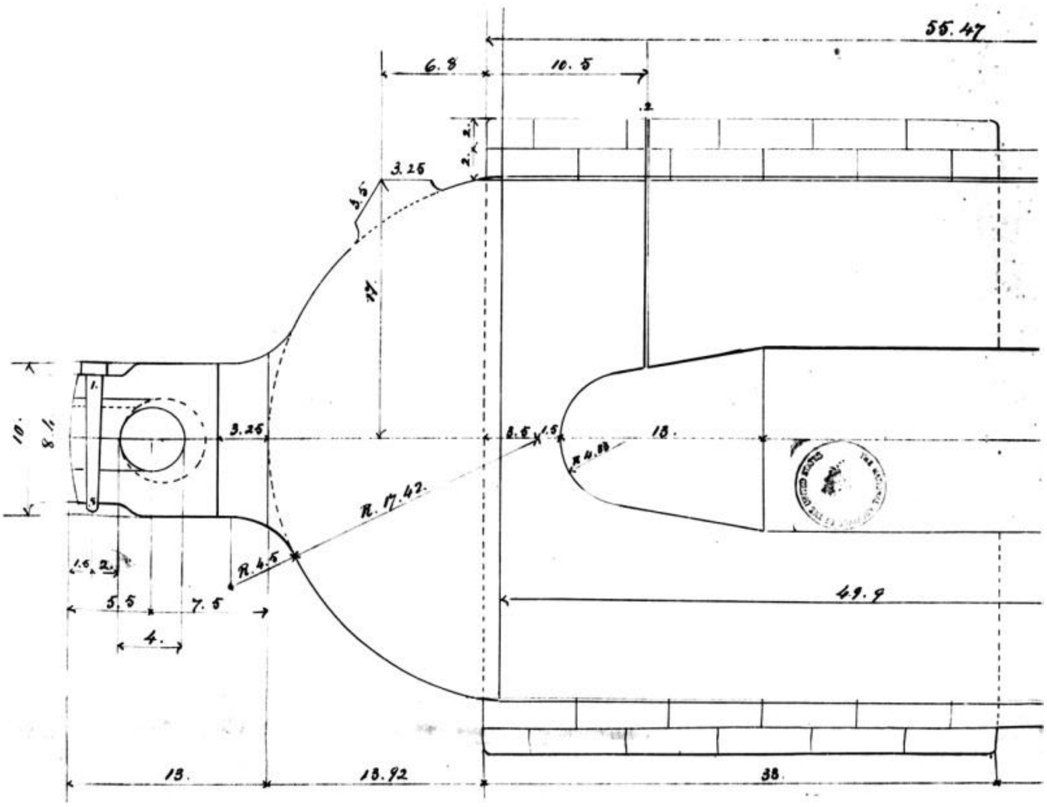


Fig. 33. Breech and Chamber of Brooke 10in

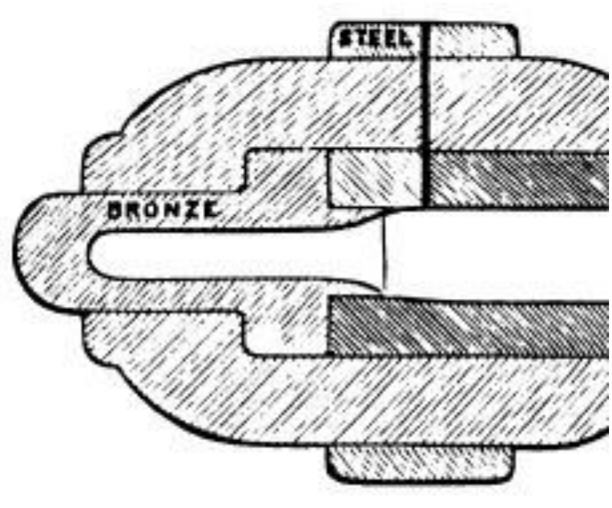
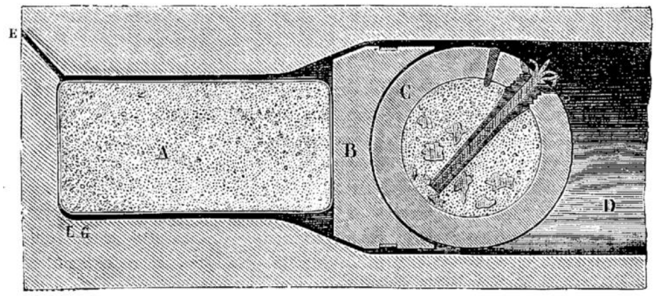


Fig. 34. Breech and chamber of Blakely 12.75in MLR from Holley



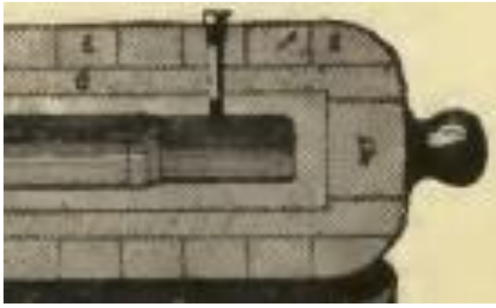


Fig. 35. Charge du canon *obusier a la Paixhans*

Breech and chamber of Vavasseur 7 in MLR

Black powder

Gunpowder is a mechanical mixture composed of 75 % saltpeter, 15 % charcoal and 10 % sulfur, though those percentages may be varied somewhat to influence the burn rate for a particular application; rockets requiring a slower burn rate than pistols, for example. In the simplest terms, the manufacturing process involves combining the ingredients with a certain amount of water and placing the 'dough' in a 'cake' mold to dry. A certain amount of pressure was applied to the cake as it dried. When dry, the cake was broken up or crumbled and then placed on a sieve or mesh to sort the grains by size, larger grains for artillery and fine grains for pistols.

Black Powder is referred to as a 'low' explosive primarily because it does not 'explode,' but rather burns very quickly, producing a considerable volume of hot gasses. And it burns from the outside surface inward, so small grains are consumed very literally 'in a flash.' Larger grains present proportionately less surface area, and hence are not consumed as rapidly. The density of the grain also retards the burning process, and density is a function of the pressure exerted on the cake. In the middle of the 19th century, density specifications for military powders were uniformly less than 1.0. For example, German Cannon Powder was to be between 0.915 to 0.935, and Large Grain for the big guns 0.96 to 0.98, Austrian Large Grain from 0.907 to 0.95, and Swiss Cannon Powder 0.96 to 0.97.

The mesh system was fairly universal, though the definitions were not. Put simply, the mesh number represents the number of sieve holes per linear inch, so a 6 mesh, considered Cannon Powder, would have four holes per linear inch and 16 per square inch. Large Grain would be a 4 mesh, 20 mesh the filler of an explosive shell, and the 'meal' powder of previous times 100 mesh.

Fig. 36. Powders from the world

With the return of large bore cannon following the introduction of the Paixhans 'shell' gun, and the successful use by the Russian Navy at Sinope in 1828, the military establishments in Britain and the United States recognized the need for a larger powder grain. Their existing Cannon Powder burned too quickly and violently for the new 'shell' guns. The result was Large Grain powder for guns bores than the 32 pdr 6.4 in (roughly 16 cm). In the United States, the specification for Cannon Powder allowed grains from 0.1 to 0.3 inches (2.54 – 7.62 mm), and a new specification for large grain powder from 0.3 to 0.5 inches (7.62 – 12.7 mm). In one way or another, many European countries introduced their own specifications and versions, France and Spain being notable exceptions.

Fig. 37. Cannon powder Large Grain powder Whale later Rifle powder

1856 was a pivotal year in the development of artillery. France had deployed their M1855 MLR, Wahrendorff was marketing his BLRs, Armstrong, Blakely, Whitworth and many others were designing, patenting and developing their ideas for rifled guns, and it was evident that rifled artillery was coming soon. But perhaps equally important was the work of Thomas Jackson Rodman, an officer with the U.S. Army Ordnance Department. Better known for the family of large smooth bore guns for coast defense which bear his name, he also perfected hollow casting and water cooling from the interior, which in essence amounted to chilling the tubes of the iron guns so manufactured, giving them unprecedented hardness. But in 1856, he turned his attention to black powder as a propellant.

Rodman correctly reasoned that the relatively small grain Cannon powder would burn too quickly in large bore guns as the 'burn rate' or speed of consumption would produce very high initial gas pressures that could injure, weaken or burst the gun, and even detract from performance if the 'all burnt' point were well before the muzzle. Even the irregular shaped Large Grain powders offered slight improvement, given that large bore guns involved a longer tube in real terms. His solutions were compressing the powder to increase its density, which, along with glazing, retards the burn rate, and use larger shapes of compressed powder, which actually reduces the surface area, making the burn last longer with lower but steadier gas pressure and causing the projectile to accelerate, albeit at a lower rate, for the length of the bore. His suggestion for the form was full-bore cakes, each about one inch (25.4 mm) thick with a perforation in the center. This had the effect of reversing the normal burning of black powder, the cakes burning from the perforation outwards, increasing the burning surface as the burn progresses. Smaller grain powder burns from the outside surfaces inwards, thus releasing less expanding gasses as the grain is consumed. The trick was to 'tune' the size and number of perforations to match the length and bore of the tube.

Various tests and trials were conducted in 1860-61, using a stand 6 pdr 3.67 in (93.22 mm) field piece with a bore length of 57.5 in (1.46 m). Originally, clearance between the bore and the full bore charge was 1/16th (1.59 mm) inch, but this was increased to 1/10th (2.54 mm) to allow more air space for gas expansion. They proved conclusively that gas pressure in the bore was greatly reduced, but at the cost of reduced muzzle velocity, which could also imply that the charge was not properly 'tuned' for such a small bore gun This, combined with the practical concerns of cracking and chipping the rather fragile cake, and difficulty in loading, played against the concept. Rodman published his ideas in 1861.

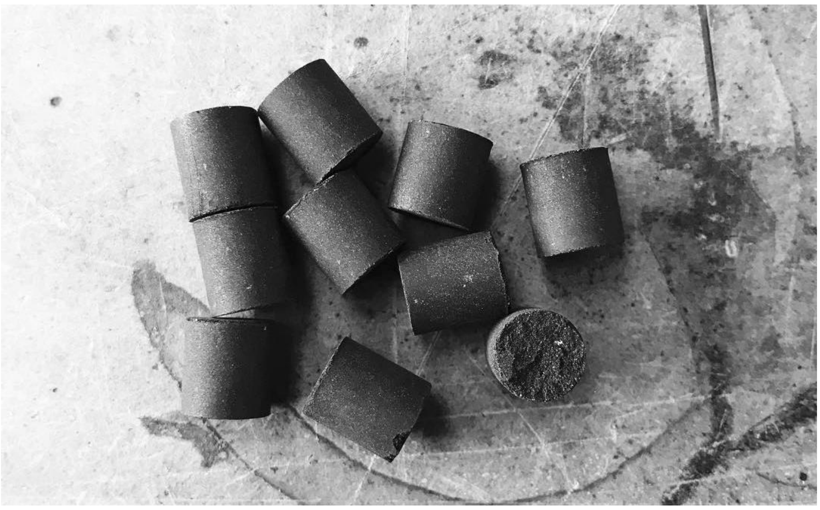


Fig. 38. RN RLG type powder Early Cubic form

During the same time frame, the British Royal Navy came to the realization that their LG powder, which performed quite well in their 8 in, 10 in and 8.12 in 68 pdr smooth-bores, was too 'quick' and too violent for the new rifled guns entering service. At the urging of Sir William Armstrong, who desired less violent charges for his Rifled Breech Loaders of relatively small caliber, a new powder was adopted in 1860. This was Waltham Abbey's A4 powder made from a compressed cake and highly glazed with black-lead; the range of grain size was between 0.185 in to 0.093 in. [Pass through a 4 mesh and stand on an 8 mesh] This powder was known as Rifle Large Grain (RLG).

But while grain sizes had been specified, density was not. In 1865, the Gunpowder Committee, in the course of its investigations, found the combined density range of LG and RLG powders in storage varied from 1.6 to 1.78, with an average for RLG of 1.67. This lack of uniformity of grain size and shape, coupled with the spread of densities, acted against regularity of muzzle velocity and ranging. Their rather ingenious solution, even if a stop-gap, was a compressed powder molded into cylindrical form and highly glazed, with a specified density of 1.72. Grain size ranged from 0.25 in in diameter and length to 0.083 in. However, it proved to be too 'hot' and violent for the larger MLRs that were introduced as the decade progressed.

They also redefined LG into a finer powder, suitable for small bore rifled guns – defined as less than 3 inches – and smooth bores [Pass through an 8 mesh and rest on a 16 mesh]. Density was to be 1.6, and the grains not glazed, so it would be very quick burning. It appears their ultimate goal was to replace LG altogether with the smallest grain of RLG cylinders.

The Gunpowder Committee also recommended the immediate adoption of the Pellet powder for the large guns then under development, that the late Select Committee had suspended, on which more below. But this, unfortunately for the Royal Navy, was not done.

Pellet Powders

As early as 1859, Rodman concluded that the reduction in MV using full-bore cake charges could be regained by using a different grain of powder in the form of compressed cubes. The Ordnance Department agreed, and duly issued a specification for 'Mammoth' Powder as no less than ½ inch (12.7 mm) and no more than 1 inch (25.4 mm). Actual production was about 5/8 inch (15.9 mm) and 7/8 inch (22.2 mm), with a density of 1.61, which would be improved to 1.82 by 1874. It was used by the 10in Parrott rifle, the 15in Rodman and possibly by the 10in Rodman coast defense guns. In an 1868 French trial against their 240mm M1864-66, the competing 15in Rodman was charged with 60 lbs of Mammoth Powder, which propelled a 441 lb solid shot at 1230 ft/sec, and an 81.5 lb charged was also used in the course of the experiment, although 100 lb charges had been used routinely.

Mammoth Powder proved quite successful in rifled guns, as demonstrated by the Table from Holley of firing trials of the 10in Parrott. Gun performance was maintained, but with much lowers pressures.

At about the same time, John Anderson (later Sir) devised a process for making a cylindrical form of molded compressed powder, in his capacity as Chief Inspector of Machinery for Woolwich and Waltham Abbey. The machine would produce 5/8th inch cylinder, both diameter and length, with a ¼ inch through perforation with slightly rounded corners at each end, weighing 100 grains. While the work was done at Waltham Abbey, the firm of Curtis and Harvey acquired the production rights, and put cylindrical pellets – in sizes up to 1 ¼ inch – on the market.

But for the largest smooth bore guns, 15in and 20in, Rodman advocated for a spherical shape; golf ball size (roughly 1.7 inches, 43.2 mm) for the 15 in gun, and tennis ball size (roughly 2.6 in, 66 mm) for the planned 20 in gun. There was an advantage to that form. The amount of compression in the molding process had the effect of making the outer layers denser than the central core. This would translate into a slower burn when the exposed area was greatest, but as the area decreased, the burn rate of the smaller core increased to maintain expanding gas pressure on the shot. Estimated density is 1.66.

The spherical form made an appearance in 1863. With the enormous 12.75 inch guns for the defense of Charleston, South Carolina, Blakely also sent a quantity of spherical powder for use in those guns, poetically described as about the size of a "hen's egg," or about one inch (25 mm) in diameter. The Confederates immediately dubbed it 'Blakely Powder,' and placed it in production as their No. 9 powder. It seems to have been used in a variety of Great Guns, as available, including the Brooke 11in, 10in, 8in and the 7in Triple. The Confederates also had a special charge for their 10 in rifled and banded Columbiads and Rodman guns. Known as the No. 10 powder or charge, it consisted of equal parts of all nine types! If nothing else, this is a testimony to Rodman's hollow-casting and water cooling from the bore out methodology.

Robert Ogden Doremus, a professor of chemistry at what is now known as the New York City College, suggested to Rodman and DuPont in early 1860 that molding compressed powder into a prismatic shape of smaller size, with one or more perforations to influence the burn rate. This proved to be the ideal form over time. He then left for France, where he had received his higher education, and presented the idea to the French government. They requested that he oversee modification of one of the government powder works to produce the compressed prismatic grain, but instead of using it for artillery, they used it as blasting powder, and continued using the unsatisfactory small grain Ripault powder.

The target was 600 feet above the level of the gun.

No. of Rounds fired.	Powder, 25 lbs.	Shell, lbs.	Elevation, deg.	Range, yards.	All shot struck within a space		Remarks.
					Feet high.	Feet broad.	
20	Dupont's Mammoth.....	252	10⅜	2500	45	30	Shell empty and plugged; two irregular; recoil, 39 to 51 in.
15	"	254	"	"	32	20	Shells loaded; time fuze; one irregular, and struck low—ring flew off.
10	"	"	5⅛	2200	25	10	Shell loaded; ignition of 3 doubtful.
1	Oriental, No. 5..........	252	"	"	...	...	Shell empty; good line shot, 30 ft. high; recoil, 60 in.
4	"	"	4⅞	"	25	5	Shell empty; ring flew off one, but went well and struck high.
21	Mammoth................	245½	10⅝	2500	40	25	Loaded shell; percussion fuze; all burst.

5	Oriental, 5	245½	10¼	2500	20	25	Loaded shell; percussion fuse; all burst.
4	Mammoth	254	"	"	20	10	Loaded shells; 3 with percussion and 1 with time fuse.
5	Oriental, 5	254¼	"	"	25	20	2 with percussion fuzes; 3 plugged.
15	Mammoth	252	"	"	...	...	Fired during snow-storm; 1 wabbled; recoil over 40 in.

Of the 100 projectiles fired, 96 took the grooves perfectly. The star-gauge and impressions showed the gun to be in perfect order at the close of the trials. 15 rounds were fired in 56 minutes.

PRESSURES.

Elevation, 10¼°. Range, 2500 yards.

10-in. Rifle; 25 lbs. Charge; 252-lb. Shell:

- Mammoth powder .... 27340 lbs. pressure.
- " .... 25670 "
- Oriental, No. 5 .... 25280 "
- " .... 22350 "
- Hazard .... 85590 } estimated.
- " .... 85000 } estimated.

Fig. 39. Trial of Parrott 10 in

Fig. 40. Cylindrical Pellet

In 1863, Russian naval squadrons visited New York and San Francisco, ostensibly to show support for the Union cause, but more likely as a demonstration for the British and French who were favoring the Confederacy, in an exercise of what Otto von Bismarck would refer to as *Weltpolitik*. They were gifted with specifications and samples of Prismatic Powder.

At that time, Russia was in the process of modernizing its artillery and defenses, and upgrading their industrial capabilities. They were already aware of 'pellet' powder and its advantages, but the application for Great Guns, which they were buying from Blakely and Krupp, was obvious. In 1868, they passed the information, and a considerable quantity, to Krupp.

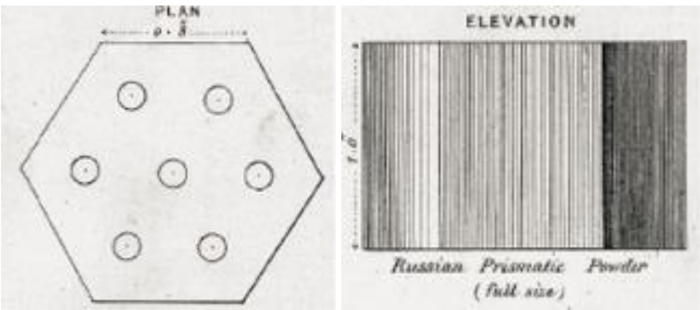


Fig. 41. Russian Prismatic

Prismatic single perf

Perhaps the greatest advantage of the prismatic form was the ease of 'tuning' the grain to the bore and length of the barrel. As Very points out in 1880, for large bore long guns, the prism was not perforated. For medium caliber or short guns large bore guns, a single perforation was used. And for smaller bores, seven perforations were used. The diameter of the perforations could also be adjusted to best suit the guns. The early prisms had a density of 1.66, but improvements in the production process increased the density to around 1.78 by 1880, though Germany seemed content with 1.75.

The British Royal Navy was aware of the progress in compressed powder, and in 1863 developed their own, officially dubbed 'Pellet Powder.' It was a shallow cylinder form, ¾ inch (19 mm) in diameter and ½ inch (12.7 mm) deep, with an indentation 1/5th inch (5 mm) deep to increase the surface area. Pellet was approved for charges of 50 lbs or more (basically, the Battering charge for the 10in MLR, and all charges for 11in, 12in and larger), but no cartridges were sealed or approved for supply to the Fleet. The administrative process was halted upon reports that compressed powder had "injured" a number of Parrott rifles, so the "powers that be" in the Admiralty determined to wait for more information. On March 9, 1864, the Admiralty approved a 19 lb charge of Pellet to replace the 20 lb 'Full' charge of RLG for an experimental 8 in gun. The density specification was 1.65 to 1.7, and the lower seems to have been the density for the limited production.



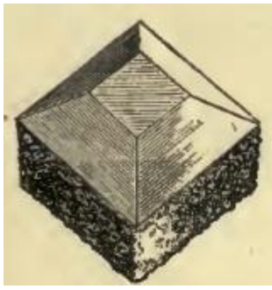


Fig. 42. British Pellet powder DuPont powder Hexagonal DuPont Cubical

This was a tragic error in judgment for several reasons. First, it left the Fleet totally reliant of RLG, which was demonstrably inferior for larger guns. Second, it brought development of compressed powders to a halt for another seven years, though the 'Trade' continued its commercial development and sales. And third, there was more involved with the 'injuries' to Parrott rifles than the use of compressed powder, which will be addressed below.

DuPont, among other producers, produced several variations of compressed powder, two of which had a lasting impact. The first of these is a cylindrical form with a perforation. It proved quite useful for the smaller bored field artillery and naval landing guns, as length and the diameter of the perforation could be 'tuned' for better performance. With grain diameters between 5/8th and 1 ¼ inches, and perforations ranging from truncated cone to only about 2/3rds the length of the cylinder, to passing completely through, and with various shapes and diameters, it was a very adaptable form. Density at the end of the 1860s is estimated at 1.7.

The second is known as Hexagonal, and was adopted by Spain in 1865. The form seems to have been a cross between flat topped molded prisms joined at the base by a hexagonal cake of compressed powder. Likely it would have had a progressive advantage in that the two hexagonal prisms would be denser due to the molding under pressure process than the cake would be.

The third compressed powder was misnamed 'Cubic.' It was not. Rather, it was a flat-topped molded pyramid on a square cake. Yet it would essentially have the same advantage of two densities as did the Hexagonal.

It appears that the Ordnance Department issued a specification to cover both the 'Cubic' and the Hexagonal; not fewer than 70 nor more than 75 grains per pound, for an average weight of 0.221 ounces. In 1880, Hexagonal and 'Cubic' were the powders of choice for the US Military, with the former, with a density 1.785 by 1880, though probably about 1.67 in the mid-1860s, used for the largest rifled guns, while the latter, likely with a same density, was used in medium caliber guns.

On August 8, 1869, the British Admiralty formed a Committee on Explosives to belatedly assess the compressed powder question. The Committee reported its findings on May 5, 1870, and formally recommended Pebble Powder on October 22. Charges and cartridges were sealed in January 1871, and new propellant was quickly issued to the Fleet.

Pebble, historically known as P1, was cubical, little different than Mammoth Powder. The specifications were ½ to 5/8 inch (12.7 to 15.9 mm) with a density of 1.75 to 1.78. It was to replace 'Full' and 'Battering' charges for all MLRs 7in to 12.5 in. In 1880, the density of P1, then dubbed simply as 'Pellet,' had reached 1.786 and 1.82.

There appears to have been a bit of chicanery and some "not invented here" to the process. One key argument favoring Pebble was a comparison with Pellet. A 30 lb charge of Pellet produced a peak pressure of 17.3 tons when the projectile had moved 0.3 feet in an 8in gun. A 35 lb charge of Pebble produced a peak pressure of 15.3 tons when the projectile had moved 0.5 feet in a 9 in gun. This is not an 'apples to apples' comparison.

Then there is the question of time. Was the Pellet performance from a test in 1863? Other than the 19 lb charge, no Pellet had been produced in years. Then there is the matter of density. The Pebble specifications mirrored the limits of manufacture in 1869-70. But the sample of Pebble used was small quantity 'laboratory' scale production with a density of 1.8. That of Pellet in 1863 was 1.65. It was hardly a competitive comparison.

The simple fact is that the Royal Navy was limited in their choices by the decision to revert to muzzle loaders earlier in the decade. Necessarily short barreled, limited adaptability and limited capacity for improvement, MLRs were increasingly an anachronism. Replacing RLG was a simple and tardy decision. But choices were limited by the short barrels; Prismatic, for example, performed efficiently in barrel length of 22 to 25 calibers, but that efficiency would be wasted on a barrel of 15 calibers. Pebble was 'good enough' for the 1870s.

By the late 1870s, technology had surpassed P1 as Armstrong and Vavasseur BLRs pointed the path to the future. Armstrong pushed the limit of MLRs with an 11in gun with a tube 23 calibers in length for China, and 17.72 in (45 cm) guns for Italy. The RN was obliged to respond with the 16 in (40.6 cm) MLR, and a new version of Pebble, labeled P2. It too was cubic, 1.5 in (38.1 mm) with a density specification of 1.75 or better, for the 12.5 in and larger guns. Ironically, the long design period allowed the Admiralty to adopt Prismatic Powder before the 16in gun was produced.

