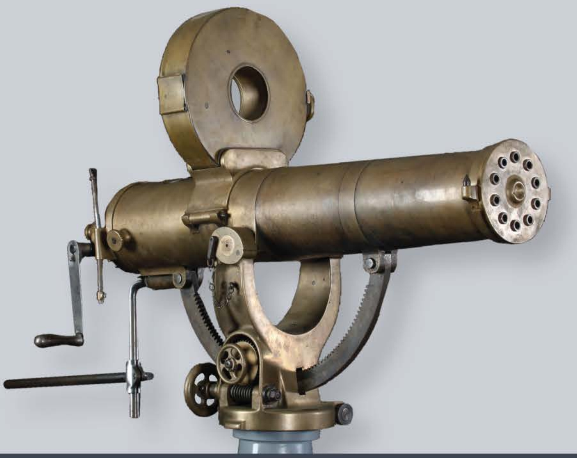
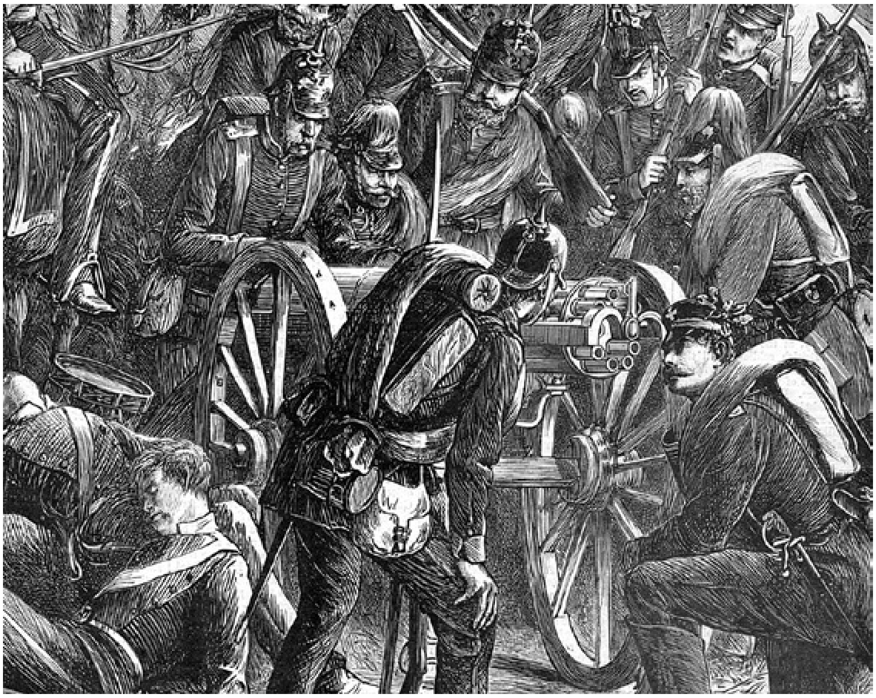


THE GATLING GUN

PETER SMITHURST

WEAPON

THE GATLING GUN



PETER SMITHURST

Series Editor Martin Pegler

CONTENTS

INTRODUCTION

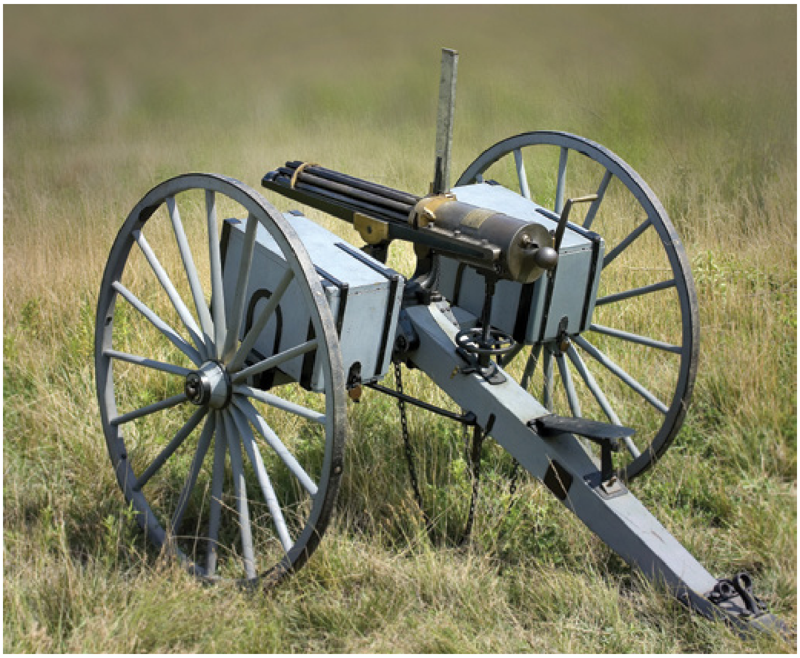
Since the first firearms appeared there have been continuous attempts to improve their 'effectiveness'. Effectiveness can mean many things. The gradual transition from the crude hand cannon in which the propellant was ignited by a piece of smouldering match cord held in the hand, through the matchlock where the human hand was replaced by a mechanical 'hand' activated by a trigger; then the technological quantum leap forward to the wheel-lock, in which sparks were generated mechanically at the instant of firing. Then came the much simpler flintlock, where the sparks were created by flint striking steel. Finally, came the allying of another chemical process to the burning of gunpowder – the ability of some sensitive chemicals to detonate when struck and provide the flame to ignite the charge. These are all impressive developments in the effectiveness of firearms. Then we have the simple transition from a smoothbore barrel firing a plain spherical ball to the rifled barrel where a series of spiral grooves in its bore make a pointed, elongated bullet spin in flight – its shape, giving it less air resistance, its tight fit in the bore to make full use of the force of the explosion and the fact that it has gyroscopic stability from its rapid spinning combine to give it far greater range and accuracy over the old round ball. These also are impressive additions to 'effectiveness'. But we should not deceive ourselves by hiding behind terminology. The bottom line of effectiveness in a military firearm is to kill or wound as many of the enemy on the battlefield as quickly as possible.

By the middle years of the 19th century, firearms were on the threshold of perhaps their biggest evolutionary step of all – the development of breechloading and the self-contained cartridge which together provide the foundations of all modern firearms. By that time also, the limited mechanization of a variety of previously manual manufacturing processes – especially in the textile, and iron and steel, manufacturing industries – was an established fact. But in the United States, where manufacturing had been stifled under colonial rule and labour was thin on the ground and expensive, after Independence ‘Yankee ingenuity’ was applied to taking mechanizing to new levels on the farm, in the home and in the factory. Once established, Eli Whitney’s cotton gin became indispensable to the processing of raw cotton. At the Crystal Palace Exhibition in 1851, Cyrus McCormick unveiled his reaper for harvesting wheat. It would not be long before the sewing machine began to appear in the home. By this time also the application of machinery to all the operations in manufacturing firearms had been brought to perfection. It should not be surprising to find that this same ‘Yankee ingenuity’ turned towards mechanizing the process of loading and firing guns also.

The arrival of a reliable self-contained cartridge allowed the development of a variety of repeating firearms in which cartridges were fed into the breech by a lever-operated mechanism which opened the breech, extracted an empty cartridge case, fed in a replacement, closed the breech and at the same time cocked the gun ready for firing when the trigger was pulled. Early examples of this type of system are the Henry and Spencer rifles of the 1860s. What if the separate actions of loading and firing could be combined so that in a single operation, the gun could be loaded, cocked and fired in a repetitive cycle and could have an unlimited supply of ammunition? Such a mechanized gun would deliver awesome firepower.