The Italian Navy provided the final pellet powder prior to the end of the Black Powder era. Fossano Powder was a huge cube in form, about 50mm (1.97 in) per side, suitable for their monster 45cm 100 Ton guns. But it was also rather unique in composition. The meal cake was compressed to a density of 1.79. Then the cake was broken up into pieces between 1/8 and ¼ inch (3.2 to 6.35 mm) thick. A certain amount of meal powder was mixed with the high density pieces, and that mixture was then compressed do a density of 1.76, then molded into cubes. The result was a cube with two densities. The theory was that the lower density material would burn at a higher rate than the denser material, extending the production and expansion of gasses in a progressive manner. This was a brilliant solution! However, the distribution of the dense powder was not uniform, so the actual burning was irregular and uneven. This irregularity, coupled with the over-sized 'battering' charge of 250 kilos (551 lbs), may have caused one of those guns to blow its breech aboard the ironclad *Duilio*.

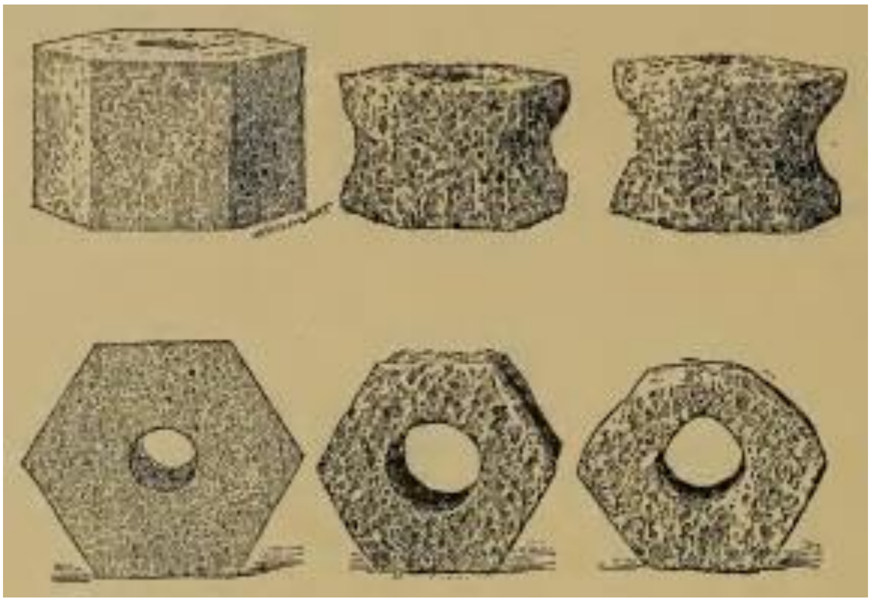


Fig. 43. Unburned and partially burned Prismatic

Fig. 44. Pebble 2

Fossano powder

Bursting Guns

"I must now say a few words on the Nature of the strains to which a piece of ordnance is subjected when fired. Gunpowder is commonly termed an explosive, but this hardly represents its qualities accurately. With a true explosive, such as gun-cotton, nitro-glycerin and its compounds, detonation and conversion of the whole into gas is practically instantaneous, whatever the size of the mass; while with gunpowder, only the exterior of the grain or lump burns and gives off gas, so that larger the grain the slower the combustion. The products consist of liquids and gases. The gas, when cooled down to ordinary temperatures, occupies about 280 times the volume of the powder. At the moment of combustion, it is enormously expanded by heat, and its volume is probably somewhat about 6,000 times that of the powder. I have her a few specimens of the powders used for different sizes of guns, rising from the fn grain of the mountain gun to the large prisms and cylinders fired in our heavy ordnance. You will readily perceive that, with the fine-grained powders, the rapid combustion turned the whole charge into gas before the projectile could move far away from its seat, so that a short, sharp strain, approximating to a blow, had to be guarded against.

"With the large slow [burning] powders now used, long heavy shells move quietly off under the impulse of a gradual evolution of gas, the presence of which continues to increase till the projectile has moved a foot or more; then ensues a contest between the increasing volume of the gas, tending to raise the pressure, and the growing space behind the advancing shot, tending to relieve it. As artillery science progresses, so does the duration of this contest extend further along the bore of the gun toward the great desideratum, a low maximum pressure long sustained." (Colonel Maitland..., 1882).

On firing, guns are subjected to four types of immediate strain and potentially two detrimental side effects. These are;

1. Tangential strain – force that would split the piece longitudinally, as in outward from the tube/powder chamber;
2. Longitudinal strain – force acting in the direction of its length, as in the breech in one direction and the muzzle in the other;
3. Compression – force that weakens the integrity of the material along the axis of the bore, as in compacting the material and expanding the chamber and bore;
4. Transverse strain – the bending outward of the material of the body of the gun, as in whiplash.

The traditional means of addressing these strains was to increase the thickness of the metal in the areas most subject to the strain, defined loosely as the critical area from the breech to the trunnions, where the gas pressure from the burning powder was the most intense. The culmination of this practice can be seen in the 'pressure curve' form of the Dahlgren and Rodman smooth bore guns. Captain Blakely took issue with the practice. "To obtain much greater strength by casting guns heavier is impossible, because in cast guns (whether of iron, brass, or other metal) the outside helps very little in restraining the explosive force of the powder tending to burst the gun, the strain not being communicated to it by the intervening metal. The consequence is, that, in large guns, the inside is split, while the outside is scarcely strained. This split rapidly increases, and the gun ultimately bursts."

In an opinion expressed by Dr. Hart of Trinity College, Dublin, General Morin, Dr. Robinson, Mr. R. Mallet and Mr. Marlow, commenting on Mr. Longridge's experiments, "…no possible thickness [of homogenous metal] can enable a cylinder to bear a pressure from within greater than the tensile strength of a square inch of the [same] material." Blakely's concurring comment noted that the cracks "were more open at the inside, and some not extending to the outside."

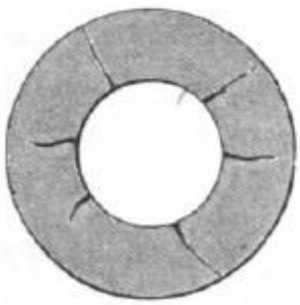


Fig. 45. Cylinder burst by internal pressure from Holley

The solution to twin problems of tangential and compression strains was the application of rings/hoops/coils [of a 'higher' metal] "with initial tension exceeding that below it so that the hoop will compress what is within it. The inner layer is thus in compression while the outer layer is in higher tension. Then the inner layer, being in compression, is able to sustain the first and greatest stretch while the outer layer, though stretched less by the explosion of the powder, has already been stretched into high tension, and thus has to do an equal amount of work. The intermediate layers [of the cast metal] bear the same relation to the initial and the strain of the powder, so that all the layers contribute equally of their tensile strength to resist the strain of the explosion." This reasoning formed the basis of Blakely's original 1855 patent, and was the guiding principle behind 'built up' guns.

The gas pressure from the burning charge also has longitudinal effects, 'pushing' the projectile forward and the breech backwards, as recoil. This pressure creates tension between the breech and the trunnions, in effect seeking to push those two points further apart, and is only lessened as the projectile moves forward and creates more volume for the gases.

Even though the breech was the strongest part of the gun, in terms of thickness of metal, the most common injury was to that part of the gun. And 'injury' includes cracks in and around the breech and vent/touch-hole as well as catastrophic failure. The dangers were exacerbated in rifled ordnance, with heavier projectiles tended to increase gas pressure as more pressure and time were required to move the projectile forward.

This vulnerability was recognized early on, no doubt from sad experience, and remedial measures were taken to alleviate the potential problem. Blakely added hoops to the rear of the reinforce by roughly one caliber beyond the rear of the powder chamber, thus putting the breech under some initial tension, in his 1859 designs. Whitworth and Armstrong followed suit in 1860, as did Parrott in 1861.

The best solution, however, was jointly patented by C.W. Lancaster, known for his elliptical 'rifled' gun of the Crimean War which bears his name, and John Hughes of the Millwell Ironworks. They realized that by extending the jacket reinforce to surround the cascabel should provide the necessary initial tension to effectively reinforce the breech.

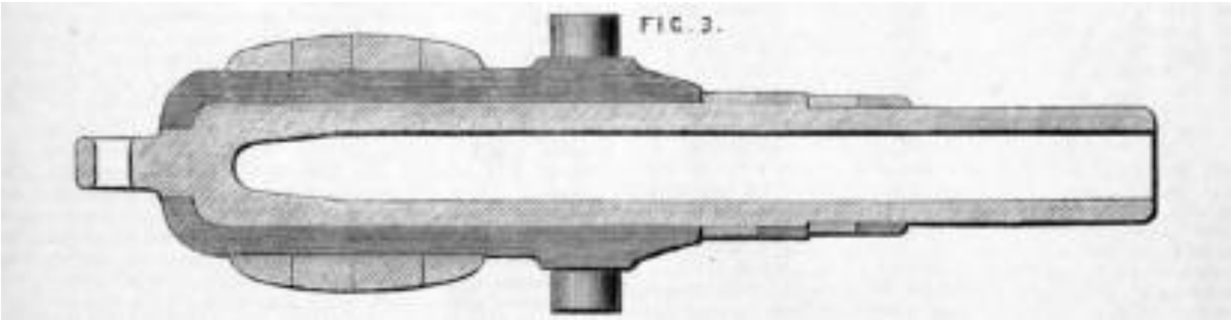


Fig. 46. Breech reinforce Lancaster patent

Knowingly or not, in the 1860 – 63 period, the Captain used similar forms on several guns, beginning with the 3.5 in 12 pdrs sold to Peru in 1861, which featured a discreet steel sleeve from cascabel to the trunnions, flush with the contour of the gun. Numerous field pieces sold to the Confederacy utilized the same feature. And in a slightly different approach, some medium caliber guns were fitted with a jacket that covered the breech to just behind the trunnions, but not flush with the contour. And the composite guns of 1862-3 featured an extension of the cast iron jacket that served as both trunnions ring and breech reinforce, though cast iron reinforcing steel seems rather absurd. See the images below in Part 2 of this article.

In 1866, Lancaster and Hughes sued Captain Blakely, et.al, for Patent Infringement. Thus, Blakely became the 'front man' representing other parties, which included Armstrong and the RGF at Woolwich, as well as Fawcett, Preston. So Blakely admitted to adopting the method and agreed to a settlement of £ 350, which presumably included licenses for the continued use of the method.

Another solution to the problem was invented by John Dahlgren, famed for his smooth bore naval guns. Essentially, he designed a 'strap' that created what one might call 'counter tension.' Essentially, a bronze 'strap' was anchored with rivets to the trunnions and wrapped around the breech under tension. The intent was to provide pressure to counter the longitudinal stress from the gas pressure; support for the gun in that critical area between the breech and the trunnions. The device was applied to all US Navy rifled guns, except the Parrotts.

The matter of transverse strain was dealt with partially by the reinforce supporting the breech and powder chamber, and as this reinforce was extended towards the trunnions. But the chase remained an issue, alleviated incrementally over the rest of the decade. Confederate designer John Brooke took the first steps in 1862 with his 7 ins triple banded gun. First, he eliminated the trunnions, which were a source of weakness in cast iron guns. He also extended the coverage of the first reinforcing layer of hoops. The gun was 153 inches long, 85 of which were reinforced. This band also tapered as it moved forward, being 2 ins. Over the breech, powder chamber and projectile, then continuing over part of the chase at a thickness of 1.5ins. The second band, 45.75 ins long, covered the powder chamber and seat of the projectile, with a thickness of 2ins. The third band, 30 ins. long, covered the powder chamber with another 2 ins. of wrought iron. In contour, its resemblance to the Dahlgren 'pressure curve' is not coincidental, though the Brooke gun was much stronger.

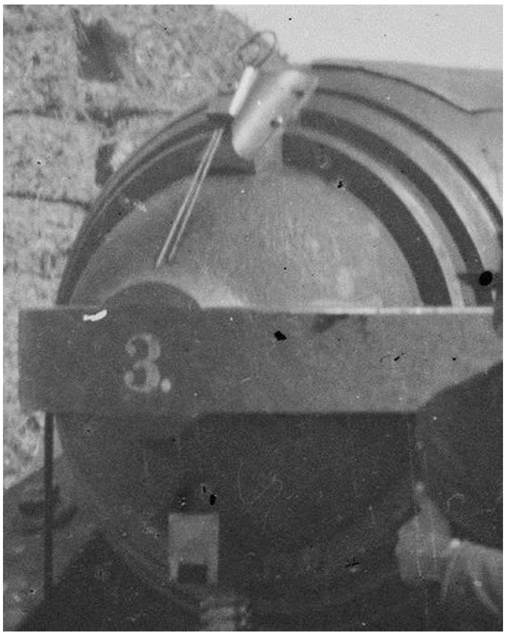


Fig. 47. Breech reinforce Brooke 7in triple

Blakely had also designed several guns without trunnions, using a separate trunnion hoop which allowed the jacket to be extended forward. Even with the composite guns, the trunnions were attached to a separate hoop, and Vavasseur followed that practice. Vavasseur also extended the reinforce to the muzzle, which countered but never eliminated the transverse strain.

Resisting pressure is one set of problems. But a side effect of the sudden strain, as in the sheer force or 'knock' of the powder explosion, is communicated from layer to layer as 'vibration.' And as Great Guns grew in size and complexity, with more and more 'parts' involved, vibration could and did have negative consequences. And in this contest, the hoops or coils or rings or bands are considered 'parts.'

If the layer or layers of hoops are not firmly attached to the layer below – say merely screwed or bolted on, or only welded in place – then the means of attachment will be greatly strained with each succeeding round fired. Screws or bolts could be sheared, welds broken, bands/hoops/coils could shift and open a gap making a weak spot…these have all happened, as will be noted below.

The safest form of attachment was carefully calculated and 'properly adjusted' shrinkage of hoops/coils/bands so that they were held in place by the same tension that is their purpose in the first place. Then the sudden strain and resulting vibration can best be absorbed by sufficient mass. No or too little initial tension results in injury or failure. For this reason, a heavy, one piece jacket or mantel were considered more effective than individual hoops/bands or coils; fewer 'parts' that could fail individually. In this regard, Blakely had used jackets/mantels in some of his designs, mostly for smaller calibers, as the reinforce in lieu of hoops, and hence forged and shrunk onto the barrel. But with the soundness of steel castings from such companies as Messers. Naylor, Vickers & Co, Bechum Company [Prussia] and Krupp of Essen [Prussia], he began using annealed cast steel for the outer jackets/mantels in his designs. These were to be fitted over the reinforcing hoops and serve as an anchor for the trunnion ring. Some critics claimed that such a structure would add little strength to the gun, which could only be obtained by much more expensive forging. But the Captain seems to have reasoned that the advantages of hollow casting and cooling from the inside, a la Rodman, would compensate for any uneven cooling of the hoops with "an increase in specific gravity and toughness."

The caveat, however, seems to have been that the reinforce, in whatever form, must be a 'higher' metal than the barrel/'A' tube, and provide the correct combination of tensile strength and elasticity to provide strong support to the inner layers and to absorb the 'blows' and stresses. Thus high steel was used to reinforce low steel, and steel or wrought iron used to support cast iron. This in part explains the numerous failures of the 'Armstrong System' of gun design, and the necessity of small powder charges in the Palliser conversions, which relied on the cast iron of the original gun to support the low steel inserted tube.

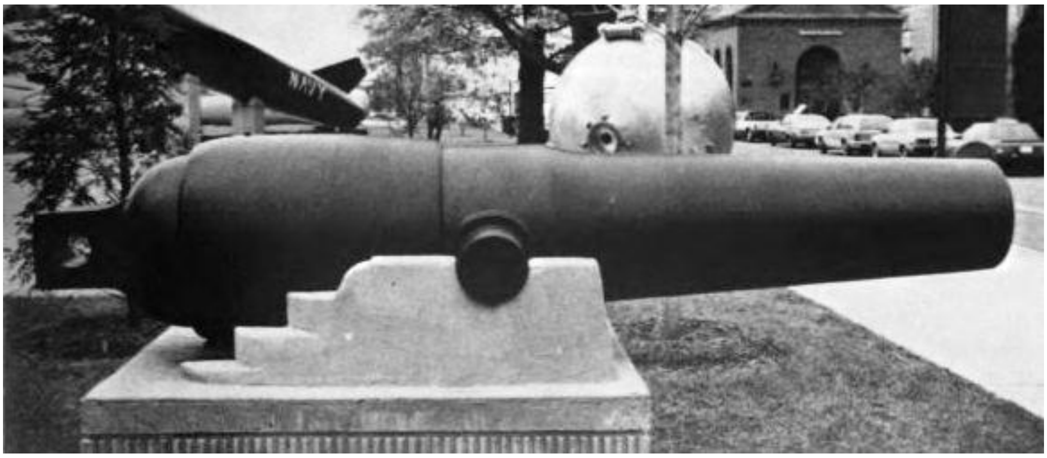


Fig. 48. Florida's 7-inch Blakely Gun at Williard Park

In these early decades of the 1860s and 70s, no one did this perfectly. Armstrong used increasing masses of wrought iron coils to reinforce an inner wrought iron coil, and later low steel. He told the Institution of Civil Engineers in 1860 that, "The outer layers and rings of metal are not put on with any calculated degree of tension; they are simply applied with a sufficient difference of diameter to secure effective shrinkage." So it would appear that, while paying lip service to 'initial tension,' Sir William was relying more on sheer mass rather than science or mathematics. Mr. Parrott seems to have relied more on 'scaling-up' from a successful design, on which more below.

The side effects associated with the heat generated by the propellant burn are several, and involve a variety of caveats and conditions.

1st, with cast iron guns, heat tends to expand the interior of the gun, putting the interior layer into compression and the exterior into tension. However, the area of the gun beneath 'properly adjusted' hoops or jackets provides support in that the exterior was already under tension, and thus counters to a considerable degree the compression of the interior layer.

During firing trials of a Parrott 100pdr 6.4in gun, at the 300th round, three incipient cracks appeared round the vent-piece, but were not much increased by constant firing...the greatest enlargement [of the bore] was 0.23 inch near the seat of the brass ring [gas check of the projectile] and opposite where the reinforce terminated.

Captain Blakely noted in an 1862 article that, in the 1859 Spanish trials of a 16.1cm cast iron hooped gun (Blakely patent construction), which had withstood 1366 rounds without injury, "on the first day 100 rounds were fired using a 7 lb. charge and 61 lb. shell, at a rate of 60 to 90 seconds between rounds, the gun became too hot to handle. So on subsequent days, the gun was fired at the same rate, but limited to 50 rounds in the morning and 50 rounds in the evening."

On May 15, 1863, the Tredegar foundry suffered a nearly catastrophic fire. This caught the second of Brooke's 7in Triple Banded gun in the final stages of completion, and the high heat severely damaged it; the extreme heat causing cracks to the outer layers and crystallization of the cast iron in the most affected areas. The gun was promptly condemned.

Mr. Norman Wiard, in an 1863 Paper addressing the tendency of Parrott guns to burst, put much, if not most of the blame on the weakening effects of heat from continued firing. He may have had a valid point when considered in the context of other circumstances, of which more below.

2nd, Mr. Wiard also noted that use of steel for the inner tube, "although in direct contact with the hot gases, would not expand much more than an outer layer of bronze, so that the initial heat wave would be little disturbed."

3rd, Mr. Wiard recommended that the various layers of the structure of the gun be composed of different metals that can expand without excessive strain on the structure.

In points 2 and 3, Mr. Wiard would seem to be advocating in favor of the all steel built-up gun, with its low steel inner layer/barrel/'A' tube reinforced by high steel.

Injured Parrots

Robert Parker Parrott had a unique and confrontational personality, and seems to have opposed any and all innovation that might reflect negatively on his gun design. He rejected Dahlgren's breech 'strap' reinforcement, seemingly because it would imply his guns were not strong enough. He opposed the use of Rodman's hollow-cast method to the point that the government was forced to make it a contractual requirement; all Parrott rifles produced after 1863 must be hollow cast. He opposed the use of Rodman's 'Mammoth Powder,' though relented in the case of the 10 in. guns. And, having developed his 'pattern' in 1861, he refused to consider that there might have been flaws in his reasoning, all evidence to the contrary notwithstanding.

Holley's description, written in 1864-5, presents some points of interest. He noted that the guns were, "…cast iron…of ordinary shape, except a little lighter at the breech, is reinforced over the chamber with a wrought-iron hoop made from a coil substantially like the Armstrong coil in proportion and manufacture…The hoops are shrunk on without taper, the difference in diameters being 1/16 inch in 1 foot. They are fastened to the cast-iron only by the adhesion due to their tension, and have never been loosened during test or in action…The length of the reinforce, which in the 100pdr is but 27 in, is believed by Captain Parrott to be sufficient to take the first and severest pressure of the powder in starting the projectile…The sole object of the reinforce is to enable a cast iron gun to stand a rifled projectile with the service charge that would be employed for a spherical shot…The gun is cheap, and has proven very serviceable…It is intended not to exhaust the capabilities of the system of initial tension…without serious risk of damage by exposure and maltreatment…"

In 1862, Parrott published a pamphlet, apparently discussing and criticizing the artillery construction systems in use, and likely extolling his guns. In the course of time, Captain Blakely read it, and responded via a letter in The Engineer, published on December 11, 1863.

"I yesterday saw, for the first time, a pamphlet published in New York last year by Mr. Parrott, in which my system of building canon is vigorously attacked by the author…He ends by claiming great originality for his own particular form of gun, which he thus describes; -- 'It is a hooped gun of the simplest kind, composed of one piece of cast iron and one piece of wrought iron. It has no taper, no screw, no successive layers of hoops.'

"I confess I have been a good deal astonished by these claims to superiority, and you will share my surprise on comparing the accompanying drawings, where you will see that the vaunted Parrott and Brooke guns are simple reproductions, in 1861 and 1862, of the guns I had made in Liverpool in 1859…

"To prevent any possibility of cavil, I send you the original working drawings of my cannon… No. 1 is a section of my 6 4/10ins. gun of 1859. You will perceive that it is dated November, 1859, and signed by Messrs. Fawcett, Preston and Co.

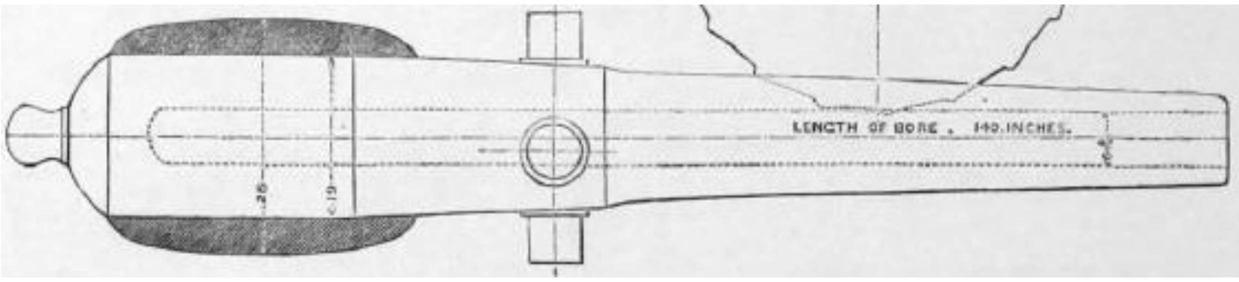


Fig. 49. Blakely 6.4in 1859

"No. 2 is a section of the Parrott gun of the same caliber first made in 1862. This is drawn from official descriptions which I enclose…

"No. 3 is a section of the Blakely 3.5in. gun… which was… adopted as the model for Confederate guns, in consequence of its being serviceable after firing upwards of two thousand rounds. This is also an original drawing, and you will perceive Messrs. Fawcett, Preston nd Co's signature, and the date of 15 May, 1860.

"No. 4 is a section of the 3.67in Parrott gun of 1861, the nearest in size to the above. The proportions you see are precisely the same [as the Parrott 6.4in. gun].