The first step along this pathway was a weapon that came to be known as the ‘Union Repeating Gun’ or the Ager ‘Coffee Mill’ gun on account of its ammunition feed hopper. It was tested by the US Ordnance Department in 1861 and a limited number were actually purchased, but it was not a great success. The weapon fired standard .58in-calibre paper cartridges

Ager ‘Coffee Mill’ gun, .58in calibre, serial no. 2, manufactured by Woodward & Cox, New York; the hopper is marked ‘E. NUGENT N.Y.’. This weapon is named after Wilson Ager, but there is some uncertainty as to when the Ager gun was invented and, indeed, whether he was actually the inventor. This doubt may also have sprung from the fact that UK patent no. 24 (1862) is in the name of E. Nugent, the same that appears on the hopper of the example shown here. However, the same weapon appears under Ager’s name in UK patent no. 152 (1866), which does nothing to clarify the situation. (Courtesy US National Park Service, Springfield Armory National Historic Site; photograph James Langone, Springfield. SPAR 5612)



Originally in .50-70 Government calibre, but later converted to .45-70 Government calibre, this Gatling gun is mounted on the later 1877-style carriage. The rectangular brass maker's plate reads 'Gatling Battery Gun #22 Patented May 3, 1865. Colt's Patent Firearms Manufacturing Co. Hartford, Conn, U.S.A.'. Only two others of this model are thought to exist. This gun was purchased by the US Navy in 1866 and installed on USS *Yorktown* (Gun Boat No. 1), remaining on board until she was decommissioned in 1919. Seeing extensive service in foreign waters 'showing the flag', *Yorktown* had numerous engagements in the China Sea during the 1890s and patrolled South American and Mexican waters prior to World War I and then US coastal waters towards the end of the war. The gun was then donated to the Houston Museum, Texas. In 1967 the museum sold the gun at public auction to a Houston collector; the collector restored and cared for the gun until 1991 (Cowan's Auctions 2007: 82–83). However, it shows various anomalies, most notably the vertical magazine, which may be the result of conversion to the .45-70 cartridge, and what appears to be a lock-removal plug, which did not appear until the 1869 (UK) or 1871 (US) patents. That may also be a result of later improvement but would have entailed changing the drive mechanism from bevel wheels to worm-and-pinion, otherwise there would not have been clearance for the bolt to be withdrawn if the patent drawings are any guide. (Photograph courtesy of Cowan's Auctions, Cincinnati, Ohio)

which were placed inside steel cartridge casings closed at one end and fitted with a percussion nipple. Like all such guns which used pre-loaded chambers with an external percussion cap, at the instant of firing the chamber had to be pressed very tightly against the breech face of the barrel to avoid gas leakage, then released so it could fall away and be replaced by the next one. Gradually, wear and tear would take their toll and obturation, the seal between breech and barrel, was compromised with the increased risk of flame from the explosion escaping and igniting the charges in the cartridges waiting in the hopper. Another important consideration was that it only had one barrel and while it functioned beautifully using empty chambers, as Major G.V. Fosbery VC – himself a firearms innovator – pointed out in 1869 when the gun was tested in Britain:

> the only thing forgotten seemed to be that when using loaded chambers, and firing at the rate of 100 discharges per minute, the flame of 7,500 grains of powder, and nearly 7lbs of lead would pass through this single barrel in that time. The effect on trial proved to be that the barrel grew first red and then nearly white hot, large drops of fused metal poured from the muzzle, and the firing had to be discontinued for fear of worse consequences. (Fosbery 1869: 543)

But a train of thinking had been set in motion and was not lost on Richard Jordan Gatling. He created what became probably the most easily recognized generic series of guns which even today, long after other manual rapid-fire guns were made obsolete by Hiram Maxim's invention of the fully automatic machine gun in 1883, find a place in modern military armament.

DEVELOPMENT

A new species of weapon is born

ORIGINS

Although not an engineer or gunmaker, Richard Jordan Gatling, like many of his fellow Americans, was ‘an interested amateur’. He embodied much of what Alexander Hamilton, first Secretary of the Treasury in the newly independent United States of America and ‘Father of American Manufacturing’, commented upon: ‘If there be anything in a remark often to be met with, namely, that there is, in the genius of the people of this country, a peculiar aptitude for mechanic improvements …’ (Hamilton 1827: 22). It is worth remembering that at that time there was no such thing as an ‘engineer’ and most of the world’s technological advances – the industrial revolution in all its varied forms – had been accomplished by amateur ‘dabblers’ and ‘tinkerers’ fired by unbridled imagination and a belief that things could be done in different and better ways.

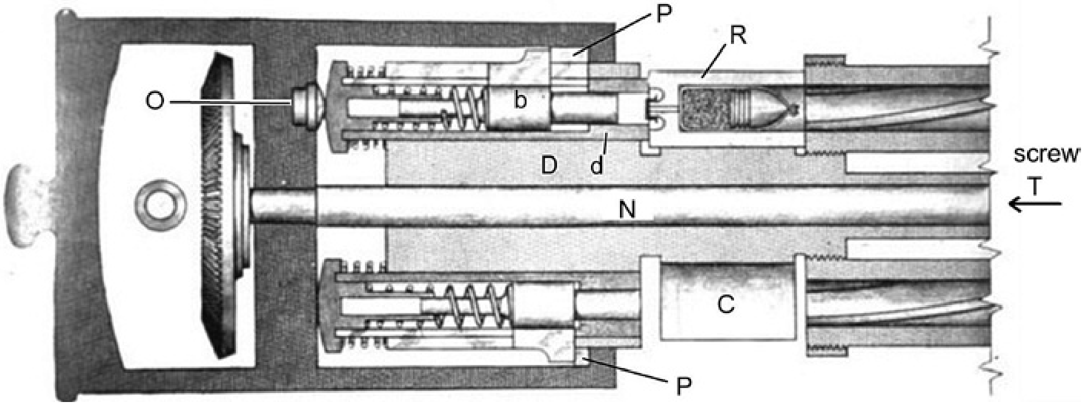
Gatling was born in 1818 on a remote farm at Maney’s Neck near Murfreesboro in North Carolina. His attendance at school was probably restricted to the winter months, when he and his fellow pupils were not needed to help on the farms, and confined to the essentials so that by the time his schooling was finished at 16 years of age he was literate and numerate. But he received informal and equally valuable education on the farm. He was part of a family of ‘dabblers and tinkerers’. His father, Jordan Gatling, was a self-taught blacksmith and carpenter, essential skills to keep a remote farm and household operational, and which had led him to obtain two patents in 1835 for a cotton thinner and cotton seed planter. Much later, in 1873, his brother James Henry constructed a flying machine which travelled 100ft before crashing into a tree.

Richard Jordan Gatling (1818–1903) is depicted in this photograph by celebrated photographer Mathew B. Brady (1822–96). What led Gatling to develop his gun? He was neither an engineer nor a gunmaker. According to a letter written to a friend in 1877 while residing in Indianapolis, his invention had been inspired by humanitarian needs: 'In 1861, during the opening events of the war I witnessed almost daily the departure of troops to the front and the return of the wounded, sick and dead. The most of the latter lost their lives, not in battle, but by sickness and exposure incident to the service. It occurred to me if I could invent a machine – a gun – which could by its rapidity of fire, enable one man to do as much battle duty as a hundred, that it would, to a great extent, supersede the necessity of large armies, and consequently, exposure to battle and disease be greatly diminished' (quoted in Keller 2008: 27). One can possibly discern here the beginnings of a concept that was to dominate the world a century later – a deterrent, not just superseding the necessity for large armies but of giving warfare itself unthinkable consequences. (Library of Congress)

By degrees the young Gatling added his father's practical skills to his own accomplishments. So much so, that when he was 18 years old he had responded to a plea from the US Government to find a better way of propelling ships than paddle wheels and oars and took his model of a screw propeller to the Patent Office in Washington, DC. There he was told he was just too late, a patent having been granted to John Ericsson a few weeks previously. Had he not delayed, waiting for winter to give way to better weather in the spring, it would be his name we associate with the invention. Richard Jordan Gatling's dabbling and tinkering was to bring him over 50 patents, his first in 1844 for a wheat-seed sower and his last in 1902 for a steam plough.

THE MODELS OF 1862

There seems to be a degree of confusion in the designation of various guns depending upon the changes that were made in their construction and functional characteristics. How far these were based on changes in the gun's basic mechanism and mechanical components or on the ammunition