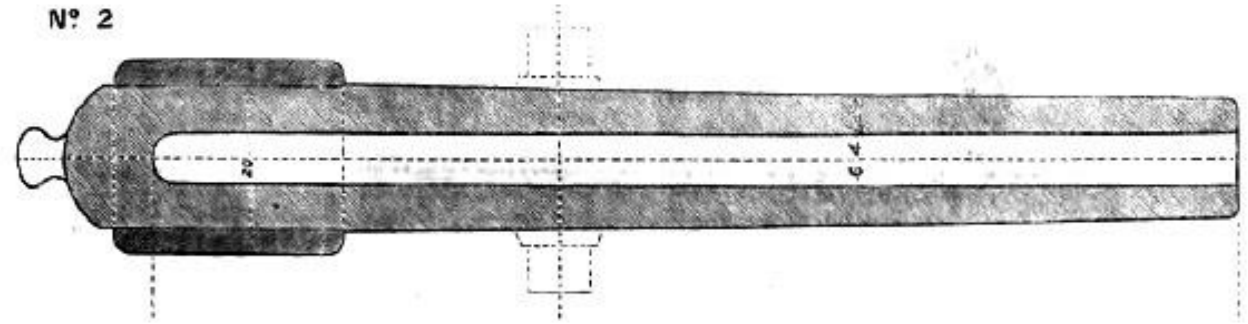


Fig. 50. Parrott 6.4in 1862

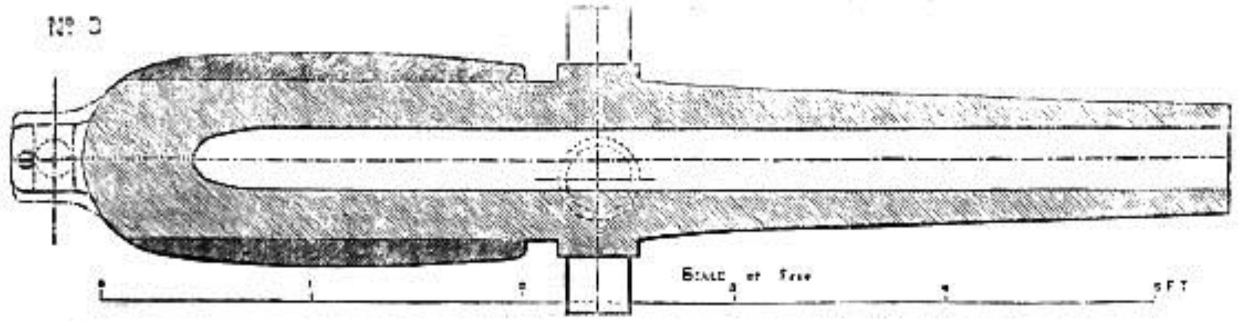


Fig. 51. Blakely 3.5in 1860

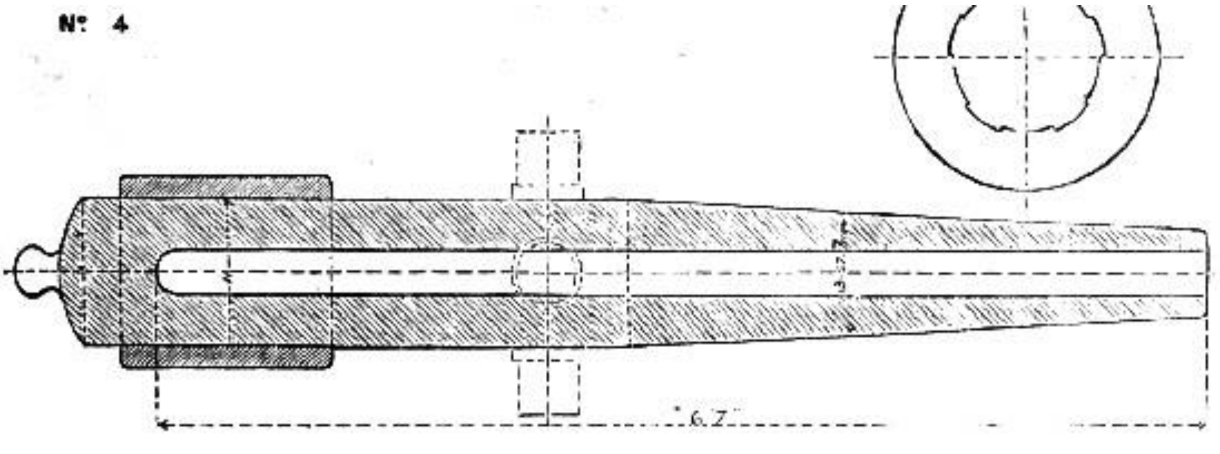


Fig. 52. Parrott 3.67in 1861

"No. 5 is the Brooke gun, also 1861. This drawing is also an original, and signed by Captain Brooke himself...It is a simple copy of my 'Sumter' gun with all its faults, sharp angled rifling, etc.

"Mr. Parrott, in his pamphlet, says, 'Succeeding layers of hoops are deemed, both by Captain Blakely and Professor Treadwell, essential in obtaining the full advantage of this plan [of initial tension for large bore guns].'

"I do think several layers necessary for large guns, and Mr. Parrott will think so, too; and he will wonder how he could, after all the published experience of Sir William Armstrong and Mr. Whitworth, have fallen into the same error they did, namely, making his large guns on the same model as the small ones, instead of greatly increasing the proportionate strength...".

The bold emphasis of key phrases expresses a major flaw in Parrott's system. Looking at the critical area from breech to trunnions, he simply scaled up from 3.67 in to the larger calibers. The length of the reinforce, for example, is proportionately the same, at a bit over four calibers; 15 ins for the 3.67 in 20 pdr, 17 ins for the 4.2 in 30 pdr, 22 ins for the 5.3 in 60 pdr, 26 ins for the 6.4 in 100 pdr and 34 for the 8 in 150/200 pdr (sources do not agree on the figures. The alternative numbers are 16.5 ins for the 20 pdr, 19 ins for the 30 pdr and 27 ins for the 100 pdr. It is quite possible that the length of the reinforce was altered at some point during the war). By way of comparison, Blakely's first field piece, the 'Sumter' gun, was a 3.75 in 16 pdr with a 22 in reinforce, and that for the 3.5 in 12 pdr was 24 in, with 36 ins for the 6.4 in.

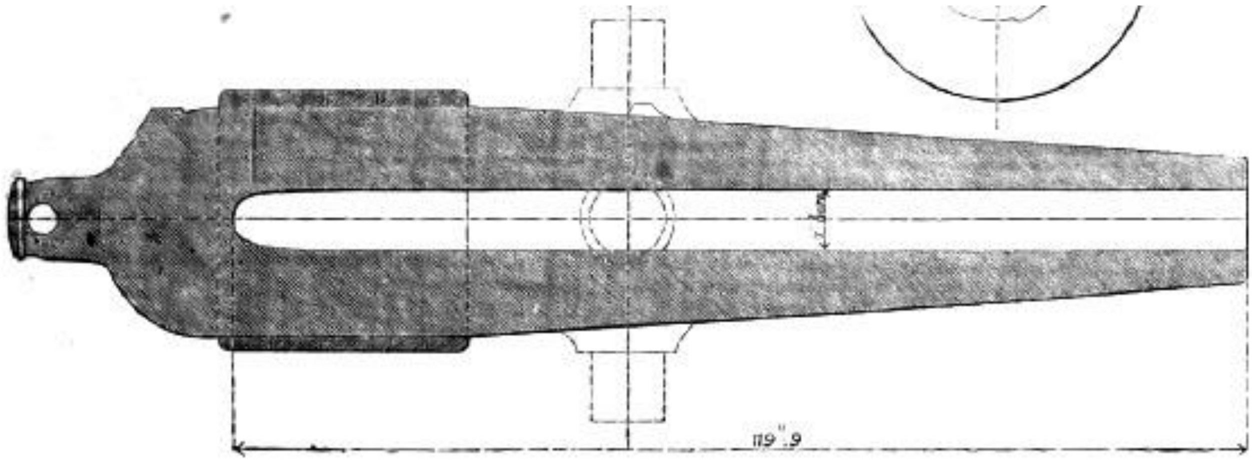


Fig. 53. Brooke original 6.4in design

Likewise, Parrott scaled the thickness of the wrought iron hoops was scaled, beginning with 1.5 in for the 12 pdr on the 20 pdr, 2.1 in on the 30 pdr, 2.66 in on the 60 pdr, 3.2 in on the 100 pdr, 4 in on the 150/200 pdr and 5 in for the 10 in; essentially a half caliber. Parrott's intention, according to Lt. Edward Simpson writing in 1862, was that the reinforce "…is only just long enough to cover the space occupied by the charge of powder and the [base of the] projectile…that a decided advantage is gained by making the reinforce no longer than is absolutely necessary to strengthen the gun at this point."

Looking at the 6.4 in 100 pdr in particular, the approximate disposition of the band was about 8 in over the breech behind the bore, and depending on the type of powder being used, the 10 lb. charge would be about 18 in in length. This leaves very little coverage for even the base of the projectile, and as the projectile advanced to the point of peak pressure, it is the unreinforced cast iron in front of the bands that would be subjected to the full gas pressure and heat of the burning powder.

In his written statement of November 15, 1864, preparatory to the official Inquiry into the injuries his guns suffered during the siege of Charleston, South Carolina, Parrott maintained his position that "…the failure of guns from blowing off the muzzle, or any part of the cast iron forward of the band, or the existence of obstruction in the bore, accidently introduced therein, though the same cause may also have brought about the destruction of the guns in other parts, as by blowing out the breech, of which one case occurred where the shell was wedged in the bore…My guns are strengthened in reference to the strains usually causing the bursting of guns not banded…In the small number of accidents which have happened with my guns in the naval service, not one has occurred from blowing out the breech…In no case is there evidence that a fracture has commenced directly in front of the band…"

In view of the preceding discussion of the forces and strains which a gun must bear, such claims should be examined, but with the understanding that often there is no single event that caused the burst. Cracks in the tube and breech can build up over time and finally give way. Pressure spikes can overcome a weakness caused by excessive heat or vibration from hard use. Human choices can produce negative consequences. And flaws in the design can have serious consequences. Most overt causes are self-explanatory, such as the shell wedged in the bore. Injuries to the chase and muzzle are most likely due to premature shell explosions.

Researcher Mike Ryan, in his work entitled Guns of Fort Sumter and Fort Moultie, compiled a list of 81 Parrott guns, 5.3 ins and larger, that burst or suffered irreparable injury during the Civil War. Since then, an additional gun has been found on Morris Island, bringing the total to 82.

Table 1. Injured Parrotts

	Army	Army	Army	Army	Navy	Navy		
Event	5.3in. 60pdr	6.4in. 100pdr	8in. 200pdr	10in. 250pdr	6.4in 100pdr	8in. 150pdr	Total	Percent
Burst in front of band	1	25	2		7	1	36	43,90 %
Burst/cracked Breech	1	3	9		5	1	19	23,17 %
Burst/cracked Vent					8	1	9	10,98 %
Burst/cracked chase/muzzle	1	1		1	7	4	14	17,07 %
Burst through band		1					1	1,22 %
Burst/cracked w/o specifics					1	2	3	3,66 %
Totals	3	30	11	1	28	9	82	
	3,66 %	36,59 %	13,41 %	1,22 %	34,15 %	10,98 %		

6.4 in. Failed breech to trunnion	49	59,76 %
8 in. Failed breech to trunnion	14	17,07 %

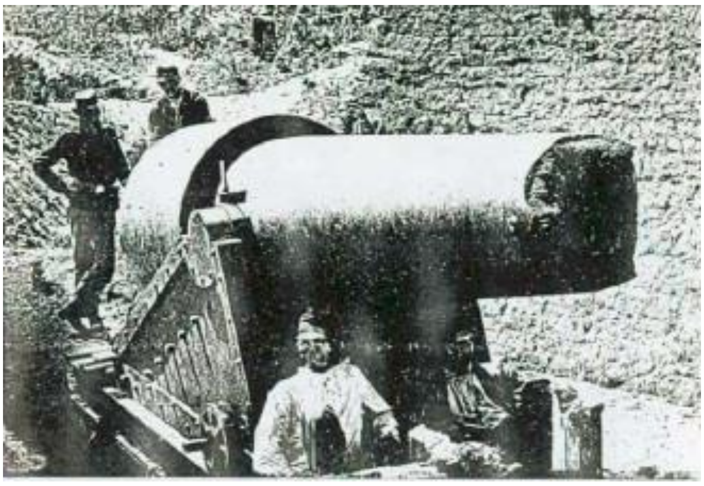


Fig. 54. Parrott 10in premature in muzzle

Shocking as those statistics are, the important questions are why did the 10in, 8in and 5.3 in suffer so much less than the 6.4in gun? Part of the answer is that the charges for the 8 in and 10 in guns were proportionately smaller; to match the proportion of the 10 lb in the 6.4 in, the 8 in should have had 19.5 lbs and the 10 in 38, instead of 16 and 26. This translates into relatively shorter charges, the one for the 8in was about 14ins, assuming the same powder. The 10 in used Mammoth powder, so the pressures were substantially lower. Second, the reinforces were longer and thus covered more of the charge and projectile. So the margin for the 8 in was appreciably better; 34 in total minus 10 over the breech behind the chamber, minus 14 ins of charge leaves about 10in of the projectile covered, and likely cover the point of peak pressure as the shell advanced. For the 10 in the situation is even better; 36 ins minus about 12in over the breech behind the chamber minus about 10 inches for the charge leaves about 14 ins of coverage.

Another contributing factor to the injuries in the 6.4 in and 8 in guns could be the type of powder used. The standard Army powder was Hazard No. 7, which in loose form was a ‘hot’ and ‘quick’ cannon powder. The Navy preferred the ‘cooler’ and ‘slower’ DuPont No. 7. But the situation around Charleston called for maximum range shooting, so the Army chose the 'hotter' and 'quicker' Hazard No. 5 powder, which would produce a slightly higher muzzle velocity and about 400 yards more range, but at the price of higher gas pressures and heat, opening existing cracks and creating new ones. Add in the exacerbating effects of high elevation, and the counter-intuitive increase in pressure from using a light shell, and bursting guns and other injuries became an almost inevitable consequence.

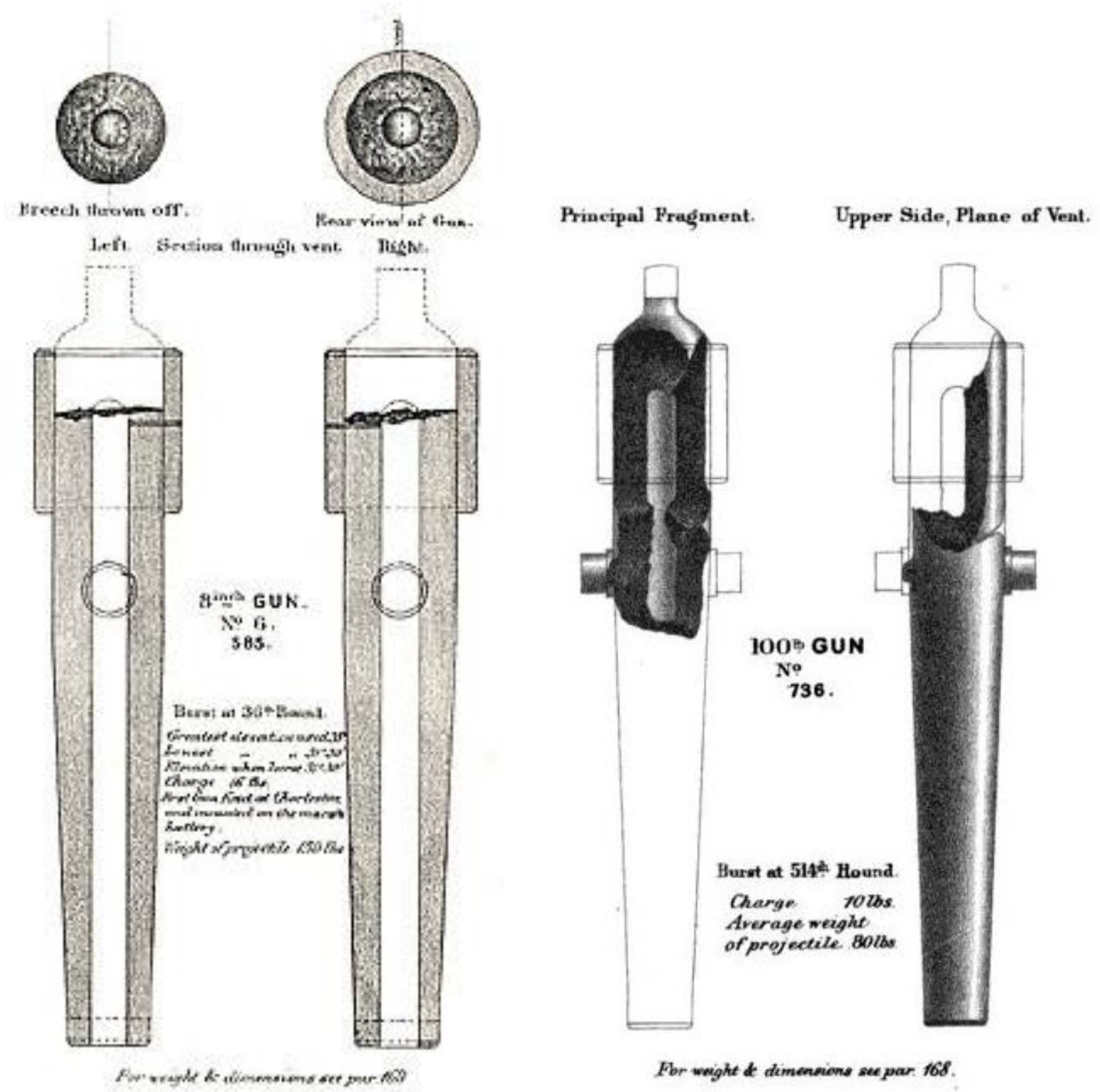


Fig. 55. Swamp Angel 8in 200 pdr blown breech (left photo), 6.4 in Parrott burst into four pieces (right photo)

And finally, there is the question of the "road not taken." Rodman's trials and experiments had already proven that his 'full bore cakes' with a single perforation, and his Mammoth Powder would greatly reduce pressures in the gun, though at the cost of reduced performance. He had also demonstrated that a 25 % increase in charge weight would restore performance while keeping gas pressures low. Indeed, a 30 % increase would likely represent no danger to the gun.

Parrott only reluctantly acquiesced to the use of Mammoth Powder in his 10in gun, but retained the same charge weight. The charge of 26 lb. flake powder was about 12ins long, but the same charge weight of Mammoth Powder was actually more than an inch shorter, providing a slightly greater margin of coverage by the reinforce. Increasing the charge weight by 25 % to

32.5 lbs would have meant an increase in length to about 11.75 ins, and a 30 % increase, to 33.75 lbs. would have increased the charge length to about 12.25ins.

By applying the same logic to the 8in gun, the 'light' 16 lb. charge of grain powder, about 16.3ins long, with a 20 lb. charge of Mammoth Powder, which would be about four inches shorter. And the full 30 % increase to a 21 lb charge would be only about 14ins long and deliver higher performance. But would the reduction of gas pressures have prevented many of the bursts in that critical area from the breech to the trunnions?

And if the answer to that question is at all positive, then what about the more numerous 6.4 in 100pdr gun, where coverage by the reinforce was marginal at best? As mentioned above, the 10 lb. charge of grain powder was about 18ins long. The same weight of Mammoth Powder would be about 10ins, but with lower performance. Increasing the charge weight to 12.5 lbs. would restore 'normal' performance, and the charge would be about 12.25 ins long, still 5ins more covered by the reinforce. The full 30 % increase would deliver better performance, and the 13 lb. charge would be about 13 ins, long, but still producing much lower gas pressures.

There is, however, a counter argument that may have some validity. Parrott chose a 'short' reinforce intentionally, on the grounds that the 'quick' cannon powders would deliver the initial shock and the peak pressure point under the protection of the reinforcing hoops. But the compressed and molded powders burned at a lower rate, which lessened the initial shock on the one hand, but also moved the peak pressure point forward which, especially in smaller guns, could be in front of the reinforce, even though at much lower pressure. So the question would be, would the cast iron from in front of the bands to the trunnions be able to withstand even that much reduced pressure? Only trials could have provided an answer, and such trials were not performed.

But two strong indications post-war lend credence to the concern. Juan L. Calvo, in his work on the history of Spanish artillery, notes that when Spain began using slow-burning powder – in this case DuPont Hexagonal – many of the pre-existing smaller guns that had been hurriedly rifled and banded in and after 1859 had burst in front of the reinforce. Obviously a longer reinforce would have precluded such a problem.

Fig. 56. Spanish gun failure due to compressed powder

And the British Admiralty limited the charge weight for the Palliser conversion of the 8.12 in 68pdr into the 6.4in 64pdr MLR to 10 lbs. of RLG, in spite of the of the wrought iron, and later steel, liner. Effective February 1, 1865, they reduced the service charge from 10 to 8 lbs; nor did they approve a charge of Pebble powder for that gun or its 'purpose built' successor, the Mk. IV.

The Bureau of Ordnance must have been thinking along similar lines, as by the end of 1864 they had reduced the charge for the 100pdr to 8 lbs. And in a final irony, the 10in, 6.4 in and 5.3 in Parrott guns Spain purchased post war – the latter two for the Navy – were modified with, among other things, had the reinforce extended almost to the trunnions, likely to accommodate the slow-burning powder. This would have made the guns considerably heavier, but also considerably safer, and was a tacit admission that Parrott's many critics had been correct.

The Parrott guns were injured in the stress of combat operations during war. But the record of Armstrong's guns is largely unknown, though Tennant wrote of a "cemetery of dead guns" behind the Woolwich facility by the Thames River. As Blakely wrote, quoted above, scaling up from a successful small gun does not produce a successful large gun, although in all fairness, Sir William had been under intense pressure to produce the RBL 7in 110pdr quickly, by those who were deluded with the belief that it would be successful against armor plate. In consequence, the necessary time for proper development was foregone. On the other hand, his reliance on wrought iron to reinforce, at first welded wrought iron coil and later a low steel tube, was, to be diplomatic, misguided. In addition, the number of 'parts' involved in the complex construction of his guns was an invitation to numerous problems.

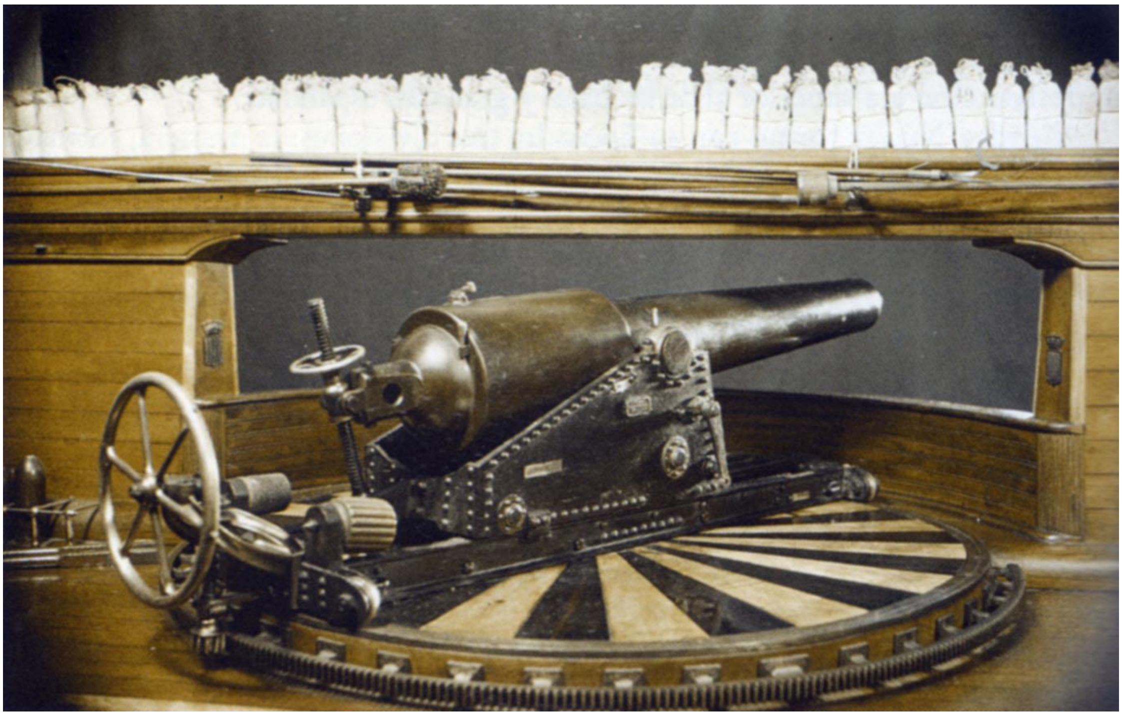


Fig. 57. Model of 100pdr Parrott gun in Spanish service

Injured Armstrong's

William Armstrong's saga as a gun designer and manufacturer was in two parts. The first can be said to have begun in July of 1855 when he presented his first design for a 3pdr RBL field piece to the War Office, and ended on February 15, 1863, when he resigned his post as Superintendent of the Royal Gun Factory, Woolwich, to which he had been appointed in 1859. During that period, he created the Elswick Ordnance Company (EOC) to cooperate and coordinate with the RFG. The division of work had the RFG responsible for repairs to injured guns, building experimental guns, and much of the production of guns. EOC designed the guns, conducted the experiments and trials and production of guns. Both build the same guns in the same manner; the Armstrong system of coiled wrought iron – only rarely was steel used.

A simple explanation of the 'system' relies on the ability to tailor-make wrought iron coils to a particular thickness and internal diameter. The coil is 'finished' by hammering and cutting to create smooth ends, then heated to welding temperatures to fuse the coil together. For the inner coil ('A' tube), the inner surface is then sanded smooth. A similar process, but slightly larger internal diameter, produces the shot chamber, and likewise, but again slightly larger internal diameter, creates the powder chamber. For example, in the 110pdr 7in gun, the bore would be 7 ins, the shot chamber 7.075 ins, and the powder chamber 7.2 ins.