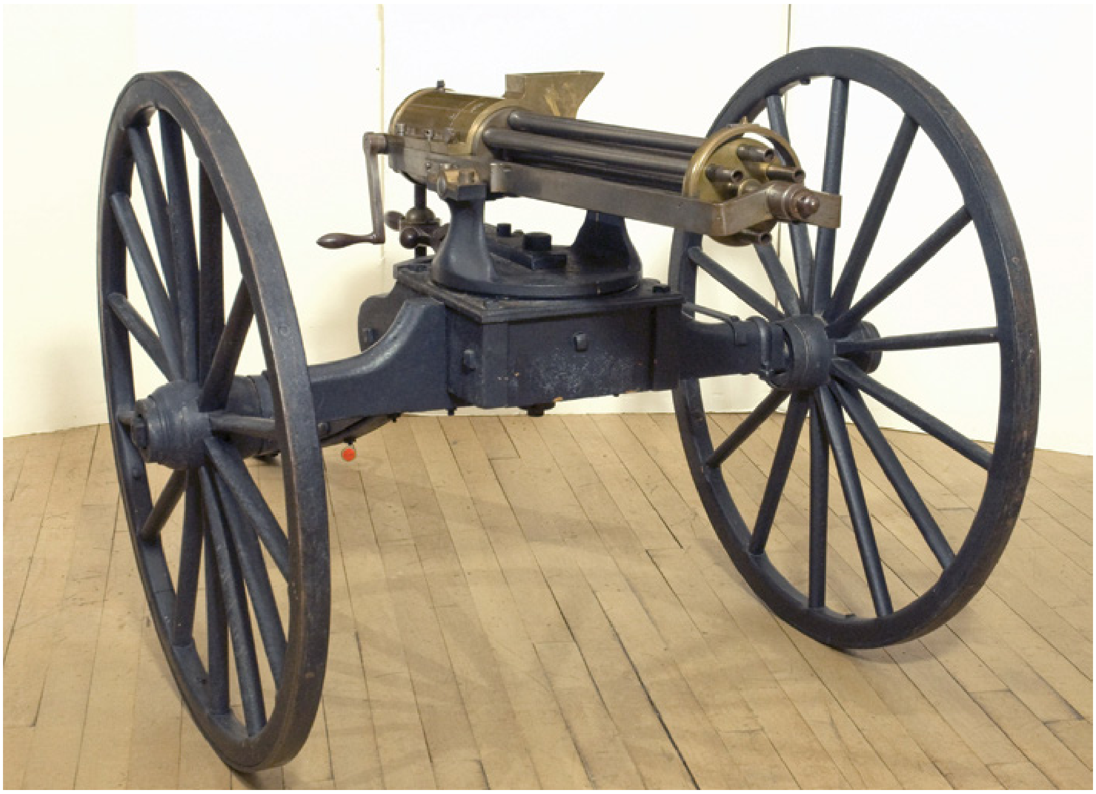
Detail of the lock mechanism showing a pre-loaded chamber (R) in position in the cartridge carrier (C) and about to be fired. As the barrel/lock assembly rotated, the head of the lock (d) was brought into contact with a raised 'button' (O) on the diaphragm which forced the lock forward slightly, pressing the cartridge chamber (R) tightly up against the mouth of the barrel. During this rotation, a projection on the hammer, or striker (b), rode against the inclined surface of a ring (P) encircling the lock carrier (D) and which acted as a cam. The inclined rear face of this ring caused the hammer (b) to be forced back against a spring and when the cartridge was in place and pressed against the mouth of the barrel, the projection on the hammer came to a step in the inclined plane, allowing the spring to drive it forward and strike the cap on the cartridge and thus firing it. Gatling noted in his patent 'an adjusting screw, T, is placed opposite the forward end of the shaft, N, for regulating the pressure on the cartridge chambers, K'. Note the use of bevel gears – a crown wheel and pinion – for the drive mechanism. Adapted from Chinn 1951: 49. (Private collection)

feed systems used is equally uncertain in some cases. The invention that put Gatling on the path to worldwide fame was US patent no. 36,836 of 4 November 1862, simply titled 'Machine Gun'. In creating his gun, Gatling incorporated a pre-loaded iron or steel 'cartridge', a cylinder closed at one end and fitted with a nipple for a percussion cap, which had been used in the Ager. Such a device was not new to Ager and had been used before; it was the simplest way of achieving what was required. But far from copying the Ager, Gatling introduced several important features which were to remain through the whole series of weapons and characterize these guns. Top of the list was the fact that it was multibarrelled. It was therefore less likely to suffer the overheating problem recounted in regard to the Ager. Allied to this was the fact that each barrel had its own individual firing mechanism, so even if one became faulty, the gun could still keep firing, albeit, in motor-car parlance, not on all cylinders.

All of the functional elements were carried on a central shaft set in a metal framework. First there was the cluster of barrels, usually six or ten; behind the barrels was a cartridge carrier; behind the cartridge carrier was the lock housing, which carried a number of locks or bolts corresponding with the number of barrels; and lastly there was a gear wheel which engaged with a gear on the crank handle on the side of the frame. All these elements were securely fixed to the shaft in such a way that they could not rotate independently, but equally importantly, to ensure that the lock housing and cartridge carrier were in correct alignment with the bore of the barrels.

After producing a prototype, in 1862 Gatling moved to Cincinnati, Ohio, where he placed an order with Miles H. Greenwood to have six guns manufactured. Unfortunately, before they could be delivered, the guns, drawings and patterns were destroyed in a fire at the factory. He then had another 12 guns manufactured by another Cincinnati company: McWhinney, Rindge, & Co. Throughout this period, Gatling continued to demonstrate his first gun, made while he was in Indianapolis, to

> many army officers of rank and distinction, all of whom were highly pleased at the result of its performance. The American press of 1862



Model 1862 Gatling Gun Type II, adapted to fire the .58in rimfire metallic cartridge. Manufactured by McWhinney, Rindge, & Co., Cincinnati, Ohio, in 1863. This is probably identical to the one demonstrated in the Washington Navy Yard in 1863. (Courtesy US National Park Service, Springfield Armory National Historic Site; photograph James Langone, Springfield. SPAR 5613)

> and 1863 teemed with accounts of these trials, and during all this period, no notice of a similar weapon, or at least none equalling or approaching the 'Gatling Battery' in the rapidity of its firing, appeared in any of the papers published in America or Europe. (Gatling 1870: 506)

As already noted, these first guns had ammunition consisting of pre-loaded steel chambers fitted with a percussion cap. However, the period of Gatling's innovation was also a time of innovation in ammunition and saw the development and increasing adoption of the self-contained metallic cartridge in America and, later, in other countries too. Without having to substantially alter his original design, Gatling adapted his pre-loaded steel chambers by simply boring them all the way through so that they could accept a metallic cartridge. It might be noted that on these guns the front sight was mounted on a bridge over the barrel cluster, allowing the gun to fire on 'top dead centre'.

During 1862 and 1863, the gun underwent various demonstrations and in March 1863, Major General Horatio G. Wright, in command of the Department of the Ohio, wrote to Brigadier General J.W. Ripley, Chief of Ordnance, suggesting that 'As a device for obtaining a heavy fire of small arms with very few men, it seems to me admirably adapted to transport steamers plying upon the Western rivers, where infantry squads are needed for security, against guerrilla and other predatory bands' (quoted in Gatling 1870: 508) and that Mr Rindge, agent for the

FIG. 12.

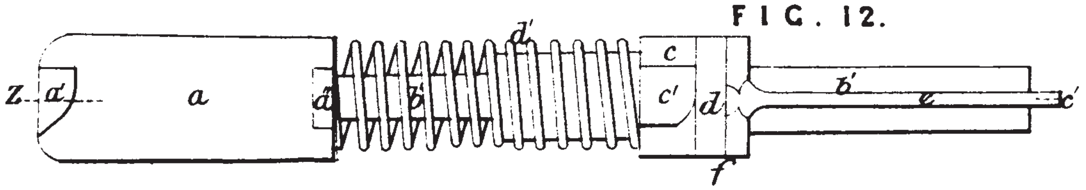
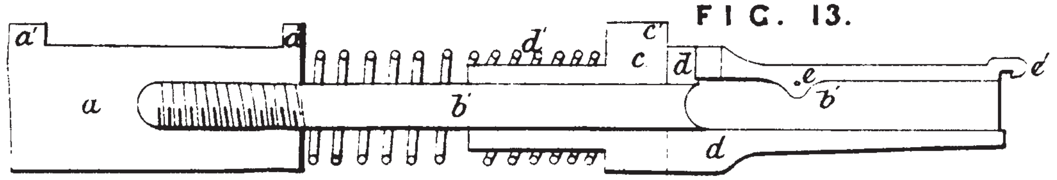


FIG. 13.