Onto this structure reinforcing coils of wrought iron would be added. Each coiled tube would be assembled and 'finished,' with an internal diameter precisely 1/16th inch smaller than the external diameter of the tube it was intended to reinforce. It was then heated to welding temperature, at which the metal would be expanded, and while still red hot, slipped onto the tube. As it cooled, it contracted and thus provided initial tension. The breech mechanism was attached to the first reinforcing coil/layer.

The 'system' seems valid on its face, and certainly provided Armstrong with a very impressive string of successful smaller guns, specifically the 6 pdr 2.5 in, the 9 pdr and 12 pdr 3 in, 20 pdr 3.75 in and the 40 pdr 4.75 in. Two other designs passed the trials stage, an 18 pdr 3.25 in and a 25 pdr 4 in, but were not adopted as they were deemed unnecessary. But the leap to 7in and larger exposed the weaknesses in the 'system,' namely the limitations of wrought iron.

While easier to work and weld, wrought iron is very ductile, and will permanently expand or compress under stress. And as a material for coils, this ductility will 'relax' as a consequence vibration, with failures occurring sooner in larger guns, allowing coils to separate as welds crack. "Once the inner coil ['A' tube] yields, all the others on the outside become useless…" opined The Engineer.

Table 2. Table summarizes the guns returned to RFG for repairs by cause, as of June 1863, some months after production of Armstrong guns ceased as a result of the Findings of the Select Committee on Ordnance.

Event	7in 110pdr	4.75in 40pdr	3.75in 20pdr	3in 12pdr	3in 9pdr	2.5in 6pdr	Total	Percent
Cracks in chase/muzzle		1		1	1		3	6,12%
Cracks in chamber	2			2			4	8,16%
Cracks in breech	1			1			2	4,08%
Coil shifted		1					1	2,04%
Lining shifted				2			2	4,08%
Coil split				1			1	2,04%
Steel tube cracked		1	1	3			5	10,20%
Chase blown or burst		1					1	2,04%
Expansion of chamber	1						1	2,04%
Flawed welds	5	5		3			13	26,53%
Rendered unservicable by								
proving vent pieces	8	5	1	1		1	16	32,65%
Totals	17	14	2	14	1	1	49	
	34,69%	28,57%	4,08%	28,57%	2,04%	2,04%		

Not yet repaired	10	20,41%
Repaired and Servicable	18	36,73%
Unservicable	19	38,78%
Unservicable – to be shortened	2	4,08%

49 guns are but 2.07 % of the 2370 such guns produced. But 2370 is the number of guns issued to the armed services, and hence does not include, for example, about a hundred 7 in 100pdrs of 75 cwt that were never issued, being replaced by the heavier 7 in 110 pdr 82 cwt when it was decided to add additional reinforcement to the breech. Nor does it include any of the experimental and trials guns produced. For that matter, the 49 guns sent for repairs were only from those guns issued, and not those that failed inspection or proof prior to delivery, which could be a considerable number. For example, of 192 40 prds produced, 153 did not pass inspection and were pulled for 'repairs! ' And of that number, it seems 46 were for more major problems, ranging from 'fitting' the 'parts' together properly to alignment to replacing various tubes.

A review of the various experimental guns and their trials and fates, insofar as known, is very revealing, and worth some consideration.

- An experimental RBL 6.4in 100pdr was ordered from Woolwich to test Mr. Wesley Richard's breech design. The gun was almost 18 feet long and weighed almost 10 tons. It was considered an enormous amount of metal for its caliber.

- A 70 pdr 6.4 in was rifled on the shunt system with six grooves. It weighed 6903 lbs (61.6 cwt), had a bore length of 109ins, twist of rifling 1:45 calibers. The shell weighed 71.7 lbs and contained a 5.375 lb burster and was fired with an 11 lb maximum charge. During trials, the gun shot well, with little drift, but with considerable variance for range. Initial velocity was 1318.7 ft/sec with the 11 lb charge, and 1259 ft/sec with a 10 lb charge.

- A 9.625 in 20 ton gun was completed with a steel barrel ('A' tube).

- Two experimental 80 pdr 6in 63 cwt were constructed in 1859, one as an RBL and one as a MLR, both used for experimentation. The RBL was a proto-type, being a scaled-up 40pdr 4.75 in, and a step in the development of the 100pdr 7 in. It used a 10 lb. charge with an 82 lb. shot, or a 9 lb. charge for a 77 lb. shell, filled with 5.5 lbs. of powder. The MLR was used for rifling experiments, and served as a model for future muzzle loading development projects.

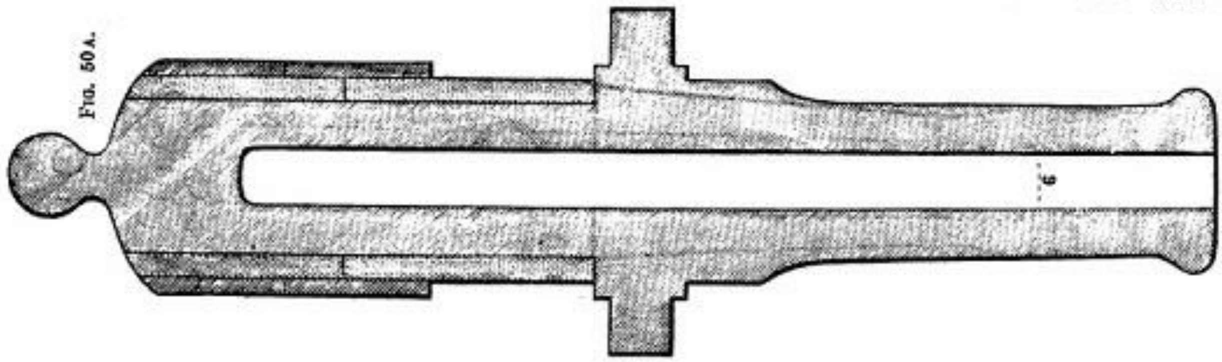


Fig. 58. Armstrong 70pdr of 1860 from Holley.

In September, 1859 the RBL was tried against the *Trusty* Target, which was a 4in armor plate backed by 25ins of Oak. Twenty two rounds were fired at ranges from 200 to 400 yards, some with 100 lb. steel bolts and a 12 lb. charge of LG. Only three penetrated the armor sufficiently to have an effect on the structure, and none passed through.

- An RBL 200 pdr 8.5 in side loader was built as follow-on to the 110pdr 7in 82 cwt gun. It weighed 8 tons 6.5 cwt (18648 lbs) with a bore length of 126.5 in and massive reinforce. Diameter over the breech and powder chamber was 35.5 ins, and 18ins at the muzzle. The 130 lb shot used a 28 lb charge, and a 24 lb charge for the 185 lb shell containing 12.8 lbs of powder.

During trials, following the seventh round, a bulge was observed astride the powder chamber, likely indicating the coils had split. This effectively dashed any hopes of further rifled breech loaders.

- A 110 pdr 7 in gun was tried to destruction. 127 rounds were fired with a charge of 27.5 lbs, and 48 with the Service Charge of 14 lbs. It was then thoroughly examined and cracks and indentations were found in the chamber. A further 133 rounds were fired with the same charge before the gun burst near the trunnions.

- Another 110 pdr fractured in the chamber and the rifling 'destroyed' after only 57 rounds.

- A 110 pdr was tried for endurance against a 6.5in gun from Mersey Steel and Iron Works. (see Appendix A) The Mersey gun burst with the 70th round; but at the 60th round the Armstrong gun had a cavity 2.75 ins deep in the chamber.

- Two experimental 120 pdr 7in guns were constructed; one as an RBL and the other as an MLR with shunt rifling. It was designed to fire a 120 lb bolt with an 18 lb charge.

Including proof rounds, the gun fired 103 rounds. In its final test shoot, the first round was a 140 lb shot using a 20 lb charge. The final round was a 98 lb shot with a 24 lb charge, when the trunnion coil gave way. As a result, the service charge for the 110 pdr was reduced from 14 to 12 lbs.

- A 120 pdr 7 in 7.5 ton gun, dubbed the 'New Naval Gun,' was ordered early in 1863, but rifling was to be determined at the conclusion of tests using the experimental gun noted above. This gun was intended to be a proto-type, and by the end of June 50 pre-production pieces had been ordered. But the bursting of the experimental gun, and a debate concerning construction, explained below, meant the order was pending.

-- Some experimental guns led to interesting and noteworthy lines of development. One such was a 150 pdr 10.5 in 12 ton smooth bore build in early 1862 using the Armstrong system, perhaps as a response to the formidable Rodman and Dahlgren guns. It was intended to throw a 167 lb steel round shot or a 152 lb cast iron round shot with a 50 lb powder charge, or a 114.3 lb cast iron shell containing a 5.25 lb burster with a 30 lb charge. The bore length was 125ins, diameter over the breech and powder chamber 38ns, with 19.5ins at the muzzle. Initial velocity with a 150 lb round shot was 1770 ft/sec using a 40 lb charge, and 2010 ft/sec using a 90 lb charge.

The gun passed proof and trials for range, and on April 18, 1862 it was fired at the *Warrior* Target. Using a cast iron shot and a charge of 40 lbs, two rounds were fired. The first made a 12 x 14 in hole in the plate and an indentation 37 x 20ins, but did not pass through the target. The second smashed 38 ins of plate, exposing the backing, with a 27 x 11in piece of the plate falling away.

The next two rounds were fired using 50 lb charges. Both passed through the target, one making a hole 11 in in diameter, and the other 11.5 in in diameter.

Fourteen identical guns were ordered.

This first 150pdr burst after firing a total of 264 rounds with 40 lb charges, with several of 50 lbs, one of 70 lbs, one of 80 lbs and one of 90 lbs. The 90 lb charge was not considered excessive as it was thought to be the equivalent of a 300 lb projectile with a 50 lb charge in a rifled gun. After the 70 lb charge, the inner coil split a spiral weld. With the next round using the 80 lb charge, that crack closed and another opened, parallel and near the first. The 90 lb charge made a crack parallel to the bore behind the trunnions. A few rounds later, the breech-piece pulled apart and blew out.

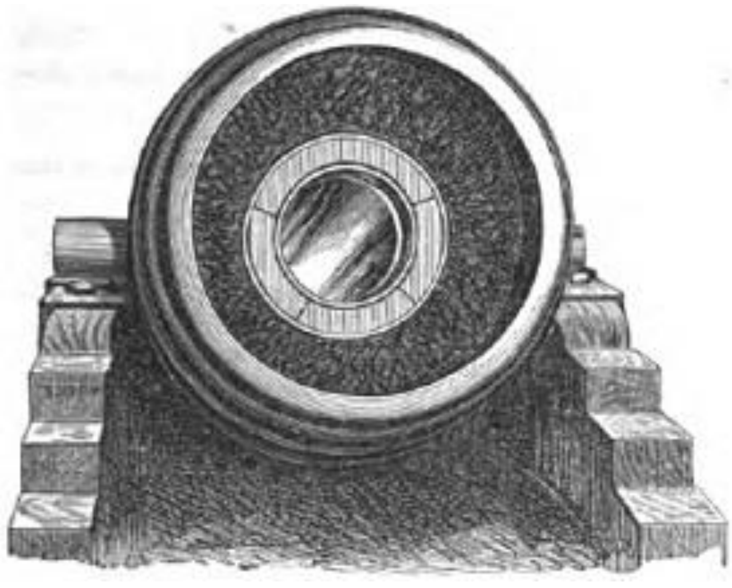


Fig. 59. Armstrong 150pdr blew breech from Holley

- As the newly built 150 pdrs were delivered in the summer of 1862, two were rifled with 10 grooves on the shunt system, converting them into 300 pdr 10.5 in MLRs. As such, they were intended to fire a 300 lb a shot, a 230 lb steel bolt, and a 278.6 lb cast iron shell containing 12.75 lbs of powder using a 45 lb charge. Initial velocity with the 300 lb shot was 1715 ft/sec using a 75 lb charge.

On 3 March, 1863 a 300 pdr fired against Captain Inglie's Second Shield, which was a truly gigantic structure representing a proposed system for protecting coastal fortifications, intended to counter the effects of vibration. The exterior face plate was of 8 ins of wrought iron, backed by horizontal slabs 5 ins thick, backed by another vertical plate 5 ins thick. The she mass of material would absorb the impact shock and vibration.

The 300 pdr with a charge of 45 lbs of powder fired a 230 lb bolt that struck with a velocity of 1400.6 ft/sec, but the resulting indentation was only 1.45ins deep and 10ins in diameter. This was followed by two shots using a 307 lb cast iron shot, which struck at 1228.4 ft/sec. The results were no better. One indented the plate 2ins by 12.5 ins in diameter, and the other 1.3 ins by 12 ins in diameter. These were followed by a 301 lb steel shot that hit with a velocity of 1293.1 ft/sec, and produced an indentation 6.2ins deep and 12.9ins in diameter. The final shot was with a 163 lb steel round shot, which struck at 1627 ft/sec and produced an indentation 3.74 ins by 13 ins.

This performance was actually considered quite good, as no ship existing or planned could carry such a mass of metal or deal with the impact shock and vibration and remain intact.

That same month, a 300pdr fired at the John Brown & Co's Target. The section of this complex target of interest consisted of 5.5in armor plate backed by 10ins of teak backed by a 1in plate, mounted on 1.5ins of skin plating, with the object of testing the effects of steel shell.

The 288 lb shell – flat headed with a thin cast iron hemispherical nose – contained a bursting charge of 11 lbs. It was fired with a 45 lb charge of powder for a striking velocity of 1318 ft/sec. It penetrated the outer plate and backing to a depth of 14ins, then burst. The teak at the point of the explosion was completely splintered and set on fire. At the back, a supporting rib was broken and the skin shredded and bulged.

On 22 April, a 300 pdr fired at the Chalmers Target, which was composed of an outer plate of 3 ¾ ins armor backed by alternating layers of timber totaling 10 ¾ ins placed horizontally, backed with skin plate 1 ¼ in thick.

Following 26 rounds from a 68 pdr smooth bore and a 110pdr, the 300pdr fired a 301 lb steel shot with a 45 lb charge, which passed completely through the target, bulging it considerably.

The next shot was a 150 lb cast iron ball using a 50 lb charge. This shot smashed an indent 11ins deep with considerable structural damage in an area 3 x 2 feet, but did not pass through. The following round indented the target 12 ins and cracked the 1 ¼ skin plate, but did not pass through.

In July, a 150 pdr fired at the *Minotaur* Target, which was composed of three plates 5.5 ins thick, stacked vertically, and backed by 9 ins of teak and ½ in skin. The upper plate was rolled by John Brown & Co; the middle plate was forged by Thames Ironworks, and the bottom plate by Messrs. Beale & Co.

The first round was a cast iron ball fired with 50 lbs of powder, which only dented the middle plate. The second round hit the upper plate, making a hole 12.5 x 13 ins. Round three hit the bottom plate, making a hole 16 x 30 ins. The fourth shot was a 162 lb wrought iron ball fired with the same charge, hit near the first shot, but remained in the indentation. The local effect was less than the first shot, but the shock effect was worse.

In December a 300pdr fired at the *Bellerophon* Target, composed of a 6in armor plate backed by 10ins of Oak and a 1 ½ in skin. The first round was a 150 lb. steel round shot fired with a 35 lb. charge. It penetrated the armor plate but imbedded in the backing, cracking the skin plate. The second round used a cast iron shot with the same charge and broke the armor plate but only dented the skin. A 300 lb. bolt fired with the same charge lacked the energy to penetrate the armor, and only dented it by 2.8 ins.

One of the 300 pdrs used for these trials in 1863 suffered a burst near the trunnion coil from no more than routine use with charges not exceeding the 50 lbs service charge. The service charge had been subsequently reduced to 45 lbs, and would shortly be reduced to 35 lbs, making them essentially useless for anything more than lobbing shells. Their lack of endurance was symptomatic of the fundamental problem.

- The performance of the 150 pdr smooth bores and the 300pdr rifled variant spawned two other lines of development. The first of these used the simple expedient of inserting a steel liner into the bore of a 150 pdr, thus creating an oversized 100pdr 9.22 in smooth bore gun.

This new test-bed smooth bore gun made its first appearance, following the usual proof round and ranging shots, was the March 3 trial against the Captain Inglie's Second Shield. It is credited with one round, 113 lb steel shot fired with a 25 lb charge. Striking velocity was a credible 1461.8 ft/sec, and the result was an indentation 2.4 in deep and 11.3in in diameter. It then went on display at the Great Exhibition of 1862.

This was sufficiently impressive that EOC determined to have the gun rifled, which produced an oversized 200pdr MLR. Subsequently it was fired at the *La Flandre* Target, which was of two levels; the upper with 4 ¾ in armor and the lower with 5 ½ in armor. These were backed by 10 inches of Teak laid horizontally, 11 inches of Oak placed vertically, and a layer of Oak plank 6 inches thick. The upper layer was supported by 4 ½ inch knee plates.

The first round, a 225 lb steel shot, using a 30 lb charge, passed completely through the target and penetrated the knee plate; a total of 9 ¼ inches of iron and 27 inches of wood.

The next round featured a 258 lb experimental chilled iron hollow shot from Captain Palliser. It passed through the target, but broke up in the process of tearing off a 4 ½ inch knee plate.

Two more rounds were fired at the upper target, both passing completely through. Then a steel shell with an 11 lb burster was fired at the lower target with the same 30 lb charge. It burst while penetrating the armor plate, splitting it and the wood backing.

EOC decided to design a new, purpose-built gun of that 9.22 in caliber using the normal Armstrong system of wrought iron coils; in concept a 'scaled down' version of the 300 pdr.

The trial gun was probably delivered by the end of May as a smooth bore because the question of rifling had not been solved. It weighed 12544 lbs (5.6 tons) and had a bore length of 106ins. Following the normal proof and ranging shoots, it was considered to be too 'light' and required additional reinforcing, but apparently it shot well, and so 50 pre-production guns to the new design were ordered. The design with additional reinforcement brought the weight up to 13514 lbs. (6.03 tons). The decision to replace the wrought iron coiled 'A' tube with tempered cast steel, and reducing the bore to 9 inches, brought the production weight down to 13216 lbs (5.9 tons). In this form, the guns served as prototypes for the 9in 12 Ton gun.

The fundamental issue which had created the schism between Sir William Armstrong and the Select Committee on Ordnance was deeper than the failures of the 110 pdr 7in 82 cwt gun, and went to the basic concepts of the Armstrong system. Sir William believed steel was too 'brittle' to be used in large cannon, and kept faith in his coiled wrought iron. After months of Inquiry, testimony and deliberation in 1862, the Committee suspended all production of Armstrong guns in January of 1863, which led to Sir William's resignation on February 15th.

In the meantime, metallurgy had made another advance, in the form of a considerably improved process for tempering steel in oil for greater 'hardness' without 'brittleness.' The RGF rapidly adopted the process for the 'A' tube of newly built guns, replacing the wrought iron coil with a tempered steel tube, though they retained the use of wrought iron coils for the reinforce. By the end of the year, EOC had followed suit [It should be noted, however, that Blakely had been using steel since 1861-62, and all-steel was the norm in 1863. Vavasseur had used oil tempered steel in his field pieces and sub-contract work, and brought the process with him into the Blakely Ordnance Company partnership. Very few Blakely all-steel guns did not use oil tempered steel, and those few exceptions were likely a matter of cost to the customer].

The pending order for fifty 120 pdr 7 in 7.5 ton guns was also affected. Four of the guns were quickly built to a new design weight of 7 tons 9 cwt, each rifled differently; Scott's, Lancaster's, Britten's and the French *la Hitte* systems, and two re-bored to 8 ins for experimental purposes. One 110pdr and perhaps three other calibers were modified – having the wrought iron inner coil pulled and a new tempered steel tube inserted – for trials.

In June of 1864, one of the new 200 pdrs fired at a target composed of a 6in armor plate backed with 30ins of Oak and the usual 1 ¼ in skin plate. Using a 220 lb bolt with a 44 lb charge, the striking velocity was 1460 ft/sec. The bolt passed entirely through the target.

- By far the largest gun built on the Armstrong system was the 600pdr 13.3 in 22.9 ton monster which, for all of its achievements, serves as a monument to over-reaching failure. Developed in 1862-63, it was basically a 'scaled up' 300 pdr, the bore length was 145.5 ins, diameter over the breech and powder chamber 51.5 ins, and 21.5 ins at the muzzle. The shunt rifling had a twist of 1:65 calibers. There were a variety of projectiles; 510 lb cast iron shot, 345 lb steel bolt, 600 lb steel shot, 601 lb cast iron shell containing a burster of 45 – 47 lbs, and a steel shell of 600 lbs with a 24 lb burster. Standard propellant charge was 70 lbs.

Following the normal proof a ranging shoots, the gun was tested in a series of trials. The first was on December 11, 1863 against the *Warrior* Target. Using a 610 lb steel shell with a 70 lb charge, initial velocity was about 1200 ft/sec. At a range of 1000 yards, the shell burst on entering the target and smashed a 20 x 24 in hole entirely through.

On March 10, 1864 the gun fired at a new target composed of an 11in armor plate. Using a 344.5 lb steel bolt and a 90 lb charge, striking velocity was 1680 ft/sec, which broke the plate into two pieces.

In July the gun was fired again at the new target the 200pdr had penetrated the month before. Using a 603 lb shot with a 40 lb charge, initial velocity was 860 ft/sec. This reduced charge and low MV were to produce a striking velocity of 840 ft/sec, representing a 70 lb charge and a 4000 yard range. The shot passed completely through the target.

But this was the end of the 600pdr. Its obituary, and that of the Armstrong system, was published on July 22 and 23 by the Army and Navy Gazette and The Engineer.

The gun had fired about 50 rounds in total, with charges ranging from 60 to 70 lbs, with one of 40 lbs and one of 90 lbs.

Muzzle velocity with a 70 lb charge and 510 lb shot was 1250 ft/sec. At an elevation of 23 deg. 9' the gun ranged to 7300 yards.

"After firing, the gun was carefully examined and found to have suffered most in the upper side of the powder chamber, which was covered with small cracks or openings, but, so far as could be ascertained, there was no flaw of any magnitude..." In fact, the chamber had been permanently deformed into an oval shape, and the inner tube started shifting after perhaps 20 rounds. "It is generally supposed that, had the inner tube been of soft steel – as all modern Armstrong's are [now] built with – instead of coiled [wrought] iron, it would have withstood the action of the powder gases better...By all doubt, however, the coils may be said to be gradually opening, and it is only a question whether or not the inner coil will stand a large number of rounds before it gives way..."

By way of an exclamation point, the two 'Laird Rams,' building for the Confederacy were impounded and then bought into the Royal Navy in 1863. As *Scorpion* and *Wyvern*, they were each armed with four 10.5in 300pdr Armstrong 'system' guns. On 5 November 1867, *Wyvern* sailed for artillery practice. One of the guns blew its breech on the fifth round, with only 33 lb charges used. Since the gun was mounted in 1863, only 57 rounds had been fired. The Admiralty promptly suspended further firings of the Armstrong gun, and ordered new 9in replacement guns from Woolwich.

Injured Blakely's and Brooke's

To put the information below into the proper context, it must be realized that it is *per force* incomplete, simply because complete information does not exist. The number of Blakely guns sold, including the early 'Conversions' from, 1859 to 1866 is not known. Even the customer list is unknown. Such information as there is comes from third party sources or official documents, all having a limited context. Many sales transactions were conducted through third parties, such as sales to China and Japan. The actual records were 'inherited' by Josiah Vavasseur, and became part of his records when he merged with Armstrong in 1883, thus becoming part of Armstrong's records, most of which were destroyed during WW II. The Prospectus for the Blakely Ordnance Co, Ltd in June, 1865 noted that the 'old company,' Blakely Ordnance Co. (the partnership) had six years worth of orders, specifically mentioning Russia, Portugal, Italy, Egypt, Sweden, China, Japan, Morocco, the Ottoman Empire and "states in North and South America..."

As a licensed user of the Blakely Patents, Brooke can be included because some information exists. Yet there is still much confusion when it comes to *bona fide* Blakely Conversions, of which there were very few. In other words, merely because the Confederacy rifled and banded a considerable number of old smooth bore guns does not mean they were legitimate Conversions, so attributing such guns to Brooke or Blakely is an error born of ignorance. The full list of licensed producers is an unknown; the Confederacy and France being the only ones confirmed by Blakely directly, though Steven Roberts states that Spain [Trubia?] and Russia [Bard?] are also confirmed.

- In September of 1861, several (possibly six) Low Moor produced Blakely Conversions of 7.44 in caliber arrived in Savannah, Georgia. One was captured by Union forces at Shipping Point, Virginia in March 1862. The most famous of these Great Guns was part of the Vicksburg. On July 22, 1863 a shell prematurely exploded in the chase, damaging the gun. The Confederate defenders sawed off 24 inches of the barrel and filed it smooth, after which it served as a howitzer with a reduced charge for the remainder of the siege. The gun survived, and became known as the "Widow Blakely," which is on display near its 1863 position overlooking the Mississippi River.

If the 'Contemporary Photo' is indeed of the 'Widow,' then at least one hoop over the breech has been removed, and possible one in front of those that remain, compared to the 1861 plan drawing. This may have been done for balance following the loss of 24 inches of the barrel, or perhaps to allow additional elevation with the improvised truck carriage.

- A short 9 pdr and a long 4 pdr burst when tried by the Peruvian Army in August of 1862. Subsequently a second 9pdr failed with a crack in the chamber. Investigation determined the faults lay with the poor quality of the boring by the manufacturer, Fawcett, Preston. All three guns were returned to Fawcett, Preston for replacement.

Fawcett, Preston promptly sent three long 9 pdr field pieces to replace the mountain guns, and so they were rejected and returned. Eventually, the three guns were replaced with like types.

-- On January 4, 1864 the War Office acquired an 11in gun similar to those being shipped to Russia. Designed to fire a 400 lb. bolt with a charge of 35 lbs. RLG or 45 lbs of 'pellet,' it was proofed with a 531 lb bolt and 52 lbs of LG powder. The War Office insisted on a 70 lb charge, which burst the gun.

Fig. 60. Widow Blakely at Vicksburg

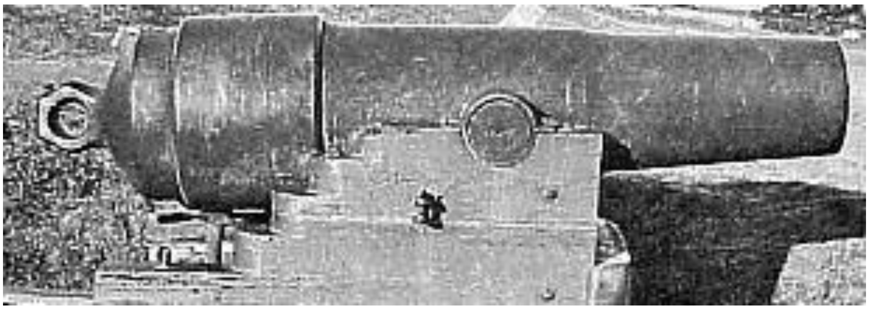


Fig. 61. Contemporary Photo of Widow Blakely

- The Admiralty bought a 7 in gun in 1865, and sent it to Shoeburyness to be proofed. Designed for a 12 lb charge of RLG, the gun was damaged by a 25 lb charge.

- On September 11, 1863, one of the huge 12.75 in Coastal Defense guns for Charleston, South Carolina was fired for the first time. Loaded with a 425 lb shell and charged with 40 lbs of powder, the breech was blown off with extensive damage up to the steel reinforce.

The fault, however, was not with the design of the gun, but with the gunners. Not realizing that the 30 inch 7 inches in diameter brass colander extending through the breech was intended to provide additional volume for gas expansion as the charge burned, they had filled it with small bags of ordinary cannon powder. It is not clear if the remainder of the charge was of the same powder or the special pellet 'Blakely' powder he had sent along with and for those guns in particular.

James Eason and Company of Charleston managed to repair the gun by adding a massive breech block and partial jacket of wrought iron over the damaged portions, and the gun eventually joined the defending forces. The second gun, when loaded correctly, performed as advertised, though the composite construction, choice of Scott rifling and cylindrical projectiles were all unfortunate.

- On December 12, 1863 four 11in guns destined for Russia were proofed with a 50 lb charge of FG and a 600 lb bolt. Three passed, but the fourth suffered a split in the rearmost hoop. The gun was returned, the hoop replaced, and the gun was sent back to Woolwich the following month, when it passed a more strenuous proof.

- On January 27, 1864 a 9 in 300 pdr gun bound for Russia was proofed with a 40lb charge of LG and a 340lb bolt. A small split/crack occurred in the hoop nearest the trunnion. Captain Blakely requested the gun be fired again with a 50 lb charge, which was done without further injury to the gun. But the officials at Woolwich declined to give the certificate of proof, and it was returned to the manufacturer for repairs. It passed a more strenuous proof – two rounds with charges of 50 lbs and a bolt of 360 lbs – on April 30, 1864.

- On April 29, another 9-inch gun suffered an injury during proof firing. With the second round, the cast iron trunnion – not an integral part of the all-steel gun but part of the separate trunnion ring – cracked. This was replaced and the gun passed in December 1866.

- In December 1866, another 9-inch gun suffered a cracked hoop. This was duly replaced and the gun passed in January 1867.

- The Admiralty bought a 7 in gun in 1865, and sent it to Shoeburyness to be proofed. Designed for a 12 lb charge of RLG, the gun was damaged by a 25 lb charge of LG.

- Part of the saga of the Second Brook 7in Triple has been noted above, in connection with damage from extreme heat. After the gun was condemned, Navy officials and Brooke reached a compromise whereby the gun could be released to the ironclad for which it had been originally intended, but with the proviso that it only be used with reduced charges. This likely meant no more than 16 lbs of 'Blakely powder or 12 to 14 lbs of ordinary loose cannon powder.

When General Beauregard, commanding the defenses of Charleston, heard the gun had been released to the Navy, he used his considerable influence to have the gun transferred to the Army, and hence to his command. Agreement was finally reached with the provision that he abide by the Navy's restrictions. He did not do so. The gun was regularly charged with 20 lbs of regular large grain cannon powder, which caused it to burst.

- In January of 1865, during the defense of Fort Fisher guarding the approach to Wilmington, North Carolina, Colonel William Lamb, in command of the Fort, reported, "My two seven-inch Brooke rifles both exploded in the afternoon... I had given the officer in charge discretion to fire upon vessels which had approached the bar, and his fire had been more rapid than any other guns, and with the disastrous results of explosion..."

It is a pity the good Colonel did not provide more detailed information. However, contemporary photographic evidence would indicate that the two 7 in guns were of the older Single Banded variant, and that one at least had suffered a premature shell explosion in the chase near the muzzle, similar injuries suffered by some of the Parrott rifles.

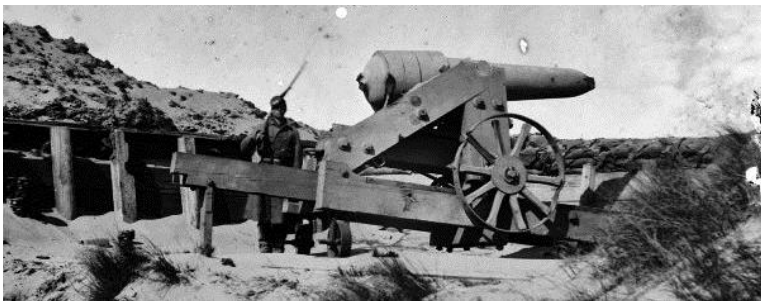


Fig. 62. Fort Fisher Muzzle damage

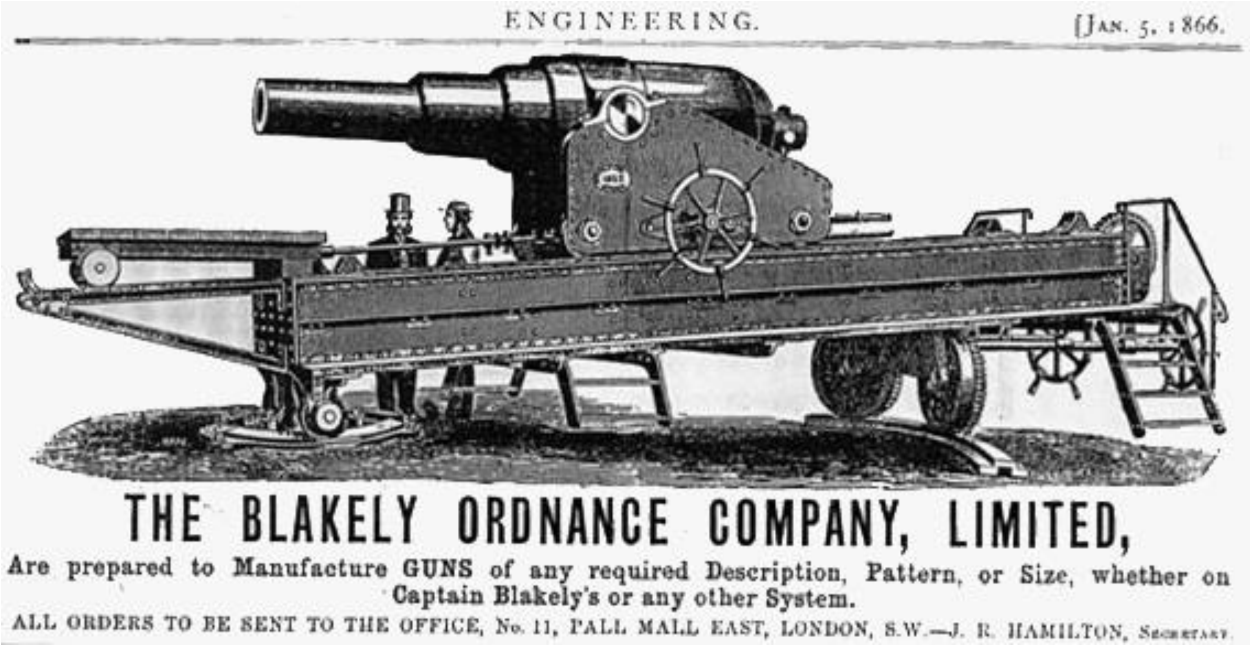


Fig. 63. Advertisement for Blakely Ordnance Co, Ltd.

Perhaps a better, and certainly more positive, testimony to the success of Blakely guns, to which can be included the Brooke guns, came from Major-General Dabney Maury, "Our Brooke guns at Mobile [Alabama] were rifles of 11 inch, 10 inch, 7 inch and 6 4/10 inch calibers. They outranged the Parrotts, and, though subjected to extraordinary service, not one of them was ever bursted [sic] or even strained."

End of Part 1

Appendix A

William Clay and Mersey Steel and Iron Foundry

Wrought iron as a material for gun-making has an interesting history. The first large scale attempt, and in this case very large, was the three so-called 'Stockton Guns,' after Commodore Robert F. Stockton of the US Navy, who wanted the powerful weapon to arm the new USS *Princeton*.

These smooth-bore guns weighed around 16700 lbs, with a 12in bore 144 inches in length, and intended to fire 224 lb shell with a charge of 45 lbs of 'cannon' powder. They were essentially large 'shell' guns.

Fig. 1. Brooklyn Navy Yard Gun Brooklyn Navy Yard Gun breech view

As is obvious from the slender lines, the breech and chamber were not constructed to withstand a large powder charge, and 45 lbs was roughly normal for shell of that bore, as opposed to 64 ½ lbs the rough normal for solid shot, it still represented more initial pressure and shock than the design could stand.

The first of the three guns, dubbed 'Oregon,' was fabricated by the Mersey Forge – later the Mersey Iron Company, and in 1859 Mersey Steel and Iron Company – of Liverpool, England. During proof and test firing, a crack developed in the area of the chamber. A wrought iron band reinforcing band was applied around the breech. It was then proofed again without further incident.

The second gun, dubbed 'Peacemaker,' was fabricated by Ward and Company of New York. A different technique was used, and the breech was fuller to provide more strength. But the gun was not extensively proofed or tested. This lack of due caution had tragic consequences.

On 28 February 1844, in the presence of President Tyler, several Cabinet Secretaries and Congressmen, 'Peacemaker' was fired a third time, and burst catastrophically, killing six – including two Cabinet Secretaries – and injuring many. *Princeton*'s Log recorded that the gun had broken off at the trunnion band and the breech, and split in two.

The third gun, dubbed the 'Brooklyn Navy Yard Gun,' was fabricated in 1845 by Mersey Forge. The diameter around the breech and chamber was increased to 28 ins but otherwise resembled its two sisters,

Three years later, William Clay burst on the scene in Liverpool. Though he had been born there on 15 May 1823, he had worked at a small ironworks near Glasgow since leaving school, which had honed his mechanical and scientific frame of mind. When that small works closed, he drifted in some mercantile pursuits, and finally approached W.J. Horsfall, owner of the ailing Mersey Forge, with a new method for rolling taper bars. The invention was adopted, and Clay offered the position of manger.

The young Mr. Clay set about reorganizing and modernizing the works, and instituted a night shift to increase output. The net result after two years was a fourfold increase in output and much appreciated profits for the business.

In late 1855 or early 1856, Messrs Clay and Horsfall determined to produce another Great Gun to a much improved design to avoid the weaknesses of the 'Stockton' guns and, incidentally, confirm wrought iron as a suitable metal for artillery.

As Clay described the process, "Puddled rough bars were made from the best selected Scotch and North Wales pig-iron, and were worked as little as possible before being sent to the forging department. The puddle balls were hammered [with a '15-ton' hammer], then rolled into No. 1 bar iron; and that was cut-up, piled, and again rolled into No. 2 bars. A core, formed of a fagot of square bars, was first welded up and rounded to about 15in diameter. Upon this, three several coats or piles of V-shaped…bars were laid on, and welded in succession… The extreme diameter of the breech end was produced by welding slabs over these [layers]…, where the mass exceeded 32 inches in diameter."

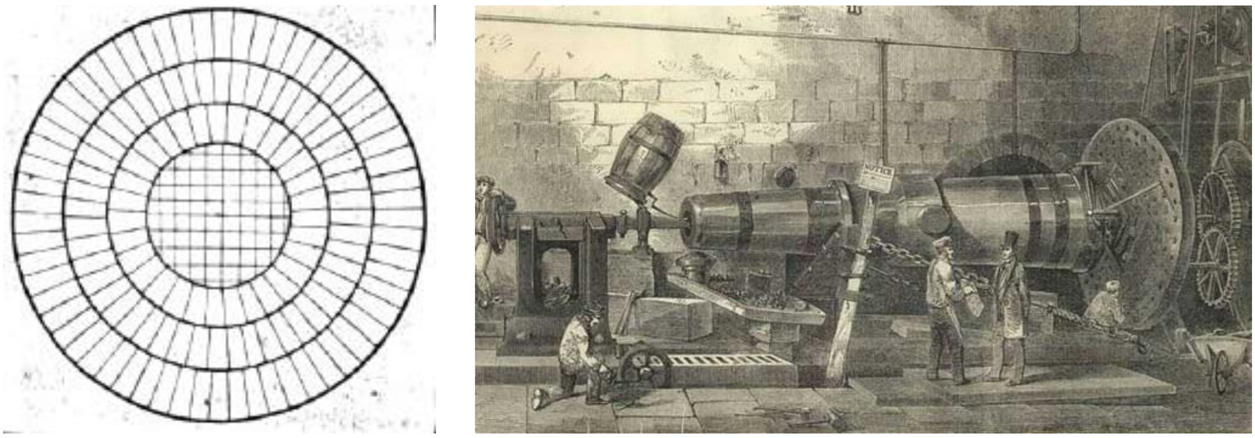


Fig. 2. Horsfall Gun cross section   Horsfall Gun under construction

The resulting gun, quickly dubbed 'Monster,' weighed 24 tons (53846 lbs), had a bore of 13ins, 160ins long; diameter over the chamber 43 inches. Construction required seven weeks, just boring the solid core took another two weeks, as flaws in the iron were located and patched. All told, the fabrication took four months. As its predecessors, it was intended as a gigantic 'shell' gun, though it's overwhelming size certainly called forth visions of heavy shot and large powder charges.

The gun was tried extensively in Liverpool, firing some 96 rounds with 50 lb charges, 21 with 40 lb charges, and a considerable number with lesser charges, one of which was against an armored floating battery. Using a 25 lb charge, the 280 lb solid shot broke the armor plate and caused extensive shock damage.

Examination of the gun revealed a number of flaws, the worst of which was a crack in the solid breech at the bottom of the bore, caused by the unequal shrinkage during the cooling phase of fabrication. A 'false bottom' or 'plug' was inserted to protect the breech.

The gun was then transported to Shoeburyness for proofing and other trials, for a total of 55 rounds. The first two were for proof using an 80 lb charge, 40 with a 30 lb charge, and 13 with charges ranging from 20 to 45 lbs. A number of the rounds fired with the 45 lb charge were with lead filled shell ranging from 310 to 318 lbs.

Mr. Horsfall presented the gun to the British Government with considerable ceremony, after which the Government unceremoniously left it unprotected on the beach at Portsmouth, where it languished for years. In 1862, no doubt as a side effect of the criticism of the Armstrong system in certain circles, the Select Committee decided to give the 'Monster' gun a shot at the *Warrior* Target. The gun was found nearly buried and much injured by rust. It was dug out and transported to Shoeburyness to be cleaned up and prepared for trial.

Prior to the actual trial, the gun was examined thoroughly, and a considerable number of injuries were documented, which seem to have been caused or exacerbated by the proofing and trials at Shoeburyness six years before.

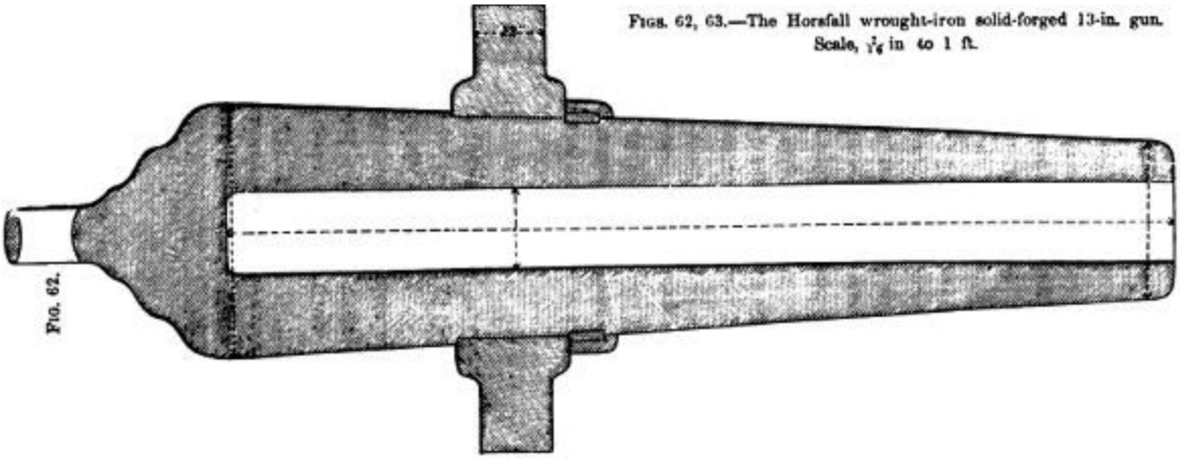


Fig. 3. Horsfall Gun section

- the plug has been compressed ½ inch,

- to the right of the plug, a hole, 1.8 in long by .65 in wide and 13.75 inches deep from the edge of the plug,

- another hole 1.5 inches from the edge of the plug, .55 inch long by .25 inch wide and .2 inch deep,

- to the left side of the plug, a hole .5 inch long by .5 inch wide and 3.75 inches deep,

- another hole 1.5 inches from the edge of the plug, .8 inch long by .3 inch wide and 5.75 inches deep [the three rounds fired at the Warrior Target would increase this to .65 inch long by .35 inch wide and 6.5 inches deep],

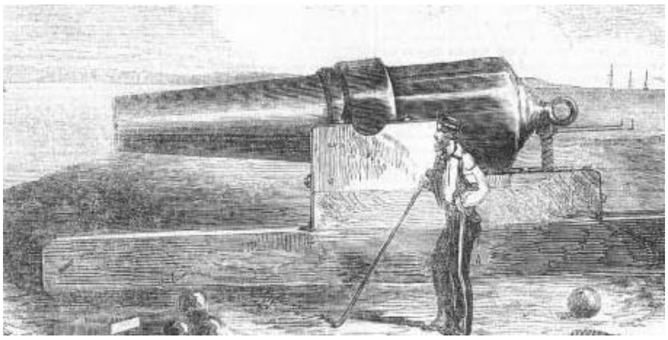
- bottom left, a crack .5 inch long by .15 inch wide and .1 inch deep,

- In the bottom a flaw or crack beginning at the edge of the plug, about .2 inch wide by .2 inch deep at the deepest, and running 25 inches along the bore,

- many small longitudinal fissures, such as are normal with wrought iron guns, visible all around the bore 35 inches from the breech.

Three rounds were fired at the *Warrior* Target, all with heavy 74.4 lb charges. The first, a 279.5 lb shot with an initial velocity of 1631 ft/sec, penetrated the plate, making an indentation 24 inches in diameter, but imbedded in the wood backing and tearing the skin plate. The second round, a 284.8 lb shot, almost missed the target. It struck a corner with a residual velocity of 1299 ft/sec at 800 yards, breaking it off, and causing shock damage for a distance of five feet. The third round was a 275.5 shot with a nominal initial velocity of 1631 ft/sec. It passed completely through the target making a 2 ½ foot hole. The local shock effects were severe, and the target structure damaged.

This was a Pyrrhic victory. When the Select Committee had finished looking at all the data, especially the lack of endurance, the Horsfall Fun was finally mounted at Tilbury Fort.



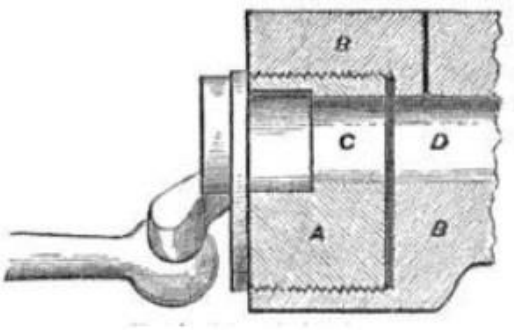


Fig. 4. The Horsfall Gun Forbes Breech Mechanism

In these years, Clay also recruited a formation of the Volunteer Artillery Corps, which entitled him to the rank of Major, and henceforth used his military rank. Originally most of his voluntary artillerists were employees of Mersey Ironworks, but as the company grew to battalion strength, he took the rank of Lt. Colonel, a position he retained until a few months before his death in February 1881.

It was reported that many of the Volunteer Artillery companies were so disenchanted with the pieces provided by the government that they raised the money to buy their own guns. By 1860, Maj. Clay's company was equipped with artillery produced by the then Mersey Steel and Iron Company.

During the period between 1856 and 1859, Mr. Horsfall passed away. A short time later, his heirs made Clay the Managing [minority] partner in the works. It seems that in late 1859, Maj. Clay turned his attention to the lucrative and growing market for ordnance, which he did with zeal and originality. The fruits of his labors were unveiled publically on 10 November 1860 at the Lancashire Rifle Contest.

The rifled tube is invariably described as being of rolled steel, with the trunnions attached to a separate ring. This is an error; the tubes were of wrought iron, and in the 3.1in 12pdr, rifled with 15 shallow grooves, most likely in the Britten system. The breech and trunnion ring were also of wrought iron, as will be clear later.

At least initially, the projectiles were rather unique, being of a form patented by Francis Preston and Thomas Kennedy on 12 January 1855. The cast iron body has a near-hemispheric nose, and the base is recessed and features a groove around the circumference into which lead or other soft metal was cast. The most interesting feature was three slanted grooves in the molded shell body, commencing and deepest just before the shoulder and tapering to nothing just before the lead ring. According to the Patent, these were to impart spin to the projectile while in flight through air resistance. It seems that these shells were intended to function when shot from a smooth-bore gun, with the lead ring providing the gas check! But in rifled guns, they fall into the group of projectiles relying on compression to grip the rifling, such as Britten's lead sabot, and the lead-coating of Wahrendorff, Krupp and Armstrong, which supports the suspicion that the shallow grooves were in the Britten pattern.

Patented by Hugo Frederick Forbes on 15 April 1856, the breech piece was an eccentric cylinder pierced by one through hole that aligned with the bore, for loading first the projectile and then the bagged powder charge. A half rotation of the eccentric cylinder would close the breech with the ease and rapidly of the Krupp sliding wedge! With a well drilled crew, the gun could be fired 19 times per minute. One of the ironies of history is that Capt. Forbes engaged Francis Preston to work the patent for him, and Preston in turn granted a sole license for manufacture to Mersey. Had the breech mechanism been rendered in high quality steel rather than ductile wrought iron, Forbes might be celebrated as the inventor of the Quick Firing gun 40 years prior to Schneider and the French 75 mm M1897!

Only four guns participated in the Rifle Contest, three from Mersey and one from Capt. Blakely. It had been expected that Mr. Whitworth would participate, but in the end he declined due to the high cost of the ammunition required. Twelve foot square targets were placed a bit over a mile downrange, but due to weather conditions, were barely visible. The three Mersey guns were mounted on field carriages, while Blakely's was on a truck carriage.

Maj. Clay's guns consisted of a long breech-loader of one inch bore, and two of the 12pdrs as described above, though there is some question regarding the shells used; one source stating that Clay used Armstrong-type lead coated shell, while another mentions the Preston-Kennedy shell already noted. Capt. Blakely introduced his new 3.5 in caliber 12 pdr, and used 11 lb Britten shell.

At least two, and very possibly more, were bought by the Confederacy, of which one survived the war. Confederate General E.P. Alexander, who was not impressed, wrote of the trial of one gun, "The Clay gun was a breechloader and was called an improvement upon the English [Armstrong] model which could not be obtained. It's grooving and projectiles were similar to the breech-loading Armstrong. Its breech-loading arrangement appeared simpler and of greater strength. On trial, it failed in every particular. Every projectile fire 'tumbled' and fell nearer the gun than the target and at the seventh round the solid breech-piece cracked through and the gun disabled."