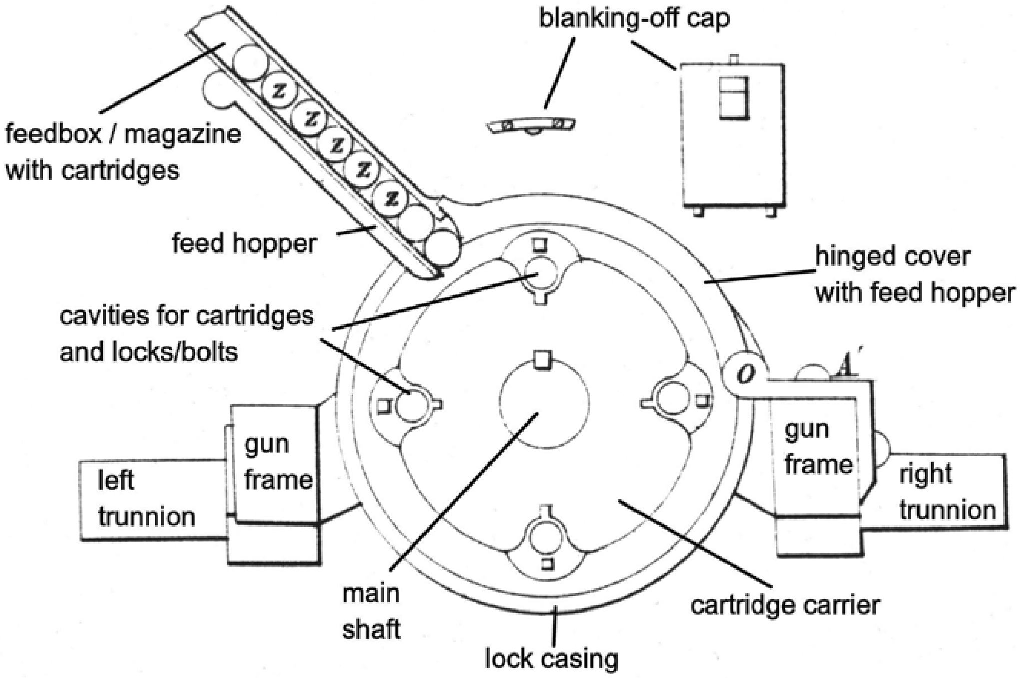
Details from the patent drawing showing the construction of the new bolt, or 'lock', assembly. UK patent no. 790 of 1865; US patent no. 47,631 of 1865. After a cartridge was fed into the cartridge carrier, the lock was driven forward by the lug (a^1) on the bolt 'head' or 'butt piece' (a) riding in an inclined elliptical cam groove on the inside of the lock casing. This caused the cartridge to be fed into the chamber of the barrel. When the cartridge was fully inserted, another cam, the 'cocking ring', in the forward part of the lock casing engaged with the lug (c^1) on the 'hammer' (c), pulling it backwards against the spring (d^1) and then releasing it, allowing the hammer to fly forwards and fire the cartridge. As the assembly continued to rotate, the lug (a^1) now encountered the elliptical cam groove as it changed direction towards the rear of the casing, causing the lock to move backwards, at the same time pulling the spent cartridge case out of the chamber by means of the extractor hooked over the rim of the case. And thus the process was repeated for each barrel in a continuous cycle. (Private collection)

gun, be given the opportunity to demonstrate it. This is not only a commentary of the virtues of the gun, it is also a telling testimony to the perils faced by western settlements when civil war was added to frontier lawlessness.

After tests at the Navy Yard in Washington, DC, it was reported to Rear Admiral J.A.B. Dahlgren, head of US Navy Ordnance, in May 1863 that 'The gun or battery has stood the limited test given it admirably; has proved itself to be a very efficient arm at short range; is well constructed and calculated to stand the usage to which it would necessarily be subjected. It is suggested that an improvement in the manner of rifling the barrels would be advantageous' (Gatling 1870: 508). Gatling followed this advice by having a new set of barrels with altered rifling made and fitted and in June of that year a further series of tests was conducted at the Washington Navy Yard. Dahlgren was so impressed with their performance that he gave permission to commanders of fleets and squadrons to order guns for their commands, but few were actually supplied on account of Gatling's inability to have them manufactured speedily and in quantity.

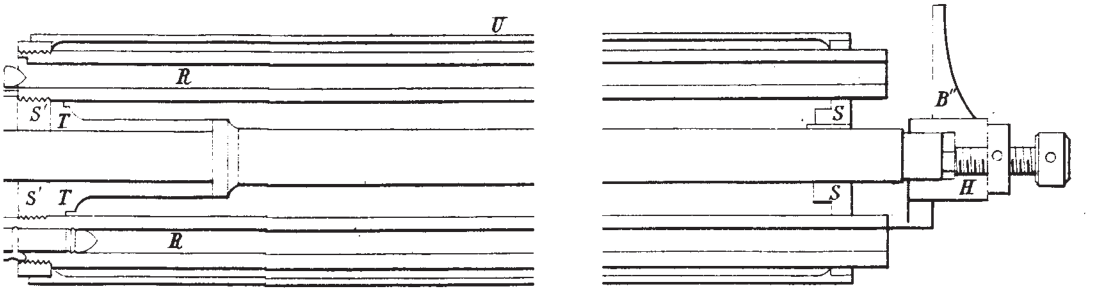
THE MODEL OF 1865

Gatling realized that the use of bored-through chambers to enable the gun to use metallic cartridges was acceptable as a temporary measure, but to ensure the gun's future success a complete redesign of its fundamental mechanism was required to allow the gun to handle metallic cartridges directly without the need for an intermediary chamber. A consideration of what was required will illustrate that this was not a simple matter. With the early guns, the chambers, whether the percussion-cap variety or those made to accept metallic cartridges, simply dropped into the gun from a magazine at the top; the bolts were pushed forward slightly to force the chamber against the mouth of the barrel to achieve a degree of gas-seal, and the striker was pulled backwards and released to fire them. After firing, the now empty chambers simply dropped out of the gun at the bottom.



What was needed now was a sequence of much more complex events. The chambers to hold the cartridge now became part of the barrel, so cartridges had to be pushed forward a distance corresponding to their length so that they entered the chamber in the barrel; after firing, the empty cartridge cases then had to be withdrawn from the chamber. Thus there was a significant increase in the distance the bolt had to travel and it would have been impossible, considering the point of entry of the cartridges, to achieve that travel within such a small arc of rotation to allow the gun to fire on top dead centre. These new guns, therefore, fired from the barrel at roughly the 7 o'clock position when viewed from the front. Not only that, the empty cases had to be physically pulled out of the chamber; this required that the bolt be fitted with an extractor to withdraw the cases and also demanded a simple and foolproof means of releasing them so that the loading, firing and extraction cycle could be repeated. As in the 'chamber-loading' guns, the bolt also had to support the base of the cartridge at the instant of firing. These fundamental elements of a new mechanism were covered in new patents, no. 47,631 of

BELOW
Detail adapted from the 1865 patents showing the cooling jacket (U) attached to the two discs (S and S^1) in which the barrels are fixed. Gatling suggested this could be filled with water, which would have produced the desired effect, or Plaster of Paris, which would have probably functioned better as an insulator than coolant! The latter may have been just a simple expedient example to allow his patent to cover both solids and liquids in the jacket. Although not specified, it is presumed the jacket revolved with the barrel cluster. (Private collection)



1865 (US) and no. 790 of 1865 (UK). The mechanism designed for the Model 1865 Gatling, with various refinements, provided the basic foundation for all future models.

This patent also incorporated two other features which did not appear on later guns and possibly did not appear on these guns in practice. Gatling recognized that one of the barrel and lock assemblies could become faulty through whatever cause. Such a fault could render the gun inoperable until repaired, so to overcome this he incorporated a blanking-off cap that could be clipped to the cartridge carrier associated with the faulty mechanism and which prevented a cartridge from dropping into place and being fed through the system with possibly serious damage resulting.

The second feature, one which would have been of benefit to the Ager and which was later adopted by Maxim – but seems never to have been actually used in practice by Gatling – was a cooling jacket surrounding the barrel cluster. This seems to be the first instance of a water jacket being proposed for cooling a barrel – the fact that it is patented suggests as much – but also seems never to have been acknowledged.

Early in 1865 Gatling transferred the manufacture of guns to the Cooper Fire Arms Manufacturing Company of Philadelphia, Pennsylvania, who, with their experience and reputation as firearms manufacturers were better equipped to produce the new guns; it was they who produced the last of the .58in-calibre rimfire guns and the first of the big 1in-calibre guns. In 1865, when the war was over, Major General John Love, acting as Gatling's agent, succeeded in initiating a series of official tests with a four-barrelled gun of .58in calibre at Washington Arsenal. These tests showed it capable of delivering 20 shots in 8 seconds, all striking the target and penetrating 11in of white pine boards at 300yd (OM §17: 18). A further test just over a year later with a 1in smoothbore gun firing canister shot containing 16 balls firing at a target 35.5ft long and 15ft high, made of 1in pine boards, showed that at a range of 250yd only 18 per cent hit the target and only 50 per cent of those penetrated (OM §17: 20). Shortly after, a test with a rifled 1in gun alongside a 24-pdr flank-defence howitzer was carried out. The Gatling, firing 'buck and ball' cartridges at the rate of about one per second, discharged in 1½ minutes around 1,600 projectiles; in the same time the 24-pdr only fired four rounds, giving, for canister 192, and for case shot 700, projectiles. The report also comments on the effect on morale of the Gatling 'in repelling an assault, as there is not a second of time for the assailants to advance between the discharges' (quoted in Wahl & Toppel 1965: 30).

After these trials, in 1866 – around which time the gun was altered to handle .50in centrefire cartridges as opposed to the .58in rimfire used previously – the US Government formally adopted the gun, and placed an order with Gatling for 50 each of the 1in- and .5in-calibre versions (Wahl & Toppel 1965: 31). With such a large contract, manufacture was once again transferred, this time to the Colt Patent Firearms Manufacturing Company. This order is confirmed by a note in the business diary of Major General William Buel Franklin, Vice President at Colt's: '27th September

OPPOSITE
A detail from the 1865 patent drawing showing the blanking-off cap for fitting over the cavity in the cartridge carrier if required. (Private collection)

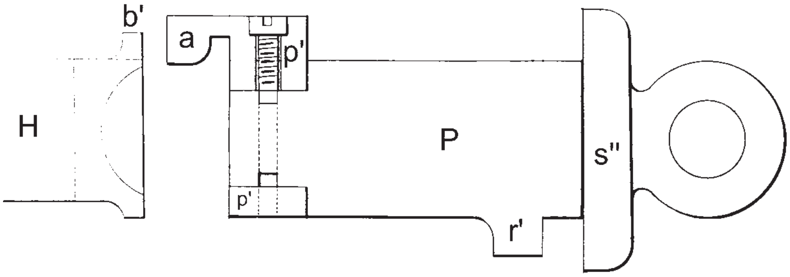
Confirmation of Colt's entry into the Gatling story is provided by this nameplate from a Model 1865 Colt-manufactured Gatling, as in the first US Government contract. This nameplate has other points of interest – on the back it has part of a name, possibly of the brass founder who made it, and, intriguingly, the British War Office 'WD' mark. When acquired in the 1970s there were no screw holes in it; this, together with the fact that it is flat, shows that it was never fitted. (Private collection)

1866: Made contract with company for man'g [manufacturing] Gatling gun, one hundred'.[1]

Further tests resulted in two interesting comments. In 1867, a 'Report on certain defects in the Gatling gun' at Leavenworth Arsenal, Kansas, noted: 'the barrels were successively discharged before they had fairly cleared the front transverse bar of the gun frame, and that it was not the undermost barrel that fired'(OM §17: 21). A few days later, trials were carried out at the Watervliet Arsenal, New York to determine at what precise point in the revolution of the barrels, when they were turned both very slowly and rapidly, the cartridge was discharged. On slow turning, it was reported that the 'ball from the 1 inch gun cleared the bar by 3⁄16th of an inch and that of the ½ inch gun by ⅙th of an inch; a more rapid motion causes the firing to take place at a lower point' (OM §17: 21). As a result of these tests, Brigadier General P.V. Hagner of the US Ordnance Department suggested the mechanism of the gun be changed so that each barrel fired when at its lowest position. Even so, in 1868, a report from Fort Leavenworth speaks of 'slugging of the balls on the front transverse bar' (OM §17: 21) but we are not told if this was an earlier gun or a later one in which the 'timing' had been adjusted. However, this fault does not appear to have been reported after this time so it is assumed it had been corrected.

THE MODELS OF 1869 AND 1871

In 1869 a further patent was granted in Britain (no. 3,341) but for some reason did not appear in the United States until two years later (no. 112,138). Possibly prompted by the significant improvements embodied in the 1869 patent, the British military authorities raised the subject again but, for some obscure reason, seemed still undecided over the merits of the Gatling or Montigny mitrailleur (as contemporaries called such weapons), which was favoured by at least one officer, Major Fosbery of the Bengal Staff Corps. However, in 1870, when the India Office enquired whether Major Fosbery should be ordered back to England, a reply was sent stating that 'Major Fosbery's services are not required in this country in connexion with the supply of a weapon which has been preferred to the one which he himself had recommended' (DAS §2873). Obviously by this time the superior merits



A composite image of details from UK patent no. 3,341 showing how the lock and plug engaged for lock withdrawal. On the inward end of the plug was a rotating collar (p^1) having a lug on its periphery with a forward-facing projection (a) with a groove. This groove corresponded with the lug (b^1) on the lock-head which engaged with the cam, giving the reciprocating motion to the lock as the barrel and lock assembly revolved. When each of the barrels was correctly aligned with a mark on the lock casing, its corresponding lock was engaged with the hook (a) on the plug and in line with the opening in the cascable. By rotating the plug to bring its lug in alignment with the cut-out in the cascable hole, the plug with the lock could be withdrawn. (Private collection)

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[1] Private communication from Ed Hull; diary held in State Library, Hartford, Connecticut.

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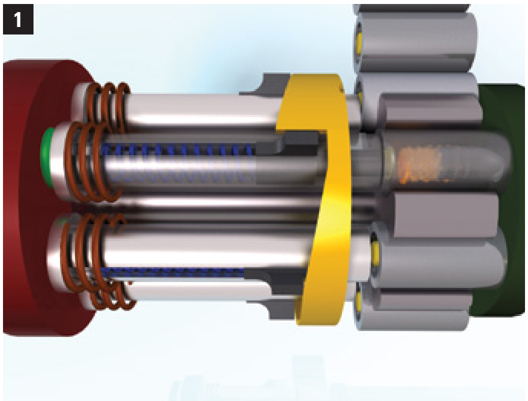

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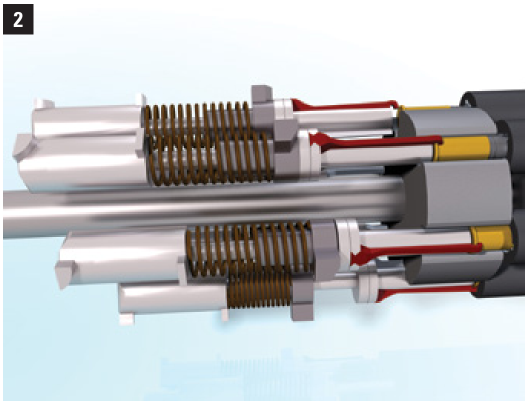

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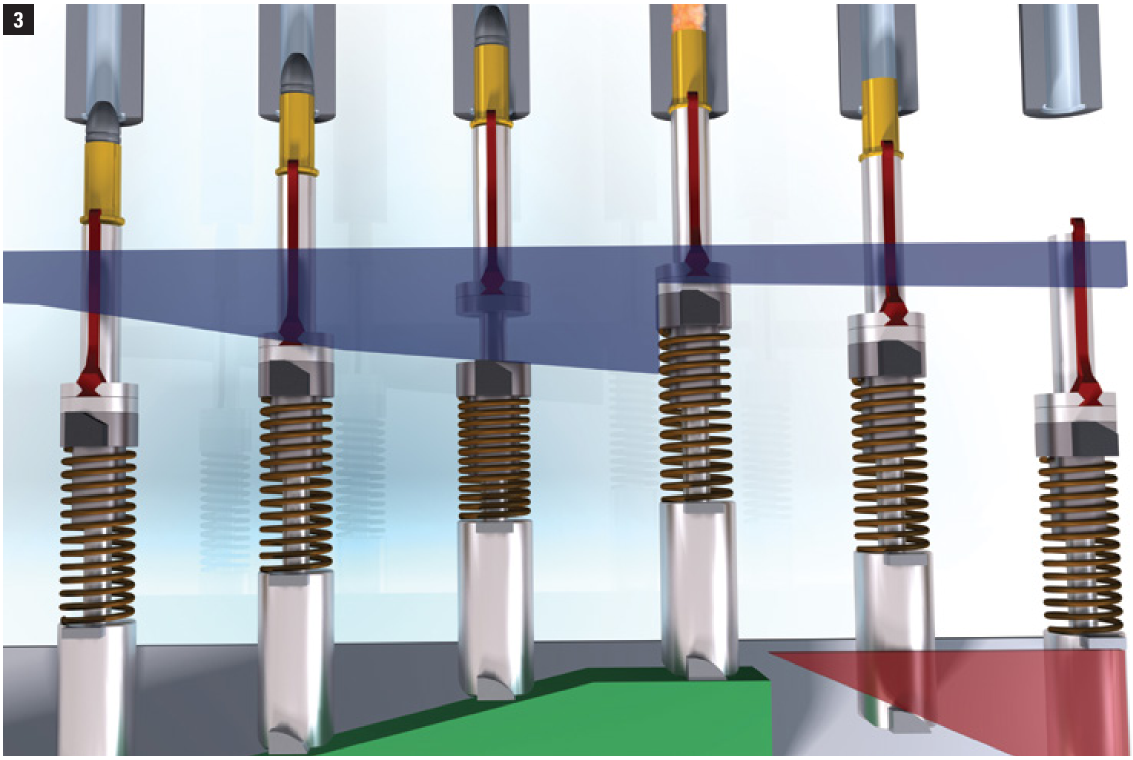
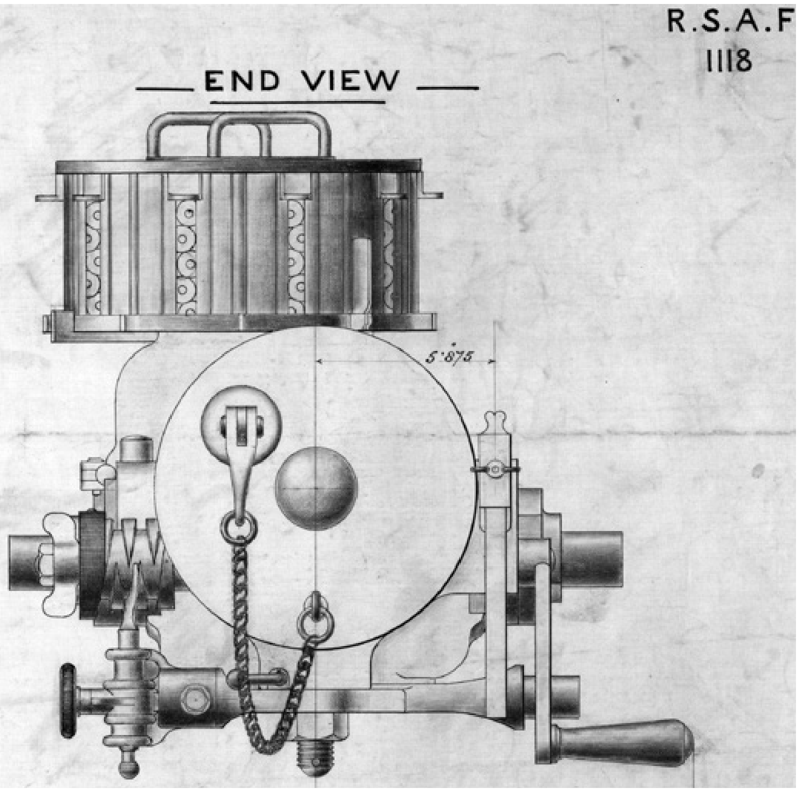