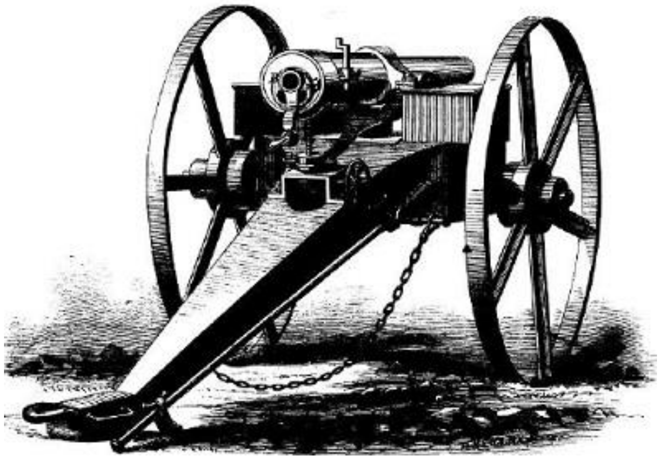


Fig. 5. Clay 12 pdr field gun Clay 18 pdr field gun

One must certainly wonder at this failure, and the lack of detailed information leaves the question of 'why' entirely open. The behavior of the shells in flight suggests numerous problems with the projectile, while the crack in the breech-piece suggests overly large charges…

Other Clay breech-loaders have stood well through very heavy trials. A 2 pdr (roughly 2.5 inch bore) was very severely tested with projectiles of 88 lbs and more with excessive charges.

The Russian government bought a 6in breech-loading blank from Mersey. It was tried with 300 lb bolts with 16 lbs of powder – both excessive – and other than the chamber being compressed, no damage was done.

The British Government ordered several 6.5 in [probably standard 6.4in] guns, likely in 1862, forged hollow in the style of the 'Prince Alfred' gun, on which more below. One of these, weighing 9282 lbs, was tried to destruction against a 110 pdr 7 in gun, as mentioned previously. The details are telling.

Such a trial involves ten rounds with the standard charge for the gun – 10 lbs in this case – followed by ten rounds with a heavier projectile and so on until the gun bursts or becomes totally disabled. Projectile weight for the first ten was 68 lbs 10 oz, increased to 136 ½ lbs for the second ten, 204 lbs for the third, 273 lbs for the fourth, 340 ½ for the fifth, 410 lbs for the sixth, and 476 for the seventh. The gun burst into eight pieces with the 71st round. Subsequent experiments determined that the tensile strength of the metal was 45359 pounds per square inch. The Armstrong gun may have 'won' this trial, but it was a wreck and unfit for further service, so it seems fair to say that one gun failed catastrophically and the other failed incrementally.

Also likely in 1862, two Mersey breech-loaders were forged in the shape of standard Armstrong guns, one 12pdr and one 40pdr. The former was proofed rather severely, and was found to have holes and indentations in the chamber afterwards, so the proof was not certified.

The 40pdr stood 100 rounds with the 5 lb service charge, and bolts weighing from 40 to 400 lbs, and 17 additional rounds with a double charge; a very severe trial. A detailed examination revealed the extent of the injuries to the gun, as the small Table below demonstrates:

Distance from Breech	Location	Vertical	Horizontal
2 in	Powder Chamber	0.031in	0.025in
6 ¾ in	" "	0.046in	0.044in
12 ½ in	" "	0.068in	0.064in
14 ½ in	Shot "	0.095in	0.087in
20 ½ in	" "	0.374in	0.314in

In addition, there were deep fissures running from 75ins from the muzzle to the lip of the shot chamber.

The Select Committee on Ordnance noted that while the Mersey guns may not be fully equal to the coil system, their endurance was sufficient to "meet the requirements of the service…" A subsequent report noted that using the Mersey solid block method instead of Armstrong coils would result in "a saving in the cost of manufacture will be affected to the extent of about £ 74 per 40 pdr, and £15 per 12 pdr."

Early in 1864, Mersey released an item reporting on the preliminary trials of their new 68 pdr 8.12 in gun which was rather unusual. The gun weighed about 9 Tons, and was rifled. But the chosen projectile was a 'light' 100 lb cylindrical bolt not intended to grip the rifling. With a 20 lb charge of powder, the initial velocity was 1508 ft/sec. In spite of the wind conditions – "half a gale across the range" – several hits were obtained at ranges from 1000 to 1500 yards. The Engineer noted that "The Mersey ironworks are now making excellent guns for foreign governments."

Lt. Col. Clay determined to fabricate a new Great Gun for the Great Exhibition of 1862, which would promote Mersey Steel's gun making business, and address the flaws of the Horsfall Gun, especially the unequal shrinkage of the breech and reinforcement and initial strain and rupture. To accomplish this, he designed a completely different construction plan, which he patented.

The barrel was forged hollow. It was made of rolled staves, truncated and shaped to form the bore, welded together at high heat, with the breech screwed in, "similar to the Armstrong 10 ½-inch [150 pdr as a smoothbore and 300 pdr rifled] gun…" After the barrel and breech had cooled, the reinforcement of "broad plates bent to the proper curve were laid out and welded upon the barrel." It is unclear if the reinforce was shrunk on or merely mechanically fitted.

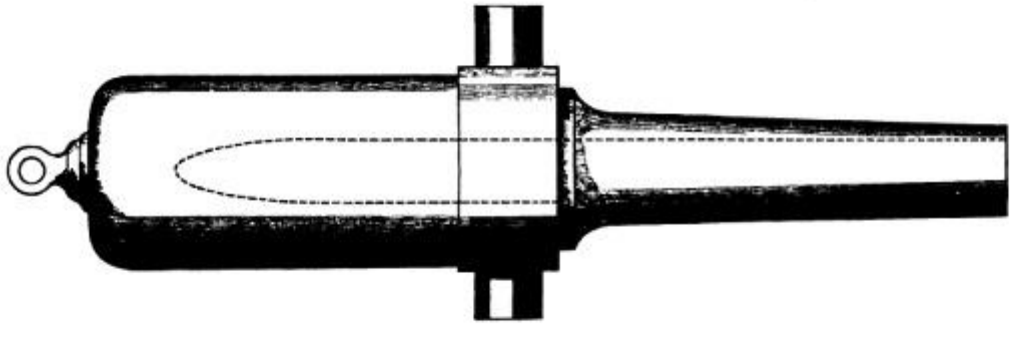


Fig. 6. Prince Alfred Gun from Holley

The finished gun weighed 24094 lbs (10.75 tons or 215 cwt) and was 151 ins long. The bore was 10 ins, 137 ins long. Diameter over the chamber was 31 ¾ inches, and 14 1/8 inch at the muzzle. It was to have been rifled on the Scott system, suitable for hurtling heavy shot and bolts, and then transported to be displayed at the Great Exhibition, which would also feature the first public display of the new 18pdr field piece. But a tragic error ended that plan.

The rifling department at the Mersey works cut the grooves backwards, twisting to the left instead of the right, and Scott rifling requires a mechanical fit between the grooves and the flanges on the body of the projectiles. The only remedy was to bore the gun out to 10 ½ inches to become a 156 lb smoothbore, but that may not have been possible given the type of construction. But for whatever reason, nothing was done.

The gun was fired twice at a target prepared by Mersey, consisting of a four inch plate backed by 18 inches of teak. 140 lb solid round shot was used both time, the first round with a 20 lb charge and the second with a 30 lb charge, at a range of 210 yards. Neither shot penetrated the iron plate, though the second round indented the plate to a depth of six inches and splintered the backing, and the shock damage was considerable. From this, Col. Clay deduced that the service charge should be 40 lbs and the 'battering' charge 50 lbs, proportionate to the 68 pdr smoothbore gun. Calls for use of an 80 lb charged were apparently rebuffed.

The Prince Alfred Gun came to an unknown and ignominious end. Captain Blakely bought the gun for a price equal to $5000, likely for experimental purposes. It was included in the list of guns and ordnance material prepared for the Bankruptcy in 1866 and its ultimate fate remains unknown.

In 1864, Mersey Steel and Iron Company was incorporated as a public company (Ltd.) and Clay lost his control of the operations of the works, and soon left their employ. With two partners, he established a new ironworks, the Birkenhead Forge, which specialized in heavy forgings for Naval and maritime applications.

Lt. Col. Clay, like Sir William Armstrong, was a devotee of wrought iron. Where the two disagreed was not the metal itself, but rather the best way to use it, forged masses or coiled masses. In the final analysis, their misplaced devotion ceded steel to Krupp and Blakely.

Appendix B

Russian Gun Trials, 1863

Some background information is necessary to fully understand the context of the 1863 Trials.

From the Russian perspective, the results of the Crimean War were unsatisfactory. Indeed, some historians believe the Russians negotiated a settlement motivated by the real concern that an Anglo-French naval attack, supported by the ironclad floating batteries such as had been used at Kinburn could neutralize the fortress island of Kronstadt and the other coastal fortifications and dictate terms to the Tsar and government. This not wholly unrealistic concern underscored the need to modernize and strengthen the defense establishment, from the coastal fortifications to the Navy to the artillery parks of the Army; a herculean task requiring vast sums of money and years of development and planning.

1859 was a pivotal year for Russia, just as it was for the other European Powers. Rifled ordnance was achieving 'pride of place' with Armstrong's successes in Great Britain, the French Navy adopting the M1858-60, and both Prussia and Austria-Hungary adopting Wahrendorff breech loaders. And the ocean-going ironclad, in the form of *La Gloire*, had become a reality. The Russian government responded by ordering a large number – several hundred by some accounts – 4- and 9-pdr field guns, and twenty of the largest guns available on the market, the 30 pdr (16.7 cm) 'shell gun from Wahrendorff's foundry at Akers, Sweden. These last were 'blanks,' meaning unrifled, delivered in 1862, which enabled the Ordnance Department to experiment with different rifling systems. One tube was rifled on the Armstrong system of many small grooves and lead-coated shells, a second with the La Hitte system developed by de Beaulien, and the third with the Krupp variation of Wahrendorff's poly-groove adopted by Prussia.

The Commission on Ordnance also reached out to a very receptive Alfred Krupp. This was a logical move, given that France, by Law, was prohibited from exporting ordnance, and Armstrong (EOC) was contractually tied exclusively to the British Government with and through the RFG, Woolwich. The number of players in the international arms trade was very limited. Krupp was positively enthusiastic at the prospect of entering the Russian market, and cooperated fully by providing guns, large and small, in preparation of the coming Trials. The largest of these was likely a standard 'block,' meaning finished externally but not bored, for the standard caliber of 23.54 cm, bored as a 9-inch blank (90 Russian '*linya*,' 228.6 mm). The smaller guns were likely blank 4- and 9 pdr field guns. Krupp also provided steel shot and shells for the 9-inch gun.

Early on, possibly in 1860, the Russian Ordnance Department had adopted the *La Hitte* system of rifling as a 'stop-gap' measure for their cast iron smooth bore 56 and 60pdr guns. They even bought a portable rifling machine from J. Vavasseur Company to simplify the task, as opposed to dismounting the guns, shipping them to an Arsenal to be rifled, and then remounting them upon their returned. This provided a large number of large-bore 'shell' guns that remained capable of firing solid round shot as required.

Fig. 89.—Russian 120-pounder. Scale, 1/12 in. to 1 ft.

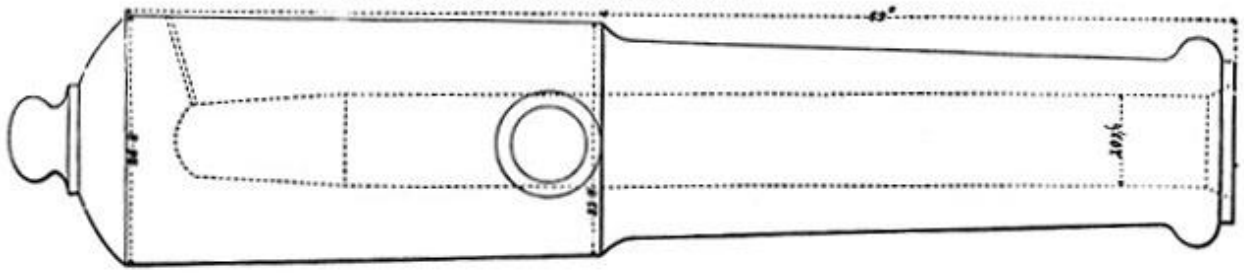


Fig. 1. Russian 120pdr SB from Holley

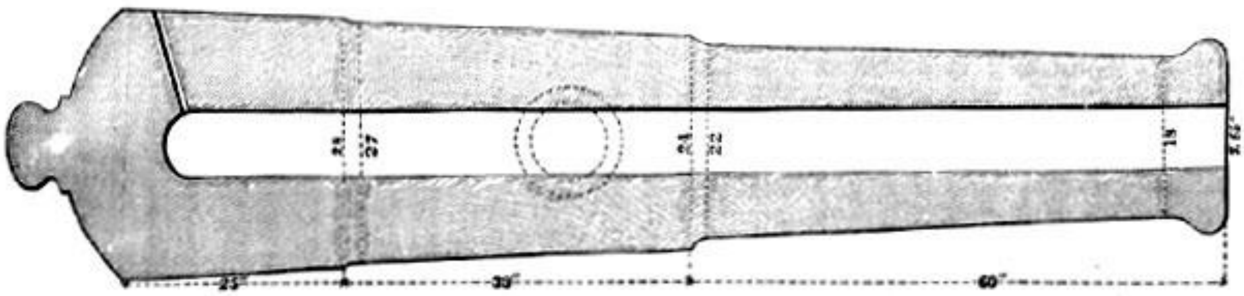


Fig. 90.—Russian 56-pounder. Scale, 1/8 in. to 1 ft.

Fig. 2. Russian 56pdr shell gun from Holley

While details of the 1862 trial are lacking, the three-fold purpose appears to have been 1) to determine the best system of rifling for breech loading guns, 2) to determine the best material for heavy muzzle loaders – cast iron, wrought iron or steel, and 3) gauge the effectiveness of large bore guns against their '*Warrior*' Target, built by John Brown and Company.

In the first phase at Volkov in September, the three Wahrendorff 30 pdrs were tried. The Armstrong small groove/lead-coated projectile combination was soon eliminated, as the shells tended to break up in the barrel and accuracy was bad. The *la Hitte* system was ultimately rejected, likely on grounds of 'ease of operation' in a breech loader was difficult. This left the Wahrendorff/Krupp/Prussian poly-groove system as the best option, and the remaining 30 pdrs subsequently sent to the St. Petersburg Arsenal to be rifled, and hence to Kronstadt and other forts in the area. This trial had far-reaching effect; poly-groove rifling became the standard for their own domestically designed and built guns, beginning with the M.1867 family of guns.

October 17th was the culmination of the Trial, and the focus was on the 9 in Krupp gun, for which some detailed results are available from Press reports. It was probably rifled with *La Hitte* grooves, since it was a muzzle loader. The gun had fired earlier, written off as a "series of cast iron shell…fired at different ranges." At least one 450 lb shot was fired using a 60 lb charge

(Russian pounds, 405.4 and 54.2 lbs in Imperial measure). But on that last day, nine rounds of shell were fired at a range of about 233 yards (213 meters).

The first shot was a 300 lb steel shell fired with a 50 lb charge (271 and 45.2 Imperial measure). It featured a truncated shoulder to a flat nose about four inches in diameter. It passed through the armor plate and the oak and teak backing, but broke up in the process.

The next two were similar, but tapered to about a 6 ½ inch flat nose and both performed identically to the first round.

The fourth round was a shell from the Poteleff foundry, made of puddle steel on Aboukoff's system, and was of the same dimensions as numbers 2 and 3. It passed through the plate and wood backing, but in the process it had been flattened and bulged to about twelve inches in diameter.

The fifth round was the same as the fourth, but performed much better. It passed completely through the target, and continued a mile down range!

The sixth and seventh rounds were Krupp shells, but filled with powder instead of sand. One burst in the plate, doing considerable damage, and the other burst in the wood backing.

The final two shells were of cast iron, and were broken while passing through the plate.

The Commissioners were justifiably proud of the performance of the fifth round on the basis of its promise for the future. They were also sufficiently impressed with the performance of the Krupp gun that they increased their order to a total of fifty. In point of fact, throughout all of 1863, Russian orders from Krupp were at least one hundred 4pdr field guns, sixty eight 8inblanks and thirty 8in blocks, twenty four 9in blocks and one or more 11in, probably blocks, all muzzle-loaders. While the question of rifling for breech loaders had been settled, the matter of the type of breech mechanism was still open.

The greatest difficulty in dealing with the 1863 Trials is deciphering the manufacturer and caliber of the ten heavy guns tried. Part of the reason is the initial French report only listed nine of the ten guns, used 'dummy' calibers, identified only one manufacturer, and took great liberties with the information. A careful reading of the second document, a June 1865 report from General Todleben, who headed the Commission, to the Tsar presents a more comprehendible version of what was actually involved. For the sake of clarity, the guns were given an alpha designation.

'A' was a 9in gun of 7 ½ tons (16800 lbs), and as weighing 148.3 cwt (16610 lbs), and as weighing only 61 times the projectile weight (16470) when the preferred ration was 100 times. It was shunt rifled. This was not the same gun that was so successful in the 1862 Trials. Rather, it is affiliated with the next gun.

'B' was an 8in gun, shunt rifled.

The key is the weights. The nominal weight of a Krupp '8in' gun was 7 ½ tons, 16800 lbs. The general explained to the Tsar that the Commission wished another trial of a 9in gun, and decided to take one of the blocks already ordered for that purpose. The Commission realized that the 8 in gun would be too 'light' to bear the 270 lb shot and 45 lb charge, and would use the normal 220 lb shot and 33 lb charge with gun 'B.' So gun 'A' was a block bored up to 9in, while 'B' was bored as intended.

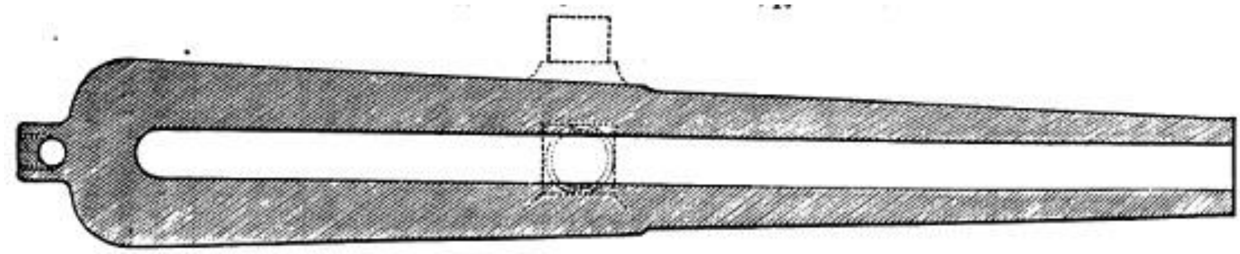


Fig. 3. Krupp 9in SB for Russia

It should be noted that Krupp did not begin reinforcing his guns until early 1868.

'C' was an 8in gun, later identified as a Blakely gun, rifled according to his system, most likely hook-slant. The original French report claimed shunt rifling, but the difference between the two was not the number of grooves, but rather a slightly different shape. On balance, General Todleben's statement carries more weight than does the biased and inaccurate initial French report.

‘D’ was an 8in gun with *la Hitte* rifling.

‘E’ was an 8in smoothbore, subsequently identified as a Krupp blank.

‘F’ was an 11in smoothbore, identified as an 8in block bored up.

‘G’ was a Blakely gun, supposedly with Parrott rifling. That rifling is possible, but doubtful. Britten rifling would be more likely. But if Parrott rifling was correct, then certainly at the behest of the Commission and not the choice of the Captain.

‘H’ was an 8in gun, shunt rifled. General Todleben refers to the other gun, ‘C’ as rifled on Blakely’s system when discussing ‘H’ so by inference ‘H’ was also a Blakely gun.

‘I’ remains something of a mystery. The original French report and translation lists it as an 8in breech loading rifle with Prussian poly-groove rifling, but does not include ‘J.’ In the Commission’s report, that description applies to ‘J’ and refers to ‘J’ in the singular, without specifically mentioning ‘I’ at all. But it also states in passing that the “trials of breech-loading guns had commenced” before the trials on ‘H’ had concluded. And a veiled reference obliquely mentions an irregularity in centering the Krupp lead-coated shot that was absent with the ‘English’ shot.

There appear to be three possibilities to account for guns ‘D’ and ‘I.’ One option is the guns were from EOC. But which guns? The new 9.22 or 9 inch guns were available, but this fails on two grounds; the Trials were centered on 8in guns, with ‘A’ as a special exception, and there was no breech-loading version. There were both muzzle-loading and breech-loading versions of their new 200pdr 8.5in gun; at least one of the former had been sold to the Confederacy. Still, that caliber would have been out of step, and the nature of the Trials was to test certain specific features on an equal basis for assessing the effects on endurance and performance. This leaves the third possibility; that ‘D’ was a mate for ‘C’ but with different rifling, and ‘I’ was a match for ‘J’ but configured as an Armstrong RBL, or possibly with the French type.

“The piece subjected to the trial (‘A’)…was muzzle-loading, had parallel grooves [shunt rifling] and fired projectiles of 300 lb with zinc studs. The charge was 50 lb of pellet powder [270 lb and 45 lb in Imperial measure]…” The French translator used the term “*poudre prismatique,*” ‘prismatic powder,’ which is highly unlikely at that date. The Report from the Commissioners post-trial states, “The results of trials with solidified [compressed] powder in America have induced us for the first time to cause a preparation of five ‘*pud*’ of the same powder at the Okhta Works for experiments.” One ‘*pud*’ is equal to 36.11 Imperial pounds. But more to the point, the visit of the Russian Naval Squadron to New York and the Washington DC area, began in mid-September and lasted until mid-December, encompassed the trials at Volkov. And it was during this visit that the details of Rodman’s and DuPont’s work with compressed powders, including Prismatic Powder, were presented to the Russian delegation. So the timing does not line up.

The Commissioners were certainly aware of the existence of pellet powders, and were also likely aware that the British Royal Navy was on the verge of adopting Pellet, which certainly explains the specification of using pellet powder in the 1863 Trials before the naval squadron even left Russian waters. And various forms of ‘pellet’ powder were available from the Trade, as evidenced by the ‘Blakely Powder’ sent to the Confederacy, so the purchase of several tons, likely from producers in Britain, seems far more reasonable.

“This gun was tried with a view to arrive at precise data as to the construction of rifled guns of large caliber and of heavy projectiles, and then to determine the amount of destructive action which we may expect them to produce on armour-plated vessels…Practice was made against plates of 4.7 in to 5.9 in [47 to 60 Russian *linya*] in thickness has proved that the destructive effect of the projectiles fired from this piece is very considerable; it may, therefore, be inferred with confidence that such plates of iron would be indubitably pierced by these projectiles, even at great distance.”

The gun burst with the 66th round.

A thorough and detailed forensic investigation followed, which included examination – and perhaps reconstruction – of the fragments of the gun and projectile, as well as an examination of each of the sixty five preceding rounds. The conclusion was that the projectiles had not been centered in the bore because the zinc studs were not strong enough to withstand the pressure of the rifling grooves and had sheared off. “Under these circumstances, the [hardened cast steel] body of the projectiles must have rubbed the sides [of the bore] and produced [indentations] which increased with every round…” until a shot became wedged in the bore which burst the gun.

The demise of gun 'A' disrupted the trial schedule while the ordnance experts determined what corrective actions to take. They decided to replace the zinc studs with copper, and added a row of slightly shorter copper studs for centering purposes.

With the new projectiles, gun 'B' was tried with a 245 lb shot and 36.5 lb charge of pellet powder [221 and 33 lbs Imperial measure]. 4.7 in plate was pierced and the gun fired very accurately. Satisfied with the results, the endurance phase was commenced, with cast iron shot replacing the steel projectiles for economic reasons, but with the same charge.

The gun burst with the 109^{th} round, and the pieces of the fragmented shot did not reach the target butt. The official verdict was that previous rounds had shed fragments and splinters which had built up in the grooves. This blockage caused the final round to shatter, bursting the gun. This was not a unanimous finding, but the Commission took the position that competing theories did not conform to the facts.

Guns 'C" and 'D' were tried together to test the effect of rifling on endurance. Both guns were fired at the *Warrior* target from a range of 1067 yards (975 meters) with the same projectile weight and charge, and both penetrated the plate. The charge for gun 'C' was then reduced to 27.5 lbs and the shot also penetrated. 'D' continued using the larger charge. This phase was curtailed after 46 rounds, and then continued with the endurance phase; both guns firing with the reduced charge. 'C' fired a further 169 rounds, and 'D' a further 240 rounds, bringing the totals to 215 rounds for the former and 286 for the latter.