RIGHT
Detail of the cocking cam from UK patent no. 3,341. A knob is connected to a spindle (I) fitted with an eccentric disc or cam (c), riding in a slot in the arm of the cocking cam (N), which projects through an opening in the lock casing (C) and sits on the rear arm of the gun frame (B). By rotating the knob, the cam (N) is moved sideways, taking the lugs (a) of the hammers or strikers in the lock (H) out of engagement with it, so that the locks cannot be cocked and the firing mechanism is disabled. (Private collection)

BELOW
The front portion of the .65in lock, showing one side with the metal removed to create a reduced-diameter lower portion leaving, at the bottom of the picture, the rib to ride in the guide slot of the cartridge carrier. Also visible is the extractor fitted in a slot in the lock body and, at the upper right, the lug on the hammer which engages with the firing cam inside the lock casing. (Courtesy Trustees of Royal Armouries; author's own photograph reproduced by kind permission of the Royal Armouries, PR.328)

of the Gatling had been more fully appreciated. At this time also, in addition to considerations over calibre and ammunition Gatling licensed Sir W.G. Armstrong & Co. to make and vend Gatling guns in the United Kingdom of Great Britain, Ireland, the Channel Islands and the Isle of Man (Wahl & Toppel 1965: 41). This patent did not change the fundamental principles of the mechanical design but added some important refinements and changes in various features. These were: (1) the introduction of a moveable cocking cam; (2) a means of removing individual locks/bolts in case of malfunction; (3) the form of the locks; (4) more positive extractor engagement; (5) a means of automatically opening the feed box as soon as it was inserted into the gun. There was also a change from the use of bevel wheels to the use of worm-and-wheel to transfer hand-power to the mechanism.

The moveable cocking cam incorporated two features. It could simply be moved laterally so that it could be disengaged, allowing the gun to be demonstrated or used in drill training exercises without snapping the locks, which could obviously lead to damage. It could also be moved longitudinally to vary the degree to which the mainspring was compressed and therefore the force with which the hammer, or striker, struck the



A detail from RSAF drawing no. 1118 depicting the rear view of a .65in Gatling; it shows the drum in place, the lock-removal plug and the automatic traversing mechanism on the left of the crankshaft. It is worth noting that this drawing shows the .65in guns for British naval service with two sets of trunnions, an upper pair attached directly to the gun frame and a lower pair, partly obscured by the handle and the clamping device foe the traversing crutch, on the 'traversing plate', as it was termed in British service. A note on one of the drawings tells us that when mounted on a wheeled (i.e. naval landing) carriage, the trunnions on the traversing plate were used; when fitted onto a 'Nordenfelt' cone mounting on the deck of a ship, the traversing plate was removed and the trunnions on the gun frame were used. This also meant that when so mounted, the automatic traversing gear could not be used. (Courtesy Trustees of Royal Armouries; © Royal Armouries, RSAF 1118)

cartridge. While this is an obviously useful refinement, it has not been possible to determine how widely it may have been adopted although it was seemingly incorporated into the British-built guns of 1873 but without the projecting knob, judging from illustrations in various handbooks and the factory drawings. On the other hand, the ability to remove individual locks was of great importance; if one became non-functional through whatever cause, or a cartridge became jammed in a chamber, the gun would be rendered inoperable until repair could be undertaken. Gatling overcame this risk by providing a simple means of quickly removing a lock if necessary.

The changes in the form of the lock were twofold. First, the mainspring and hammer (striker/firing pin) were fully encased in the lock body, and secondly the lock body itself was in one piece and of a single diameter throughout with parts of the forward portion cut away as necessary. This allowed the lock to clear the trough in the cartridge carrier and feed the cartridge into the chamber; it also allowed the creation of an integral rib which rode in a slot in the cartridge carrier and prevented the lock from rotating on its own axis. The extractor was made so that when the cartridge was being fed, a slight play allowed the claw on the extractor to lift and ride over the cartridge rim. Conversely, when being withdrawn, the claw was securely pressed down onto the cartridge to prevent it from accidentally riding over the cartridge rim.

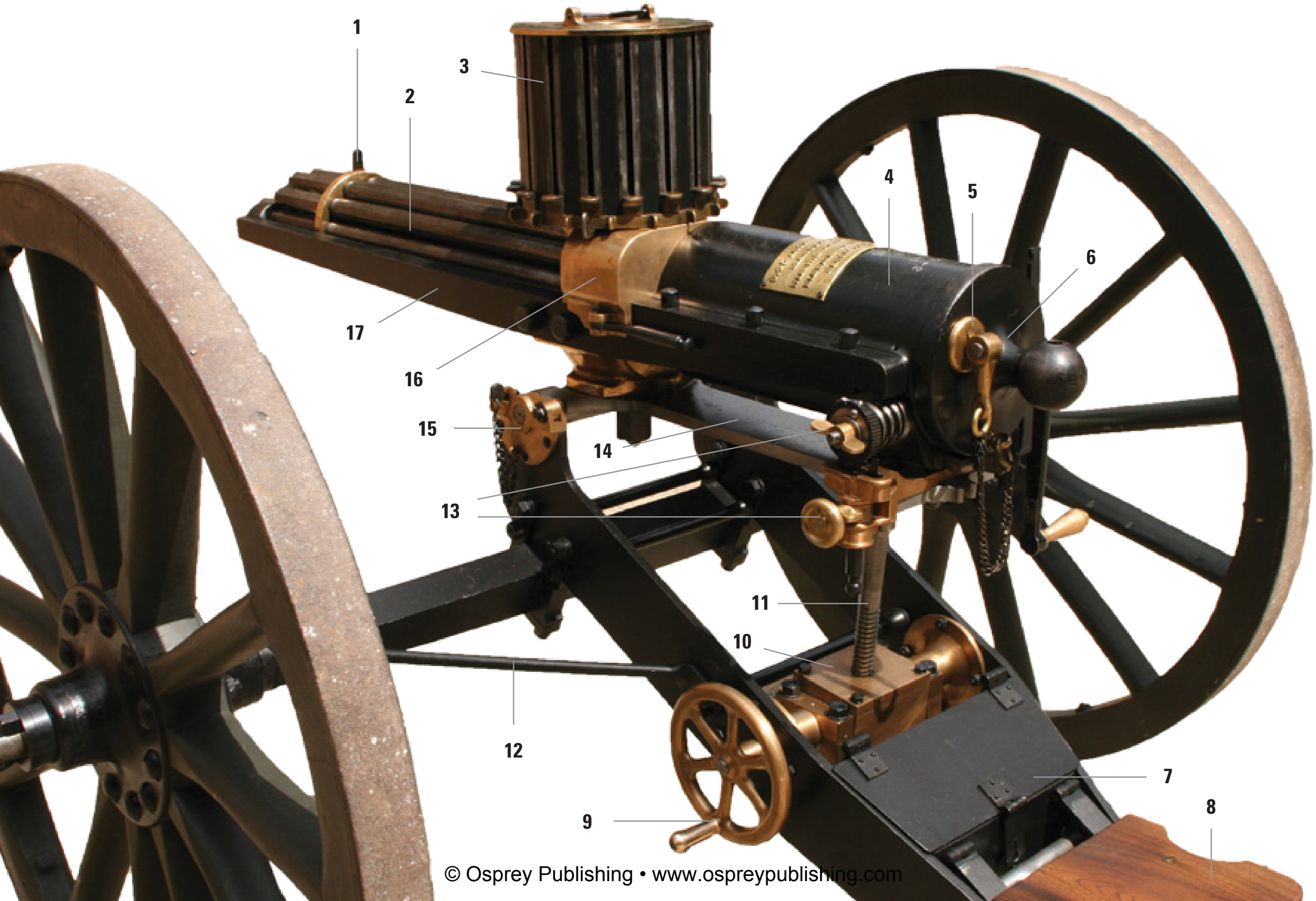
A major addition to the gun's attributes, an automatic traversing mechanism, received a British provisional patent in 1870, followed by full