The guns were then carefully examined carefully, and found to have slight wear at the seat of the shot, which was attributed to the effect of the hot gasses from the burning charge acting around the windage. This wear was somewhat worse in gun 'D' than in gun 'C' due to the greater number of rounds fired. From this data they concluded that the service life of muzzle loading rifles firing projectiles without a 'gas check' to be 250 rounds.

Critics have made much of that conclusion, considering 250 rounds to be absurdly low for steel guns. But Todleben and the Commissioners were quite specific in their report that the application was limited to shunt and *la Hitte* rifling using projectiles that did not have a gas check and hence windage.

The trials of the smooth-bore guns, 'E' and 'F,' were included by order of the Minister of Marine, with the twin motives of conclusively proving the strength of Krupp steel under the stress of heavy solid shot and large charges, and gauging the effect of large caliber round shot on armor plate.

To this end, 'E' stood 1025 rounds using a charge of 27 ½ lbs of common cannon powder, after which the gun was examined. There was considerable wear around the seat of the shot, but the gun was still serviceable

Gun 'F' stood 790 rounds firing a 178 lb steel shot with 40 lbs of pellet powder. Practice against the *Warrior* target demonstrated that 4.7 in plate could be penetrated at 934 yards (about 854 meters), but accuracy of fire was not good. The target was roughly 13 ft long by 6 ft high, but of eighteen shots fired at it, only three hit. Inspection of the gun revealed some wear around the seat of the shot, but very much less than in 'E,' which was attributed the difference in gas pressure – the common cannon powder producing more than the pellet powder did.

Gun 'G,' which fired Blakely's projectiles with the copper cup gas check, was fired very few times, and hence not enough to determine if the cup would prevent the wear that had been noted in guns 'C' through 'F.' And the trials were behind schedule due to the bursting of 'A' and 'B.' The reasons given were that the trials of guns 'I' and 'J' had already commenced, and the Blakely projectiles "had no studs, and the movement of rotation was given to them by the expansion of the bottom [the cup] , whose edges were forced into the shallow grooves of the bore." It seems that concerns about centering, though not mentioned specifically, were of the greatest concern.

Gun 'H' was shunt rifled, and used the modified projectiles used in gun 'B,' and further trials appear to have been considered unnecessary. The only comment was that 'H' shot more regularly than 'G.' Todleben concludes with a cryptic statement that implies the Commission had already decided the projectile issue. "It may be stated positively that notwithstanding the greater wear of metal which occurs in these guns their endurance is not affected, because it can be so arranged in loading the gun that the axis of the shot shall be centered in the bore..."

The trials of gun 'J' were extensive, and the Report to the Tsar includes some detail. In fact, 'I' is not even mentioned, except by inferential comparison.

Only a single round was fired at the refurbished *Warrior* target. It was a 240 lb steel shot using a 30 ½ lb charge of pellet powder (216 and 27.5 in Imperial measure). Though the range is not given, the shot pierced the armor plate and 12ins of the new wood backing, but did not pass completely through. This was considered sufficiently successful that the endurance phase was commenced with round two.

The gun stood 400 rounds. Accuracy was considered excellent, hitting targets at ranges varying from about 620 yards to 775 yards 70 % of the time, compared to 30% for muzzle-loaders.

"The [breech] mechanism has given great satisfaction, and the manipulation is perfectly simple…" as opposed to the unmentioned Armstrong or French mechanisms.

At round157, examination revealed that the obturation intended to prevent the escape of gasses from the breech was not entirely successful, though wiping around the breech and the breech piece [wedge] after every round produced some improvement.

After round 212, examination revealed some damage to the lands in the bore implied the shot was not properly centered and the projectile body was rubbing the rifling. This should not happen with a lead-coated projectile, and as mentioned above, was not a problem Armstrong guns experienced. While the actual damage was considered trivial, it did imply a flaw in the construction of the projectiles.

"On the basis of the results of actual experiment the Commission nominated by Imperial Command to inquire into the manufacture of cannon for fortresses and fleets has acknowledged the 8 in breech-loading gun as perfectly suitable for the armament of coast batteries. It has decided on its immediate introduction, and to convert all the 8in guns, not only those already made, but also those which M. Krupp has still to deliver, into breech-loading guns," concluded the Commission.

But the results of the 1863 Gun Trials settled several outstanding questions. It was the death knell of the smooth bore guns. Heavy smooth-bore guns, from the 120pdr down to the 24 pdr were to be rifled and banded.

The system of rifling breech-loaders had been settled the year before, but whose breech-loaders using which form of breech mechanism? And were large caliber breech-loaders suitable to displace large caliber muzzle-loaders?

Admittedly, the number of manufacturers able to produce strong breech-loaders in 1863 was very limited. French production was not available. EOC had only entered the market early that year, and Armstrong was experiencing great troubles producing serviceable breech-loaders and so was focused on muzzle-loaders. Baron Wahrendorff had died two years previously, and the Akers Foundry specialized in using the high quality Swedish iron. Blakely, with whom Russia had a large contract for heavy muzzle-loaders (8 in and 9 in guns for the Navy, 9in and 11in guns for coastal fortresses, and a development specification for 13 in and 15 in guns), may have been contemplating adding breech-loaders to his product line in the future, still produced only muzzle-loaders. That left Krupp as the only viable provider, and the inevitable choice. The selection of Krupp's 'sliding wedge' breech mechanism added strength to that inevitability. But the Commission accepted only the 8 in caliber, exercising a degree of caution, and only for coastal fortresses and batteries. Krupp did receive development specifications for a 9in breech-loading rifle for fortresses to fire a 230 lb shot with a 35 lb charge of pellet powder (roughly 207.5 and 31.6 Imperial measure), and if the gun were successful, fourteen trial guns would be ordered, with a development specification for an 11 in gun.

Fig. 4. Russian 1864 8in BLR CD gun Russian 1864 8in BLR breech view

For the rifled muzzle-loaders, the Commission established that the rifling should be the shunt system. Subsequent experiments with projectile design produced an interesting compromise that met the Commission's concerns of centering and gas check. Projectiles would have a second row of centering studs, but also the Blakely copper cup gas check. This combination was believed to enhance performance by eliminating windage, reduce barrel wear, and provide the centering and 'regularity' that were deemed important considerations. Oddly, the British Royal Navy would adopt much the same configuration fifteen years later, in an effort to keep their large number of muzzle-loading rifles more competitive with the new breech-loaders that were appearing in the world's navies.

The Commission's mandate to improve Russia's ability to manufacture modern ordnance produced its first fruit the following year. Designed by General of Artillery Nikolai Maievskii and produced under his guidance in 1864, an experimental 8in rifle resembling contemporary Krupp guns fired over 700 rounds during trials.

Note the lead-coated projectiles from the 1860s and the more modern projectiles with Vavasseur copper bands providing the gas check. The gun still exists at the Artillery Museum in St. Petersburg, next to hooped M.1867 gun.

More important than any other effect the gun had on the decision making processes involved with coastal fortifications is the simple fact that it proved Russia could manufacture modern steel ordnance.

Appendix C

Third Party Transactions

Much of the story of Blakely's business cannot be written because it remains intentionally unknown, just as which countries and/or companies were licensees for use of his patents. The private/commercial trade in ordnance depended greatly upon such factors as who was the prime contractor and who was sub-contracted, who was acting as agent for whom, and a network of connections and relationships.

It is not possible to reconstruct all the threads of the various relationships, but Fawcett, Preston and Co. Their history with Blakely goes back to 1858-59, if not earlier. They build many of his early proto-type, and as a licensee of his patents, built most of his early production models. In many transactions, Fawcett, Preston was a prime contractor, or a sub-contractor as warranted. The Peruvian order came through the advocacy of Fawcett, Preston, as did the first quantity order of three batteries of 12 pdr field guns for the Confederate Army.

A fascinating study of how the 'system' worked can be found in July and August of 1860. The screw steamer *Queen of England* was being outfitted as an auxiliary warship for the revolutionary Giuseppe Garibaldi in one of the many shipyards in the Liverpool area [financed by whom?] during July, and sailed on 2 August. According to press reports, the vessel was armed with twelve or thirteen guns provided by Fawcett, Preston; several were said to be six or seven inch caliber to Blakely's design, one being a large piece on a pivot mounting on the forecastle. In the holds were two 6in [sic, 6.4 in] Blakely guns and carriages, fourteen 12pdr smoothbore field guns [no doubt Fawcett production], plus 40 cases of shells and 336 'loose shells' in addition to 30000 small arms with ammunition, plus medical and military stores. The August 17 edition of Mechanics Magazine reported that two weeks after receiving the order [from whom?] Fawcett, Preston was producing three 70pdrs per week for Garibaldi. The 6.4 in 70 pdr of 3.5 tons was specifically designed for this order.

But the *Queen of England* and her cargo were only part of a well organized and financed effort being orchestrated by Messrs Feletti, late of the Sardinian Army, and Orlando, an industrialist from Genoa, who retained the services of Curry, Kellock & Co. to serve as prime contractor. The paddle steamer *Independence* had sailed the week before loaded with 1530 Tons of coal to support the *Queen of England*.

In an odd twist, in May 1860, Sir Richard Burton, the famous explorer, who referred to the Captain as "My friend Blakely of the guns," and the Captain formed a plan to provide ordnance for Francesco II, King of the Two Sicilies, when Garibaldi invaded southern Italy. It remains unknown what became of this plan.

George Forrester of Low Moor Ironworks in Liverpool was behind the first delivery of a Blakely field piece to the Confederacy in early 1861. This was the 16 pdr 'Sumter' gun, manufactured by Fawcett, Preston and financed by Charles Kuhn Prioleau, a partner in the firm of Fraser, Trenholm and Co. of Liverpool, which became the Treasury agents for the Confederacy. Low Moor, another licensee of the Blakely patents, produced the vast majority of Conversions, and from the autumn of 1863 on, was a sub-contractor building 11in and the 'long' 9in guns of the Russian order. Their financial arrangement with Blakely for the Conversions was on a 'per ton' basis rather than a 'per gun' basis that applied to 'purpose built' guns, so the number of Conversions sold, and to whom, is unknown, save for those for the Confederacy.

Commander Robert Scott, RN, who had designed the flange rifling system that bears his name, was an ally of Blakely. In 1862 he brokered the sale of a large number of 40 pdr Blakely guns through Fawcett, Preston, for the Khedive of Egypt. The guns were shipped in December.

On 4 March 1862, Blakely invoiced Caleb Huse, agent for the Confederate Army, for six 6.3 in guns, 1800 [likely Bashley Britten, who was also an ally] shells and 2000 percussion fuzes. The original order now doubt came from Charles Kuhn Prioleau. The guns were delivered, and a few survived the war. In Confederate records, they were listed as Blakely guns, but the late Steven Roberts suspected they were not patent pieces, though they were rifled, due to the very low price. It is possible the guns were 'sleeved' or 'lined' with wrought iron, a form of construction the Captain had used occasionally, and possibly produced by Low Moor.

But just a few months later, in June, Blakely approached the firm of Thomas Astbury & Son for a sample of their 6.3 in 'American' cast iron rifled gun to be delivered to J. Vavasseur & Co in July, as he had a large number of projectiles for that caliber. But they tried to deliver a 6.5 in 'Sardinian' pattern, which was rejected.

The firm of A & E Croskill, which manufactured wagons and ordnance equipment, ordered six 3.5in 12pdr and six 4in 18pdr rifled field pieces, and four 12pdr smoothbore howitzers in March 1862. Croskill had received an order for guns, carriages and other equipments, and sub-contracted the guns to Blakely. It is possible this artillery train was for the Emperor of Morocco, and was delivered in 1862.

The June 1865 Prospectus of the Blakely Ordnance Co, Ltd specifically mentioned a pending order from the Ottoman Empire. Perhaps not coincidently, one Augustus Charles Hobart, RN, was one of the Directors of the corporation. In his career, Hobart and served in the Mediterranean and Middle East, and had been a successful blockade runner into the Confederacy. He had developed extensive contacts in the Ottoman Navy to such an extent that in 1868 the Sublime Porte appointed him as an Admiral in that service. Unfortunately, the details of that order are unknown, but likely included naval and perhaps coastal guns.

There were numerous transactions of which little is known. Guns were known to have been sold, but the details were unrecorded. As a licensee of the Blakely patents, Fawcett, Preston was most likely involved, though not necessarily. In chronological order, these included;

In October 1860, an 8 in cast iron gun 'lined' or 'sleeved' with wrought iron, possibly a production of Low Moor;

In January 1862, a 5 in gun for field service;

In April 1862, the shipyard of B & J H Thompson purchased an unspecified gun;

In July 1862, a 5 ½ inch gun with a fortress carriage;

In December 1862, it was reported that three nations had adopted the Blakely 9in 300pdr for their ships, but which nations were unmentioned. Given the timing, one was obviously the guns for the Liard Rams being built for the Confederacy, but the other two remain unknown.

In 1863, Liard Brothers purchased two 9 pdr cast steel with a steel jacket, perhaps as boat guns for the famous Liard Rams.

Fawcett, Preston remained sales agents for Blakely guns from 1859 through the collapse and bankruptcy in the autumn of 1866 and beyond. For example, in February 1866, they advertised four 2 ½ inch steel Blakely rifles with 48 in barrels, suitable for a 'gentleman's yacht.'

In 1864, in the face of worsening relations between Chile and Peru on the one hand and Spain on the other, both countries were anticipating hostilities. Chile ordered two corvettes, to be named *Chacabuco* and *O'Higgins*, through the firm of Ravenhill, Hodgson and Co as the designer and general contractor. At the same time, both countries ordered a considerable number of Great Guns from Blakely for both naval and coast defense. Hostilities broke out before the ships were ready, and they were duly impounded under Britain's Neutrality laws. The war ended shortly after the defeat of the Spanish squadron at Callao on May 2, 1866, due in large part to the 11in and 9 in

Blakely guns protecting that port. The two ships were released and served for many years in the Chilean Navy.

The armament of these ships is invariably listed as Armstrong guns. This is a common error, an exercise in the fallacy of false equivalence. Rifled Muzzle Loaders does not automatically equal Armstrong. Both Blakely and Vavasseur, in turn, produced superior MLRs than did Armstrong, and at a lower cost. And in the 1870s, Vavasseur produced superior breech-loaders than did EOC, which Part 2 of this article will cover. Anyway, in 1864-65 both Blakely and Armstrong produced 7 in, 6.4 in 70 pdrs and 40 pdrs – Blakely's of 4.62 in caliber, and Armstrong's 4.75 in – the difference being the former's guns were all-steel, while the latter's steel 'A' tube and coiled wrought iron. Given that Chile already had experience with Blakely guns; it seems only reasonably that they would order the guns for their new ships along with the other guns. Plus, Ravenhill and Blakely had had prior dealings through Fawcett, Preston, so the element of familiarity was already extant.

The Oriental Connection

Josiah Vavasseur's elder brother, James, was a figure of considerable influence in the silk trade. In this capacity, he had dealings with both John Dent of Dent and Co. of Hong Kong and Shanghai, and Henry Leighton of Henry Leighton Co.

John Dent was the senior partner in Dent and Co during the 1860s. He was a man of many contacts and much influence. From 1858 to 1867, he was the appointed consul for the Kingdom of Sardinia, and later of Italy. In 1863 he was elected Chairman of the Hong Kong Chamber of Commerce for the third time, and in that capacity had a leading role in the establishment of the Hong Kong and Shanghai Banking Company. When the bank incorporated in 1866, he was one of the proprietors. He returned to London in 1864 with a fortune of some £800000, and joined in the partnership Blakely Ordnance Company, of which he was Chairman. He returned to China when the Ordnance Company went public, and in 1866 he was appointed to the Legislative Council of Hong Kong. He resigned from the Council in 1867 when Dent and Co entered bankruptcy, and moved his operations to Shanghai.

The bankruptcy in 1867 was part of the worldwide financial crisis that began in London in 1866, which also drove the Blakely Ordnance Company Ltd into bankruptcy, though Dent blamed his immediate problem on a Portuguese employee in the Macao office who had embezzled some £200000 from the company.

Following the Second Opium War, and faced with the Taiping Rebellion, the Imperial government in Peking determined to obtain modern ships and arms from abroad. Horatio Nelson Lay, the Inspector General of Maritime Customs negotiated an Agreement with Prince Kung of the Imperial Court to form an Anglo-Chinese naval force to help defeat the Taipings and suppress the endemic piracy. Captain Sherard Osborne, RN, was seconded to purchase suitable ships and armaments, and recruit crews.

Purchases began in early September, and the first units left for Hong Kong within a couple of weeks. It was reported in December that ten gunboats were fitting out in Hong Kong for service in the flotilla.

In February 1863, the news reported that two batteries of artillery – one of 24 pdr howitzers and the other of 8in naval mortars – were ready for Osborne to ship to China.

In September 1863, the flotilla had gathered in Hong Kong and was ready to deploy. At about the same time, Blakely received an order for twelve field guns under the auspices of Henry Leighton, who was affiliated with John Dent and James Vavasseur, to be delivered in January 1864. For his involvement, Leighton received a commission for the two 4.5 in 20 pdrs, four 3.5 in 12 pdrs, four 3 in 9 pdrs and two 2 ½ inch 6 pdrs.

The Lay – Osborne flotilla never operated against either pirates or Taipings. A dispute arose over how control of the force should be exercised. Prince Kung believed he had direct authority. Commissioner Lay believed he had operational control. In disgust, Sherard gave up in November and left, and the flotilla was officially disbanded in January.

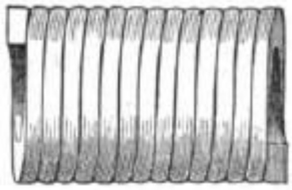
Through John Dent and Henry Leighton, there were further orders, though the only specific information that has survived is the Japanese order of 8 ½ inch coastal guns in 1865. But it should be noted that the reputation and good will, and the connections, developed before the financial crisis and bankruptcy carried over to the benefit of Josiah Vavasseur and the London Ordnance Company, especially in China, which will be addressed in Part 2.

Appendix D

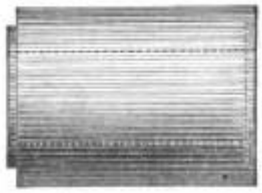
The opposition to Sir William Armstrong's 'System' of gun construction among the armed services and the 'technical' experts and scientific communities reached a crescendo in the last half of 1862, as each new failure and revelation became public knowledge. But to fully grasp that, except for the breech mechanism, the entire gun was built of wrought iron coils, welded and fitted together, and 'finished' to appear solid.

The process commences with the forging of the iron into bars of the required thickness and angles to produce the desired internal and external diameter.

Section of bar coil from Holley



Bar coiled to make a hoop from Holley



Finished hoop recessed to fit with others from Holley

Fig. 1. This bar is then wrapped around a mandrel to produce the desired dimensions.

The spiraled metal coil is then heated to welding temperature, and when cooled, the ends, interior and exterior surfaces 'finished' and ready for assembly.

The next step depends upon the intended use of the hoop; if part of the barrel ['A' tube] then the assembly is made and rifled, but if for a reinforcing hoop, at the proper time it is heated to high temperature, for expansion purposes, and then placed in the appropriate location and layer.

The Select Committee on Ordnance heard much Evidence, both pro and con, before making their final decision at the end of 1862, as already mentioned. Below are four examples of the coverage the great question generated.

In the June issue of the Journal of the Royal United Services Institution (RUSI), a Captain Fishbourne wrote in part, "The coils are shrunk on hot; the metal of course contracts in every direction, consequently the joints open; it were impossible they should be close; the overlapping pieces at the joints indicate the knowledge of this defect. All these are points of weakness, and the whole of the great vibration which takes place every time the gun is fired, must be thrown in turn on these separate parts, and not distributed, owing to the continuity being broken, which must lead early to the disintegration of the gun."

John Anderson, Esq., an engineer at the RGF, Woolwich, made a lengthy response in the August edition of RUSI. He cited at length the many tests and experiments dealing with the strength of the metal itself, and notes that the welds in the coils are in the direction of the least strain. He also included one salient paragraph that essentially undermined the Armstrong 'system.' "With iron of the very best quality which we have as yet been able to obtain, the highest average tenacity of the welding of the coil has been 32140 lbs per square inch, the iron being 55500 lbs... It will thus be seen that the ultimate strength of a coil in the circumferential direction, is about 55000 lbs per inch, while in that of its length it is only 32140 lbs per inch."

This was correctly interpreted to mean that the welds of the inner coil ('A' tube) would split from the pressures of large charges, or even service charges over time. The following year, Mr. Anderson and others, in Testimony before the Select Committee, admitted that such splits were frequent occurrences. In the fullness of time, Woolwich was quick to abandon the coiled wrought iron inner hoop for closed-end steel 'A' tubes, and replacing the mass of coiled wrought iron reinforcing hoops for a single massive wrought iron mantel.

In their October 31st edition, the Editors of The Engineer leveled a scathing attack on the Select Committee, and by extension the Government. "...How little is it known that, in the summer of 1855, the than Mr., now Sir William Armstrong, was making a gun for Mr. Longridge under license from Captain Blakely; how little is it known that until within a very few months, every Whitworth cannon was put together with so little tension in the outer hoops that they burst in the inner tube without opening on the outside!...Yet, while the French, the Spaniards, the Austrians and the Americans have condemned the Armstrong and Whitworth guns, they have adopted Captain Blakely's mode of strengthening ordinary cast iron. [For the sake of clarity, France and Spain were licensees of the Blakely patents, and perhaps so were the Austrians, which were not known at the time. The veiled inclusion of the Americans refers to the Parrott guns.] And while all that really essential to the strength of our present service guns has come from an application of principles laid down by Captain Blakely, the authorities, not recognizing him in any way, are lavishing vast sums of money upon experimental breech pieces, fancy rifling, impracticable projectiles, and unsettled refinements, which, there is no good reason to believe, actually render our guns inferior in nearly every working requisite to those already adopted by nations with whom we may at any time find ourselves at war. The Blakely principle is capable of application in steel, which, we must believe, would insure very greatly increased strength, and this strength once attained, the whole detail of rifling, loading, etc, may be worked out with much greater simplicity than is to be found in our present service guns. At any rate, not only have many of our gun constructors already successfully done this, but so have those of foreign nations. If we should sometime have a change of Ministry we may have a new Ordnance Committee, and possibly something like reform in the construction of our service guns."

The following week, the Editors continued in the same vein. "The whole question of ordnance, however, is still so unsettled – the old fashioned 68-pounders being still the most powerful guns in the naval service, while also out costly weapons have been rejected by other nations – that we cannot so easily judge what our actual progress has been during the last ten years, further than that, by making stronger guns and burning more powder we have accomplished somewhat more destructive results."

References

Carlucci, 2014 – *Carlucci, D.E.* (2014). Ballistics, Theory and Design of Guns and Ammunition. CRC Press.

Holley, 1865 – *Holley, A.L.* (1865). A Treatise on Ordnance and Armor. New York: D. Van Nordstand.

Colonel Maitland..., 1882 – Colonel Maitland Superintendant of Ordnance at the Royal Gun Factory, Woolwich. Paper read to the Society of Arts, London, on February 8, 1882. *Scientific American. Supplement*. № 324. March 18, 1882.

Report..., 1867 – Report of the Commissioners to the Paris Universal Exhibition, 1867, Appendix, p. 545. Secretary of State, 1869.

Roberts, 2012 – *Roberts, S.* (2012). Captain Alexander Blakely RA.

Shirokorad, 2000 – *Shirokorad, A.* (2000). Encyclopedia of Motherland Artillery. Minsk: Harvest.

Tredrea, Sozaev, 2010 – *Tredrea, J., Sozaev, E.* (2010). Russian Warships in the Age of Sail 1696–1860. Barnsley: Seaforth Publishing.

Лебединая песня: Блекли, Брук и Вавассер. Часть 1

Кент Р. Крауфорд [a,*], Дональд Е. Карлуччи [b]

[a] Gunnery Fire Control Group, Indianapolis (IN), США
[b] Stevens Institute of Technology, Hoboken (NJ), США

Аннотация. 1860-70-е годы характеризуются одной из самых глубоких технологических революций, которые когда-либо видел мир, ее назвали «второй промышленной революцией». Эта революция затронула военно-морские силы мира не меньше, чем любые другие сферы применения усилий человека. В области артиллерии железная гладкоствольная пушка, стреляющая ядрами, была вытеснена нарезной пушкой.

[*] Корреспондирующий автор
Адреса электронной почты: krand7@yahoo.com (К.Р. Крауфорд),
Donald.e.carlucci.civ@mail.mil (Д.Е. Карлуччи)

В истории остались много имен инженеров и/или производителей Великих Пушек. Был, однако, один конкретный инженер, чья короткая карьера до недавнего времени оставалась незамеченной.

Технические характеристики и подробная информация о наиболее известных создателях оружия хорошо задокументирована и легкодоступна, но у менее известных производителей она была потеряна для истории. За исключением некоторых отчетов третьих лиц, небольшого количества официальных документов и нескольких отчетов о продажах – вот и все, что осталось от работ капитана Блейкли. Похоже, что почти все его деловые документы были переданы Вавассеру в 1867 году, чьи записи и документы вошли в состав архива Армстронга, при объединении Лондонской артиллерийской компания и Армстронга в 1883 г. и впоследствии погибла в годы Второй мировой войны. Задача этой статьи исправить данный недостаток в максимально возможной степени. За немногими исключениями, баллистические характеристики являются расчетными и должны считаться номинальными.