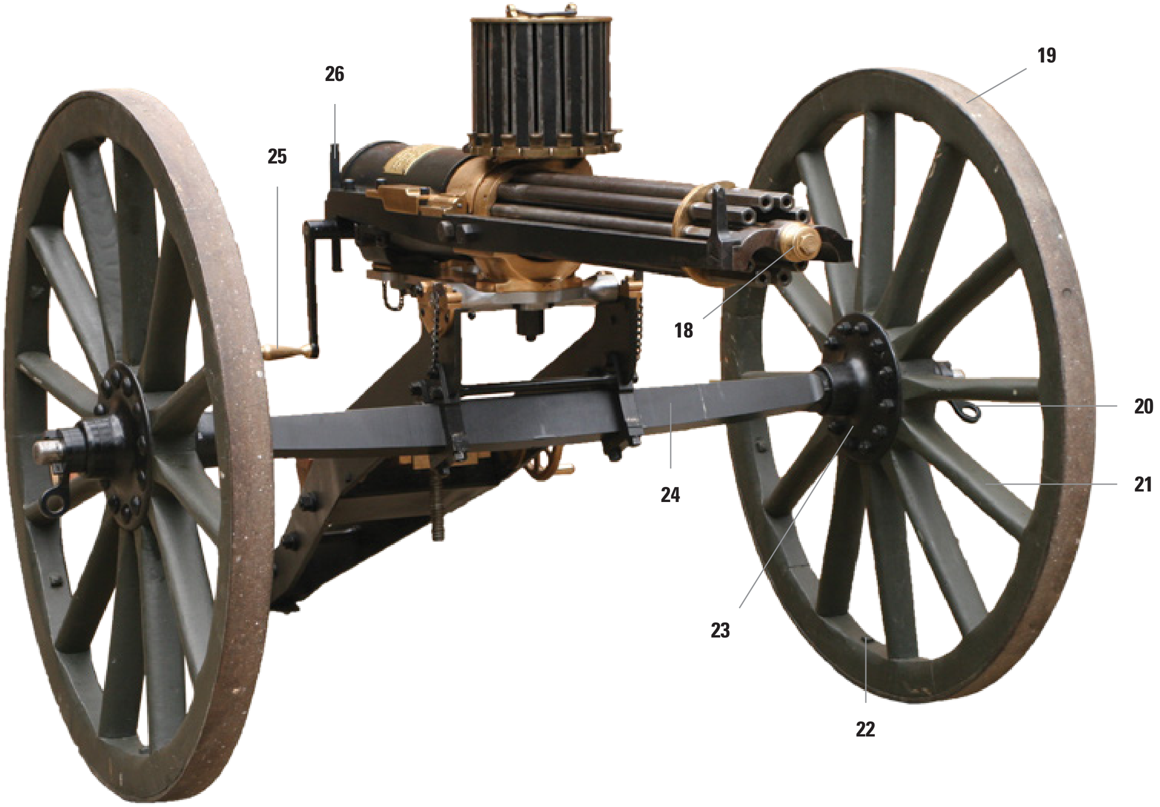
THE GATLING RESTORED

.45in Royal Artillery Gatling

A restored standard British Army .45in Gatling gun, serial Number 41 and dated 1874, on the Royal Artillery field carriage, as opposed to the Royal Navy wheeled carriage known as a 'landing carriage'. The field carriage differed in various ways, most noticeably in having a straight 'axletree' – the iron shaft to which the wheels were fitted – as opposed to the naval version with a dip in its centre, and being fitted with trunnion bearings. It is awaiting the fitting of axletree boxes for the Broadwell drum magazines. (Private collection)

1. Front sight
2. Barrel cluster
3. Broadwell drum magazine
4. Lock casing
5. Lock withdrawing plug
6. Cascable plate
7. Tool box
8. Folding trail seat
9. Elevating handwheel
10. Elevating gearbox
11. Elevating screw
12. Brace
13. Auto-traversing gear
14. Traversing plate with trunnions
15. Trunnion bearing and capsquare
16. Cartridge carrier cover and magazine platform
17. Gun frame
18. Cover for headspace adjusting screw
19. Iron tyre
20. Drag shoe washer
21. Spokes (12 per wheel)
22. Felloes (six per wheel)
23. 'Madras' pattern hubs
24. Axletree
25. Crank handle
26. Rear sight
27. Iron trail side plates
28. Trail handle
29. Trail eye
30. Traversing lever

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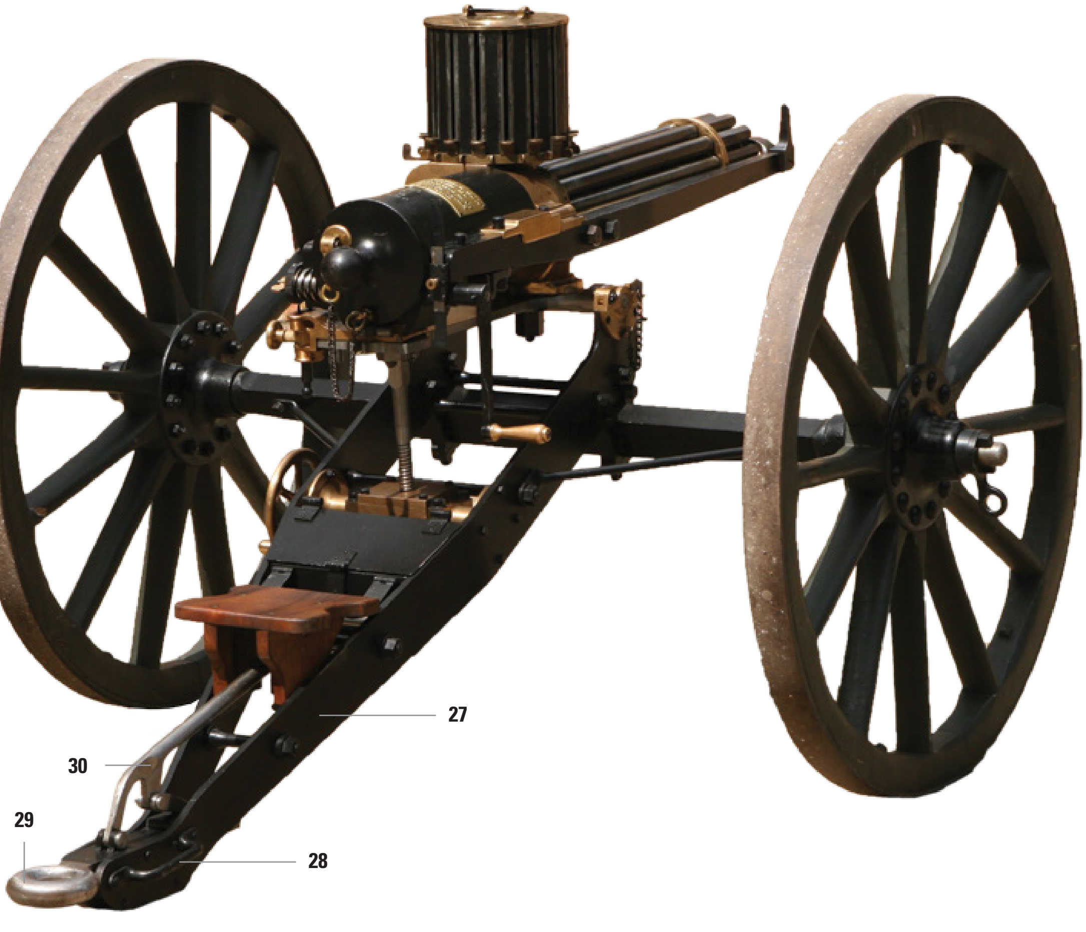
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FIG. 5

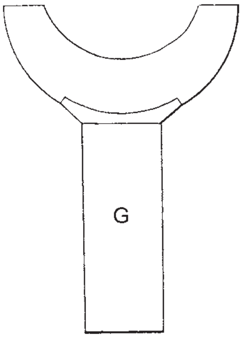
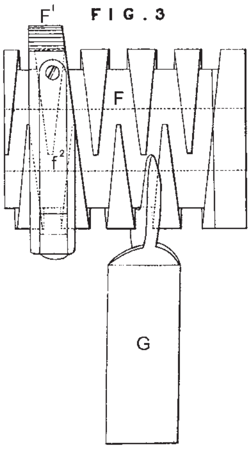


FIG. 3



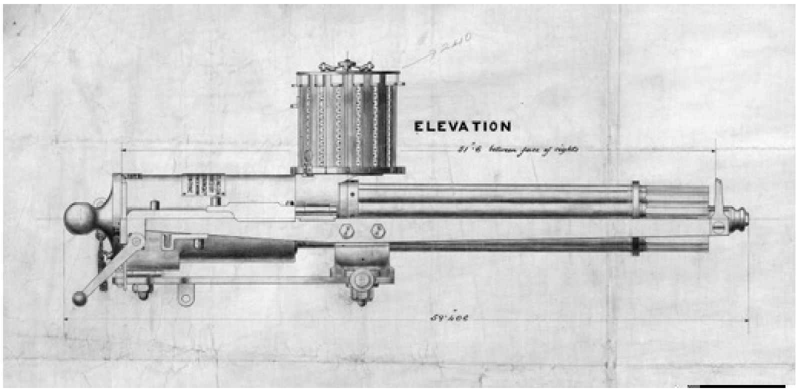
patent (no. 2,463) in 1871, followed by US patent no. 120,588, dated 7 November 1871. It was invented by George O. Kinne of Hartford, Connecticut. Since Colt's factory was in Hartford and was actively engaged in manufacturing the guns, it raises the question of whether Kinne was a Colt employee or an independent inventor. However, according to the US patent, Kinne is described as 'assignor to Colt's Patent Firearms Manufacturing Company'. It was an ingenious device, requiring the Gatling – or any similar gun – to be mounted on a separate mounting plate fitted to a pivot on the gun carriage.

Although actual construction details varied in practice, this allowed the gun to be moved laterally independently of the carriage. A refinement of this idea of Kinne's was covered in a UK patent (no. 380) by Lewis Broadwell, Gatling's agent in Vienna, in the same year and was certainly used on British-made guns. In this, the worm had a simple cone clutch device – the conical recesses in the ends of the worm are shown on this page – which was operated by a thumb nut threaded on the worm shaft, and is clearly shown on page 17. The alacrity with which this refinement was adopted is apparent from a commentary, published in The Times on 6 October 1873 and concerning the Third Anglo-Ashanti War of 1873–74:

> The gun is fitted with an arrangement by which a traversing motion may be given to the barrels while the firing continues. It is obvious that it would be absurd constantly to fire a Gatling gun in one direction. A few men immediately in front would be perforated, while those on the flanks would escape. But the traversing arrangement enables us to 'waterpot' the enemy with a leaden rain.

Around the same time, a Mr H. Bigg put forward a proposal to improve the lateral spreading of shots by 'hinging together three sets of Gatling barrels together at their bases without interfering with their rotary action, and then by a simple and easily regulated mechanism spreading laterally the two outer series of barrels while the centre remains stationary' (DAS §3227). It sounds excessively complicated and the President of the Committee to which this proposal was made recommended that no encouragement was to be given to Mr Bigg!

Broadwell's UK patent no. 380 also covered the use of a wrought-iron carriage in place of the traditional timber variety; this also incorporated a folding shield to protect the gunners while in action. The granting of a patent for this suggests it was the first carriage of its kind and within a few years, iron gun carriages had become more or less standard practice. By 1870, however, it would seem that the first guns for the British War Department were being manufactured by Armstrong's, who were additionally asked to submit a design for an iron field carriage. It would appear that this, after various small changes to reduce weight, was adopted and differed from Broadwell's design quite markedly in having plain iron-plate sides with round bolts acting as transoms (cross bracing or spacers) and which, almost beneath the breech of the gun, commenced tapering towards a very narrow trail piece.



OPPOSITE
Details of the automatic traversing mechanism from the drawing accompanying Kinne's UK patent no. 2,463 of 1870. Kinne used a worm having double threads, one left-hand and one right-hand, crossing over each other, with the end nearest the gun blanked off (F) and fitted to an extension of the crank-handle shaft, so that when the gun was operated by turning the crank, the worm also rotated. Fitted to the worm was a moveable collar (F^1) which acted as the second end-stop and could be moved and fixed at different positions on the worm. In the threads of this worm rode a Y-shaped fork, or 'crutch' (G) with tapering 'prongs', supported on a short shaft which pivoted in a socket on the gun carriage. As the work rotated during operation of the gun, the fork moved along the threads until it reached the end. Then, being pivoted, it was flipped so that the leading 'prong' ran into the opposite-handed thread and now followed this. As the gun was pivoted, this fork, in effect fixed to the carriage, in following the threads of the worm, caused the gun to traverse from side to side. The degree of traverse could be adjusted by repositioning the moveable collar (F^1). In the patent, the traversing mechanism was disconnected by dropping the fork out of engagement with the worm. (Private collection)

THIS PAGE
Three details from RSAF drawing no. 1119, showing a .45in gun manufactured by William Armstrong & Co. of Newcastle, for British service. The gun is dated 1873. (Courtesy Trustees of Royal Armouries; © Royal Armouries, RSAF 1119)

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Since 1935, the NRA Museum collection has become one of the world's finest museum collections dedicated to firearms. Now housed in three locations, the NRA Museums offer a glimpse into the firearms that built our nation, helped forge our freedom, and captured our imagination. The National Firearms Museum, located at the NRA Headquarters in Fairfax, Virginia, details and examines the nearly 700-year history of firearms with a special emphasis on firearms, freedom, and the American experience. The National Sporting Arms Museum, at the Bass Pro Shops in Springfield, Missouri, explores and exhibits the historical development of hunting arms in America from the earliest explorers to modern day, with a focus on hunting, conservation, and freedom. The Frank Brownell Museum of the Southwest, at the NRA Whittington Center in Raton, NM, is a jewel box museum with 200 guns that tells the history of the region from the earliest Native American inhabitants through early Spanish exploration, the Civil War, and the Old West.
For more information on the NRA Museums and hours, visit www.NRAmuseums.com.

Dedicated to the memory of H.J. (Herb) Woodend, custodian of the MOD Pattern Room until it closed. His untimely death deprived many firearms historians of a great friend and a wealth of knowledge and wisdom.

Acknowledgements

Very few factual books, especially those touching upon historical subjects, can be written without the help of others, past and present. The bibliography indicates the heavy reliance placed upon both earlier and more recent writers and commentators. However, to leave it at that would not do justice to those of the present day who have given invaluable help and support in various ways and for which they have my special thanks and gratitude: trustees and colleagues of Royal Armouries, notably Chris Streek, Stuart Ivinson and James Avison in the library, Alison Watson, Curatorial Manager, and Lisa Traynor, Assistant Curator, Firearms; Alex MacKenzie, Curator, and Richard Colton, Historian, Springfield Armory National Historic Site, Springfield, Massachusetts; Edward Hull; Joe Moran and Evan Sikes, Cowan's Auctions, Inc., Cincinnati, Ohio; J. Wesley Dillon of James D. Julia, Inc. (Auctions), Fairfield, Maine; Janice Murray, Director, and Shane Bartley, Commercial Manager, National Army Museum, London for taking time to supply images in the midst of reorganization; Joss Grandeau, Twin Falls, Idaho; David Alderson; Rob Brassington for supplying images from his excellent series of animated gun mechanisms; Tony Watts; and Steve Fjestad, Blue Book Publications, Inc., Minneapolis, Minnesota. Finally, any errors are my responsibility. As Thomas Jefferson said, 'He who knows nothing is closer to the truth than he whose mind is filled with falsehoods and errors.'

Editor's note

In this book linear, weight, and volume measurements are given in imperial units of measurement (yards, feet, inches, pounds, ounces, grains). The exception is weapons calibre, where metric is used in some cases, depending on the context. Where imperial units of measurement differ from US customary, the former are used in the text. The following data will help when converting between imperial and metric

1yd = 91.44cm
1ft = 30.48cm
1in = 2.54cm
1lb = 453.59kg
1oz = 28.35g
1 grain = 0.002oz
1 grain = 0.065g

measurements:

Front cover, above: The Model 1883 Gatling, unlike earlier models which relied on gravity ammunition-feed systems, was fitted with Accles' Positive Feed. This allowed extremes of elevation and depression to be handled easily using the simple 'pointer bar' and enabled rates of fire from 800 to 1,500 rounds per minute depending on whether the crank handle operated through gears as when fitted to the side, or fitted directly to the mainshaft at the rear. Such rates of fire required the gun's mechanism to be substantially strengthened.
(NRA Museums, NRAmuseums.com)
Front cover, below: A Naval Brigade Gatling in action in the streets of Alexandria. Only 'warning shots' over the heads of the rioters were fired to prevent a massacre, which showed great restraint on the part of the sailors. Illustrated London News,
29 July 1882, p. 101. (Private collection)
Title page: Prussian soldiers examine a captured Gatling gun. Every Saturday, 22 October 1870, p. 673. (Private collection)