Ключевые слова: военно-морской, артиллерия, Блекли, орудие.

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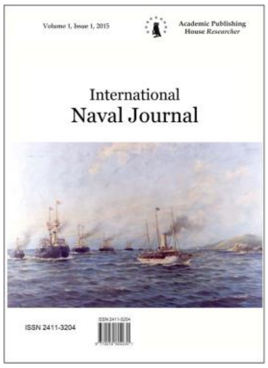

First Spanish Submarines

Alexander F. Mitrofanov [a, *]

[a] International Network Center for Fundamental and Applied Research, Washington, USA

Abstract

The paper gives a brief history of the creation and experiments of the first submarines of Spain. Despite the industrial left the second half of the XIX century, Spain was nevertheless among the pioneers in the creation of underwater weapons. During this period, the construction of submarines Narcíso Monturiol and Isaac Peral, which for the first time applied technical solutions on their boats that are still used on these weapons, falls on this. Currently, all three boats are used as monuments in Spain.

Keywords: Spain, submarine, naval, Isaac Peral, Narcíso Monturiol.

Первой испанской подводной лодкой принято считать построенную в 1859 г. в Барселоне "Ictíneo I". Она была создана конструктором-любителем Narcíso Monturiol y Estarrol и обладала основными чертами классической подводной лодки. Лодка длиной 7 м имела прочный корпус сферической формы и обтекаемый легкий корпус, в котором размещались четыре балластных цистерны. Набор корпуса был выполнен из дуба, обшивка из оливкового дерева обшита двухмиллиметровыми медными листами. В прочном корпусе размещался экипаж из пяти человек – капитана и четырех гребцов, приводивших в действие с помощью педального привода гребной винт, здесь же находились клапаны для заполнения и опорожнения балластных цистерн. Для дифферентовки лодки служил груз, перемещавшийся вдоль размещенной в диаметральной плоскости направляющей. Аварийное всплытие осуществлялось путем отдачи твердого балласта. Для наблюдения за окружающей обстановкой служили 4 иллюминатора. Лодка освещалась свечой, являвшейся также и своего рода индикатором содержания кислорода.

"Ictíneo" совершила 59 демонстрационных погружений-всплытий без каких-либо проблем. При этом лодка погружалась на глубину до 20 м, могла находиться в подводном положении до двух часов и двигаться со скоростью до 1 уз.

Следующим шагом Narcíso Monturiol y Estarrol стало создание большей субмарины, способной вместить до 20 человек – "Ictíneo II". Первоначально лодка, спущенная на воду в 1864 г., также имела мускульный педальный привод, но в 1867 г. была оснащена паровой машиной, при этом ее вместимость уменьшилась до двух человек. Не исключено, что "Ictíneo II" можно считать первой подводной лодкой с AIP (Air Independent Propulsion). Тепло, необходимое для производства пара, выделялось в результате химической реакции между цинком, диоксидом марганца и хлористым кальцием. Побочным продуктом реакции являлся кислород, служивший для дыхания экипажа. В ходе испытаний "Ictíneo II"

* Corresponding author
E-mail addresses: aleksmitr@yahoo.com (A.F. Mitrofanov)

погружалась на глубину до 50 м и находилась под водой до 8 час. Согласно утверждения конструктора, лодка смогла бы погрузиться и на 500 м.

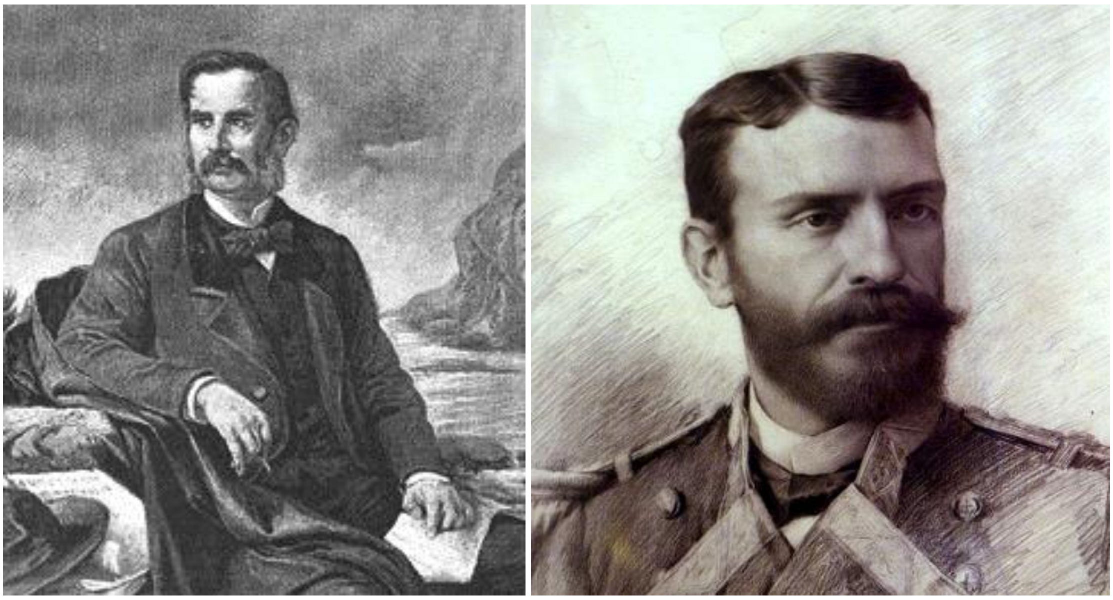

Рис. 1. Нарсисо Монтуриоль (слева) и Исаак Пераль (справа)

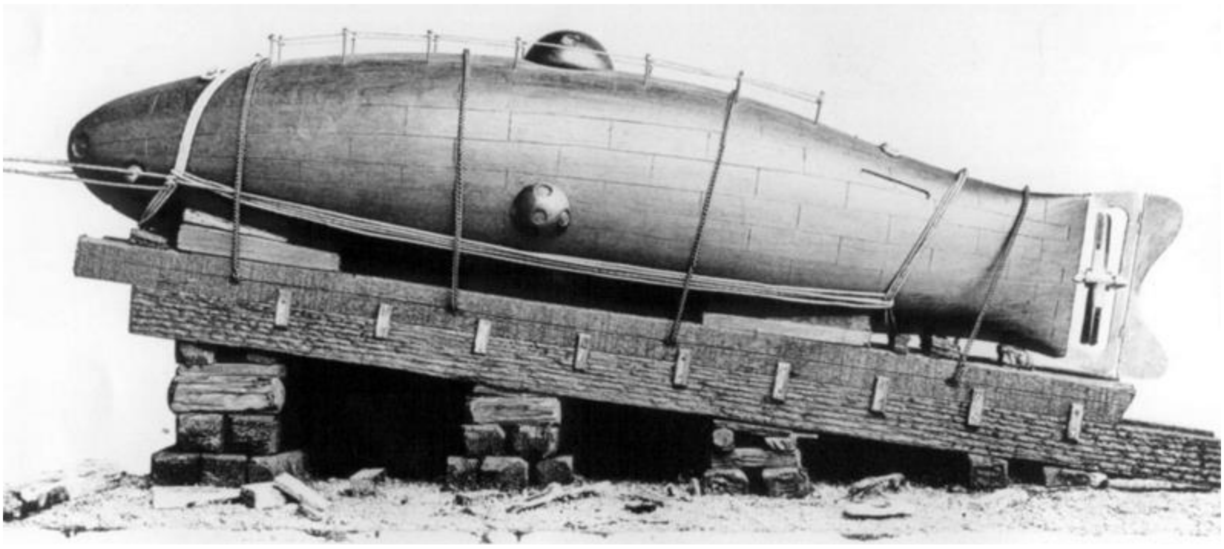

Рис. 2. Вторая лодка Монтуриоля

Так как Монтуриоль планировал использовать свою субмарину для подводных исследований и помощи водолазам, то он оснастил ее и своего рода механическими руками-манипуляторами. Пытаясь заинтересовать своим изобретением военных, Монтуриоль вооружил “Ictíneo II” пушкой, но ни Мадрид, ни иностранные правительства интереса не проявили. Жизнь творений изобретателя оказалась недолгой – в 1868 г. судоверфь за долги конфисковала обе лодки и пустила их на слом.

В настоящее время построены реплики обеих субмарин Монтуриоля – “Ictíneo I” находится во дворе морского музея Барселоны, а “Ictíneo II” – в местной гавани.

Следующим шагом в создании испанских подводных лодок был сделан 20 сентября 1884 г., когда лейтенант испанского флота Isaac Peral y Caballero (1861-1895) представил свой проект «подводного миноносца» (Proyecto de torpedero submarino). Проект нашел поддержку у военно-морского руководства и 23 октября 1887 г. началось строительство субмарины в

Arsenal de La Carraca. 8 сентября следующего года лодку, получившую название "Peral" в честь ее создателя, спустили на воду, а 8 марта 1889 года начались ее испытания.

"Peral" имела однокорпусную конструкцию из стали, в корпусе размещались и балластные цистерны емкостью 8 т. Гребные электродвигатели мощностью по 30 л.с. приводили в действие два гребных винта. Для изменения и стабилизации глубины погружения служило оригинальное устройство, спроектированное Пералем и получившее название "el aparato de profundidad". Этот аппарат состоял из расположенных в носу и корме двух вращающихся в горизонтальной плоскости гребных винтов с приводом от электродвигателей мощностью по 4 л.с. и автоматического устройства для поддержания заданной глубины погружения с точностью до 30 см и удержания лодки на ровном киле. Для наблюдения за надводной обстановкой использовался неподвижный перископ, электрические прожекторы в подводном положении имели дальность действия до 150 м.

Основные ТТХ подводной лодки „Peral“

Водоизмещение, т:	
надводное	77
подводное	85
Длина, м	22
Ширина, м	2,9
Осадка, м	2,8
Мощность гребных электродвигателей, кВт (л.с.)	2x27 (2x30)
Скорость, узлов:	
надводная	10,9
подводная	8
Дальность плавания, миль (скорость, узл.):	
надводная	132 (6)
подводная	?
Глубина погружения, м	30
Вооружение	1 x 360-мм ТА
3 запасных торпеды	

Для регенерации воздуха внутри субмарины служила гидроокись натрия, поглощавшая углекислый газ, воздух через которую прогонялся вентилятором с электродвигателем мощностью 6 л.с. (от него же приводился и осушительный насос) и кислородные баллоны. Это позволяло экипажу из 12 чел. находится под водой в течение довольно продолжительного времени. Источником электроэнергии являлись 613 аккумуляторных батарей общим весом 30 т.

"Peral" был оснащен расположенным в носовой части торпедным аппаратом калибра 360 мм и тремя запасными торпедами типа Scharzkopf. В конце августа 1889 г. лодка успешно выполнила первую торпедную стрельбу, а 25 июня следующего года в присутствии двух сотен военных и гражданских гостей продемонстрировала свои возможности, дважды симулировав торпедную атаку крейсера "Cristóbal Colón". Дневная атака была признана неудачной, так как лодка была обнаружена уже на дистанции около 900 м. Ночью же, несмотря на использование прожекторов, субмарина, оставаясь незамеченной, успешно выполнила торпедную атаку.

Хотя в целом результаты испытаний подводного корабля были признаны положительными, флот не удовлетворили его малые скорость и дальность действия, а также заметность в светлое время суток, поэтому Пералю было поручено спроектировать лодку с более высокими характеристиками. Конструктор разработал проект новой субмарины длиной 30 м. и водоизмещением 130 т., но 11 ноября 1890 г. было принято решение о прекращении дальнейших работ по созданию испанских подводных лодок.

Каким-то чудом предназначенная на слом первая испанская субмарина продолжала ржаветь в арсенале La Carraca до 1928 г., когда по инициативе создателя подводных сил контр-адмирала Mateo García de los Reyes началась ее реставрация. В 1930 г. лодку установили перед зданием командования базы подводных лодок в Картахене, а в 1965 г. ее подарили городу. В настоящее время “Peral” украшает набережную Картахены.

Рис. 3. Устройство подводной лодки Исаака Пераля

Рис. 4. Памятник «Подводная лодка Исаака Пераля» в настоящее время

Литература

Анка, Митюков, 2006 – *Анка А.А., Митюков Н.В.* Переезд памятника // *Флотомастер*. 2006. № 4. С. 48-50.

Военные флоты..., 1897 – Военные флоты и морская справочная книжка на 1897 г. / Под ред. Е.И.В. Вел. князя Алексея Михайловича. СПб.: Типография Э. Гоппе, 1897.

Митюков, Порцева, 2013 – *Митюков Н.В., Порцева Л.П.* Подводная лодка Исаака Пераля – памятник военно-морским инновациям Испании конца XIX века // Гуманитарное знание в XXI в.: значение, тенденции и перспективы. Новосибирск, 2013. С. 8-25.

Смирнов, 1974 – *Смирнов Г.* "Исход войны мог оказаться совсем иным..." // *Моделист Конструктор*. 1974. № 2.

Сырица, 1999, 2000 – *Сырица В.* Удар из-под воды. Подводное кораблестроение во второй половине XIX века за рубежом // *Флотомастер*. 1999. № 1; 2000. № 1.

Шеленков, 2001 – *Шеленков А.* Исаак Пераль: моряк и изобретатель // *Флотомастер*. 2001. № 3. С. 10-18.

Mitiukov, 2002 – *Mitiuckow N.W.* Pierwsze okręty podwodne Hiszpanii i Stanów Zjednoczonych // *Okręty Wojenne*. 2002. № 3. pp. 6-11.

Mitiukov, 2014 – *Mitiukov N.W.* Innovations of Spanish Shipbuilding of the Regency's period // *Bylye gody*. 2014. № 2. pp. 215-225.

Mitiukov, 2013 – *Mitiukov N.W.* Isaac Peral's Submarine and World Shipbuilding // *Voennyi sbornik*. 2013, № 1, pp. 4-12.

Mitrofanov, 2015 – *Mitrofanov A.* Okręty podwodne hiszpańskiej floty, Część I // *Okręty Wojenne*. 2015. № 5. pp. 2-4.

Referenses

Anca, Mityukov, 2006 – *Anca, A.A., Mityukov, N.V.* (2006). Pereezd pamyatnika [Moving the monument]. *Flotomaster*. № 4. pp. 48-50. [in Russian]

Mitiukov, 2002 – *Mitiuckow, N.W.* (2002). Pierwsze okręty podwodne Hiszpanii i Stanów Zjednoczonych. *Okręty Wojenne*. № 3. pp. 6-11.

Mitiukov, 2013 – *Mitiukov, N.W.* (2013). Isaac Peral's Submarine and World Shipbuilding. *Voennyi sbornik*. № 1, pp. 4-12.

Mitiukov, 2014 – *Mitiukov, N.W.* (2014). Innovations of Spanish Shipbuilding of the Regency's period. *Bylye gody*. № 2. pp. 215-225.

Mitrofanov, 2015 – *Mitrofanov, A.* (2015). Okręty podwodne hiszpańskiej floty, Część I. *Okręty Wojenne*. № 5. pp. 2-4.

Mityukov, Porceva, 2013 – *Mityukov, N.V., Porceva, L.P.* Podvodnaya lodka Isaaka Peralya – pamyatnik voenno-morskim innovaciyam Ispanii konca XIX veka [The submarine of Isaac Peral – a monument to the naval innovations of Spain at the end of the XIX century]. Gumanitarnoe znanie v XXI v.: znachenie, tendencii i perspektivy. Novosibirsk. pp. 8-25. [in Russian]

Shelenkov, 2001 – *Shelenkov, A.* (2001). Isaak Peral': moryak i izobretatel' [Isaac Peral: a sailor and inventor]. *Flotomaster*. № 3. pp. 10-18. [in Russian]

Smirnov, 1974 – *Smirnov, G.* (1974). "Iskhod vojny mog okazat'sya sovsem inym..." ["The outcome of the war could turn out to be quite different ..."]. *Modelist Konstruktor*. № 2. [in Russian]

Syrica, 1999, 2000 – *Syrica, V.* (1999, 2000). Udar iz-pod vody. Podvodnoe korablestroenie vo vtoroj polovine XIX veka za rubezhom. *Flotomaster*. 1999. № 1. 2000. № 1. [in Russian]

Voennye floty..., 1897 – Voennye floty i morskaya spravochnaya knizhka na 1897 g. [Military fleets and marine reference book for 1897]. Pod red. E.I.V. Vel. knyazya Alekseya Mihajlovicha. SPb.: Tipografiya EH. Goppe, 1897. [in Russian]

Первые испанские подводные лодки

Александр Федорович Митрофанов [a, *]

[a] Международный сетевой центр фундаментальних и прикладних исследований, Вашингтон, США

Аннотация. В работе дается краткая история создания и экспериментов первых подводных лодок Испании. Несмотря на индустриальную осталось второй половины XIX в. Испания тем не менее была в числе пионеров в создании подводного оружия. На этот период приходится постройка подводных лодок Нарсисо Монтуриоля и Исаака Пераля, впервые применившими на своих лодках технические решения, до сих пор использующиеся на этом оружии. В настоящее время все три лодки используются как памятники в Испании

Ключевые слова: Испания, подводная лодка, военно-морской, Исаак Пераль, Нарсисо Монтуриаоль.

[*] Корреспондирующий автор
Адреса электронной почты: aleksmitr@yahoo.com (А.Ф. Митрофанов)

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Anniversaries

70th Anniversary of Kent Rand Crawford

Anvar Mamadaliev [a], [*]

[a] International Network Center for Fundamental and Applied Research, Washington, USA

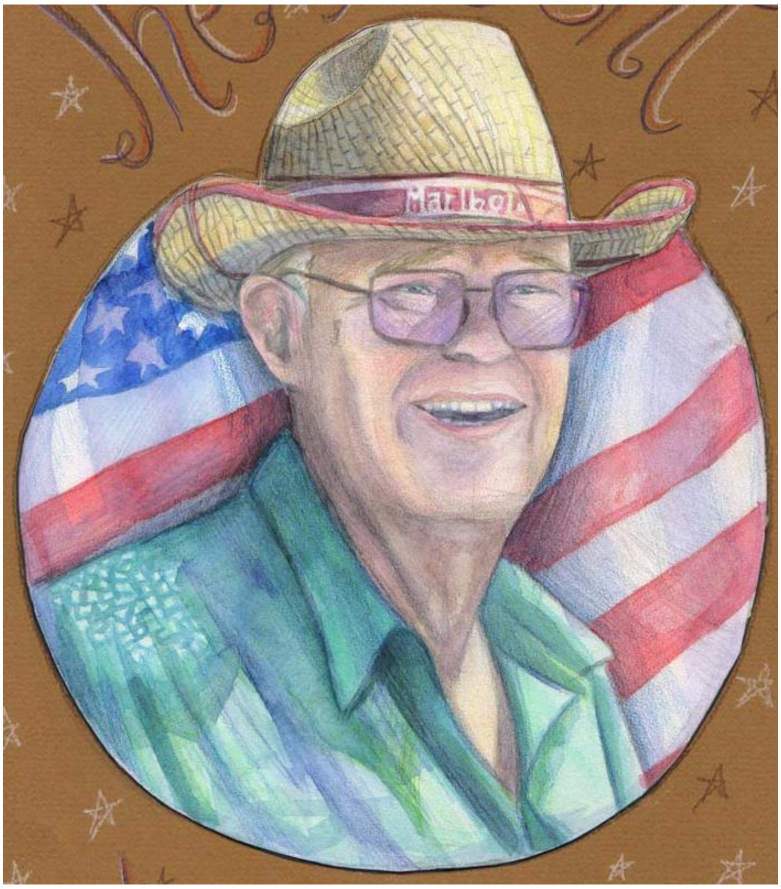

Рис. 1. Кент Рэнд Крауфорд

[*] Corresponding author
E-mail addresses: anvarm@mail.ru (A. Mamadaliev)

Кент Рэнд Крауфорд родился 18 апреля 1948 г. Бакалавр философии, истории и бизнеса (1974 г.), магистр истории (1978 г.), профессор естествознания (2008 г.), доктор натуральной истории (2012 г.). Получив образование в США, он долгое время жил за границей. В последний раз из-за несогласия с экономической политикой Барака Обамы он несколько лет провел в Коста-Рике и Колумбии.

Более четырех десятков лет он занимается изучением морского оружия. Итогом этой работы стали десятки публикаций. За десять лет, предшествовавших его эмиграции из США, он активно ездил по миру, встречаясь со своими коллегами из Великобритании, Испании, России. В настоящее время находится на пенсии, проживает в США.

Наибольшую известность он получил за работы по идентификации баллистических параметров морской нарезной артиллерии. В настоящее время занимается подобной задачей в отношении к дульнозарядной гладкоствольной артиллерии. В этом выпуске начинается публикация его новой объемной работы в нескольких частях.

Важнейшие работы К.Р. Крауфорда:

Митюков Н.В., Крауфорд К.Р. Верх совершенства. Броненосцы типа "Коннектикут" // Наука и техника. 2018. № 2 (141). С. 29-39.

Митюков Н.В., Крауфорд К.Р. Быстро устаревший идеал. Американские броненосцы типа "Вирджиния" // Наука и техника. 2017. № 12 (139). С. 34-43.

Crawford K.R., Mitiukow N., Mokrousow S. W Kwestii brytyjsko-włoskiego konfliktu na morzu śródziemnym w okresie II wojny światowej // Okręty Wojenne. 2016. № 4. С. 40-45.

Crawford K.R., Mitiukov N.W. Spanish naval artillery on 1890-1900 // International Naval Journal. 2016. № 4 (12). С. 211-318.

Mitiukov N.W., Crawford K.R. The method of analysis derived coefficients of database as a new method of historical research (for example, a database of ballistic parameters of naval artillery) // Bylye Gody, 2015, Vol. 38, Is. 4, pp. 1078-1084.

Crawford K.R. Rozważania nad technologią w bitwie pod Jalu // Okręty Wojenne. 2015. № 6. С. 9-15.

Mitiukov N.W., Crawford K.R. Mystery of the first Russian rifle naval guns // Военный сборник. 2015. № 3 (9). С. 135-139.

Crawford K.R., Mitiukov N.W. The British-Italian performance in the Mediterranean from the artillery perspective // History & Mathematics: Trends and Cycles. Volgograd, 2014. С. 300-313.

Mitiukov N.W., Crawford K.R. An estimation of the pneumatic guns effectiveness // Warship International. 2014. T. LI. № 2. С. 163-166.

Crawford K.R., Mitiukov N.W., McSherry P. An estimation of the pneumatic gun's effectiveness // Военный сборник. 2014. № 2 (4). С. 89-94.

Crawford K.R., Mitiukov N.W. Identification of the parameters of naval artillery. Prague, 2013.

Crawford K.R., Mitiukov N.W. The British – Italian performance in the Mediterranean from the artillery perspective // Военный сборник. 2013. № 2 (2). С. 95-102.

Митюков Н.В., Крауфорд К.Р. и др. Внутренняя баллистика дульнозарядных гладкоствольных орудий // Химическая физика и мезоскопия. 2012. Т. 14. № 3. С. 371-375.

Романенко И.В., Крауфорд К.Р. и др. Закон сопротивления дозвукового поражающего элемента типа сфера // Вестник СГАУ. 2012. № 5-1 (36). С. 43-45.

Крауфорд К.Р., Митюков Н.В. Орудия Блекли на вооружении русского флота // Новый университет. Серия: Технические науки. 2012. № 3 (9). С. 62-65.

Crawford K.R. Hitting the target. Naval fire control 1860 to 1900 // Вестник КИГИТ. 2012. № 6 (24). С. 4-26.

Crawford K.R. Thoughtson the naval technology used in the battle of the Yalu // Вестник КИГИТ. 2011. № 1-2 (15). С. 43-51.

Crawford K.R. Cavalli, Wahrendorff and the making of Krupp // Вестник КИГИТ. 2008. № 1-2 (7). С. 73-106.

Mitiuckow N.W., Fernández R.C., Crawford K.R. Battleships "España" class. Tarnowsky Gory, 2007.

Fernández R., Mitiuckov N., Crawford K. The Spanish dreadnoughts of the “España” class // Warship International. 2007. T. XLIV. № 1. C. 63-114.

Mitiuckov N.W., Crawford K.R. Reconstruction the 120-mm guns of the destroyer ”Oquendo” // Argonauta. 2007. T. XXIV. № 3. C. 18-19.

Crawford K.R. Mathematics and the analysis of naval gun performance and projectiles // Вестник КИГИТ. 2006. № 2. С. 6-13.

Crawford K.R., Митюков Н.В. База данных по морской артиллерии «Database of Naval Guns» // ГР в ВНТИЦ 17.10.2006 № 50200601789. Заявл. 23.09.2006 № .03524577.01610-01 99 01.

Крауфорд К.Р., Митюков Н.В., Мокроусов С.А. К вопросу об англо-итальянском противостоянии на Средиземном море периода Второй мировой войны // История корабля. 2005. № 2. С. 50-54.

Рисунок – А.Н. Пислегина